A study of the aggregate United States labor supply function
by Jeanette Marie Oster

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Applied Economics
Montana State University


Abstract:
The study attempts to explain why individuals in the U.S., on average, are working one-third less in the market in 1978 than in 1890. An aggregate labor supply function is estimated using time series data from 1890-1978. The data used is calculated in terms of a “representative” individual. The measure of labor supply used is total hours worked in the economy divided by the population 14 and over. The principal explanatory variables are: the after-tax wage rate, private, non-labor income, an income term arising from the progressivity of taxes, government social welfare expenditures which include social insur-ance, public aid, housing, health and veterans’ benefits, and an income term stemming from investment in education. Increased time devoted to education was also considered in some variations of the labor supply model through the creation of an alternative dependent variable.

The supply function was estimated using four different model specifications. A two-stage least squares procedure was employed to account for endogeneity of the regressors. The four model specifications were estimated for both the entire sample period, 1890-1978., as well as for the post WWII period, 1948-1978, since it was in the latter period that most of the income terms increased dramatically relative to the complete sample period.

Estimates indicate a relatively inelastic, negatively sloped supply curve with the fourfold increase in the real wage offering the strongest explanation to the observed decline in hours worked in the last century. The results also indicate that a progressive tax structure provides an “additional” negative income effect that does not exist under a proportional tax system. This finding implies that a progressive tax structure creates a greater disincentive to work than a proportional tax structure. However, some estimated wage elasticities suggest that replacing a progressive tax system with a proportional tax system may lead to a further decrease in hours worked thus presenting a contradiction to recent supply-side theory.

Although the overall evidence for the effects of social welfare expenditures and the income effect from time spent in school is weaker, estimates for the time period 1947-1978, in particular, lend support to a priori theory that transfer problems are a disincentive to work and that individuals who invest more time in school work more hours in the market, on average. Evidence for the effects of changes in non-labor income on labor supply suggest that it is insignificant in explaining changes in hours worked.

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## ABSTRACT

The study attempts to explain why individuals in the U.S., on average, are working one-third less in the market in 1978 than in 1890. An aggregate labor supply function is estimated using time series data from 1890-1978. The data used is calculated in terms of a "representative" individual. The measure of labor supply used is total hours worked in the economy divided by the population 14 and over. The principal explanatory variables are: the after-tax wage rate, private, non-labor income, an income term arising from the progressivity of taxes, government social welfare expenditures which include social insurance, public aid, housing, health and veterans' benefits, and an income term stemming from investment in education. Increased time devoted to education was also considered in some variations of the labor supply model through the creation of an alternative dependent variable.

The supply function was estimated using four different model specifications. A two-stage least squares procedure was employed to account for endogeneity of the regressors. The four model specifications were estimated for both the entire sample period, 1890-1978, as well as for the post WWII period, 1948-1978, since it was in the latter period that most of the income terms increased dramatically relative to the complete sample period.

Estimates indicate a relatively inelastic, negatively sloped supply curve with the four-fold increase in the real wage offering the strongest explanation to the observed decline in hours worked in the last century. The results also indicate that a progressive tax structure provides an "additional" negative income effect that does not exist under a proportional tax system. This finding implies that a progressive tax structure creates a greater disincentive to work than a proportional tax structure. However, some estimated wage elasticities suggest that replacing a progressive tax system with a proportional tax system may lead to a further decrease in hours worked thus presenting a contradiction to recent supply-side theory.

Although the overall evidence for the effects of social welfare expenditures and the income effect from time spent in school is weaker, estimates for the time period 1947-1978, in particular, lend support to a priori theory that transfer problems are a disincentive to work and that individuals who invest more time in school work more hours in the market, on average. Evidence for the effects of changes in non-labor income on labor supply suggest that it is insignificant in explaining changes in hours worked.

# CHAPTER 1

# INTRODUCTION

From 1890 to 1978 average hours worked in the market per adult have declined by one third while the real, after tax wage has increased four-fold.[1] Such evidence seems to contradict the conventional notion of an upward sloping supply curve. This situation might be explained by the income effect from an increase in the wage. It is also possible that these statistics do not trace out a labor supply curve but rather such phenomena could be explained by shifts in supply curves over time. Because there have been significant changes in factors postulated to affect labor supply other than the wage, it is of interest to determine whether the decline in hours worked is attributable to rising wages, or, alternatively, whether it can be explained by increases in such factors as wealth, taxation, and social welfare expenditures, the effects of which serve to shift the supply curve.

As Mark Killingsworth notes in his book entitled *Labor Supply*, empirical studies of labor supply models are of interest for at least four reasons.[2] First, they may be used to test the predictions and implications of theoeretical models, for example, is the own-substitution effect of a wage increase on labor supply positive? Second, such studies may provide information on the signs and magnitudes of effects about which theoretical models make no *a priori* predictions, for example does the supply curve slope upward or downward? Third, such studies may shed light on a variety of important labor market developments, such as the large increase in labor force participation of women in the last 25 years.

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[1] The measure of hours worked in this study is total hours worked in the economy divided by the population 14 and over.

[2] See Killingsworth (1983, p. 67).

Finally, empirical studies are an important tool for evaluation of proposed government policies, for example, will tax cuts or transfer program increases affect work and if so, by how much?

## Statement of the Problem

Because taxation and most social welfare expenditures are thought to be disincentives to work, they stand out as potential explanations of the decline in hours worked over time. Also, as mentioned above, determining the signs and magnitudes of their impact on labor supply is important for public policy considerations. In recent years supply-side theory has postulated an increase in work in response to a cut in marginal tax rates. As of yet this hypothesis has not been empirically tested in the aggregate. Given the fact that between 1890 and 1978 the average marginal tax rate has risen from essentially zero to 41%,[3] verification of the supply-side argument seems to have great import. Similarly, *a priori* theory suggests that the nature of most transfer programs (i.e., a lump-sum grant and implicit marginal tax rate) serves to discourage work. Because social welfare expenditures have grown from zero to 10% of GNP in the last one hundred years, determining their impact on hours worked is also an important public policy issue.

Another factor that must be considered in explaining changes in hours worked is education. In the last century both educational enrollment and median years of education have greatly increased. This has resulted in more time being devoted to school on average, a factor which can help to explain the decline in hours worked in the market. On the other hand, economic theory suggests that increases in time spent in school (i.e., a greater investment in education) should result in less time devoted to leisure and, in turn, more time

[3] The average marginal tax rate cited is one computed for this study and is defined in Chapter 3.

spent working.[4] These two effects, then, should be accounted for when explaining changes in hours worked over time.

Finally, in the last one hundred years the level of wealth in the American economy has increased. For some individuals changes in wealth derive from non-labor sources. Because economic theory postulates that increases in non-labor income, *ceretus paribus*, serve to decrease hours worked, it may be that the increase in wealth in the last century has contributed to the decline in hours worked in the market.

This study will estimate the aggregate U.S. labor supply function in a time series context. While there have been many cross-sectional studies performed which have tested for the effects of changes in such factors as non-labor income, taxes, transfers, and education, relatively few time series studies have been done measuring aggregate effects. In fact, no time series study on labor supply has used marginal tax rates in the computation of the net wage, explicitly accounted for transfer payments, considered the dual effects of changes in education, or considered the additional income effect from progressive taxation, all of which will be incorporated into the proposed model of this study. Moreover, as far as it is known, no study has simultaneously accounted for these factors in estimating a labor supply function.

The purpose of this study is basically two-fold. First, the study attempts to determine whether the general finding from previous time series studies of an inelastic aggregate labor supply curve will hold when the effects of changes in non-labor income, taxation, social welfare expenditures, and education are simultaneously considered. Second, in estimating the effects of taxation and social welfare expenditures in particular on labor supply, the study will hopefully shed light on public policy issues such as the recent supply-side argument and whether transfer programs have strong work disincentives.

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[4] See Hirschleifer (1980, pp. 472-473).

The following chapter is a discussion of the theoretical framework within which the labor supply function is estimated. A standard neo-classical model of labor supply is first reviewed. Separate sections then consider the effects of changes in non-labor income, taxation, government social welfare expenditures and other factors influencing aggregate labor supply. Chapter 3 is a review of the existing literature on labor supply. Special emphasis is given to studies done testing for the effects of transfer programs as well as the time series studies. Chapter 4 provides a discussion of the data used in calculation of the regressors in the labor supply function estimated. Chapter 5 reviews the results of estimation and Chapter 6 provides a summary and conclusion for the study.

# CHAPTER 2

## THE STANDARD LABOR SUPPLY MODEL

The theoretical framework of labor supply is the classical model of consumer choice applied to the demand of the leisure.[1] Using the wage rate as the price of leisure, the analysis proceeds as it would with any commodity in an individual's choice set. It is the assessment of how different factors affect the individual's budget constraint and, in turn, his demand for leisure that labor supply is determined.

More formally, an individual will maximize utility,

$$u = u(x,l)$$

subject to a budget constraint,

$$y^{o} + wh - x = 0$$

with the added constraint,

$$h = \bar{l} - l$$

where $\bar{l}$ is total time available to the individual, $l$ is leisure time, $h$ is hours of work, $y^{o}$ is non-labor income, $w$ is the real wage, and $x$ is commodity consumption. Substituting the second constraint into the first and defining full income as,[2]

$$m = y^{o} + w\bar{l}$$

a single constraint follows,

$$m - wl - x = 0$$

which is the budget constraint now used in maximizing utility.

[1] This paradigm was first introduced by Lionel Robbins in an article published in 1930 and has been refined by labor economists subsequently, notably Becker.

[2] The notion of full income is from Becker (1965).

From the Lagrangian function,

$$L(x,l) = u(x,l) + \lambda(m - wl - x)$$

the leisure and commodity demand functions are derived.

$$\hat{l} = l(w,m)$$

$$\hat{x} = x(w,m)$$

Referring to Figure 1, the standard leisure demand/labor supply model is displayed diagrammatically. If leisure is a normal good then,

$$\frac{\partial l(w,m)}{\partial w} = l_1 < 0$$

and,

$$\frac{\partial l(w,m)}{\partial m} = l_2 > 0$$

The labor supply function is the complement of the leisure demand function:

$$h(w,m) = \bar{l} - \hat{l}\,(w,m)$$

and thus,

$$\frac{\partial h(w,m)}{\partial w} = h_1 > 0$$

$$\frac{\partial h(w,m)}{\partial m} = h_2 < 0$$

The income effect from a change in non-labor income is also displayed with the standard model of leisure demand.

$$\frac{dl}{dy^o} = l_2 \frac{\partial m}{\partial y^o} = l_2$$

Thus, since $l_2$ is positive, a change in non-labor income results in a change in leisure demand in the same direction. Graphically, a change in non-labor income is displayed in Figure 2 by making a parallel shift in the budget constraint, resulting in the individual

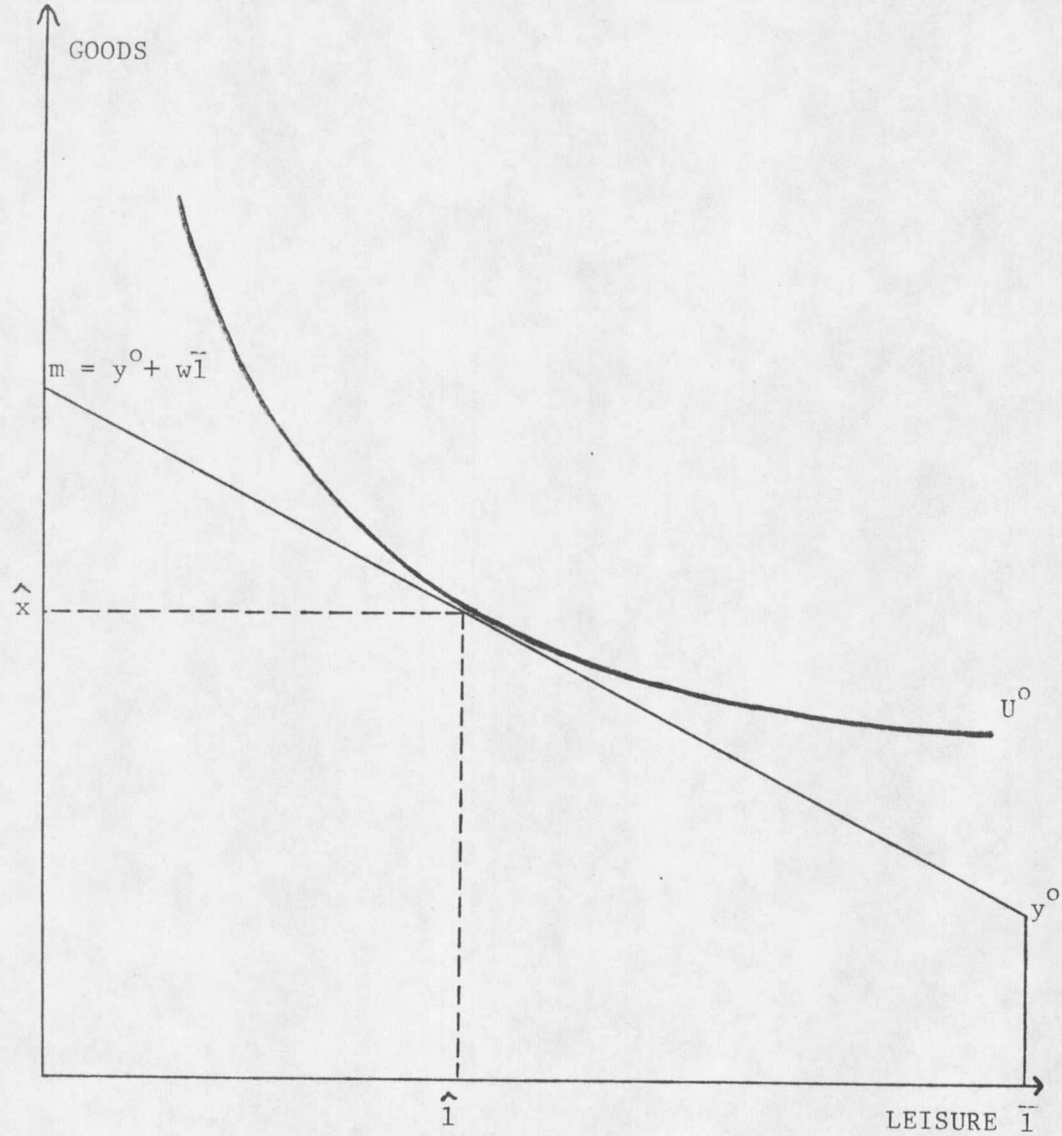


Figure 1. Standard leisure demand/labor supply model.

moving to a different indifference curve. Since leisure is assumed to be a normal good, an increase in income leads to an increase in leisure consumed, and vice versa.

Perhaps the most fundamental question in analyzing labor supply is how does an increase/decrease in the wage affect the amount of hours an individual works? Again, in the demand for leisure framework this is the same as asking what will be the change in leisure consumed given a change in its price? The answer is derived through the Slutsky equation which decomposes the effect of a change in the wage into substitution and income effects.

Given an indirect utility function,

$$v(w,m) = u(x(w,m), l(w,m))$$

compensated (utility constant) leisure demand is

$$l = l^*(w,v)$$

and the effect of a change in the wage, utility held constant is

$$\frac{\partial l^*(w,v)}{\partial w} = l_1^* < 0$$

This known as the substitution effect of a wage change on leisure demand.

The Slutsky decomposition of the effect of a wage change, full income held constant is,

$$l_1 = l_1^* - l \cdot (l_2)$$

with $l_1$, $l_1^*$, $l_2$ defined as before. Since full income is

$$m = y^o + w\bar{l},$$

a change in the wage also increases full income which tends to increase leisure demand. The total effect of a change in the wage then, is

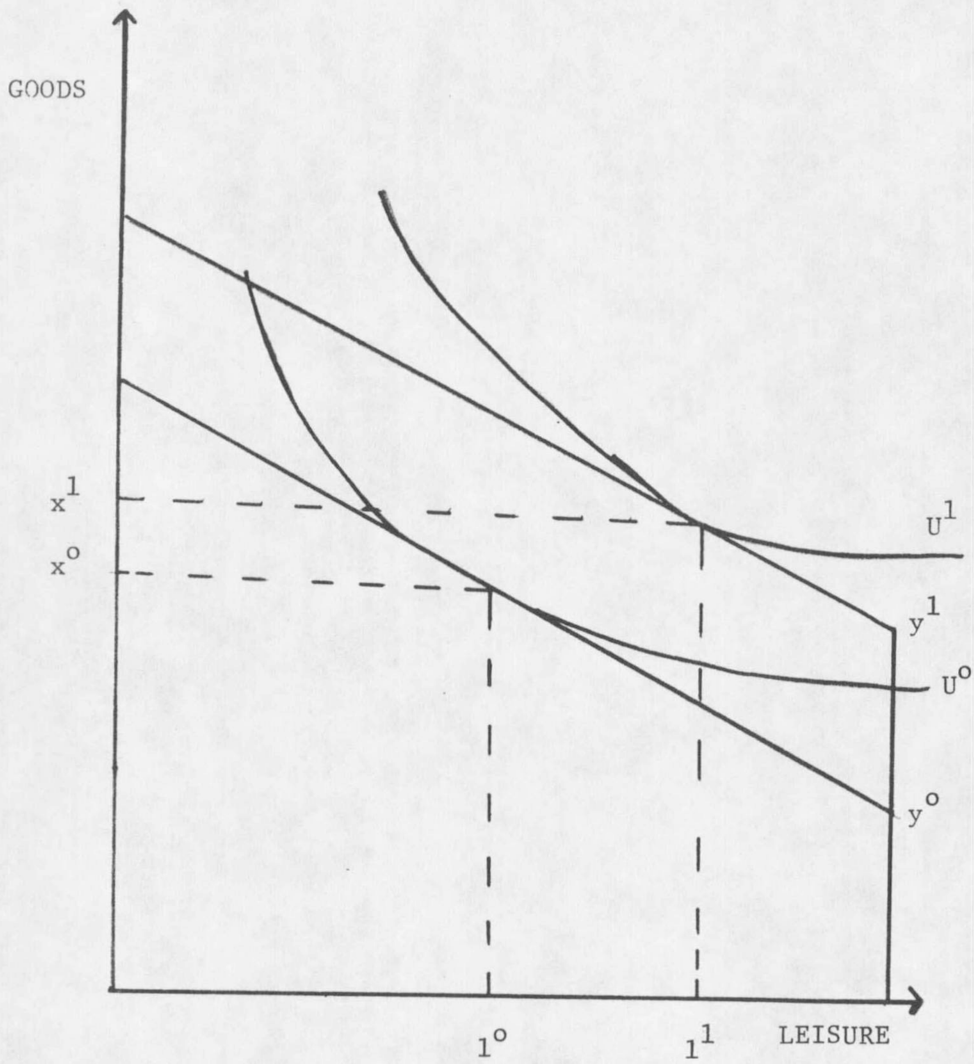


Figure 2. The effect of a change in non-labor income on leisure consumed.

$$\frac{dl(w,m)}{dw} = \frac{\partial l}{\partial w} + \frac{\partial l}{\partial m}\frac{\partial l}{\partial w}$$

$$= l_1 + l_2 \bar{l}$$

$$= l_1^* + (\bar{l} - l)l_2$$

$$= l_1^* + h \cdot (l_2)$$

Since $l_1^*$ is less than zero and $l_2$ is greater than zero, the effect of a change in the wage on the demand for leisure is, *a priori*, indeterminate.

Referring to Figure 3, the income and substitution effects arising from a change in the wage can be seen. An increase in the wage, for example, rotates the budget constraint clockwise about the point ($\bar{l}$,$y^0$). A substitution effect comes from the price of leisure increasing as a consequence of a rise in the wage rate, holding utility constant (A to B). An income effect results from having more real income due to a higher wage (B to C). The amount and direction by which the individual's hours of work are changed depends on which effect dominates, which in turn, is determined by the shape of the indifference curve. In this diagram an increase in the wage decreases hours worked (increases leisure demand, $l^0$ to $l^2$).

Just as in consumer theory, a change in the price of leisure (the wage) results in a movement along the demand curve while a change in non-labor income serves to shift the entire curve. Alternatively, changes in work hours can result from either a movement along the supply schedule due to a change in the wage or a shift in the supply curve as a consequence of a change in non-labor income. Considering these two factors alone then, a decline in hours worked can be explained by either the income effect from a rise in the wage or from shifts in the supply curve over time due to increases in non-labor income, or both.

It should be noted that, in theory, non-labor income is an exogenous value of income with which an individual is endowed. However, in practice, such a value of non-labor

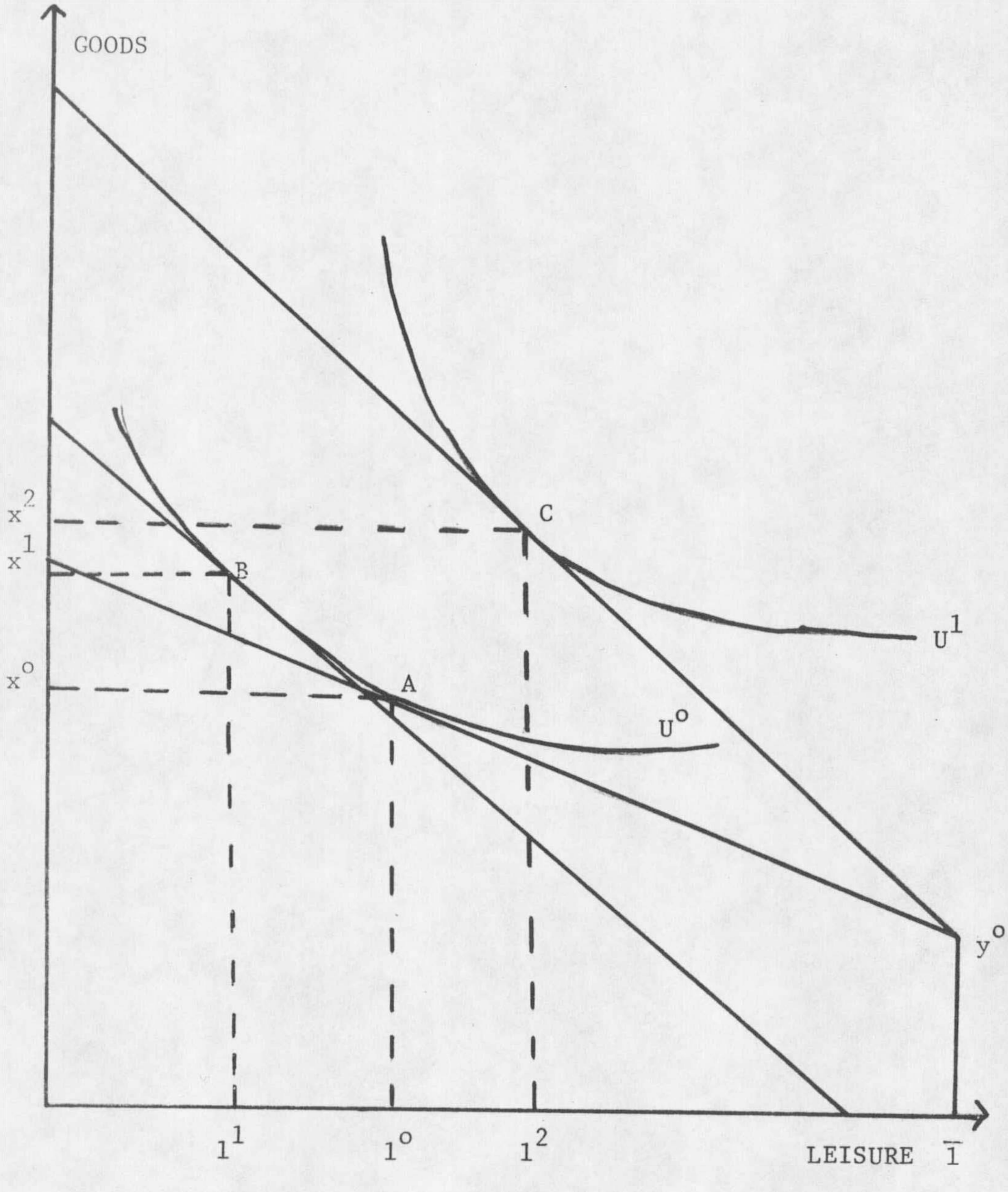


Figure 3. Income and substitution effects from a change in the wage.

income is difficult to measure. Most measures of non-labor income are derived from some value of current wealth which in turn is determined, at least in part, from past labor supply. If some measure of current wealth is used to represent an individual's non-labor income the consequence may be that the estimates of the effect of changes in non-labor income on labor supply are biased. In particular, the greater is an individual's lifetime labor supply, the greater is his/her wealth likely to be. Thus, non-labor income may appear to have a positive effect on labor supply, rather than the negative effect implied by theory.

