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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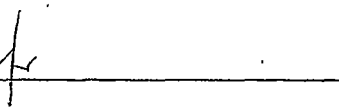
Signature 

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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.

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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

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[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.

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[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

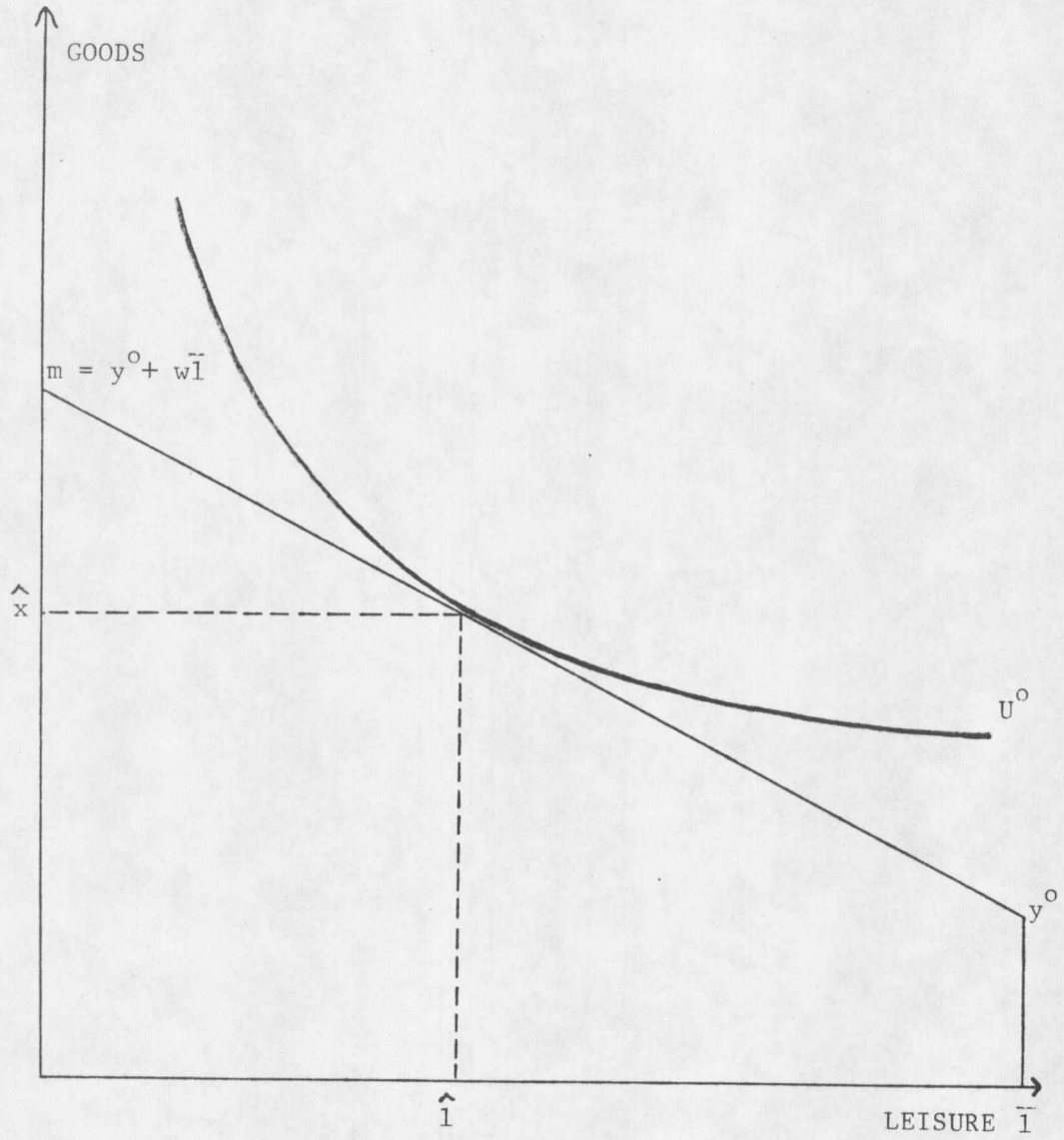

Figure 1. Standard leisure demand/labor supply model.

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,

$$v(w,m) = u(x(w,m), 1(w,m))$$

compensated (utility constant) leisure demand is

$$1 = 1^*(w,v)$$

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

$$\frac{\partial 1^*(w,v)}{\partial w} = 1_1^* < 0$$

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,

$$1_1 = 1_1^* - 1 \cdot (1_2)$$

with 1_1, 1_1^*, 1_2 defined as before. Since full income is

$$m = y^o + w\bar{1},$$

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