There are factors other than the wage and non-labor income that influence the amount of leisure an individual will consume or, alternatively, the number of hours he/she will work. Thus the standard model must be augmented. As will be discussed subsequently, not all variables influencing people's decision to work can be easily characterized through the classical leisure demand model, particularly in the aggregate.

## Taxation

One of the things that makes modeling labor supply decisions within the demand for leisure framework difficult is the nature of the tax system. A proportional tax alters the wage by the amount (1–t) when t is the tax rate. If all taxes were proportional, analyzing their effects would be a fairly straightforward process. However, many taxes imposed, both directly and indirectly, are characterized by progressivity, which results in non-linearities in the budget constraint.

Referring to Figure 4, a proportional tax on labor income changes the budget constraint from

$$y^o + wh - x = 0$$

to

$$y^o + (1-t)wh - x = 0$$

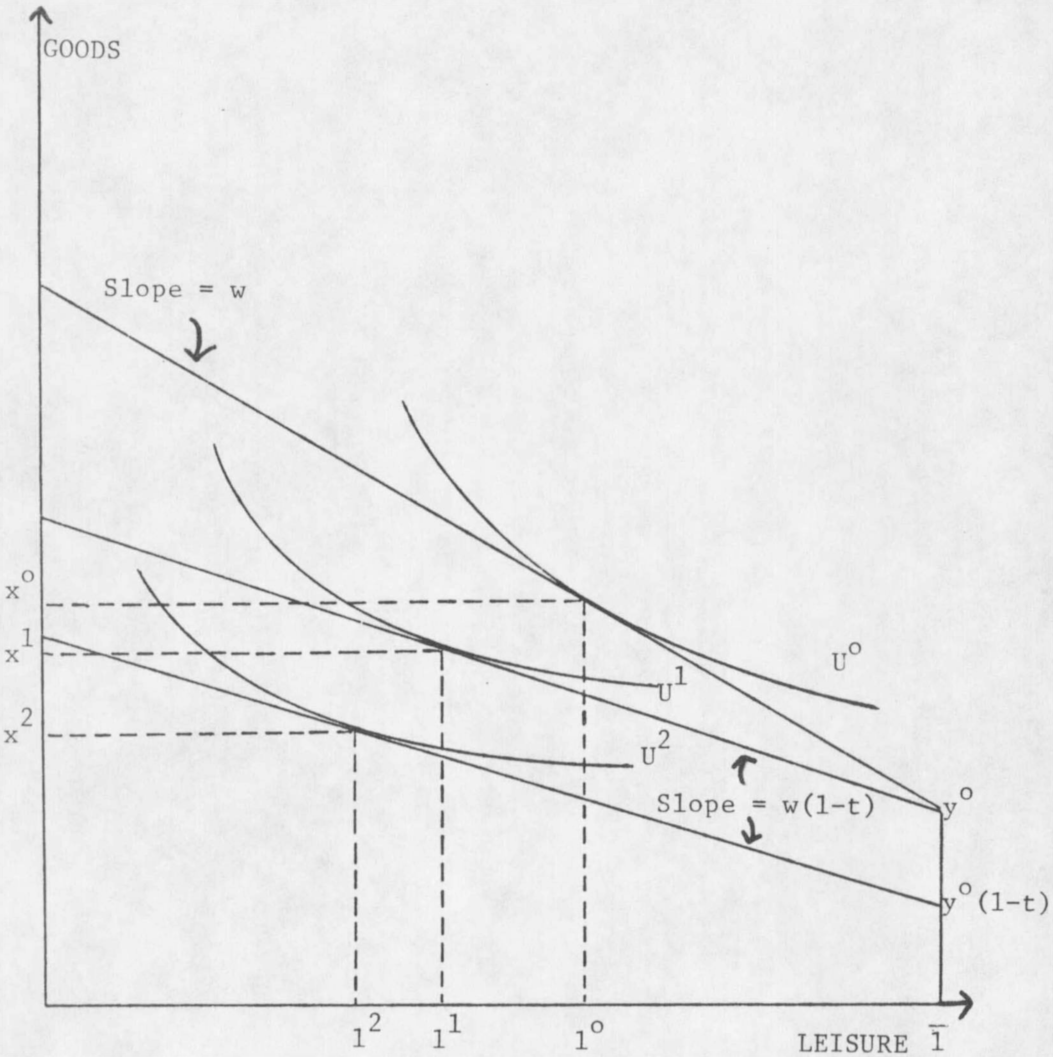


Figure 4. The effect of a proportional tax on labor supply.

which is the same as a reduction in the wage. Depending on preferences then, hours worked may be higher or lower when the net wage is (1-t)w than when it is just w. The ambiguous effect of the Slutsky equation arises again. *A priori* theory cannot determine whether the compensated substitution effect, which lowers hours worked, or the income effect, which raises them, will dominate.

It should be noted that a tax rate effect on labor supply can also arise from a tax on non-labor income. The effect of imposing a tax on non-labor income is to reduce its value and thus, in light of the demand for leisure paradigm, reduce leisure demand (increase hours worked). Graphically this effect is displayed in Figure 4 by the budget constraint extending from the lower y (non-labor income) term. When there is both a tax on the wage and non-labor income, the effect remains *a priori* indeterminant due to the ambiguity of the Slutsky equation. In this diagram taxation serves to decrease leisure consumed (increase labor supply).

If all taxes were proportional then, assessing the effects of taxation on labor supply would be a fairly straightforward procedure, similar to analyzing the effects of changes in the wage. Unfortunately, not all taxes are proportional. In particular, two kinds of taxes affecting labor supply, the income tax and the implicit tax arising from various government transfer programs, are progressive in nature. When a tax is progressive difficulties arise in using the standard leisure demand model to analyze the effects of taxation on labor supply.

A progressive tax thwarts the conventional procedure of analyzing the effect of a tax through a change in the wage as it causes the net wage to be dependent on hours worked and thus results in a non-linear budget constraint. For example, the solid line concave to the origin in Figure 5 displays the budget constraint for a tax system in which the marginal tax rate continually increases with income. The problem, from an analytic standpoint, is

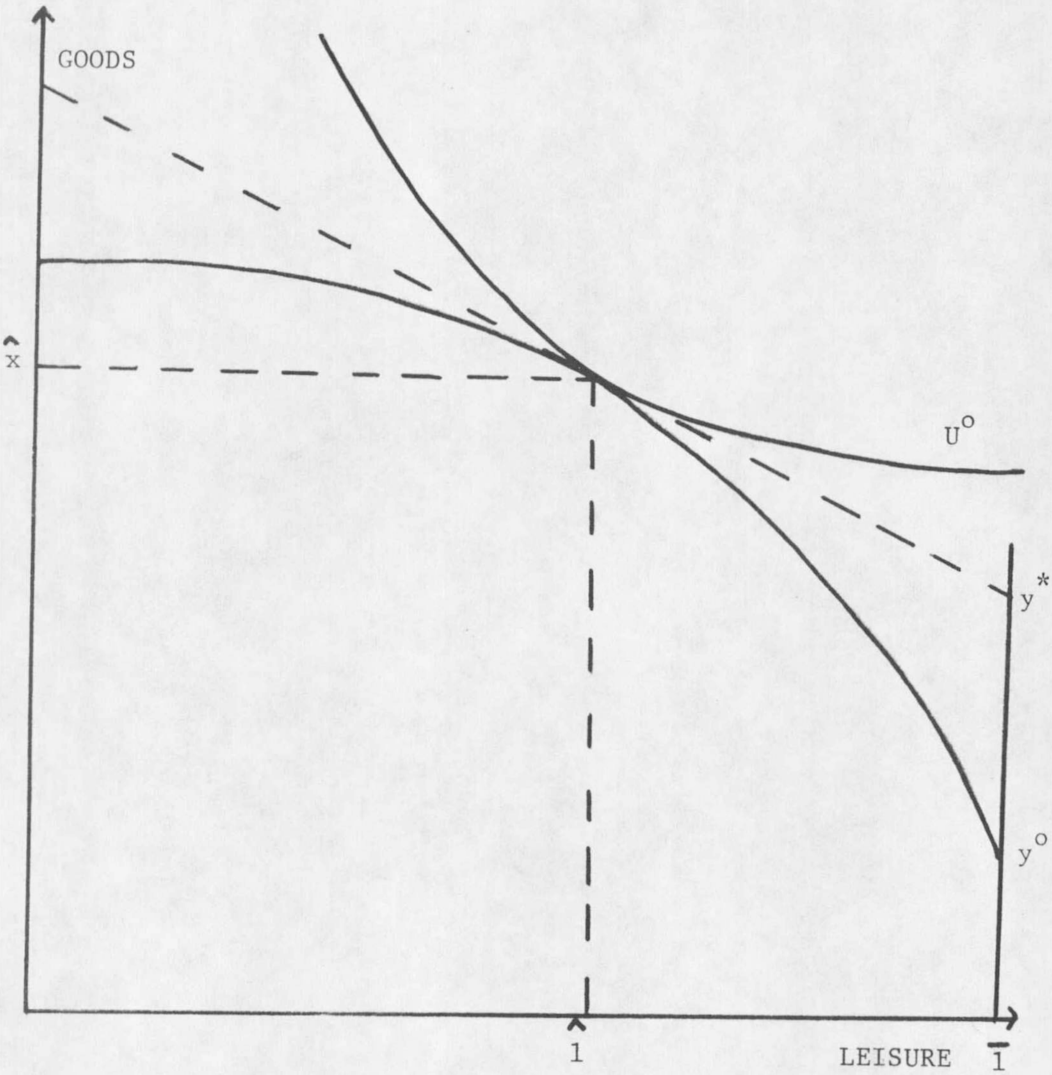


Figure 5. Non-linear budget constraint arising from marginal tax rates.

that the standard income and substitution effects from the Slutsky equation are difficult to measure due to the non-linearity of the budget constraint.

To overcome the difficulties of measuring the effects of a progressive tax on labor supply, a method was devised by Hall (1973) and Hausman (1978, 1981). The technique involves linearizing the budget constraint at the point of tangency between the individual's indifference curve and the budget segment depicting the marginal tax rate he faces. Referring to Figure 5, the linear budget constraint allows changes in marginal tax rates to be analyzed in the same way as a change in a proportional tax. Thus, comparable income and substitution effects can be derived. In addition, an "extra" income term is created through linearizing the budget constraint, this being the difference between the y intercept arising from extending the constraint ($y^*$) and the individual's initial endowment of non-labor income. Hausman refers to the imputed value of non-labor income ($y^*$) as virtual income. Thus the effects of changes in marginal tax rates could be viewed in light of both a change in the wage and a change in virtual income.

Given the concept of virtual income, it is postulated that an individual will respond to a change in marginal tax rates "as if" he were experiencing a change in non-labor income, as well as the wage. Thus, when non-labor (virtual) income increases via an increase in marginal tax rates, hours worked decline. If taxes were not accounted for in this manner but rather treated as if they were proportional, the additional income effect stemming from the imputed addition to non-labor income would not be measured. This would result in an understatement of the effects of taxes given that they are in fact progressive.

As a consequence of creating a new income term the budget constraint changes to

$$y^* + (1-t)wh - x = 0 ,$$

where $y^* = y^o + y^p$, $y^o$ being private non-labor income, $y^p$ being the imputed addition to non-labor income from linearizing the budget constraint, and t is the marginal tax rate faced by the individual.

To compute $y^p$, one can consider the budget constraint arising from the average tax rate that would exist at the point of tangency between the indifference curve and the budget segment corresponding to the marginal tax rate faced. Referring to Figure 6, it can be seen that,

$$\hat{x} = y^o + w\cdot(1\text{–AVTR})\hat{h}\,,\ \text{AVTR} = \text{average tax rate}$$

$$\hat{x} = y^* + w\cdot(1\text{–MTR})\hat{h}\,,\ \text{MTR} = \text{marginal tax rate}$$

thus,

$$y^* = y^o + w\hat{h}\cdot(\text{MTR–AVTR})$$

and

$$y^p = y^* - y^o = w\hat{h}\cdot(\text{MTR–AVTR})$$

Thus $y^p$ reflects the additional effect on hours worked from progressive taxation versus proportional taxation.

## Transfer Programs

Government transfer programs such as Social Security, Unemployment Insurance, Public Aid, and AFDC (Aid to Families with Dependent Children) are other factors that necessitate expanding the standard labor supply model. Because many transfer programs are thought to have significant work disincentives, economists have become greatly concerned with their potential effects on labor supply due to the dramatic increases in these expenditures in the last thirty years.

Many government transfer programs are similar in terms of how they affect an individual's labor/leisure choice set. In many programs a lump-sum grant (benefit) is received which can be thought of as an addition to non-labor income. In addition, the amount of the benefit one receives is contingent on the amount of income from hours worked in the market (i.e., the more hours worked the smaller the benefit received). This situation gives

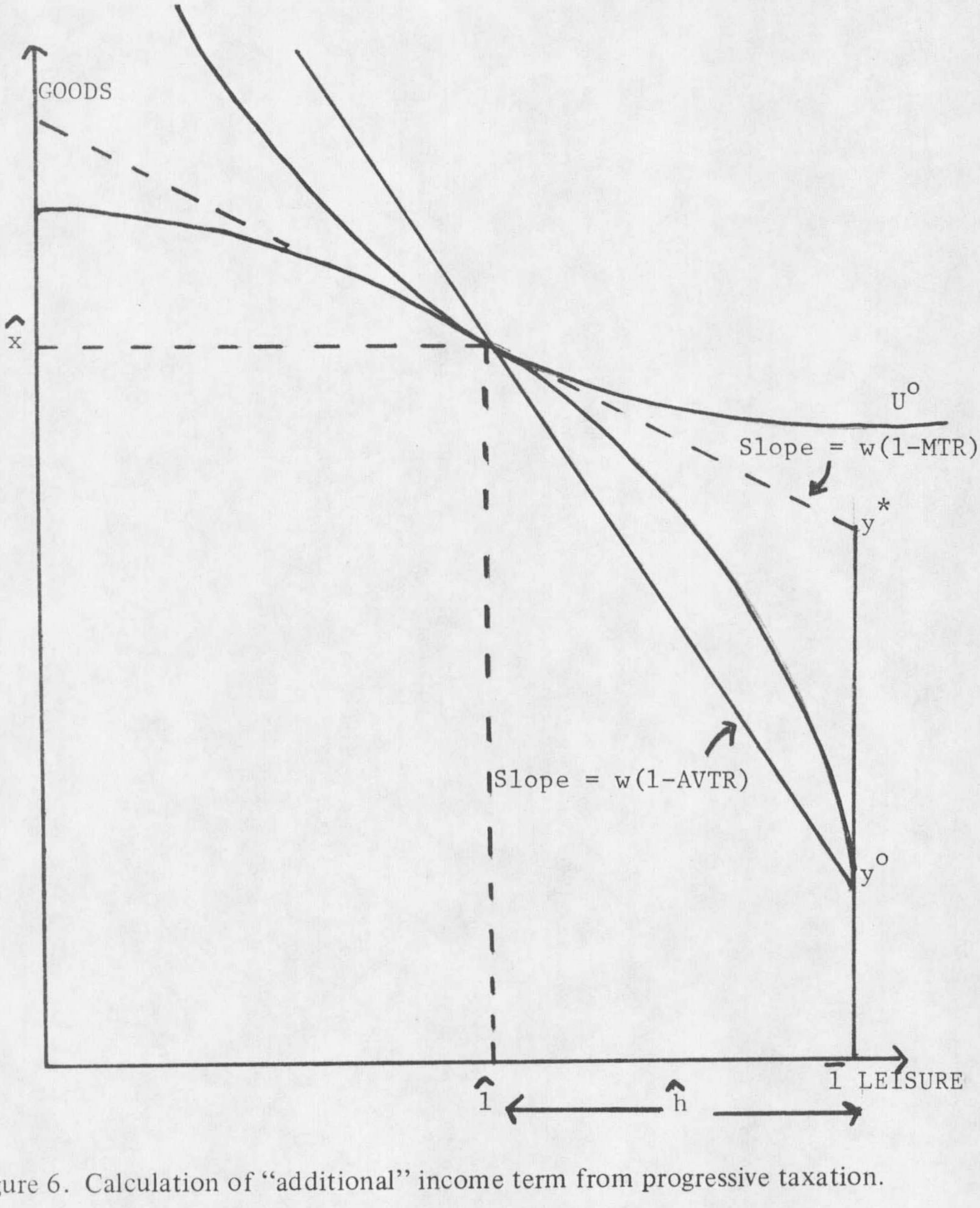


Figure 6. Calculation of "additional" income term from progressive taxation.

rise to an implicit tax on labor income. Thus there is both an income effect and a tax rate effect to be considered when assessing the influence of these programs on labor supply.

Using a hypothetical government transfer program as a model for the majority of income conditioned transfers, the nature of the programs and their effects on labor supply can be seen graphically. The program is the Negative Income Tax (NIT).

Figure 7 shows how income transfers can affect the amount a person works through the income and substitution effects. The budget constraint is now

$$y^{o} + g^{o} + (1-t)wh - x = 0,$$

where $g^{o}$ is "guarantee" level (i.e., lump-sum grant to an individual), and t is the implicit tax rate arising from the conditions imposed for receipt of a transfer.

The income effect of a transfer is the increase in leisure from $l^0$ to $l^1$ (A to B). This results from giving the recipient enough income to attain indifference curve $U^1$ without affecting the net wage received. Since leisure is assumed to be a normal good, an increase in real income results in increased consumption of leisure. This, of course, translates into a reduction in work effort of the individual.

For those programs where the amount of the benefit is contingent upon the number of hours worked, a substitution effect arises through the reduction of the net wage of recipients as a consequence of the implicit tax imposed. When benefits are reduced as income from work rises an individual receiving a transfer essentially faces marginal tax rates just as he would under taxation on work income. For instance, if a person were able to receive $4 an hour from working but would lose $2 an hour in benefits for every hour he worked, his real wage is $2 an hour. For every dollar he receives from working he is indirectly taxed 50% by the loss of benefits. By changing the real wage, tax rates serve to change the slope of the budget contstraint and it is this change that gives rise to a substitution effect.

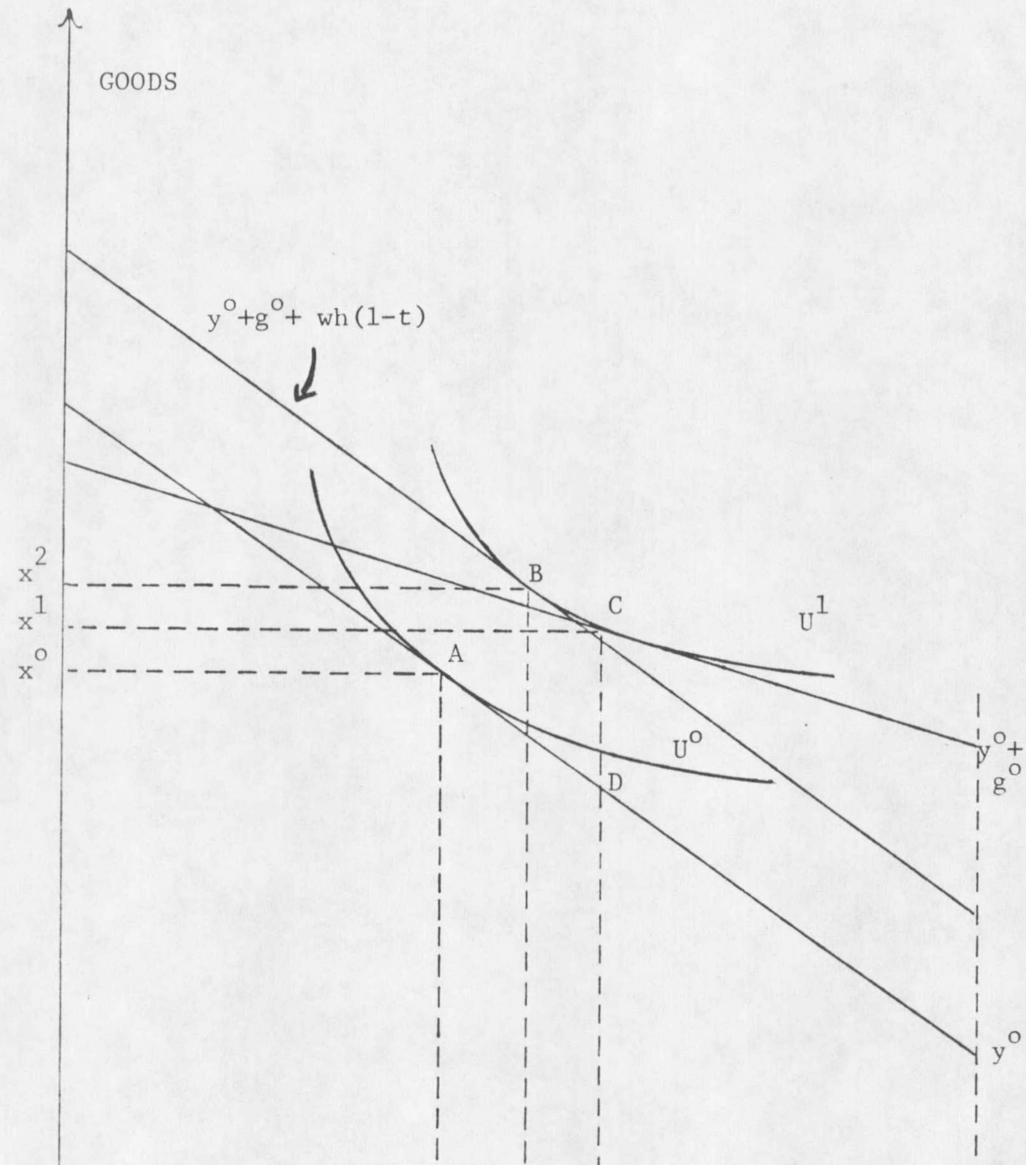


Figure 7. Effect of NIT program on leisure demand/labor supply.

In Figure 7, the increase in leisure from $l^1$ to $l^2$ depicts the substitution effect (B to C). It is the change along an indifference curve due to a change in the relative price of leisure. Lowering the real wage lowers the price of leisure. A priori, one would expect an increase in the consumption of leisure. When more leisure is consumed labor supply is reduced. Because an individual is necessarily on a higher indifference curve when participating in a transfer program, the income and substitution effects of income transfer programs reinforce one another serving to unambiguously reduce work effort.

The analysis for the effects on labor supply of an NIT program is transferable to other income transfer programs. AFDC is identical to the NIT program in the way it affects an individual's budget constraint. Benefits received are dependent on how much income from work one earns and are increased/decreased accordingly. Thus both the income and substitution effects operate just as modeled above. The Food Stamp program, a transfer that accounts for a significant portion of Public Aid, also can be viewed according to the NIT model since the value of coupons one receives is based upon the level of labor income.

The effect of the Unemployment Insurance program differs somewhat from the NIT model in that you cannot receive an unemployment benefit and be working at the same time. However, during the period of unemployment a comparable income and substitution effect operate as under the NIT program. The benefit serves as the cash transfer while the replacement ratio (average weekly benefit/average weekly earnings) gives rise to a substitution effect by implicitly altering the net earnings from work. This, in turn, means a higher indirect tax on work income. The combination of the benefit and tax rate effect then, serve to increase the amount of leisure consumed.

The Social Security program functions similarly to the above programs except when recipients are paid Social Security benefits automatically at age 70. Prior to this age any income received from work is subject to an earnings test resulting in the same kind of implicit tax on earnings as mentioned above, that is, benefits are reduced when labor income rises.[3] Beyond age 70 only the income effect of the benefit is relevant to an analysis of labor supply.

The effects of such social welfare expenditures as Education, Health and Housing are not as easily modeled since the conditions upon which payment is based are broader than the above four programs. In general, however, there is an income effect from these transfers since they are essentially income from a non-labor source and this effect must be considered in regard to labor supply.

Finally, a difficulty arises in testing for the effects of these transfers on labor supply, especially in a time series context. Referring to Figure 8, this diagram could be viewed as a representation of the effects of transfer programs when aggregated, that is, $g^O$ would be the total of the lump-sum grants of the various programs and the budget constraint $y^O + g^O + (1-t)wh - x = 0$ would reflect the aggregate tax rate effect of the programs.

Two problems exist, however, when measuring the effects of transfer programs in the aggregate. First, there are no data for the implicit tax rate of the programs over the entire period considered, 1890-1978. Second, even if one were to measure only the income effect of the programs (i.e., the parallel shift of the budget constraint), what would be used as a measure of the lump-sum grants from the programs is the distance AB, the amount actually transferred, since this is all that can be observed. As Figure 8 shows, however, if this value is used, the result is an understatement of the overall effect of the programs on labor supply of the amount $l^2 - l^1$. Without measuring the full amount that would be granted in the absence of work, as well as the implicit tax arising from working and receiving benefits, an accurate estimate of the actual effect of transfer programs on labor supply cannot be made. In practice a regression will attempt to provide the best fit to the actual data, i.e.,

[3] Working past age 65 raises the benefit level when an individual does retire. This mitigates the impact of the earnings test. See Blinder, Gordon, and Wise (1981) and Barkhauser and Tulner (1981).

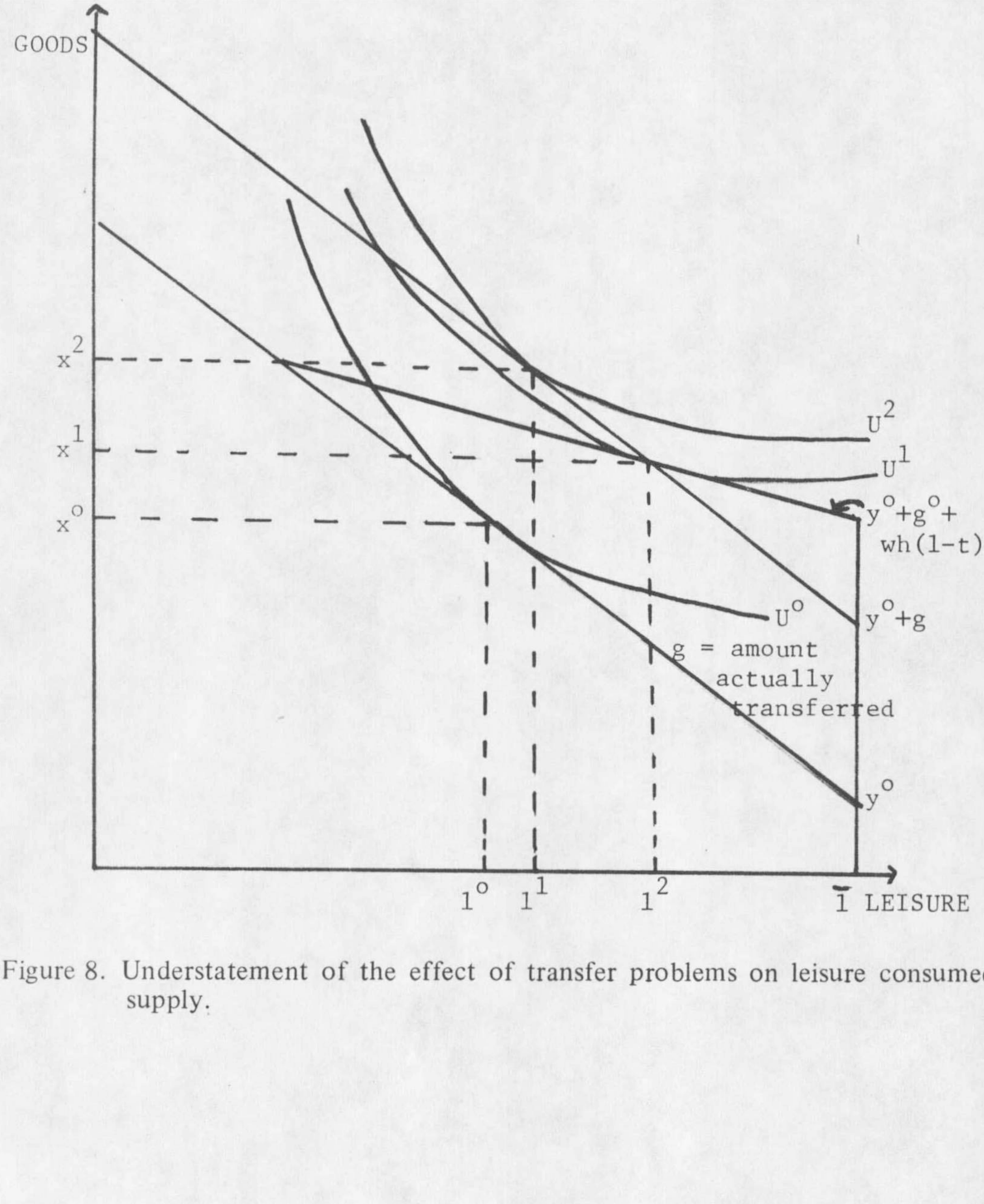


Figure 8. Understatement of the effect of transfer problems on leisure consumed/labor supply.

$l_2$, g. Consequently the estimated coefficient on g, the amount actually transferred, will tend to overstate the negative effect on labor supply of a lump sum grant.

## Education

Another factor that must be considered in explaining changes in hours worked is education. From 1890 to 1978 the average number of days spent in school by secondary and high school students has increased from 86 to 164 and median years of education have risen from 7.9 to 12.4.[4] The conventional definition of labor supply does not include time spent in school as work. If, however, as economic theory postulates, education serves as an investment in human capital, it seems reasonable to consider time devoted to school as work. When education is counted as work, changes in the number of hours spent in school can help to explain the decline in hours worked in the market.

To account for the increased time devoted to school work, one must consider both the change in enrollment and the change in days spent in school over time. A measure of school work can then be derived by multiplying the number of individuals enrolled by the number of days spent in school and then by the number of hours spent in school on an average day. This measurement could be used either as an explanatory variable in a regression equation or be added directly to hours worked in the market to create a new dependent variable ("EFFORT"). In the latter case, EFFORT would be regressed on the variables just as hours worked is.

The use of a variable like EFFORT implies that individuals who are enrolled in school would otherwise be working. Thus, in light of human capital theory, school is another form of work. More specifically, accounting for hours spent in school suggests that when the average number of days spent in school was 86, for example, individuals of the age 14

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[4] See Historical Statistics, Colonial Times to 1970 (1975, pp. 369, 391, cols. 424, 429, 432, 618) and extensions in Statistical Abstract, 1984 (1984, pp. 318, 1037).

and over (10 and over for the period 1890-1910) were engaged in some kind of work that at the time was measured as hours worked in the market. If this assumption is correct, and if one regards time spent in school as work, the change in educational factors can account for some part of the decline in hours worked in the market.

There is, however, an additional effect that arises from an increase in educational attainment that serves to offset the direct, negative impact this change has on hours worked in the market. Because education is thought to have a positive effect on the wage, the more education an individual obtains, the higher the opportunity cost of leisure. In theory, this would result in the individual working more (i.e., consuming less leisure) than he would without investment in education.

To account for education in this way, it is again necessary to modify the standard demand for leisure framework. Total time is now allocated between leisure, market work and school. Thus,

$$\overline{1} = 1 + h + s$$

where $s$ is hours spent in school. As mentioned above, it is postulated that education, $s$, affects the wage one receives from market work, that is the market wage is some positive function of time spent in school.

$$w = w(\hat{s})$$

Thus education involves an opportunity cost of foregone leisure (or market work) which is the amount $w(\hat{s})\cdot\hat{s}$. In addition, there may be direct costs of schooling such as tuition, books, etc., which can be represented by $c(\hat{s})$.

Given this consideration of schooling the budget constraint becomes,

$$y^{o} + w(\hat{s})\cdot h - c(\hat{s}) - x = 0$$

where $c(s)$ is the direct costs of schooling. Full income, $m$, is now defined as

$$m = y^{o} + w(\hat{s})\cdot(\overline{1}-\hat{s}) - c(\hat{s}).$$

Referring to Figure 9, the role of schooling in leisure demand (labor supply) can be shown. The diagram displays the hypothesis that an increase in education affects an individual's demand for leisure "as if" his non-labor income had been reduced. Over a lifetime, if the wage and non-labor income are held constant, an increase in schooling results in a reduction in leisure consumed, if leisure is a normal good.

Leisure demand remains a function of the wage and full income

$$l = l(w,m)$$

But not taking into consideration schooling

$$\frac{\partial l}{\partial s} = -l_2 \cdot w \Bigg|_{w = \text{constant}} , \quad \frac{\partial c}{\partial s} = 0 \text{ by assumption .}$$

As Figure 9 shows, an increase in the level of education (i.e., $s_1, s_2, \ldots$), holding the wage and non-labor income constant serves to decrease "as if" non-labor income (i.e., $\hat{y}_1, \hat{y}_2, \ldots$) and thus the individual will consume less leisure than he would if he did not devote time to schooling.

Moreover, when considering a change in the wage, it can be seen that education provides an added negative income effect that did not appear in the model without education. Thus, given

$$m = y^O + w \cdot (\overline{l} - \hat{s}) - c(\hat{s})$$

a change in the wage results in,

$$\frac{\partial l}{\partial w} = l_1 + l_2 \cdot (\overline{l} - \hat{s})$$

$$= l_1^* + l_2 \cdot (\overline{l} - \hat{s} - l)$$

$$l_1^* + l_2 \cdot h$$

($l_1, l_2, l_1^*$ defined as before). This reflects the fact that, given s, an increase in the wage has an "extra" negative income effect, $-(l_2 \cdot \hat{s})$, because the opportunity cost of schooling

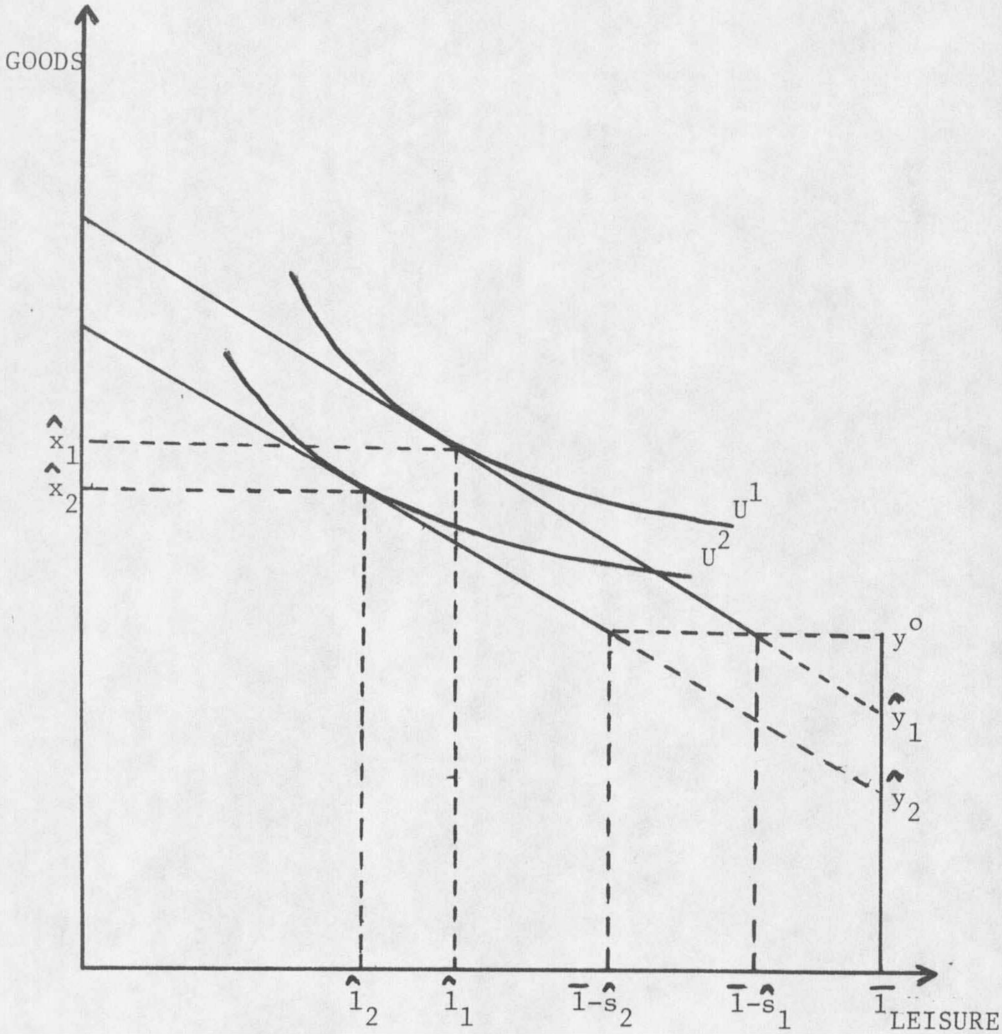


Figure 9. The effect of different levels of schooling on leisure demand, given the wage and non-labor income.

is higher. Equivalently, the positive income effect of a higher wage applies only to hours actually worked, h, rather than to $(\bar{1}-1)$.

Figure 10 shows how an increase in the wage, given some level of schooling, decreases an individual's "as if" non-labor income as a consequence of increasing the opportunity cost of leisure. In the diagram "as if" non-labor income (i.e., $\hat{y}_1$, $\hat{y}_2$) is reduced by the amount $[w(\hat{s})\cdot\hat{s} + c(\hat{s})]$, where again, $w(\hat{s})\cdot\hat{s}$ is the opportunity cost of attending school and $c(\hat{s})$ is the direct cost of schooling. Given some level of schooling then, an increase in the wage increases the opportunity cost of leisure resulting in the individual consuming less leisure, or alternatively, working more.

This model suggests, then, that individuals with higher levels of education, *ceteris paribus*, behave as if their non-labor income is reduced. Assuming that leisure is a normal good, a lower non-labor income results in less leisure consumed and thus individuals with more schooling are expected to consume less leisure. Conventional specifications of labor supply are incorrect because the income term $[-w(\hat{s})\cdot s - c(\hat{s})]$ is excluded. To account for the positive impact increases in education have on hours worked, the term $[-w(\hat{s})\cdot s - c(\hat{s})]$ can be calculated and added to the labor supply model as an income term.

It should be noted that for many individuals much of the direct costs of schooling, $c(\hat{s})$, are paid for by government expenditures. This situation results in the income term $[-w(\hat{s})\cdot\hat{s} - c(\hat{s})]$ being larger for the individual than it would be if the individual incurred the direct costs of schooling. Thus, in the presence of government expenditures on education, the "cost" of schooling is not as high and this would tend to mitigate the positive impact on hours worked from this income term. While the level of government expenditures may influence the amount of time individuals spend in school, since this study will directly account for changes in time devoted to school, accounting for educational expenditures by the government would be redundant as they do not affect labor supply given the level of schooling.

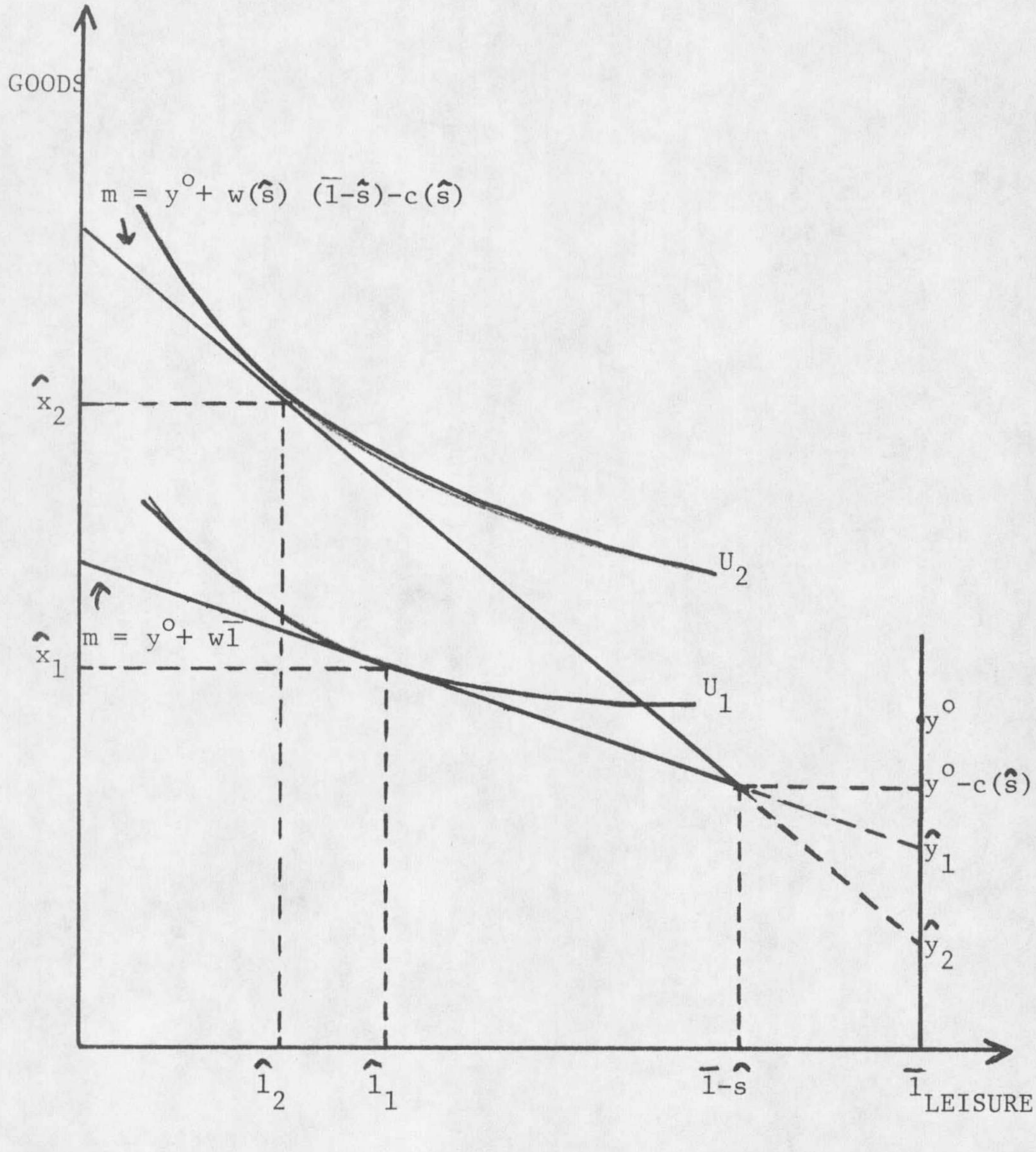


Figure 10. The effect of a change in the wage on leisure demand, given some level of schooling.

## Aggregate Labor Supply

The demand for leisure framework is a good way to view how individuals are affected by different factors in their labor supply decisions. There are a few other considerations, however, that cannot be analyzed within this paradigm yet are influential in determining labor supply in the aggregate.

First, in estimating a labor supply function, it is important to recognize the distinction between the hours people would supply to the market (the supply curve) and the amount that is actually supplied to the market (the intersection of the demand and supply curves). Because hours actually supplied to the market are all that can be observed it is these observations which estimation of an aggregate labor supply function is based on. However, just observing average hours worked in a year over time and making a correlation with factors thought to influence people's decision to work could be spurious due to the fact that the change in actual hours worked could be a consequence of changes in the demand side of the labor market. Figure 11 shows that changes in hours worked over time may stem from either a shift in the demand curve for labor or the supply curve.

As suggested earlier, the observed decline in hours worked in the last one hundred years could be explained by shifts in the aggregate supply curve over time. In particular, these shifts could be the result of the income effects from increases in non-labor income and increases in government expenditures on social welfare expenditures. On the other hand, a decline in hours worked might be explained by a decreased demand for labor. In a time series context, the most obvious and significant factor affecting the demand for labor is technology. Most likely, the decline in hours worked over time can be explained by some combination of these shifts. Such a simultaneity problem can be controlled for in estimating the labor supply function.

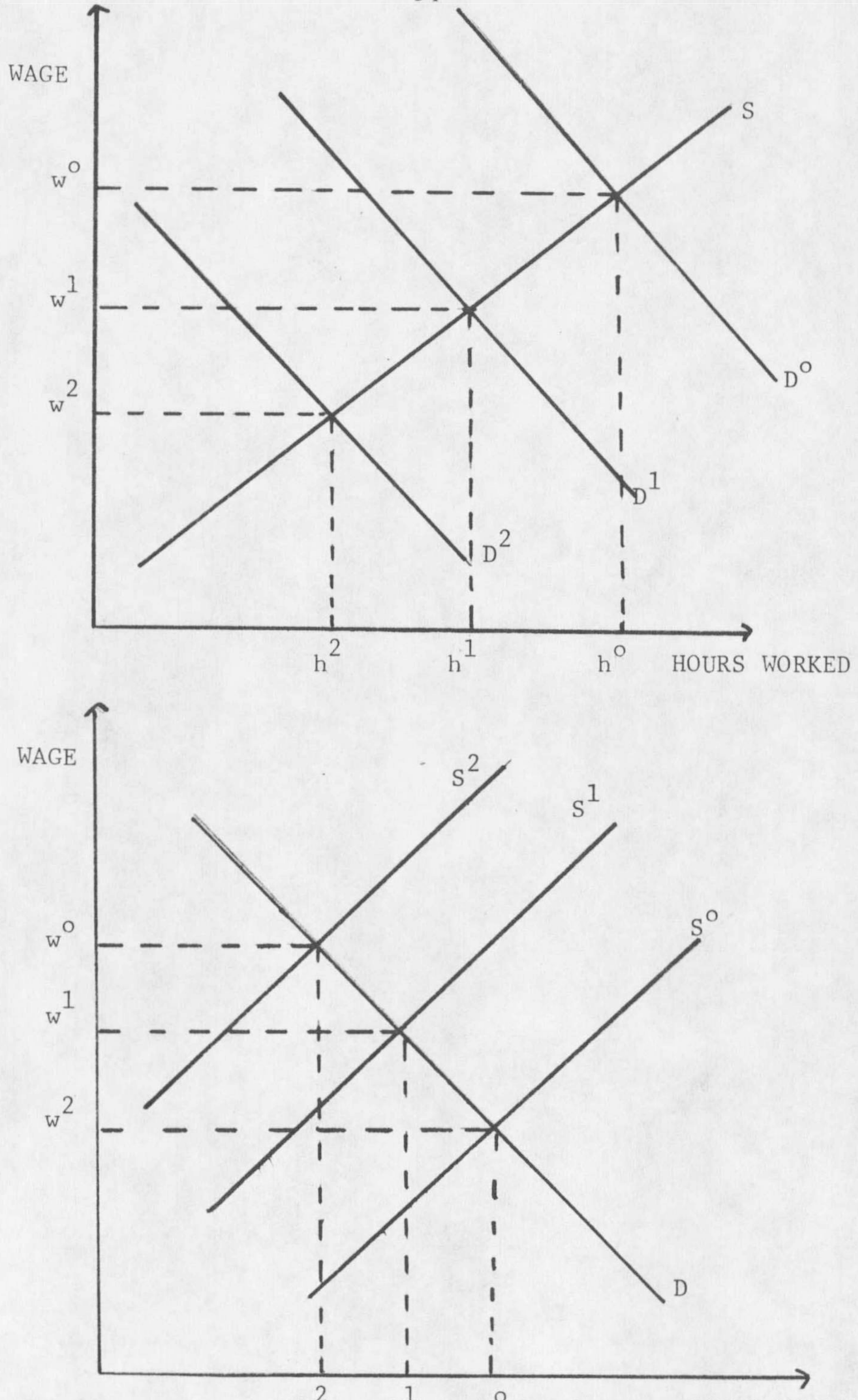


Figure 11. Effect on changes in demand and supply on leisure/labor supply.

An important consideration in a time series study of labor supply is the fact that the average lifetime of Americans has increased in the last one hundred years. In 1900 the average American was expected to live 47 years, in 1970, the expected lifetime was 70.5 years.[5] Longer lifetimes make their appearance in demographic statistics by increasing the proportion of the population 65 and over. Referring to Table 1, this figure has risen from .06 in 1890 to .14 in 1975.

Table 1. Population Density by Age.[6]

| | 15-24 | 25-54 | 55-64 | 65 and Over |
|---|---|---|---|---|
| 1890 | .31 (14-25) | .55 | .08 | .06 |
| 1975 | .27 | .47 | .12 | .14 |

As life cycle theories suggest, a longer lifetime does not necessarily mean extended productivity and in reality the majority of individuals 65 and over are fully retired from market work. A problem that arises is that the measure of average hours per year, aggregate hours divided by population, declines over time because the population is not growing at a uniform rate, particularly since most individuals over 65 are not adding to the measure of hours worked. This, too, can be controlled for in estimating an aggregate supply function.

It is also important to recognize an analysis presented by Gwartney and Stroup in a paper entitled "Labor Supply and Tax Rates: A Correction for the Record."[7] They challenge labor supply analyses that suggest that there can be an income effect from a reduction in tax rates (or vice versa) which would at least partially, if not entirely, offset the substitution effect from a higher wage.[8]

[5] See Historical Statistics, Colonial Times to 1970 (1975, p. 437, col. 127).

[6] See Historical Statistics, Colonial Times to 1970 (1975, p. 15, series A119-134) and extensions in Statistics Abstract, 1984 (1984, p. 31, 7B.30).

[7] See Gwartney and Stroup (1983).

[8] Given the concept of virtual income, the income effect from a higher real wage would have to offset the effect from changes in this term as well.

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The income effect from a tax reduction is attributed to the rise in real income stemming from an increase in the net wage. Gwartney and Stroup contend that a "fallacy of composition" is committed when analysts apply the work-leisure paradigm for the individual in regard to a tax rate change to the aggregate economy. They argue that while on an individual basis the leisure demand analysis may postulate an income effect in response to a tax cut, in the aggregate, assuming government allocation of goods and services is socially efficient, real income does not change when tax rates are reduced. What goods and services are eliminated as a result of less tax revenue will be compensated for through private consumption due to the assumption that, at the margin, goods provided by the government are valued equally to goods consumed in the private sector. Thus, the two income effects (the increase in income from a reduction in taxes and the decrease in income from reduced government goods and services) will cancel and all that would remain would be the substitution effect from the higher net wage which unambiguously increases labor supply.

There are reasons to believe that the assumption that individuals, at the margin, value the goods and services provided by the government the same as those consumed in the private sector (or alternatively, the same as an additional dollar of taxes paid) is not realistic and in this case conclusions are contingent upon assumptions. Not only is there the strong likelihood that everyone in the economy does not value the additional goods and services produced by the government equally to an additional dollar paid in taxes but also there is the likelihood that there are no private substitutes for certain goods and services the government provides (i.e., defense) and thus an equal value of goods and services may not be purchased in the private sector when taxes (and tax revenues) are reduced. If in fact, as Gwartney and Stroup note,

> if the initial output of public goods is larger than optimal, (then) the utility derived from the expansion in consumption of private goods will exceed the utility foregone by the decline of output of public goods as a result of the tax cut.[9]

[9] See Gwartney and Stroup (1983, p. 449).

In this case, a tax cut will increase real income and result in income and substitution effects that are in opposite directions. Thus, the kind of negative income effect in the aggregate suggested in this study becomes a possibility.

Another consideration is that changes in tastes and preferences may offer a significant explanation to the decline in hours worked in the last one hundred years. People may just "prefer" to work less. Because this variable is not quantifiable it makes its appearance in the error term of a regression equation, which like any other misspecification problem can create bias in the estimated coefficients. Normally in labor supply studies, tastes and preferences are assumed constant.

Finally, given that the model proposed is for the aggregate U.S. labor supply function a *caveat* is in order. Since the model used in this study is essentially a partial equilibrium model, estimated for a "representative" individual, there is danger and, indeed, likelihood of error in making inferences about aggregate behavior. Not only are there the ramifications from making predictions about aggregate behavior from *ceteris paribus* changes but also, in reality, it may be that different demographic, or more specifically, income groups have different wage elasticities. The latter consideration implies that changes in the wage may not affect everyone's labor supply in the same way and thus any public policy decisions that have an indirect effect on the wage (i.e., taxation) may not have the effect suggested by a model that accounts for a representative individual, in one income bracket. Nonetheless, hopefully the estimates can at least provide a general guideline to the possible effects of changes in factors that have public policy implications.

This completes the theoretical discussion of labor supply. The following chapter will review the literature in labor supply analysis.

# CHAPTER 3

# LITERATURE REVIEW

This chapter presents a survey of studies done on labor supply. The increasing interest in labor supply in the last few decades has resulted in a large number of studies on this subject and thus this review is by no means complete. The review is divided into three sections. The first section is a discussion of labor supply studies in general with particular emphasis on cross-sectional studies and the problems encountered in estimating labor supply functions. The second section focuses on studies done testing for the effects of transfer programs on labor supply. Finally, the third section is a review of labor supply studies using time series data.

## Cross-Sectional Studies

What is not lacking in labor supply analysis is a sufficient quantity of studies done testing for factors postulated to affect labor supply. What is lacking is consistency in results. As Michael Keely notes in his book, *Labor Supply and Public Policy: A Critical Review,*[1] the most striking feature of the existing body of empirical results is the extreme diversity of estimates of wage and income elasticities. Keely attributes the wide range of empirical findings to the different assumptions made by different researchers. He states,

> . . . in some studies there is control for taxes, in others there is not, variables included in the control set differ greatly from study to study, different measures of the dependent variable are used, and finally, very different specifications of the labor supply function are used. Theory offers little guidance as far as which empirical specification is best, and researchers often have very different prior

[1] See Keely (1981, p. 92).

notions about what assumptions and simplifications should be made. Unfortunately, it appears labor supply estimates are very sensitive to the choice of assumptions.[2]

Three common problems encountered in estimating a labor supply function are sample selection bias, measurement bias and endogeneity of varibles used as regressors. Each of these can create biased coefficients in estimating the supply function. Sample selection bias arises when a sample is selected according to factors that may be determined along with labor supply such as current earnings or current income. There are numerous possibilities for measurement errors. One example is that in constructing wage rates it is common to divide earnings by hours worked. Because hours worked is constructed using a measure of labor supply any errors in the measurement of labor supply will be duplicated in the computation of the wage rate. This, in turn, would give rise to a spurious correlation between hours worked and the wage in a regression equation. Finally, in theory, the labor supply of an individual is determined by an exogenous wage rate and an exogenous endowment of non-labor income. However, most measurements of the wage or non-labor income suffer from being determined by previous action by the individual and may therefore be endogenous. For example, since wages depend on the level of education, and since the level of education may depend in part on preferences for work, preferences for work may have a positive effect on the wage rate. As for non-labor income, virtually all measures are of current wealth which most often depends on past savings. Past savings, in turn, depends on labor supply.

Killingsworth has classified contemporary labor supply studies as first generation and second generation. He characterizes first generation empirical studies as using simple methodology and as a consequence raised more questions than they set out to answer. In general, these studies ignored the problems of endogeneity, measurement and sample selection bias, and most were limited in their functional form to a linear specification. The

[2] See Keely (1981, p. 93).

inadequacy of these studies fostered a number of studies which date from the mid-1970s and which Killingsworth refers to as "second-generation." This body of research confronted the problems ignored in the first generation studies and generally refined the econometric techniques of estimating a supply function. Although the results of these studies still suffer from wide variation, the methodologies employed are generally considered to be more sound and this, in turn, has contributed to a more solid framework within which labor supply is analyzed.

Most labor supply studies use cross-sectional data rather than time series data as is used in this study. Each class of data has an advantage as to the kind of information provided for analysis. They also have their respective caveats with regard to creating bias in the estimated coefficients. While cross-sectional data offers detailed information on a large number of individuals at a given point in time, because it must make comparisons across different individuals at different points in their lives, it is difficult to separate life-cycle variations among individuals. In addition, with cross-sectional data it is difficult to control properly for the effects of unmeasured variables such as tastes and preferences. Aggregate time series data, on the other hand, has the advantage of allowing for differences in tastes and other unmeasured variables to be averaged out. However, due to the fact that aggregate variables often move together over time, time series data are often characterized by extreme multicollinearity which causes large variances of the estimators.

While there has been wide variation in the results of cross-sectional empirical studies in particular, two results seem to come up consistently, especially from the second generation studies: (1) the uncompensated wage elasticity for men is near zero, making their supply curve inelastic, and (2) the uncompensated wage elasticity for women indicates a positively sloped supply curve. Discarding studies which estimate negative compensated wage elasticities, the range of uncompensated elasticities from second generation studies on U.S. males is –.03 to .14. The range for females is between .6 and 2.2.[3] A positively sloped, relatively elastic supply curve for women is explained by a higher reservation wage for women, and more substitutes for market work than exist for men. A higher reservation is attributed to the traditional cultural roles women have performed, this of course being house work versus market work. A more elastic supply curve is attributed to the wider choice set women have for work, that is housework has traditionally been a more viable (and valuable) alternative to market work for women than for men. This causes women to be more sensitive to changes in the market wage than men. It may be that with more and more women entering the labor market due to less children, increased household conveniences, changing societal attitudes, etc., that the labor supply curve of women will also become less elastic.

One cross-sectional study that deserves individual attention due to the methodology employed is by Hausman (1981). Hausman's study is one of the few to use the technique of linearizing the budget constraint as a consequence of progressive taxation. Hausman's work is an extension of studies by Hall (1973), Kurz (1974) and Hurd (1976). Unlike the previous work, however, Hausman not only accounts for sample selection bias, but he also applies his method to the impact of implicit marginal tax rates arising from a transfer program. As far as it is known this is the only study to simultaneously consider both taxes' and transfers' effects on labor supply.

The theory underlying Hausman's study was discussed in the previous chapter. The thrust of Hausman's analysis, as stated in that discussion, is the (virtual) income effect created by the progressivity of taxes. Hausman's results indicate that accounting for non-linearities in a budget constraint arising from changes in marginal tax rates is crucial in estimating the effects of taxes and transfers on labor supply. While Hausman's estimate of a small uncompensated wage effect for husbands was in accord with previous empirical

[3] See Killingsworth (1983, p. 185).

findings,[4] his results in estimating the effect of taxes are contrary to previous studies except that of Hall. Hausman found that the (virtual) income effect of a progressive tax system reduced labor supply for husbands by 8% and found significant adverse effects for wives and female heads of households. Hausman also finds a significant adverse effect on labor supply from the AFDC program for female heads of households.

Almost every other study controlling for taxes inferred from a small estimated uncompensated wage elasticity for males that taxes would have little effect on labor supply. Among those few studies that did show an adverse impact on labor supply, none had the significance of results Hausman did. Although Hall (1973) is the only other study to find a similar income effect as Hausman, Hausman's study tends to be more well regarded due to its wider scope of taxes accounted for as well as his consideration of sample selection bias. A major criticism of Hausman's study, however, is that he constrains the virtual income term to have a negative effect on work. Thus, the negative impact of progressivity follows from his assumptions rather than being tested.

Table 2 presents a review of the results from other major cross-sectional labor supply studies done in the last fifteen years testing for the effects of changes in the wage and non-labor income in particular. A brief synopsis of the characteristics of the data is provided.

## Transfer Programs

Transfer programs have grown from 4.6% of GNP in 1965 to 10% in 1981.[5] The theoretical implications of the effects of most income transfer programs are that they unambiguously result in a reduction of work. Given the dramatic increases in transfers in recent years, it is of interest to determine the magnitude of their impact on labor supply.

[4] Hausman's estimates of significant positive uncompensated wage elasticities for wives and female heads of households also confirmed previous empirical findings.

[5] See Danziger, Haveman, Plotnick (1981, p. 977).

Table 2. Selected Cross-Section Studies of Labor Supply.

| Study | Characteristics of Sample | Wage Elasticity Compensated | Wage Elasticity Uncompensated | Total Income Elasticity[2] |
|---|---|---|---|---|
| Tella et al. (1971) | Basic male sample –SEO data | .17 | .14 | –.13 |
| Ashenfelter & Heckman (1973) | Married white men –SEO data | .12 | –.15 | –.27 |
| Greenberg & Kosters (1973) | Basic male sample –SEO data | .2 | –.09 | –.29 |
| Hill (1973) | Male family heads, 25-54–SEO data | .47 | –.21 | –.68 |
| Wales & Woodland (1976) | Married males –PSID data | n.a. | –.11 | 0 |
| Masters & Garfinkel (1977) | Married white men, 25-54–SEO data | .08 | .04 | –.04 |
| H. Rosen (1978) | Black married men –NSL data | 1.00 | –.02 | –1.02 |
| Coagan (1980) | White women, 30-44–NSL data | 2.64 | 2.45 | –.19 |
| Hausman (1981) | Husbands, 23-55 –PSID data | 0 | 0 | –.15 |
| Ransom (1982) | Wives with husbands, 30-50–PSID data | .46 | .4 | –.07 |

[2] Total Income Elasticity is defined as the change in earnings from a one dollar increase in non-labor income.

Danziger, Haveman and Plotnick, in an article entitled "How Income Transfer Programs Affect Work, Savings, and the Income Distribution: A Critical Review," provide a general review of the majority of studies done testing for the impact of income transfer programs. As they note, it is difficult to draw precise conclusions about the overall impact of transfer programs on labor supply. They state,

> . . . (because) most analyses concentrate on marginal responses of transfer recipients to changes in the characteristics of a specific program, . . . extrapolation to derive an estimate of the programs' total effect becomes difficult.[6]

[6] See Danziger, Haveman, Plotnick (1981, p. 995).

The most commonly examined programs are Social Security, Unemployment Insurance, Disability Insurance and AFDC. The methodologies employed to measure the effects of transfer programs are as varied as the programs themselves. There are differences in how the dependent variable is measured, how taxes are taken into account, how implicit tax rates of a particular program are measured and what control variables are used. Also, there is no consistency among the studies as to what factors are included or omitted. Nonetheless, whether assessed individually or viewed in aggregate by averaging, the results of various studies do provide information on the potential labor supply effects of the programs. In general, the studies' findings indicate a negative supply response to transfer programs although, as with the general results from other cross-sectional studies, the estimated magnitudes of the responses vary greatly.

It is also important to remember that almost all labor supply studies use a select group of individuals to test for effects, e.g., white men not self-employed, 58-67; white married men, 61-65; white married women, 50-54. Thus the estimates of the effects of programs, although statistically significant, may not be representative of the aggregate labor force response to the existence of transfer programs.

Social Security probably has the greatest impact on labor supply because of its size. Of the expenditures on major transfer programs almost half goes to Social Security alone. Also, it is the one transfer program for which almost all workers are actual or potential beneficiaries. Social Security can be viewed in two ways; one, as an asset yielding current and future benefits, or two, as a liability requiring current and future tax payments.[7] If Social Security is perceived as a net asset a wealth effect may reduce work earlier than if the program did not exist. This potential labor supply effect has been the focus of many recent labor supply studies. A very common dependent variable used in regressions testing

[7] See Danziger, Haveman, Plotnick (1981, p. 983).

for the effect of Social Security on labor supply is the probability of retiring while the estimated annual benefit is a frequent program (independent) variable.

The other aspect of the Social Security program theorized to have adverse effects on labor supply is the earnings test. Since benefits are reduced by 50% of earnings in excess of $5,000 for individuals up to age 70, an implicit tax exists in the program and this is postulated to be a disincentive to work. The earnings test is also a common variable used as a proxy to test the impact of the Social Security program on labor supply.

Unemployment Insurance is perhaps the most controversial transfer program. Because it provides compensation for those unable to find a job and because such compensation typically exceeds 50% of previous after tax earnings, many feel it discourages people from productive work or at least prolongs unemployment unnecessarily. On the other hand, it is argued that the entitlement effects of Unemployment Insurance may induce some persons to enter the labor force to qualify for future benefits or work more hours to raise the benefits to which they are entitled. Economists, then, are concerned about the net effects of this program on labor supply. The most common way Unemployment Insurance benefits have been tested for is to measure their impact on duration of unemployment.

The other two programs commonly analyzed are Disability Insurance and AFDC. As stated in the previous chapter, benefits received under AFDC are dependent on how much income from work one receives. Thus there are both income and implicit tax rate effects on labor supply. Like Unemployment Insurance, Disability Insurance provides income as an alternative to work. As Danziger et al. note, while Disability Insurance has a stringent definition of disablement, higher benefit levels and relaxed eligibility requirements may have induced some persons to accept Disability Insurance and leave the labor force.[8] Expected benefits or a benefit-wage ratio is commonly tested for with Disability Insurance while income guarantees and implicit tax rates are program variables tested with AFDC.

[8] See Danziger, Haveman, Plotnick (1981, p. 988).

There are almost as many studies done testing for the effects of transfer programs as there are studies testing generally individuals' responses to changes in the wage and non-labor income. All studies use cross-section data. The number of studies precludes specific discussion in a paper of this size. However, a synopsis of various studies done testing for the effects of transfers are provided in Table 3.

Danziger, Haveman and Plotnick "guesstimate" an overall effect on aggregate labor supply of transfer programs based on a review of these and other studies. They arrive at the following conclusions: Social Security reduces aggregate labor supply by approximately 1.2%; Unemployment Insurance reduces labor supply by .3%; Disability Insurance results in a loss of labor supply of a maximum of 1.2% and AFDC negatively affects labor supply by approximately .6%. Another 1.5% is attributed to the combined negative effects of various other transfer programs which provide such things as food stamps and housing assistance. In total then, the authors guesstimate a 4.8% reduction in aggregate labor supply as a consequence of existing transfer programs.

## Time Series Studies

Two of the more notable studies on labor supply using time series data were done by Abbott and Ashenfelter (1976, 1979) and Barnett (1979). Their work is exceptional because they take account of commodity demand in their estimation of labor supply elasticities. Joint estimation of commodity demand and labor supply functions may make more precise the estimated coefficients of each. Since the studies focus on the interaction of commodity prices and wage rates, time series data is of greater benefit than cross-sectional due to the greater variation in the data. These studies are two of the few time series studies to estimate both income and substitution elasticities for labor supply and to account for the effects of non-labor income.

Table 3. Selected Cross-Section Studies Testing for Transfer Program Effects.

| Study | Characteristics of Sample | Dependent Variable | Program Variable | Results |
|---|---|---|---|---|
| Boskin (1977) | White married men, 61-65—PSID data | Prob. of change between work and retirement | Estimated annual benefit | Large effects on prob. of retiring |
| Boskin-Hurd (1978) | White men, working in 1979, 62-65 | Prob. of change between work and retirement | Estimated annual benefit | Benefits raise prob. of retiring |
| Burkhauser-Quinn (1980) | Men, working in 1973, 62-64 | Prob. of retiring | Social Security asset value | Insignificant effect |
| Gordon-Blinder (1980) | White men, not self-employed, 58-67 | Prob. of retiring | Ratio of asset value to full income | Statistical significant economically unimportant |
| Marston (1979) | All unemployed, quitters, or laid off workers | Manufacturing quit rate | Expected weeks of unemployment after quit | Program variable does not increase quits |
| Barron-Mellow (1981) | Unemployed workers, CPS data, 1976 | Prob. of employment, remaining unemployed or leaving labor force | Dummy for receipt of UI | UI raises prob. of remaining unemployed |
| Moffitt-Nicholson (1982) | Claimants of UI | Fraction of observation period when employed | Replacement Ratio | Increase in RR decrease in employment, but insignificant |
| Parsons (1980) | Men, 48-62, NLS data | Participation in work force | Ratio of potential DI benefit to wage | Significant adverse effects |
| Moffitt (1980) | All female heads of families with children | Hours | AFDC Guarantee, Tax rate | Guarantee has large negative impact, tax rate has weak impact on hours |

Because labor supply is normally analyzed from a two good perspective (leisure and "all other goods") the accompanying income and substitution elasticities using this framework may be incorrect due to the aggregation of goods in the individual's commodity bundle. In the standard labor supply model, the "price of leisure" is the only price explicitly accounted for as a determinant of labor supply. Due to the nature of some goods, however (i.e., complements or substitutes to work), changes in their prices may also affect labor supply. If the relationship between changes in the prices of certain goods and leisure demand (labor supply) is not also explicitly accounted for the estimated income and substitution elasticities may be overstated since aggregation of goods only allows for changes in leisure demand to be explained by changes in its own price (the wage).

As an example of the problems arising when commodity demand is not taken into account, consider the following. Recreation equipment is thought to be a complement to leisure time and it may be that a decline in the price of such equipment would stimulate increased comsumption of leisure time. If labor supply is analyzed from a two good perspective, leisure and "all other goods," the effect of a change in the price of recreational goods gets lost, in a sense, in aggregation. Increased leisure time may well be influenced by a higher real wage but if it was also determined by reductions in the prices of complements to leisure, an estimation of a labor supply function that does not account explicitly for these price effects is likely to lead to an overstatement of the effect of changes in the wage. The same analysis can be applied to substitutes for leisure, e.g., convenience goods.

Disaggregation of the individual's commodity bundle is also important because it provides more information about an individual's preferences. Because of the restrictions imposed by neo-classical theory on commodity demand (e.g., symmetry conditions),[9]

[9] Although symmetry conditions do not hold in the aggregate this is often ignored in labor supply studies estimating commodity demand in conjunction with a labor supply (leisure demand) function. See Abbott and Ashenfelter (1976, 1979).

estimating the effect of a change in the wage on the demand for a certain commodity can in turn provide information about the effect of a change in the price of that commodity on labor supply (demand for leisure). This consideration is closely related to the previous discussion for in knowing the cross-elasticities between goods and labor supply, substitutability and complementarity are more clearly established and, in turn, labor supply elasticities more accurately estimated.

Abbott and Ashenfelter estimate an explicit supply equation along with demand functions for seven different commodity groups. Barnett, on the other hand, estimates a demand for leisure function in conjunction with four other commodity demand equations.

Each study has its respective strengths and weaknesses. Abbott and Ashenfelter's study is exceptional because it is one of the few time series studies to both control for taxes in constructing wage rates and to include non-labor income in the commodity demand and labor supply equations. Barnett does not control for taxes which of course creates a bias in the estimated response to the wage. One major criticism raised against Abbott and Ashenfelter's study is in regard to the way hours worked are measured. The authors divided total hours worked in the economy by "number of persons engaged in production." By accounting only for persons already working the estimated labor supply function is a conditional labor supply function and does not account for changes in the employment to population ratio. Barnett uses a population figure to compute his hours worked measure thus making his estimates more appropriate for labor supply considerations. Neither study takes account of the impact of transfer programs on labor supply.

Abbott and Ashenfelter estimate the system of demand and supply equations using four different model specifications while Barnett uses variations of one. The results of Abbott and Ashenfelter's study indicate a downward slope to the labor supply curve. The uncompensated wage elasticity in their study ranges from –.07 to –.143. The compensated wage elasticity (substitution effect) ranged from .03 to .08, a result which affirms *a priori* theory. The authors estimate that the total income elasticity is –.173. Finally, although with less confidence, they also find evidence of complementarity and substitutability between various commodities and leisure time.

In general Barnett's estimates are also in accord with *a priori* theory. It would be difficult to make comparisons between this study and that of Abbott and Ashenfelter's since Barnett estimates a demand for leisure equation versus a labor supply function. However, he does find a negative price elasticity for leisure which translates into positive compensated and uncompensated wage elasticities for labor supply. He estimates that the uncompensated wage elasticity is .14 while the compensated wage elasticity is .34. Thus, although of opposite signs, the uncompensated wage elasticities from the two studies indicate a relatively inelastic supply curve. Finally, similar to Abbott and Ashenfelter, Barnett estimates the total income elasticity with respect to non-labor income is –.197.

Barzel and McDonald (1973) provide a provocative discussion of labor supply in their article entitled "Assets, Subsistence and the Supply Curve of Labor." In the article they set out to show that taking into account the wealth position of an individual on the one hand and survival considerations on the other, greatly expands the variety of shapes that can be derived for the supply curve from some simple utility functions. They also analyze a time series study on labor supply in the context of their theoretical discussion.

Barzel and McDonald assert that the asset holdings of the individual play an important role in determining the shape of the supply curve of labor. Simply stated, they suggest that wealthy individuals (i.e., individuals whose assets allow them to maintain an existence without working) initially always have a positively sloped labor supply curve as long as work itself reduces utility. On the other hand, individuals with no wealth whatsoever (i.e., no income source other than work) initially always have a negatively sloped supply curve. This is because at sufficiently low wage rates an individual must be working the maximum possible hours just to survive.

Using a neoclassical utility function modified to take account of assets and survival requirements, and specifying the elasticity of substitution between work and leisure to be a constant value, the authors derive a supply function that allows for nine different shapes to the labor supply curve (see Figure 12). The slope of the supply curve, given the supply function derived, depends on the magnitude of the elasticity of substitution and the difference between assets (non-labor income), A, and the subsistence level, S.

The authors submit that since few individuals, even in western countries, start their work career with asset holdings sufficient for survival, the third row of diagrams is most pertinent to labor supply analysis and in fact the middle diagram in this row conforms with data from many time series studies on labor supply. The negative slope is explained by the change in wealth arising from increases in the wage.

Finally, there is a labor supply study to be noted due to its consideration of the impact of changes in education on labor supply. The work by Kniesner (1976) entitled "The Full-Time Workweek in the U.S., 1900-1970" concludes that increases in education result in increased hours of work. More specifically, Kniesner finds that an additional year of education causes an individual to increase work by one hour per week or fifty hours per year. This result in part supports empirical observation of a more stable full-time workweek since 1940 in contrast to a steady and significant decline in the full-time workweek between 1900 and 1940.[10] Kniesner also tests for the effect of changes in the wages of

[10] Kniesner provides the following footnote in his study: Finegan, "Hours of Work in the United States," suggests two additional reasons for a positive relationship between education and the average workweek. First, highly educated people may have access to more pleasant jobs than others; consequently, differences in money wage rates between persons of low and high education understate real differences in wage rates. Since the nonpecuniary aspects of a job cannot be "spent" outside the place of work, they tend to increase hours worked for the highly educated. Second, differences among people in basic attitudes toward market work or market goods may induce both high educational attainment and more hours worked. See Kniesner (1976, p. 10).

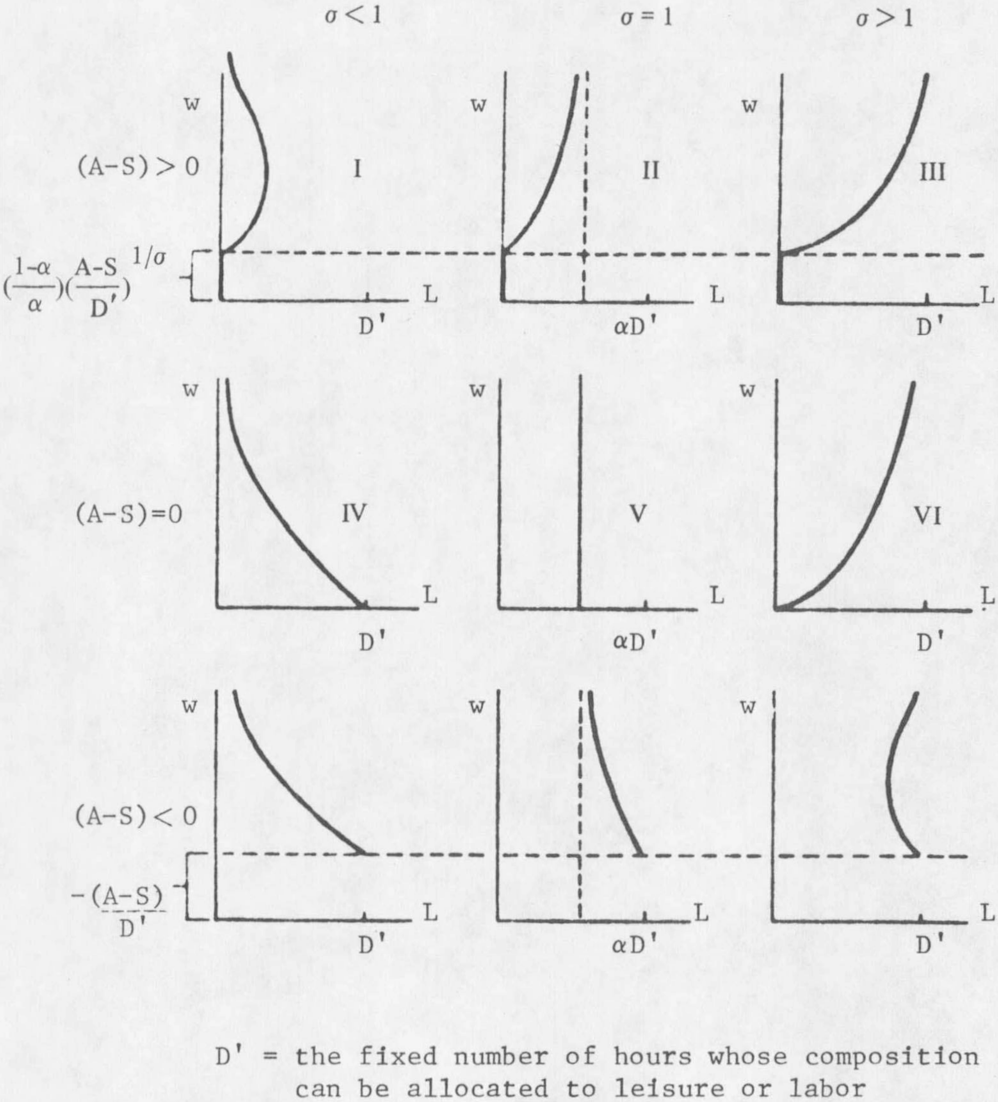


Figure 12. Supply curves resulting when assets and subsistence levels are considered.

females to help explain a more static workweek in the last thirty years. Although a subsequent publication found errors in two estimated wage coefficients in Kniesner's study, a reevaluation by Kniesner maintained his original finding in regard to education.

This completes the review of the literature on labor supply studies. The following chapter will provide a discussion on the general characteristics of the variables used in the labor supply model of this study.

# CHAPTER 4

## THE DATA

The measure of hours worked (labor supply) used in this study is simply total hours worked in the economy divided by the population fourteen and over. Total hours worked in the economy was taken from a series computed by Kendrick which he used for productivity studies.[1] Proprietors, unpaid family workers and employees from various major industries (including agriculture, government and the military) were counted as labor. Also Kendrick's computation of hours worked were for manhours worked rather than manhours paid for. As he notes,

> the difference between the two concepts is not operationally significant prior to 1939, but with the trend toward paid vacations, holidays and sick leave during and after the war, the divergence has been increasing.[2]

One problem that arose in using this measure of labor supply was that a changing age distribution of the population created a bias in the computation of hours worked. This problem was generally discussed in Chapter 1. The concern of this study is with the change in individual's behavior in regard to hours worked in the market. If the labor force is viewed in terms of age groups, then it is of interest to know if, on average, hours worked within age groups has significantly changed since this would potentially explain a significant change in total hours worked.

More specifically, if the population is divided into two age groups, 14-64 and 65 and over, then the measure of hours worked would be,

$$\text{HOURS} = \frac{h_1\ \text{POP}_{1t} + h_2\ \text{POP}_{2t}}{\text{POP}_{(14\text{ and over})_t}}$$

[1] See Kendrick (1961, p. 311).
[2] See Kendrick (1961, p. 50).

where $h_1$ is the average hours worked by individuals in the age group 14-64, $h_2$ is the average hours worked by individuals in the age group 65 and over, $POP_{1t}$ is the number of persons 14-64 in year t, and $POP_{2t}$ is the number of persons 65 and over in year t. This study, then, is interested in changes in the two variables $h_1$ and $h_2$. A bias in measurement of hours worked however can arise if these variables remain the same but rather the age variables (that is the proportion of the population 14-64 and 65 and over) change. As is the case, the proportion of the population 65 and over has steadily increased since approximately 1930 and if in fact $h_1$ and $h_2$ have not changed, the measure of hours worked would be biased downward since $h_2$ is normally less than $h_1$.

To account for this potential bias an adjustment was made to the hours worked measurement. Essentially a new total population figure was computed which was then used as the divisor. The new population figure is weighted by labor force participation rates in a base year as a proxy for hours worked by the respective groups. Thus the new population figure is,

$$POP^*(14 \text{ and over})_t = \frac{[LFPR_1 \ POP_{1t} + LFPR_2 \ POP_{2t}] \ POP_t}{POP(14 \text{ and over})_t \ LFPR}$$

$$= [LFRP_1 \ (1\text{-}AGE65_t) + LFPR_2 \ (AGE65_t)] \ \frac{POP_t}{LFPR}$$

where LFPR is the aggregate labor force participation rate in the base year. The base year used is 1930. In the base year, then, $POP_t^* = POP_t$.

From these equations it can be seen that as the age distribution changes, that is as the proportion of the population age 65 and over gets larger, $POP_t^*$ will be less than $POP_t$ and, in turn, make average hours worked larger than they would be without accounting for the effects of a changing age distribution. Thus the new measure of hours worked is cleansed of the bias created through dividing by a population not growing at a uniform rate. If in fact labor force behavior by the respective age groups does not change, the adjusted measure will be constant despite changes in the age distribution.

The wage rate was taken from a series computed by Barnett.[3] Since his series ran only to 1955 it was extended by applying the percentage change in the wage as reported in the *Economic Report of the President, 1980.*[4] The wage rate was then multiplied by (1-MTR), where MTR is an average marginal tax rate. The marginal tax rate reflects the tax burden the individual faces for each addition to income and thus is the appropriate tax rate to use in computing a net wage that is a determinant of labor supply.

The average marginal tax rate used in calculating the net wage consists of three different tax components. The first is an average marginal tax rate for federal personal income. This tax rate was taken from a series computed by Barro.[5] The second component is the employee portion of the Social Security tax.[6] The third component is the average tax rate on personal income at the state and local level. Since no official series exists for this tax rate an average tax rate was derived by dividing total state and local taxes by personal income.[7] Thus the marginal tax rate, for state and local taxes, is assumed equal to the average tax rate. The fact that state and local taxes are deductible from federal tax returns

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[3] See Barnett (1981, pp. 348-349).

[4] See Economic Report of the President (1980, p. 244).

[5] Barro and Sahasakul contend the economic effects of taxation depend on the configuration of marginal tax rates. They compute a measure of the marginal tax rate for Federal Individual Income Tax which has a graduated rate structure and allows for numerous legal and illegal deductions from total income. The tax rate used in this study is one of four measures they computed and is an arithmetic average of marginal tax rates for each year weighted by adjusted gross income. See Barro (1983).

[6] See Pechman (1983, p. 318).

[7] See Historical Statistics, Colonial Times to 1970 (1975, p. 1119, col. 505) and extensions in Statistical Abstract, 1984 (1984, p. 676).

state and local taxes are deductable from federal tax returns was accounted for in the computation of the overall average marginal tax rate. To compute the tax rate, then, the three components were added together.[8]

An average tax rate was also used in this study. An average tax rate is essentially tax revenue divided by personal income. It was computed using the same three tax components as before except of course using average values rather than marginal. The average federal personal income tax rate was again taken from a series done by Barro.[9] The state and local average tax rate is the same as the marginal as described above. Finally, an average Social Security tax rate was derived by dividing revenue received from Social Security taxes by personal income, where personal income includes non-labor income.

As a measure of private non-labor income, or wealth, a percentage of the capital stock was used as a proxy. The capital stock was taken from a series originally computed by Goldsmith and extended by Kendrick.[10] The value used was for the "private domestic economy" and excluded government structures and public land. A value of .05 was chosen as a representative rate of return on investment. The figure was then multiplied by (1-AVTR), where AVTR is the computed average tax rate as described above.

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[8] If $T$ = total taxes, $T_f$ = federal income tax, $T_s$ = state and local taxes, $T_0$ = OASDI (Social Security) tax, $t_f$ = federal income tax rate, $t_s$ = state and local tax rate, $t_0$ = OASDI tax rate, and $Y$ = income then,

$$T = T_f + T_s + T_0 ,$$

where

$$T_f = t_f(Y - T_s)$$
$$T_s = t_s \cdot Y ,$$

and

$$\begin{aligned} T &= T_f + T_s + T_0 \\ &= t_f(Y - t_sY) + t_s \cdot Y + t_0 \cdot Y \\ &= [t_f(1 - t_s) + t_s] \cdot Y + t_0 \cdot Y \\ &= [t_f + t_s + t_0 - t_f \cdot t_s] \cdot Y \\ &= MTR \cdot Y \end{aligned}$$

Thus a multiplicative term was subtracted that accounted for the deductibility of state and local taxes on federal returns.

[9] See Barro (1983, p. 437).

[10] See Goldsmith (1956, p. 41), Kendrick (1961, p. 320) and Kendrick and Grossman (1980).

Another independent variable used was an income term from the effect of (progressive) taxation. In principle this term is the same as the one used by Hausman (1981). As was shown in Chapter 1, this income term is the imputed addition to non-labor income as a consequence of linearizing the budget constraint. The Y-intercept from linearizing the budget constraint is what Hausman refers to as virtual income. Thus, the imputed addition to non-labor income is the difference between virtual income and non-labor income (see Figure 13).

To compute the income term, the two equations

$$\hat{x} = y^* + wh^*(1\text{-MTR})$$

$$\hat{x} = y^o + wh^*(1\text{-AVTR})$$

must be considered, where $y^*$ is virtual income, $y^o$ is (after-tax) non-labor income, MTR is the average marginal tax rate and AVTR is the average tax rate. It follows,

$$y^* = y^o + wh(\text{MTR–AVTR})$$

and,

$$y^* - y^o = y^p = wh(\text{MTR–AVTR})$$

where $y^p$ is the imputed addition to non-labor income arising from changes in marginal tax rates. It is this value which is used as an income term in the model.

Other income terms in the model are those for social welfare expenditures. These figures were taken from a series provided in *U.S. Historical Statistics, Colonial Times to 1970.*[11] They include Social Insurance, Public Aid, Housing, Health, and Veterans Benefits. These variables are in per capita terms as are all income terms used in the model. Also it should be noted that all nominal variables used in this study have been deflated to 1967 dollars using the CPI.

To account for the effects of education, two variables measuring the offsetting effects were created. One variable measures directly the amount of hours people spend in school.

[11] See Historical Statistics, Colonial Times to 1970 (1975, p. 340, cols. 6, 14, 16, 21, 27) and extensions in Statistical Abstract, 1984 (1984, p. 1037).

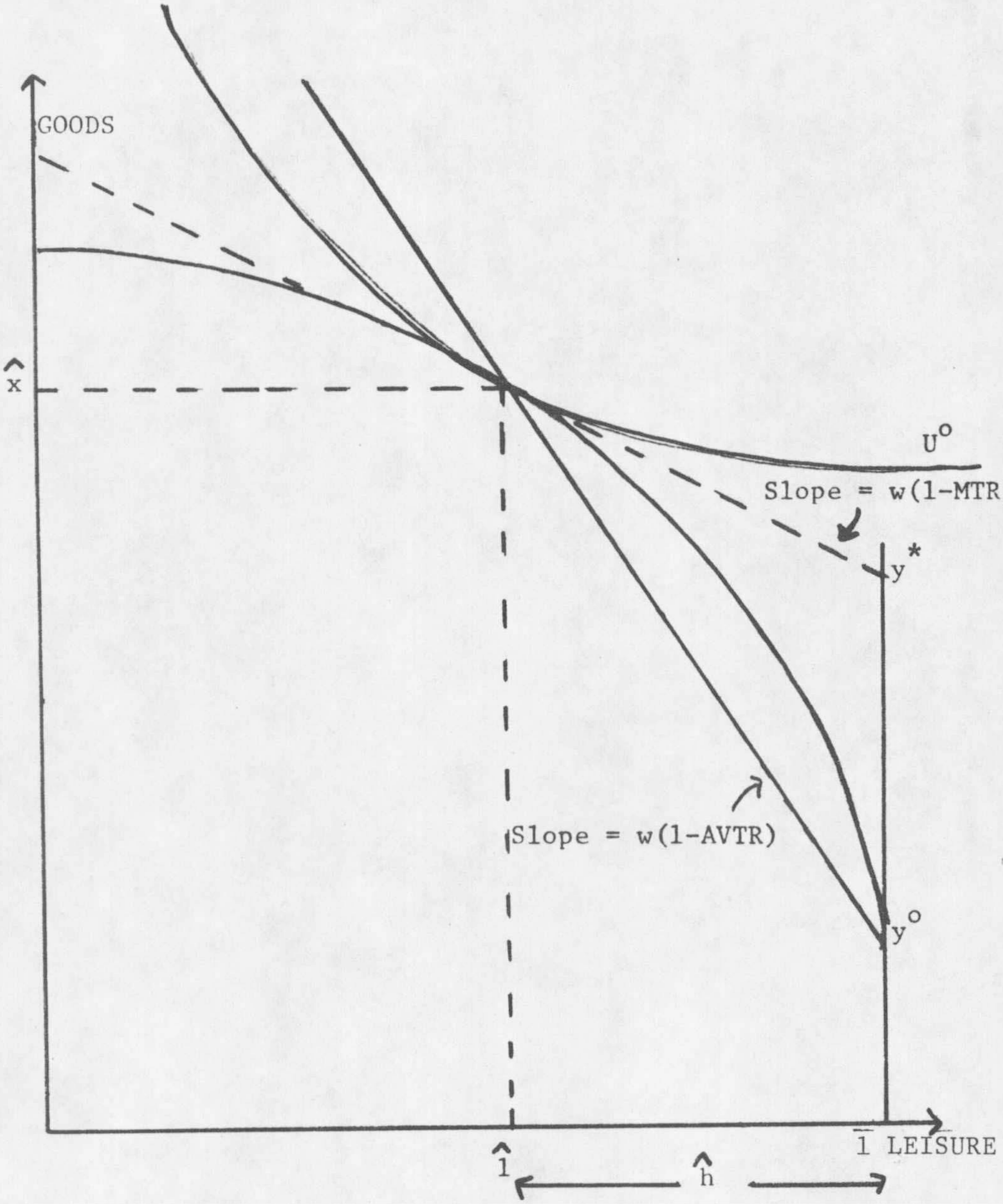


Figure 13. Calculation of "additional" income term from progressive taxation.

of hours spent in school.[12] The other variable, income foregone from education, was derived by multiplying the net wage by a proxy for the amount of time an individual has spent in school. Because the population 14 and over was used, median years of education beyond eight years of education was multiplied by the average number of hours spent in school was used as the proxy to represent the time devoted to education.[13] Thus in 1890, when median years of education was eight, income foregone from school was zero. In 1978, when median years of education was twelve, the net value of four years of education was multiplied by average number of hours spent in school that year. Finally, the term was multiplied by .05. As with non-labor income, it was necessary to annualize the "investment" in schooling and thus the same value was used as a rate of return on investment. In this case, given the theoretical implications of the term, the annualized value is income foregone as opposed to income received and thus should serve to increase labor supply.

The last variable used as a regressor in the labor supply model is unemployment. The actual term used was the average number of unemployed people in a year, that is the number of unemployed people divided by the population 14 and over. The value for the unemployment rate used was the deviation of the actual rate of unemployment in a particular year from the natural rate of unemployment in that year.[14] This variable serves to account for short-term fluctuations in hours worked brought on by business cycles or temporary shocks to the economy as opposed to long-term changes in patterns of work thought to be influenced by the other independent variables in the model.

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[12] See Historical Statistics, Colonial Times to 1970 (1975, pp. 369, 375, cols. 424, 429, 432, 522) and extensions in Digest of Educational Statistics (1980, pp. 76, 85). An arbitrary value of six hours was chosen as a measure of average number of hours spent in school and it remained constant throughout.

[13] See Historical Statistics, Colonial Times to 1970 (1975, p. 381, col. 618) and extensions in Statistical Abstract, 1984 (1984, p. 384).

[14] See Gordon (1978, Appendix B).

Finally, as mentioned in the theory section of this study, a dependent variable that captures the effect of changes in education is used as an alternative to the hours worked measured. In this study a variable entitled "Effort" was computed that is simply the sum of hours worked in the market and hours spent in school. As mentioned before, the Effort variable is justified if time spent in school is regarded as equivalent to time spent working in the market.

Between the years 1890 and 1978, average hours worked in the market per person have declined from 1591 to 1076 or by 32%. The data can be divided into three periods that demarcate distinct changes in the pattern of labor supply. These periods are 1890-1918 (although 1918 is not a typical year due to WWI), 1919-1947, and 1948-1978 (see Figure 14).

During the first period, hours worked remain essentially constant, that is the level of hours worked up to around 1915 is almost exactly the same as hours worked in 1890. There is variation in this period but overall hours worked stabilize around an average number of hours worked of approximately 1485.

From 1919-1947 hours worked decline dramatically. In fact, more than 60% of the overall decline takes place in this period. There are also sharp fluctuations in hours worked in this period due to the Depression and WWII. However, it is important to note that the measured decline is the difference between hours worked in 1919 and hours worked in 1947, which indicates that even with sharp fluctuations, hours worked arrive at a level that was 20% less than the average level in the previous period. Thus despite strong anomalies in the pattern of hours worked in this time period the data indicate a trend to lower average hours worked.

Finally, in the period 1948-1978, hours worked continue to decline although at a slower rate than in the previous period. Between 1948 and 1978 hours worked decline by

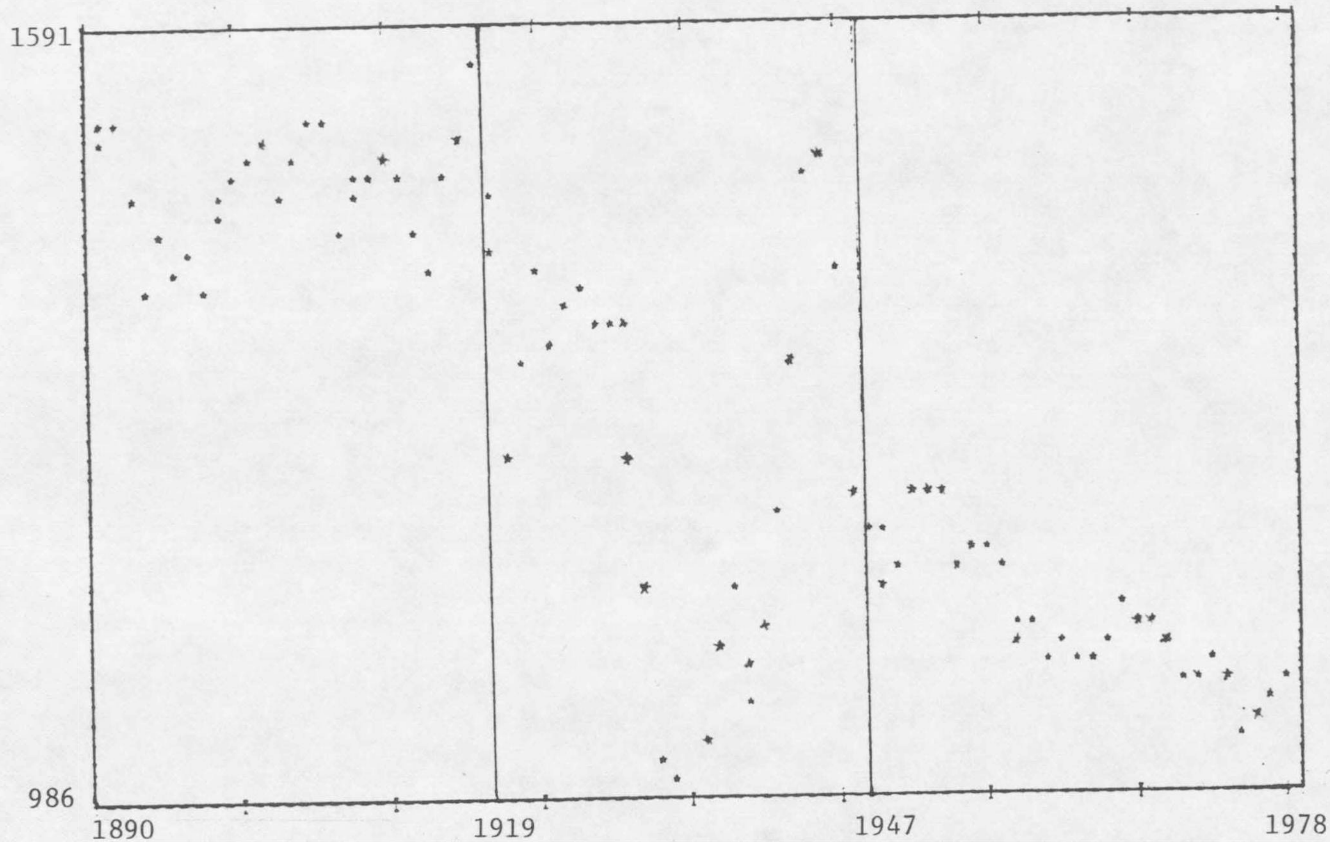



Figure 14. HOURSWORK vs. TIME.

another 12%. As in the first period, while there are fluctuations in hours worked they are nowhere nearly as dramatic as those between 1919 and 1947.

## Discussion of Data, 1890-1918

During the period 1890-1918, the only two variables that display any significant change are the net wage and non-labor income, both of which steadily increase (see Table 4). All other variables, except for the hours spent in school, are essentially zero. However, because the change in this variable is relatively small, changes in hours worked are almost exclusively explained by changes in the net wage and non-labor income.

The situation, then, is that the net wage is rising, non-labor income is rising and hours worked through most of the period have remained constant except for a fairly significant drop between 1893-1897, a recession. The fact that hours worked remained essentially constant suggests two possibilities. First, the supply curve could be positively sloped with the increase in non-labor income having shifted the curve upward (see Figure 15). Thus it may be that the income effect from an increase in non-labor income and the income effect from a rise in the wage offset the substitution effect from an increase in the wage resulting in hours worked remaining constant. Alternatively, it is possible that the labor supply curve is highly inelastic and that changes in non-labor income do not significantly affect hours worked (see Figure 15).

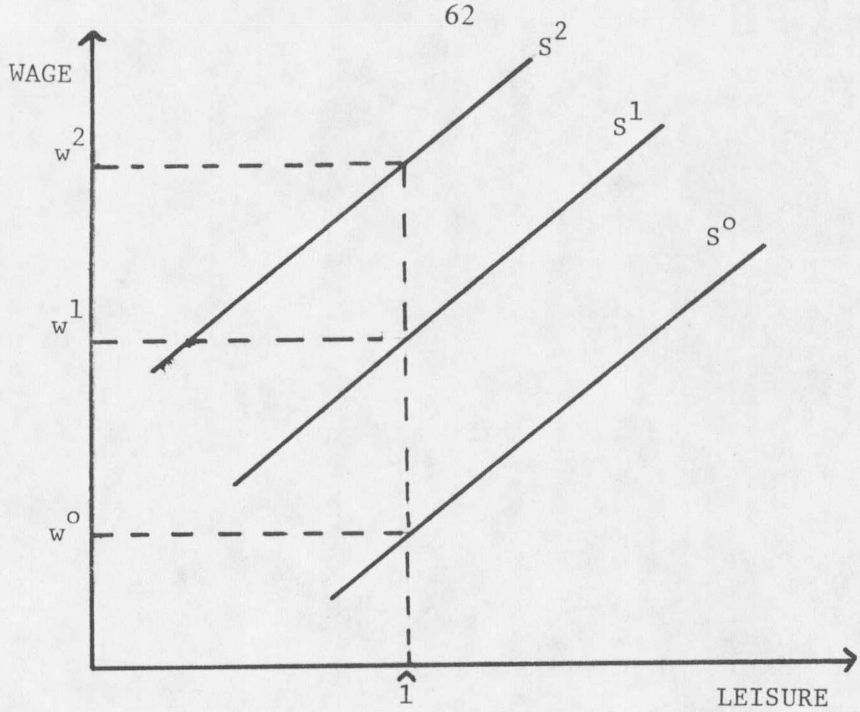
## Discussion of Data, 1919-1947

While all the variables undergo significant changes in the period 1919-1947, only two seem to offer explanatory power for the large decrease in hours worked. These are the net wage and time spent in school.

Table 4. Values of Variables Used in Labor Supply Model, 1890-1978.

| Year / Variable | 1890 | 1900 | 1910 | 1920 | 1930 | 1940 | 1950 | 1960 | 1970 | 1978 |
|---|---|---|---|---|---|---|---|---|---|---|
| Hours Work | 1514 | 1470 | 1481 | 1370 | 1091 | 1078 | 1227 | 1121 | 1091 | 1076 |
| Effort | 1532 | 1476 | 1490 | 1391 | 1123 | 1137 | 1236 | 1208 | 1236 | 1308 |
| Net Wage | $.5 | .62 | .76 | .82 | .98 | 1.18 | 1.42 | 1.58 | 1.94 | 1.77 |
| Non-Labor Income* | $260 | 300 | 361 | 391 | 361 | 340 | 391 | 502 | 532 | 652 |
| Progressive Income Tax* (YPROG) | $0 | 0 | 0 | 46 | 40 | 46 | 292 | 338 | 462 | 615 |
| Social Insurance* | $0 | 0 | 0 | 0 | 0 | 39 | 65 | 117 | 377 | 522 |
| Other Social Welfare Expenditures* | $0 | 0 | 0 | 16 | 16 | 91 | 83 | 116 | 174 | 349 |
| Income Foregone From School* | $0 | 0 | 0 | 0 | 32 | 44 | 88 | 176 | 341 | 396 |
| Hours School | 7 | 7 | 13 | 31 | 49 | 63 | 63 | 84 | 115 | 154 |

*Per capita.



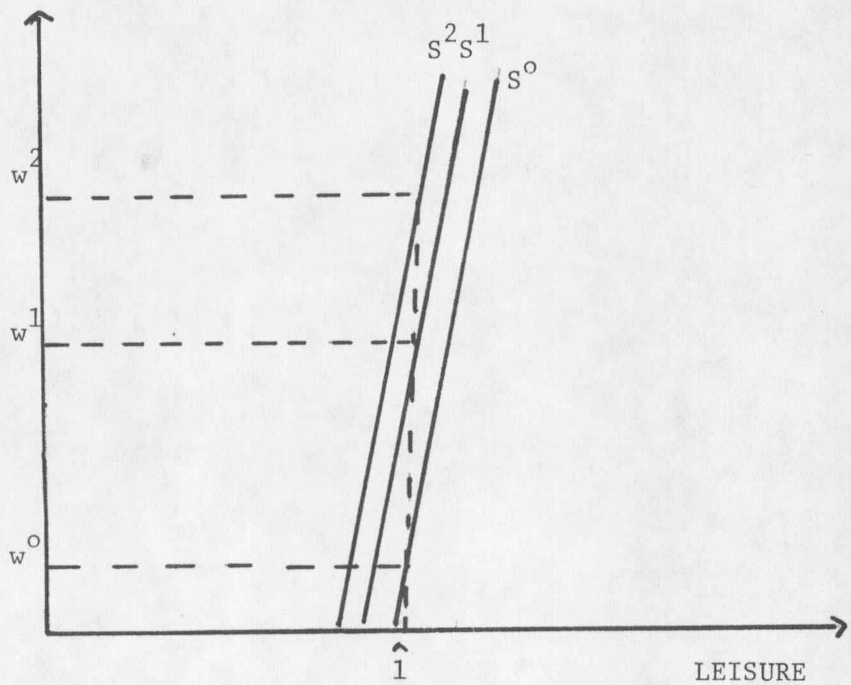




Figure 15. Effects of changes in elastic and inelastic supply curve on leisure demand/labor supply.

The real net wage almost doubles in this time period, the largest increase among the three periods. This is attributed to pressure from unions for higher wages and also technological improvement which manifests itself through higher wages. Hours spent in school increase significantly during this period. The variable drops off somewhat during the war and then increases again. Time spent in school makes a three-fold increase between 1919 and 1940. As for the other variables, as can be seen from Table 4, either they remain inactive up until the very latter part of the time period or their activity does not theoretically explain a decrease in hours worked.

The income term from changes in marginal tax rates increases by a small amount in 1919, remains essentially constant up to approximately 1940, then rises dramatically and reaches an all time high in 1943. This of course is a consequence of WWII. It decreases significantly after the war but to level that is a great deal larger than in 1940. Despite the substantial change, the fact that it occurred within the last five years of the period does not offer a strong explanation to the large decline in hours worked.

Not surprisingly, government expenditures on social welfare programs begin to significantly increase in the late 1930s. The most active expenditure, however, was for Public Aid, an expenditure, the majority of which was devoted to direct employment programs such as the Civilian Conservation Corps and the Public Works Administration. While there was some increase in the other social welfare expenditures, relatively, they do not appear significant and even if they adversely impacted hours worked, the size of the increase suggests that the impact would be small.

Non-labor income rises and falls a number of times during this period. However, it arrives at a level that is less than the period started out with. Theoretically, a decline in non-labor income would increase hours of work. Similarly, while the income term for investment in schooling increases significantly during this period, the theoretical implication of its effect is to increase work.

Thus, it appears that the income effect from a rise in the wage and increased time devoted to education offer the strongest explanation to a decline in hours worked in this time period.

## Discussion of Data, 1948-1978

As stated earlier, during the period 1948-1978, average hours worked declined from 1228 to 1076, or by 12%. The previous period, 1919-1947, was characterized by a 20% decline in hours worked. During the latter period social welfare expenditures and taxation rose dramatically relative to the two previous periods. By 1978 social welfare expenditures per capita were 4.3 times larger than the peak reached between 1919-1947 and the imputed income from negative taxation in 1978 was almost ten times the value that prevailed for most of the previous period. The tremendous increases in these two variables in particular would seem to portend a relatively large decrease in hours worked. As the statistics above indicate, however, hours worked in the previous period declined by a larger amount than in this period, the previous period being a time when both variables increased little relative to the latter period.

Because government transfers in particular are postulated to discourage work the question is, how much have these expenditures contributed to a decline in hours worked through a reduction in the number of individuals participating in market work? As mentioned in the previous chapter, almost half of total social welfare expenditures goes to Social Security alone. Thus it is this expenditure that would potentially have the greatest impact on hours worked. Because the majority of Social Security benefits go to the elderly, the concern is that such a program encourages early retirement.

Statistics indicate that long before Social Security was instituted the labor force participation rates of individuals 65 and over were declining. From 1890 to 1918 they fell from 68.3% to 55.6%, a time when no Social Security existed. Even if Social Security has encouraged individuals to reduce their hours of work, because of life-cycle considerations, the amount of hours they would have worked may not have constituted a large part of total hours worked. Thus, given that Social Security accounts for a large part of social welfare expenditures, it is well within reason that social welfare expenditures could dramatically increase in the period 1948-1978 and not adversely affect hours worked in a significant way.

As mentioned above, the income term from taxation rises substantially in this period thus reflecting the increased tax burden individuals face. The theory put forth in conjunction with the virtual income concept postulates a decrease in hours worked as a result of an increase in this term. Thus this variable may explain a significant part of the decrease in hours worked observed in this time period.

The two variables suggested to have the strongest explanatory power in the previous period continue to increase in this period and it seems likely that they would continue to exert influence on labor supply. While the net wage continued to rise, its increase relative to the previous period is not as great (see Table 4). The fact that the net wage rose by a lesser amount than in the previous period offers an explanation as to why hours worked did not decline by as much between 1948-1978, that is the income effect may not have been as strong. Time spent in school increased by approximately the same percentage amount as in the previous period.

Non-labor income, or wealth, increased one and a half times per capita in this time period. Given the considerations discussed previously in regard to non-labor income, it is uncertain what impact this variable would have on hours worked.

Finally, the income term used to measure investment in schooling increased from $77.00 in 1947 to $429.00 in 1978. Income foregone from school is postulated to increase hours of work and it could be that this factor has been a major reason that the decline in hours worked has been at a slower rate than in the previous period. Thus again, the more education obtained by the working population, and, in turn, the higher the value of their foregone income, the more hours they will work.

In this period, then, there are a number of possibilities as to why people are working less, or at least, more possibilities given the greater activity of the variables postulated to affect labor supply. Given that the real net wage continued to rise, despite large increases in taxation, and considering the factors already discussed in regard to social welfare expenditures, it seems likely that the income effect from the wage as well as changes in time spent in school remain strong explanatory variables for a continued decrease in hours of work. It could be, however, that the supply curve is positively sloped, or relatively inelastic, and that the income effects from non-labor income, taxation and government expenditures significantly explain a decline in hours worked.

The next chapter discusses the regression model used to estimate the magnitude of the effects of the variables just discussed.

# CHAPTER 5

## RESULTS

This chapter reports estimates of several models having the following general form:

$$\text{HRSWORK} = f(\underset{?}{\text{WAGE}}, \underset{-}{\text{YNONLAB}}, \underset{-}{\text{YPROG}}, \underset{-}{\text{YGOVT}}, \underset{+}{\text{YSCH}}, \underset{-}{\text{UNEMP}}) + \epsilon$$

and,

$$\text{EFFORT} = f(\underset{?}{\text{WAGE}}, \underset{-}{\text{YNONLAB}}, \underset{-}{\text{YPROG}}, \underset{-}{\text{YGOVT}}, \underset{+}{\text{YSCH}}, \underset{-}{\text{UNEMP}}) + \epsilon$$

where,

HRSWORK = aggregate hours worked

EFFORT = HRSWORK plus aggregate hours in school

WAGE = after tax wage rate

YNONLAB = income from capital (non-labor income)

YPROG = income term resulting from the progressivity of taxes

YGOVT = government social welfare expenditures, net of education

= YSOC (Social Insurance expenditures) + YOSOC (other social welfare expenditures)

YSCH = income term resulting from changes in time devoted to education

UNEMP = number of unemployed persons

$\epsilon$ = a random disturbance term

As discussed in the previous chapter, all variables, except the wage, are measured per person fourteen years of age and over. The expected signs of coefficients for the variables are indicated beneath each variable. The unemployment rate is included to explain short-run fluctuations in hours worked. All of the other variables are postulated to affect long-run, desired hours of work.

In estimating the labor supply function four different model specifications were employed, a linear equation and three non-linear equations. Of the non-linear equations one uses the logs of the hours and wage variables, one has the income terms (YNONLAB, YPROG, YGOVT, YSCH) divided by the wage, and the third uses the inverse of the wage as well as the income terms divided by the wage. These specifications were chosen based upon how well the slope and elasticities conformed to the nature of the hours worked data.

Furthermore, each model was estimated using both HRSWORK and EFFORT. In turn, each of these were estimated using either YGOVT as an independent variable or disaggregating this term into YSOC and YOSOC. Finally, due to distinct changes in the behavior of the independent variables, the labor supply equations were estimated for two different time periods, one being the period 1890-1978 and the other being the period 1947-1978.

There are four potential problems in estimating equations of this form. First, as discussed earlier, some of the variables may both determine labor supply and be determined by labor supply (i.e., some variables may be endogenous). Second, the data from the 1930s and early 1940s do not appear to be representative of long-run labor supply.[1] The abnormal fluctuations in hours worked in this time period are attributed to the Great Depression and WWII. Third, the disturbance term may be serially correlated. Serial correlation can arise for a number of reasons, the most common being the omission of a relevant independent variable. Finally, given that the data used is time series, the estimated coefficients may be affected by multicollinearity.

Conventional models of supply and demand imply that the wage is endogenous and is assumed as such in this study. Non-labor income is assumed to be exogenous since it is measured as a fraction of the capital stock which changes slowly through time. YPROG and YSCH are calculated from the data on hours worked and the wage and thus are taken

[1] 1918 and 1921 also appear as anomalies in the data, 1918 being the height of WWI, 1921 being a major recession.

to be endogenous. Social welfare expenditures are considered to be endogenous because they depend, in part, on individuals' decisions about whether and how much to work. Finally, unemployment is clearly influenced by labor supply as well as the demand for labor.

A two step estimation procedure is used to correct for endogeneity. Each of the endogenous variables is first regressed on a set of instrumental variables and the predicted values from these regressions are employed in the estimation of the labor supply function. In principle, the instruments should consist of exogenous variables that affect the endogenous variables. Instruments assumed to affect the wage via the demand for labor include: median years of educational attainment of the adult population, the capital stock, the Social Security and Unemployment Insurance tax rates, and time, a proxy for technology. Instruments which are assumed to influence social welfare expenditures include: the fraction of adults over 65 years of age, the fraction of households headed by females, the fraction of jobs covered by Unemployment Insurance, the Social Security replacement rate (the ratio of the average monthly benefit to average monthly earnings after taxes), the Unemployment Insurance replacement rate, and the AFDC replacement rate. Four additional instruments are used to represent business cycle and war factors. These are the predicted values and residuals from regressions of the growth of the money supply (M2) and the growth of defense expenditures on their lagged values and other variables.[2] Finally, the marginal and average tax rates are also used as instruments.

The second problem is the exceptional behavior of measures of labor supply during the Great Depression and WWII. Figure 16 displays the data on hours worked and the wage. The very low and high levels of hours worked in those periods are apparent. Because the labor supply function performed poorly in this period, even with the unemployment rate included, the years 1929-1946 have been omitted from the data for all estimates

[2] For a rationale for this procedure see Barro (1984, Chapters 13, 14, 17).

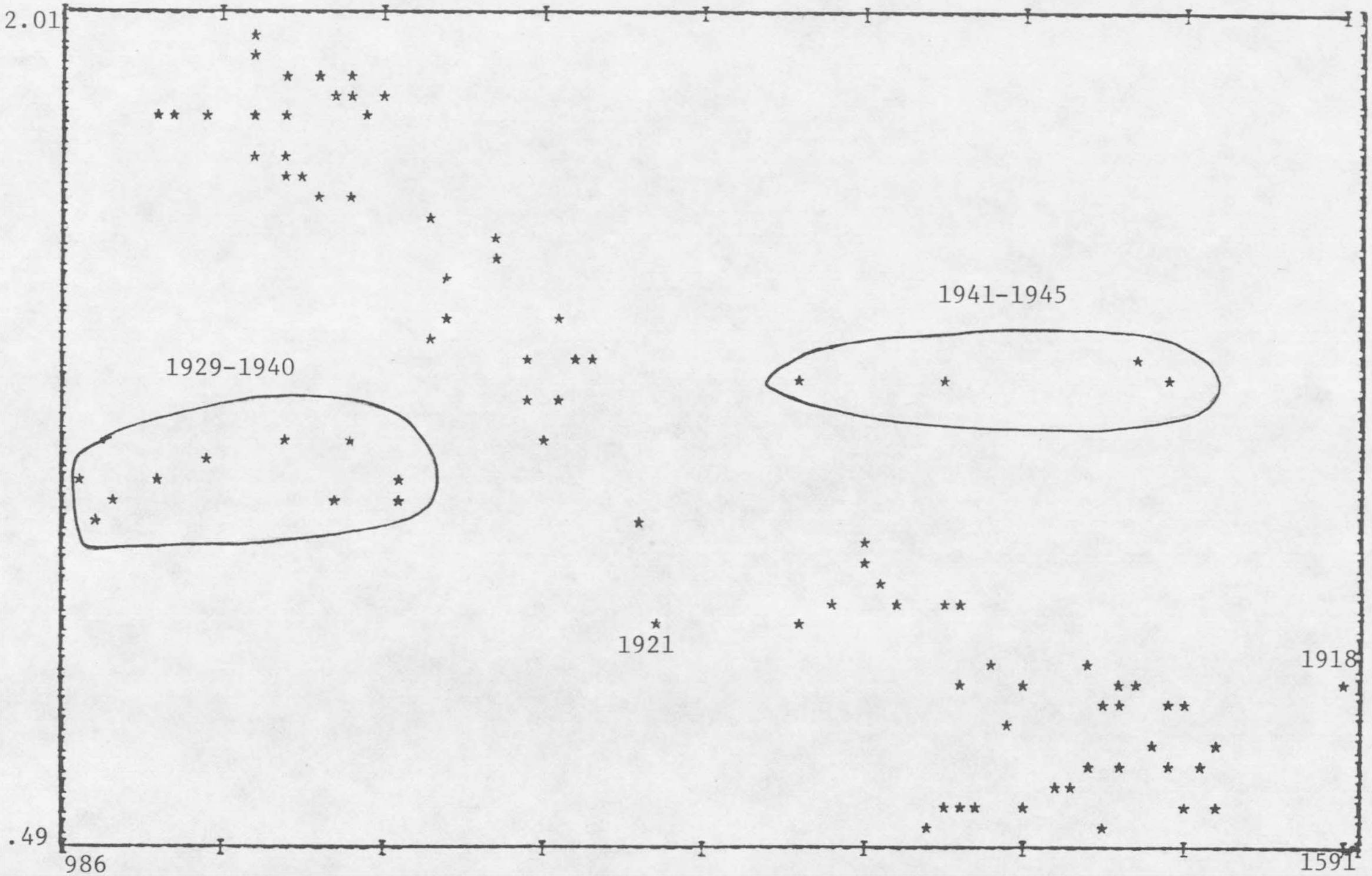



Figure 16. NETWAGE vs. HOURSWORK.

reported in this study. Similarly, the years 1918 and 1921 appear as outliers in the data. As a consequence, the supply equations were also estimated including dummy variables for these years.

Initial estimation suggested that in all model specifications serial correlation was present. Estimates for the first order serial correlation coefficient for all specifications ranged from .3 to .8. Consequently, the labor supply equations were reestimated allowing for second order serial correlation (modified for the 1929-1946 gap in the data[3]). There is no evidence of second order serial correlation in any of the equations when estimated from 1890-1978 (omitting 1929-1946). Thus adjustment for only first order serial correlation is undertaken. On the other hand, when the supply function was estimated for only the years after 1946 (post WWII), the results from all labor supply equations indicate significant second order correlation. Estimated coefficients range from –.3 to –.45. As a result, this was accounted for in the estimates for this time period.

Lastly, due to the nature of the data (i.e., most of the independent variables increase fairly smoothly over time), the estimates may suffer from the effects of multicollinearity. The most prominent effect is low t-ratios due to the variance of the estimators being larger than they would be in the absence of multicollinearity. Techniques to deal with this problem are limited and no attempt was made in this study to adjust for possible effects. Aggregation of variables is one means to eliminate collinearity but since the separate effects of each of the variables are of interest, a composite variable is not a helpful measure.

## Discussion of Data, 1890-1978

Table 5 presents estimates from the period 1890-1978 (1929-1946 excluded) where hours worked are a linear function of the independent variables. With the exception of the

[3] See Savin and White (1978).

Table 5. Linear Labor Supply Equations—1890-1928, 1947-1978.*

| | Hours | Hours | Effort | Effort |
|---|---|---|---|---|
| WAGE | -376<br>(4.3) | -408<br>(3.4) | -315<br>(3.7) | -370<br>(3.1) |
| YNONLAB | .435<br>(1.6) | .493<br>(1.6) | .450<br>(1.7) | .551<br>(1.8) |
| YPROG | -.224<br>(1.2) | -.215<br>(1.1) | -.242<br>(1.3) | -.225<br>(1.2) |
| YGOVT | -.309<br>(1.6) | | -.264<br>(1.4) | |
| YSOCINS | | -.514<br>(.96) | | -.603<br>(1.1) |
| YOSOC | | -.091<br>(.16) | | .096<br>(.17) |
| YSCH | .639<br>(2.4) | .760<br>(1.9) | .712<br>(2.7) | .917<br>(2.3) |
| UNEMP | -1058<br>(1.9) | -987<br>(1.7) | -1029<br>(1.9) | -914<br>(1.6) |
| CONSTANT | 1600<br>(27) | 1597<br>(27) | 1569<br>(28) | 1563<br>(27) |
| $R^2$ | .94 | .94 | .91 | .91 |
| RHO | .30 | .31 | .30 | .31 |
| WAGE ELASTICITIES | | | | |
| MEAN | -.34 | -.37 | -.27 | -.32 |
| 1978 | -.60 | -.65 | -.44 | -.52 |

*Absolute values of t-ratios in parentheses.

coefficient on non-labor income, the results generally support the hypotheses put forth in the theoretical section of this study.

The results indicate that the aggregate labor supply curve has a negative slope and, as signified by the t-ratios, that the wage offers the strongest explanation for a decrease in hours worked over time. Thus, in terms of the Slutsky decomposition, the income effect dominates the substitution effect. The fact that the elasticities for all variations of the linear supply equation are between -.3 and -.65 lends support to the general empirical result of previous cross-sectional studies that the labor supply curve of men is highly inelastic. Also, it confirms the findings of the time series studies done by Abbott and Ashenfelter and Barnett which also indicate an inelastic aggregate labor supply curve. The fact that an inelastic supply curve appeared when such factors as wealth, taxation, transfer payments and education were simultaneously accounted for seems to give even stronger support to this general empirical finding.

Estimated coefficients for the YPROG term affirm the postulated effect of progressive taxation on work although t-ratios suggest the effect is not significant. Similarly, the coefficients for the income terms representing social welfare expenditures support *a priori* theory but they too have low t-ratios. Thus the estimates suggest that an increase in the progressivity of taxation or transfer payments would serve to reduce hours worked. The coefficient for the income term OSOC is positive in the EFFORT equation, a result that violates the hypothesis put forth in regard to this term.

The estimates when YGOVT is disaggregated into YSOC and YOSOC are only reported for the linear specifications. In general, the results for the non-linear equations are similar to those of the linear ones. That is, YGOVT appears more significant than the individual terms. YSOC did not have significance in any of the equations estimated indicating that the combined effects of Social Security and Unemployment Insurance in particular do not significantly affect hours worked although as with YGOVT the sign of the term was negative in the majority of the equations.

The income term for investment in schooling is the second most significant variable in the linear labor supply equations for this period. The positive coefficients are in accord with *a priori* theory and thus suggest that more education induces people to work more during the years they are working.

The unemployment variable borders on significance in explaining changes in hours worked and is always negative. Coefficient indicate that as one more person becomes unemployed hours worked decline by approximately 1000. A significant t-ratio for this variable would support the notion that business cycle fluctuations do affect the amount people work.

All of the estimated coefficients for non-labor income violate the theory by being positive. One explanation for this result, as mentioned in the theory chapter, is that the measure of non-labor income used in this study (i.e., a percentage of the capital stock) may not accurately represent the exogenous value of wealth (non-labor income) that, theoretically, influences individuals' decisions to work. Thus, an imperfect measure of private, non-labor income may result in estimates that contradict *a priori* theory.

Finally, when hours spent in school are accounted for via the EFFORT variable the results indicate that both the wage coefficients and elasticities are reduced. Thus, the supply curve is more inelastic when education is accounted for, a result which indirectly supports the contention made that growth in time spent in school helps explain the decline in hours worked in the market.

Table 6 presents results from estimations of the three non-linear functional forms for the same time period. The results are generally in accord with *a priori* theory with the coefficients for non-labor income continuing to be a prominent violation. The wage coefficients and elasticities of these equations also indicate a negatively sloped, inelastic supply curve. The most notable differences between these equations and the linear estimations is the change in significance of the YNONLAB and YSCH terms. In the linear equations YSCH is statistically significant and YNONLAB is insignificant while in the non-linear ones it is the reverse.

It may be helpful to note more specifically why these functional forms were employed. As mentioned previously, the general rationale for choosing certain functional forms was how well their slope and elasticities conformed to the hours worked versus wage data. The slope of all functional forms used generally fit the pattern of the data. Income terms were divided by the wage in some specifications to allow the coefficients to be

Table 6. Non-Linear Labor Supply Equations–1890-1928, 1947-1978.

| | LG Hours | LG Hours | | Hours | Effort | | Hours | Effort |
|---|---|---|---|---|---|---|---|---|
| LG WAGE | -.236 (4.3) | -.186 (3.4) | WAGE | -148 (2.0) | -98.2 (1.3) | 1/WAGE | 69.1 (2.1) | 39.2 (1.1) |
| YNONLAB* | .440 (2.0) | .390 (1.8) | YNLABW | .644 (2.3) | .603 (2.1) | YNLABW | .758 (3.1) | .705 (2.8) |
| YPROG* | -.243 (1.9) | -.253 (2.1) | YPROGW | -.210 (.85) | -.267 (1.1) | YPROGW | -.240 (.95) | -.277 (1.1) |
| YGOVT* | -.165 (1.3) | -.114 (.93) | YGOVTW | -.427 (1.7) | -.337 (1.3) | YGOVTW | -.313 (1.2) | -.269 (1.1) |
| YSCH* | .780 (.56) | .203 (1.5) | YSCHW | .425 (.88) | .635 (1.3) | YSCHW | -.190 (.49) | .227 (.58) |
| UNEMP | -.856 (2.2) | -.838 (2.2) | UNEMP | -729 (1.2) | -778 (1.3) | UNEMP | -744 (1.3) | -728 (1.2) |
| CONSTANT | 7.06 (73) | 7.11 (75) | CONSTANT | 1275 (7.0) | 1276 (6.9) | CONSTANT | 1014 (9.0) | 1099 (10) |
| $R^2$ | .99 | .99 | | .95 | .91 | | .95 | .91 |
| RHO | .30 | .33 | | .27 | .30 | | .29 | .32 |
| WAGE ELASTICITIES | | | | | | | | |
| MEAN | -.24 | -.19 | | -.29 | -.24 | | -.17 | -.18 |
| 1978 | -.24 | -.19 | | -.50 | -.39 | | -.04 | -.14 |

*These coefficients have been multiplied by 1000.

interpreted as "total income elasticities." This was previously defined as the fraction of an additional dollar of income (i.e., non-labor income, virtual income, transfer income, income foregone from education) that is spent to increase leisure. In other words, it is the change in earnings as a consequence of a change in income. Thus, given

$$\text{HRSWORK} = \alpha w + \beta \frac{y}{w}$$

$$\frac{\Delta \text{HRS}}{\Delta y} = \frac{\partial \text{HRS}}{\partial y} = \frac{\beta}{w} \quad \text{or} \quad w \cdot \Delta\text{HRS} = \beta \cdot \Delta y$$

and, therefore, $-\beta$ is the total income elasticity.[4]

[4] As may be obvious this value is not actually an elasticity but the term was coined by Killingsworth in his review of various labor supply studies and thus was adopted here for consistency's sake.

Finally, the functional form where the inverse of the wage is used allows for an elasticity that decreases in absolute value over time, something which the hours worked data indicate to be a possibility. This hypothesis is also a prominent feature of Barzel and McDonald's analysis.[5] A positive coefficient on the wage term is expected for this functional form since as the wage increases this term becomes smaller while at the same time hours worked are decreasing. The estimates conform to expectations in this regard and the estimated wage elasticities are closer to zero than for any other functional form. The income school variable (YSCHW) is unexpectedly negative in the hours equation of this specification. Apparently this functional form explains the slowing in the decline of hours worked after WWII as a consequence of a decreasing wage elasticity rather than increased educational attainment. The coefficient of YSCHW turns up positive in the EFFORT equation however. In general, the results provide little basis for choosing one functional form over another. The $R^2$ terms are identical in the equations employing 1/WAGE and the otherwise identical equations employing WAGE.

Tables 7 and 8 give results for the labor supply equations with dummy variables included for the years 1918 and 1921. It is apparent, as indicated by the t-ratios for the dummy variables for 1918 and 1921, that the two years are distinct outliers relative to the estimated functions. Unfortunately, adjusting for their influence suggests a lack of robustness among the results.

A notable change in this series of estimates is that the coefficient for non-labor income reverses sign in three out of the four functional forms. However, it is consistently insignificant. The social welfare expenditure terms also change signs and are positive in all of the labor supply equations, a contradiction of *a priori* theory. The most significant explanatory variable (other than UNEMP and D18) becomes YPROG with t-ratios consistently exceeding three. Its sign remains in accord with the postulated effect. The YSCH

[5] See Barzel and McDonald (1973, p. 629).

Table 7. Linear Labor Supply Equations—1890-1928, 1947-1978 (D18, D21).*

| | Hours | Hours | Effort | Effort |
|---|---|---|---|---|
| WAGE | -205<br>(2.5) | -176<br>(1.6) | -150<br>(1.9) | -141<br>(1.3) |
| YNONLAB | -.134<br>(.51) | -.190<br>(.64) | -.102<br>(.40) | -.120<br>(.42) |
| YPROG | -.548<br>(3.1) | -.190<br>(3.1) | -.102<br>(3.2) | -.120<br>(3.1) |
| YGOVT | .105<br>(.58) | | .140<br>(.79) | |
| YSOCINS | | .277<br>(.57) | | .197<br>(.42) |
| YOSOC | | -.061<br>(.12) | | -.085<br>(.18) |
| YSCH | .14<br>(.56) | .037<br>(.10) | .229<br>(.92) | .193<br>(.52) |
| UNEMP | -1800<br>(3.4) | -1862<br>(3.3) | -1771<br>(3.4) | -1793<br>(3.3) |
| D18 | 149<br>(5.2) | 151<br>(5.2) | 148<br>(5.3) | 149<br>(5.2) |
| D21 | -76.6<br>(2.8) | -77.0<br>(2.9) | -75.0<br>(2.8) | -75.0<br>(2.8) |
| CONSTANT | 1683<br>(29) | 1687<br>(28) | 1650<br>(29) | 1652<br>(29) |
| $R^2$ | .96 | .96 | .94 | .94 |
| RHO | .47 | .46 | .46 | .46 |
| WAGE ELASTICITIES | | | | |
| MEAN | -.19 | -.16 | -.13 | -.12 |
| 1978 | -.33 | -.28 | -.21 | -.20 |

*D18 and D21 are dummy variables for the years 1918 and 1921.

term also remains positive in all but one of the labor supply equations although it loses much of its significance in comparison with the first set of linear equations. When 1918 and 1921 are dummied, the unemployment coefficient is always significant. This series of estimates also indicates a more inelastic supply curve; the specification employing 1/w yields a small but positive wage elasticity.

Table 8. Non-Linear Labor Supply Equations–1890-1928, 1947-1978 (D18, D21).

| | LG Hours | LG Effort | | Hours | Effort | | Hours | Effort |
|---|---|---|---|---|---|---|---|---|
| LG WAGE | -.131 | -.086 | WAGE | -234 | -188 | 1/WAGE | 109 | 80.8 |
| | (2.4) | (1.7) | | (3.2) | (2.6) | | (3.1) | (2.2) |
| YNONLAB* | -.210 | -.057 | YNLABW | -.081 | -.126 | YNLABW | .113 | .061 |
| | (1.0) | (.28) | | (.28) | (.44) | | (.45) | (.24) |
| YPROG* | -.438 | -.439 | YPROGW | -.760 | -.809 | YPROGW | -.775 | -.808 |
| | (3.6) | (3.8) | | (3.1) | (3.3) | | (3.1) | (3.2) |
| YGOVT* | .100 | .142 | YGOVTW | .129 | .211 | YGOVTW | .294 | .330 |
| | (.81) | (1.2) | | (.54) | (.90) | | (1.2) | (1.4) |
| YSCH* | -.125 | .008 | YSCHW | -.016 | .220 | YSCHW | -.986 | -.565 |
| | (.92) | (.05) | | (.03) | (3.3) | | (2.6) | (1.5) |
| UNEMP | -1,35 | -1.35 | UNEMP | -1834 | -1926 | UNEMP | -1954 | -1879 |
| | (3.5) | (3.7) | | (3.1) | (3.3) | | (3.1) | (3.2) |
| D18 | .101 | .100 | D18 | 155 | 158 | D18 | 153 | 155 |
| | (4.7) | (5.0) | | (5.2) | (5.4) | | (5.2) | (5.3) |
| D21 | -.055 | -.053 | D21 | -75.6 | -72.7 | D21 | -69.3 | -68.6 |
| | (2.8) | (2.8) | | (2.8) | (2.8) | | (2.6) | (2.6) |
| CONSTANT | 7.27 | 7.30 | CONSTANT | 1699 | .705 | CONSTANT | 1279 | 1362 |
| | (75) | (80) | | (9.0) | (9.2) | | (12) | (13) |
| $R^2$ | .99 | .99 | | .96 | .94 | | .96 | .94 |
| RHO | .46 | .48 | | .45 | .46 | | .49 | .50 |
| WAGE ELASTICITIES | | | | | | | | |
| MEAN | -.13 | -.09 | | -.14 | -.09 | | .03 | .02 |
| 1978 | -.13 | -.09 | | -.17 | -.13 | | .22 | .11 |

*These coefficients have been multiplied by 1000.

In summary, the two sets of estimates for the years between 1890 and 1978 suggest inelastic labor supply functions. Elasticities at the mean range from .03 to -.4. The results indicate that the wage offers the strongest explanation for decline in hours worked over time. The results also suggest that there is some work disincentive from the progressivity of taxes. The specifications yield conflicting estimates of the effects of non-labor income, social welfare expenditures and investment in schooling. It seems there is no strong rationale for preferring one specification over the other; estimates from each of the functional forms violate at least some predictions from theory.

## Discussion of Data, 1947-1978

Lastly, Tables 9 and 10 present results for the labor supply equations estimated for the years 1947-1978. The most significant changes in the variables representing the effects of taxation, social welfare expenditures, and education took place in this time period (see Figures 17, 18, 19). Thus, their effects are expected to be most pronounced during these years. Furthermore, even if coefficients are not constant over the entire period 1890-1978, the estimates for recent years are the most appropriate for current public policy considerations.

Table 9. Linear Labor Supply Equations–1947-1978.

| | Hours | Hours | Effort | Effort |
|---|---|---|---|---|
| WAGE | -402<br>(2.6) | -318<br>(1.9) | -485<br>(3.5) | -413<br>(2.7) |
| YNONLAB | .282<br>(.91) | .295<br>(.94) | .250<br>(.89) | .265<br>(.94) |
| YPROG | -.236<br>(1.4) | -.137<br>(.71) | -.255<br>(1.6) | -.162<br>(.88) |
| YGOVT | -.254<br>(1.7) | | -.268<br>(1.9) | |
| YSOCINS | | -.646<br>(1.5) | | -.628<br>(1.5) |
| YOSOC | | .325<br>(.57) | | .255<br>(.45) |
| YSCH | .650<br>(1.8) | .586<br>(1.6) | 1.08<br>(3.3) | 1.02<br>(3.2) |
| UNEMP | -190<br>(.36) | -178<br>(.34) | -129<br>(.25) | -98.3<br>(.19) |
| CONSTANT | 1701<br>(10) | 1509<br>(6.0) | 1877<br>(12) | 1706<br>(7.0) |
| $R^2$ | .93 | .93 | .96 | .95 |
| RHO 1 | .49 | .51 | .41 | .42 |
| RHO 2 | -.43 | -.42 | -.44 | -.43 |
| WAGE ELASTICITIES | | | | |
| MEAN | -.62 | -.49 | -.68 | -.58 |
| 1978 | -.64 | -.51 | -.68 | -.58 |

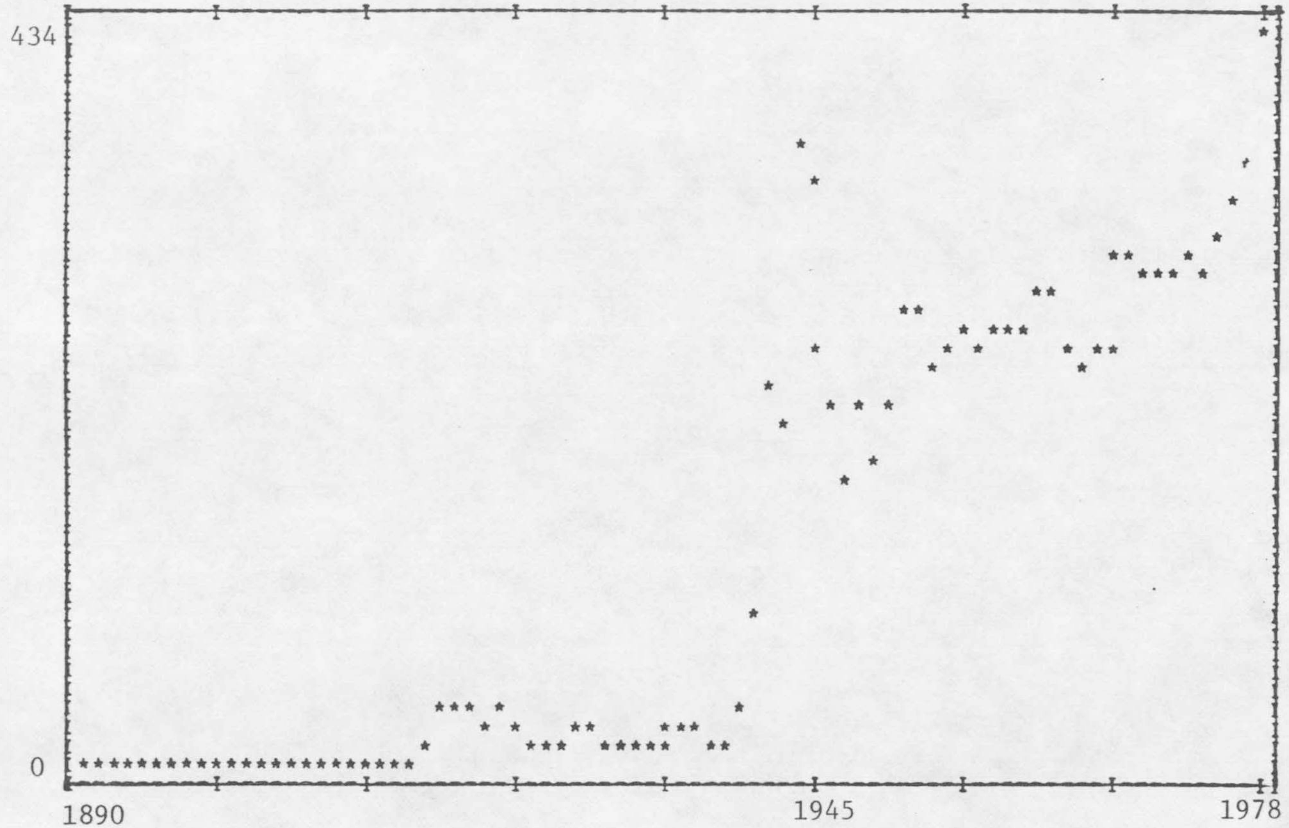



Figure 17. YPROG vs. YEAR.

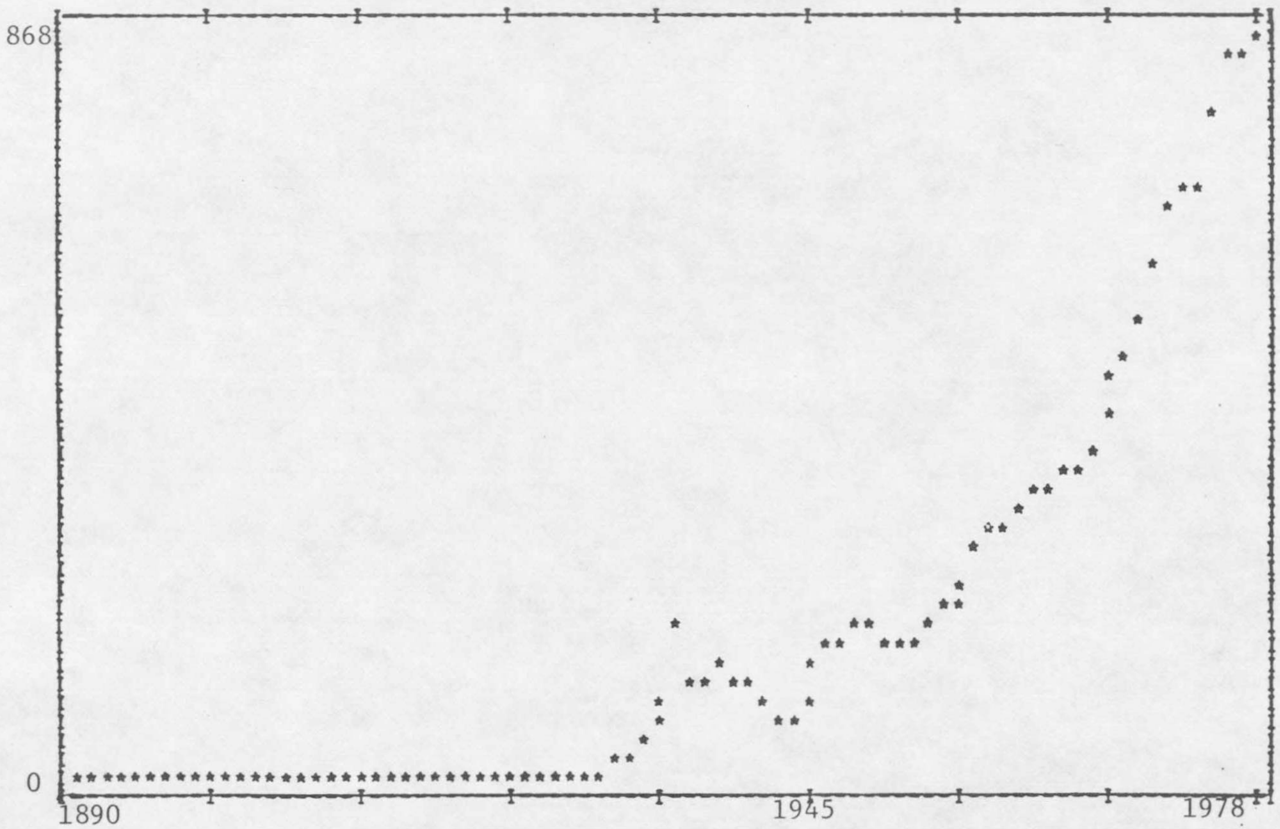



Figure 18. OGOVT vs. YEAR.

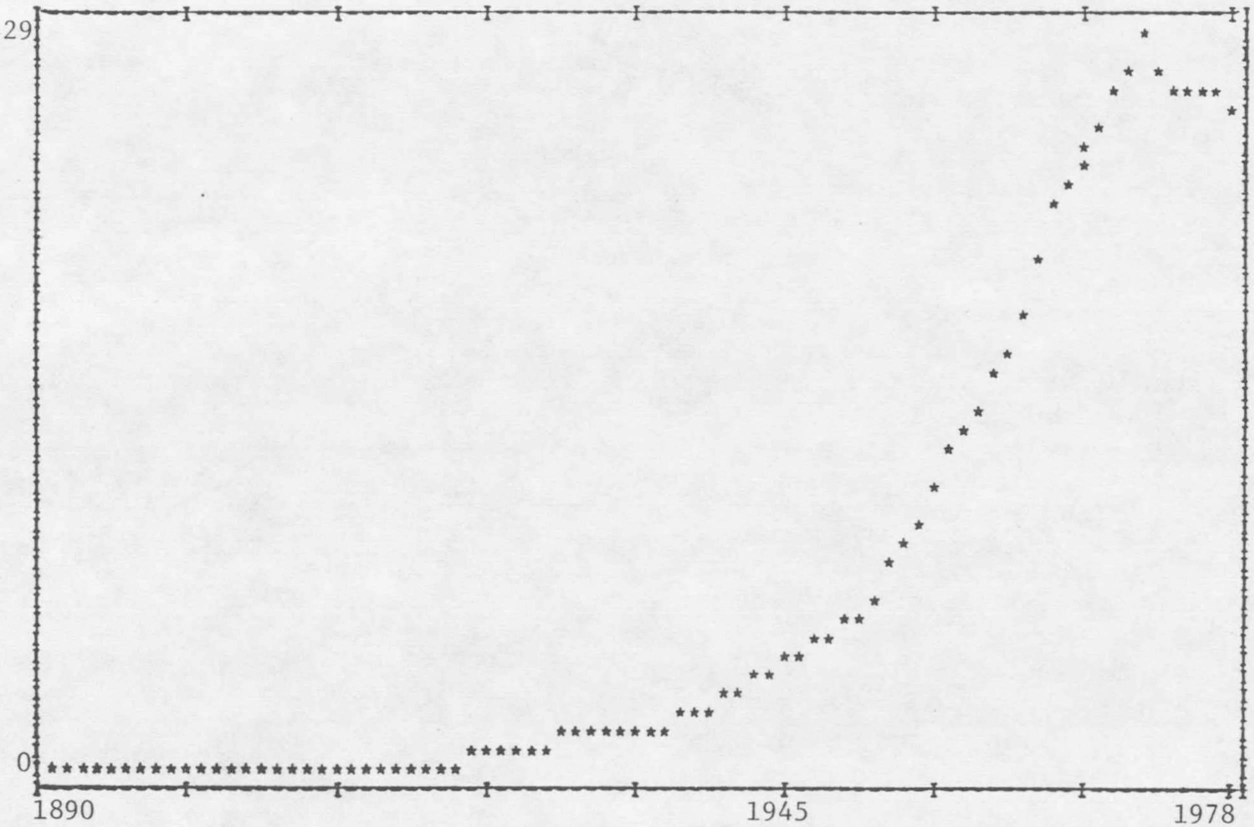



Figure 19. YSCH vs. YEAR.

Table 10. Non-Linear Labor Supply Equations–1947-1978.

| | LG Hours | LG Effort | | Hours | Effort | | Hours | Effort |
|---|---|---|---|---|---|---|---|---|
| LG WAGE | -.671 | -.668 | WAGE | -370 | -558 | 1/WAGE | 618 | 598 |
| | (3.8) | (4.4) | | (2.5) | (4.4) | | (2.7) | (2.6) |
| YNONLAB* | .390 | .278 | YNLABW | .126 | .128 | YNLABW | .287 | .111 |
| | (1.5) | (1.3) | | (.38) | (.46) | | (.83) | (.32) |
| YPROG* | -.172 | -.177 | YPROGW | -.373 | -.469 | YPROGW | -.330 | -.405 |
| | (1.2) | (1.5) | | (1.6) | (2.3) | | (1.4) | (1.8) |
| YGOVT* | -.295 | -.236 | YGOVTW | -.363 | -.533 | YGOVTW | -.238 | -.127 |
| | (2.6) | (2.4) | | (1.6) | (2.7) | | (1.2) | (.62) |
| YSCH* | .665 | .854 | YSCHW | 1.11 | 2.55 | YSCHW | .389 | .75 |
| | (1.8) | (4.1) | | (1.4) | (3.9) | | (.77) | (1.5) |
| UNEMP | -.109 | -.403 | UNEMP | -343 | -97.8 | UNEMP | -621 | -936 |
| | (.26) | (.10) | | (.61) | (.18) | | (1.2) | (1.7) |
| CONSTANT | 7.2 | 7.2 | CONSTANT | 1735 | 2023 | CONSTANT | 751 | 868 |
| | (87) | (105) | | (8.0) | (11) | | (3.4) | (3.9) |
| $R^2$ | .99 | .99 | | .92 | .97 | | .90 | .88 |
| RHO 1 | .37 | .30 | | .50 | .32 | | .47 | .48 |
| RHO 2 | -.45 | -.43 | | -.40 | -.45 | | -.29 | -.23 |
| WAGE ELASTICITIES | | | | | | | | |
| MEAN | -.67 | -.67 | | -.54 | -.93 | | -.33 | -.30 |
| 1978 | -.67 | -.67 | | -.59 | -.97 | | -.29 | -.28 |

*These coefficients have been multiplied by 1000.

There are a couple of *caveats* given the length of the period considered. Since most variables consistently and significantly increase during this period, multicollinearity continues to be a potential problem. Also, the sample size and, hence, the degrees of freedom are necessarily reduced. These two considerations suggest less precision (i.e., higher variances, lower t-ratios) of the estimators than for the equations estimated for the entire period.

Among the variables affecting long-run, desired hours of work, the wage again has the strongest explanatory power. In all but one of the equations the t-ratios are larger than two. For the linear specifications elasticities range from –.5 to –.7, while for the non-linear equations the range if from –.3 to –.97. While remaining quite small, the elasticities are generally somewhat larger in absolute value than those estimated from the full sample.

YNONLAB again displays a positive coefficient in all of the supply equations in this time period, although it is insignificant. All other variables, except OSOC, are consistent with a priori theory; however, the significance of the estimates varies among specifications. In general, YPROG appears insignificant while the income terms for social welfare expenditures are significant in half of the specifications. The YSCH term displays significance in all but one of the EFFORT equations and is significant in the LOG hours worked equation. Finally, it appears that accounting for second order serial correlation has compensated for much of the explanatory power previously attributed to the unemployment term. The second order rho estimates range from –.2 to –.45, while all t-ratios for the unemployment term are insignificant.

The results from this time period, both for the linear and non-linear specifications, are very much in accord with the set of estimates when only the years 1929-1946 were omitted (i.e., the first set of estimates). The t-ratios for YPROG, YGOVT and YSCH are consistently higher in the period 1947-1978 than for the entire period with YGOVT and YSCH being significant in about half of the equations. As suggested before, the fact that these three variables were most active in the 1947-1978 period would seem to indicate that the estimated coefficients for the variables in this time period are the best representations of their effects on labor supply.

Tables 11 and 12 summarize the effects of a one dollar change in the YPROG, YGOVT and YSCH terms on hours worked and earnings for the four different model specifications at 1978 values. These coefficients were estimated from the results for the 1947-1978 data. In giving more specific interpretation to the coefficients estimated for the labor supply functions it is the values in these tables which are relevant for policy considerations.

Table 11. Effect of a $1 Increase on Hours at 1978 Values.*

| | Linear Hrs | Linear Effort | Log Hrs | Log Effort | Hours (y/w) | Effort (y/w) | Hours (1/w) | Effort (1/w) |
|---|---|---|---|---|---|---|---|---|
| YPROG | -.236 | -.255 | -.172 | -.177 | -.211 | -.265 | -.186 | -.289 |
| YGOVT | -.254 | -.268 | -.295 | -.236 | -.205 | -.301 | -.134 | -.072 |
| YSCH | .750 | 1.08 | .665 | .854 | .627 | 1.44 | .220 | .424 |

*Coefficients estimated from the 1947-1978 data.

Table 12. Effect of a $1 Increase on Earnings at 1978 Values.*

| | Linear Hrs | Linear Effort | Log Hrs | Log Effort | Hours (y/w) | Effort (y/w) | Hours (1/w) | Effort (1/w) |
|---|---|---|---|---|---|---|---|---|
| YPROG | -.418 | -.451 | -.304 | -.313 | -.373 | -.469 | -.330 | -.405 |
| YGOVT | -.450 | -.474 | -.522 | -.418 | -.363 | -.533 | -.238 | -.127 |
| YSCH | 1.15 | 1.91 | 1.17 | 1.51 | 1.11 | 2.55 | .389 | .750 |

*Total income elasticity.

Use of the variable YPROG was motivated by the concern over the effects of progressive taxation versus proportional taxation on labor supply. Thus, it might be of interest to determine what labor supply would be if the progressivity of taxes were eliminated, that is if all taxes were proportional.

According to the estimates from Table 11, an increase in progressivity (i.e., an increase in marginal tax rates) that increases YPROG by one dollar would reduce hours worked by -.17 to -.29 hours. In comparison, Hausman's estimates of the same effect, when adjusted to 1967 dollars, range from -.14 to -.26.[6] The value of YPROG in 1978 is $615. If YPROG were reduced to zero by equating the marginal tax rate with the average tax rate, linear extrapolation implies that hours worked would increase between 106 and 179 hours. In other words, the progressive nature of the tax system reduces hours worked by about 9 to 14%, in 1978.[7] Again in comparison, Hausman estimates that hours of husbands, aged

[6] See Hausman (1981, p. 51).
[7] Welfare costs are ignored in this study.

25-55, are reduced about 188 hours, or 8%, by progressivity with even greater reductions for wives and female heads of households.[8]

Labor supply increases from reductions in progressivity could, however, be offset by responses to changes in the after-tax wage. For example, by eliminating progressivity the marginal tax rate is now equal to the average tax rate and thus the net wage is derived by using the average tax rate. In this case, the net wage in 1978 would increase from \$1.77 to \$2.66, or 41%. The estimated wage elasticities from the post WWII data range from -.28 to -.97. These imply that the reduction in marginal tax rates would lead to a reduction in hours worked by 11 to 33%, thus possibly more than offsetting the increase in hours worked from eliminating progressivity. Of course, wage elasticities closer to zero would indicate less of an offset. If the elasticity is only -.1, for example, the net effect of adopting a proportional tax system would be an increase in hours of 4 to 9%.

If it is the case that a reduction in marginal tax rates leads to a net reduction in hours worked then tax revenues would also decrease.[9] If the same bundle of goods and services are to be provided by the government the average tax rate would have to be raised to offset the reduction in revenues and this would tend to mitigate the decrease in hours worked predicted as a response to increasing the net wage via eliminating progressivity.

The coefficient on social welfare expenditures, YGOVT, tends to show more significance in the post WWII labor supply equations than for the entire sample. As with the

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[8] Hausman's approach to testing for the effects of progressivity differ somewhat from the approach used here. To eliminate progressivity Hausman eliminated the federal tax component from his imputed tax rate while it is assumed here that the MTR = AVTR. Hausman's method would lead to a lower AVTR than when federal taxes were included. However, because Hausman's estimate of the wage elasticity is essentially zero, the result of an 8% reduction in labor supply is strictly attributable to the income effect stemming from reducing virtual income to zero by eliminating federal taxes. Thus, his results, as far as a testing for the effects of progressivity are concerned, are a fair basis of comparison for the results from this study.

[9] Reducing YPROG to zero by making MTR = AVTR in itself would not lead to a reduction in taxes in the aggregate if the tax base remains constant.

YPROG term, on average, a one dollar change in YGOVT is estimated to reduce hours worked by –.2. A similar question can be asked in regard to this term as with the effect of taxation, that is what would be the impact on labor supply from reducing social welfare expenditures to zero?

The value of YGOVT in 1978 was $868. If this were zero, *ceteris paribus*, hours worked would increase by 174 or by 16%. Danziger, Haveman and Plotnick performed the exact same exercise in their study and, as stated earlier, they estimated an approximate 5% increase in hours worked.[10] Thus there is a substantial discrepancy between the two estimates. It is interesting to note that if the coefficient for YGOVT from the functional form employing 1/WAGE is used to estimate the effect of eliminating social welfare expenditures the result is an increase in hours worked of 10% for the HOURS equation and an increase in hours of 6% for the EFFORT equation. These estimates are more in accord with Danziger et al.'s findings.

Again, however, in this situation *ceretis paribus* is a very strong assumption. The estimate implies that no compensation for the services provided through social welfare expenditures would take place through the private sector. Also, eliminating Social Security expenditures in particular, would entail eliminating the Social Security tax. A similar analysis as was done with the YPROG term would have to be undertaken to determine the net effect of this change in hours worked. Due to the complications of reevaluating the average marginal tax rate by eliminating the Social Security tax rate this exercise will not be performed.

Finally, in regard to income foregone from school, it is of interest to know by how much increases in education, or the value of education, would increase hours of work. On average, the estimated coefficients indicate the one dollar increase in the YSCH term

[10] The programs covered in their study account for approximately 73% of total social welfare expenditures excluding education while this study accounts for all social welfare expenditures except education.

will increase hours worked by .6. Because the value of this term was computed by multiplying the net wage by time spent in school, either a change in the wage or a change in time spent in school will serve to changes its value.

In 1978 the value of YSCH was $368. A one dollar increase in the wage would result in this term increasing by $208. Given the level of schooling, this in turn would serve to increase hours of work by 125 or by 12%. On average, the wage elasticity for 1978 is –.5. This elasticity indicates a reduction in hours worked of 215 hours or 20% given a one dollar increase in the wage. The net effect then of increasing the "value" of education would be an 8% decline in hours worked. It is important to remember that despite the net effect, accounting for investment in education makes the reduction in hours worked from an increase in the wage less than it would be otherwise.

Alternatively, the increase in this term as a consequence of an increase in the median years of education by one year is $84. This, in turn, would result in an increase in labor supply of 50 hours or 5%. Results from the study done by Kneiser testing for this same effect, as reported earlier, also found that an additional year of education causes an individual to increase work by fifty hours per year. Since 1890 median years of education attained increased by 4.4 years. Estimates imply that, *ceteris paribus*, the change would account for an increase in average hours worked by an individual of 256 hours since 1890.

Table 12 gives estimates of the effect of a one dollar change in the income terms on earnings. This table was essentially provided for easier interpretation of the effects of changes in the income variables affecting labor supply. Thus, for example, if social welfare expenditures were increased by one dollar, on average, 30 to 40 cents would go toward consumption of leisure. Such a measure seems to put the goods/leisure tradeoff in a better perspective than the direct estimates from the labor supply equations provide. It is obvious that the coefficients for the YSCH variable are implausibly large in three out of four of the specifications. In fact, such measures imply that consumption goods are inferior goods as when income foregone from school goes up by one dollar (i.e., "as if" non-labor income goes down) an individual's consumption of goods will increase due to the fact that leisure consumption will decrease by more than one dollar, and vice versa. The coefficients for the model specification using the term 1/WAGE are in line with expectations for this measure.

This completes the discussion of the results of estimation of the four labor supply equations. The following chapter will give a summary and conclusion for the findings of this study.

# CHAPTER 6

## SUMMARY AND CONCLUSIONS

This study has attempted to explain the observed decline in average hours worked in the market by individuals in the last ninety years. A labor supply model was developed which accounted for the effects of changes in the wage, non-labor income, taxation, social welfare expenditures and education on individuals' decisions to work. The model is the first among those using time series data to use marginal tax rates in the computation of the wage, explicitly account for transfer payments, consider the dual effects of changes in education and account for the additional income effect from progressive taxation. While there have been many cross-sectional studies performed testing for these effects, no study, cross-sectional or time series, has accounted for them simultaneously. Using data for a "representative" individual, four different functional forms were employed to estimate a labor supply function. The results from these estimations were then interpreted for the aggregate economy.

While there is variation among results for the labor supply equations estimated there are also a couple important consistencies which lend support to previous empirical findings. First, all model specifications for all periods considered suggest a negatively sloped, relatively inelastic supply curve. In general, elasticities at the mean range from .03 to −.7. In particular, these results uphold the findings of the two previous time series studies done by Abbott and Ashenfelter and Barnett, whose combined results indicate uncompensated wage elasticities ranging from .14 to −.14. This situation suggests that previous studies did not err by ignoring the effects of taxation, transfers and schooling. Furthermore, the results indicate that the wage offers the strongest explanation for the observed decline in hours worked over time as well as for the post WWII years. Coefficients were significant in 25 out of the 30 equations estimated.

Second, progressive taxation tends to reduce hours worked through the virtual income effect. Estimated coefficients were negative in all of the labor supply equations and significant in approximately half. Not only is the finding of a negative income effect from changes in marginal tax rates consistent with previous studies done by Hall and Hausman but also the estimated magnitude of the virtual income term is in strong agreement with Hausman's findings in particular. Estimates for a one dollar increase in YPROG from this study range from –.17 to –.29 while estimates for the comparable term from Hausman's study range from –.14 to –.26. Because Hausman also estimated the wage coefficient for males to be essentially zero, he did not find an income effect from a rise in the wage when progressive taxation was eliminated. As a consequence, his results indicate hours of work increase when a progressive tax structure is replaced by a proportional tax structure.

While the finding from this study of a negative coefficient on the YPROG term accords with Hausman's conclusion that a progressive tax system creates an "additional" negative income effect that does not exist under a proportional tax system, consideration of the income effect of a change in the wage indicates that eliminating progressive taxation by equating the marginal tax rate with the average tax rate may serve to decrease hours worked. Thus, given the estimated wage elasticities of this study, a proportional tax system may result in less hours worked than a progressive tax system.[1]

[1] It should be mentioned that if progressive taxation is reduced and all individuals are taxed proportionally, the marginal tax rate will be reduced for some individuals but increased for others and thus in net, in the aggregate, there may not be the reduction in hours from the income effect suggested by this study. Marginal tax rates will be reduced for individuals in higher income brackets and increased for individuals in lower income brackets thus creating two opposing income and substitution effects as well as two opposing income and substitution effects as well as two opposing virtual income effects. The overall effect of eliminating progressivity then will depend on how hours worked in the economy are divided up among income brackets.

The evidence for the effects of social welfare expenditures and the income effect of time spent in school is weaker. In particular, there are greater discrepancies between the estimates from the post WWII period and the complete sample. If the former are viewed as more reliable then YGOVT and YSCH always have the expected signs and are significant in all but one of the EFFORT equations.

A comparison was made between the estimates from this study and that of Danziger, Haveman and Plotnick's study for the effect on labor supply from reducing social welfare expenditures to zero. The two results, 16% for this study, 5% for theirs', display a large discrepancy. The fact that their estimates did not arise from any direct estimation procedure but rather from extrapolation from other studies' findings makes for difficulty in determining which of the two estimates is more suspect. There has been only one other time series study accounting for the effects of schooling, that of Kneiser, and as stated earlier, the finding for the effect on labor supply from a one year increase in education from his study was exactly the same as the finding from this study, that is an increase in median years of education attained by one year results in an increase of 50 hours worked per year.

Despite variations in signs and significance levels, the results also indicate a strong consistency in the magnitudes of the YPROG and YGOVT income terms in particular. This finding also lends support to previous empirical results. As noted earlier, Killingsworth suggested that, on average, the total income elasticity for non-labor income from previous empirical studies was –.2. As the results for this study show, the total income elasticity for YPROG and YGOVT, on average, was –.3.

If time spent in school is considered a direct substitute for market work then the overall decline in hours worked is mitigated by increases in education. When EFFORT is used as a dependent variable the decline in hours worked from 1890 to 1978 is approximately 20% versus 30% when education is not accounted for.

Perhaps the most important finding from this study is that of a negatively sloped, relatively inelastic supply curve. Not only does it corroborate many previous empirical findings but also it has important implications when the effects of the other variables are considered. As displayed in the previous chapter, although progressive taxation may have work disincentives as signified by a negative coefficient for the YPROG term, the sign and magnitude of the coefficient for the wage determines what the overall effect from changes in taxation will be. The results from this study suggest that lowering marginal tax rates will tend to decrease labor supply, indeed, a contradiction to the supply-side argument.

Before concluding the discussion of the results from this study some *caveats* should be mentioned. Despite the fact that the labor supply model proposed in this study simultaneously accounts for more explanatory variables than any previous study, there are several things that have been ignored. First, the analysis does not consider the detailed structure of the tax and transfer programs affecting labor supply, especially the implicit tax rates of transfer programs. Second, the model does not account for changes in a family/household structure and division of labor within these units. Changes in the average number of children, changes in the number of single parents households, and technological changes in household production are all thought to have an impact on labor force participation rates and, in turn, the amount of hours worked in the market. Third, the effects of changes in prices of substitutes and complements to leisure on labor supply were not accounted for. This consideration was discussed previously and as stated in that discussion, in general, the consequence of ignoring cross-elasticities is an overstatement of the explanatory power of the wage. Fourth, the change in benefit levels accompanying wage income as well as changes in working conditions were not considered. This again can result in biased, estimated coefficients for the wage. Finally, while an increase in education was cited as an explanation to the decline in hours worked in the market over time, no consideration was given as to why education has increased over the last one hundred years. It is likely that government subsidies are in part responsible for the rise in schooling. Since a change in the amount of schooling impacts labor supply it follows that the effect of changes in government expenditures on education should be considered when assessing changes in labor supply. As stated earlier, however, accounting for both the direct effect of changes in the level of education and the effect of governmental educational expenditures on hours worked would be redundant when considering the impact of changes in education on labor supply in general.

Because no other study has simultaneously accounted for the effects of changes in wealth, taxation, transfer programs, and education, this study was experimental in many ways and the lack of robustness in results may, in large part, be a consequence of the time constraint on further experimentation. However, the fact that estimates of the wage coefficient in particular were consistently in accord with previous findings, especially when these four other factors were accounted for, seems to give credibility to the study overall. It also suggests that the estimated coefficients for the income terms are not wildly off-base.

In conclusion, the findings from this study indicate that it has been the income effect from increases in the wage over time that provides the strongest explanation for the fact that, on average, individuals are working less. An inelastic supply curve may suggest that over time individuals have raised their standard of living. Long-run estimates in particular indicate that progressive taxation serves to discourage work while the results from the period 1947-1978 support *a priori* theory that transfer programs are a disincentive to work. Finally, although the estimates for the effect from investment in schooling are less robust among the four model specifications, the linear model, both in the long-run and for the post WWII period, gives strong support to the theory that increases in education encourage people to work more.

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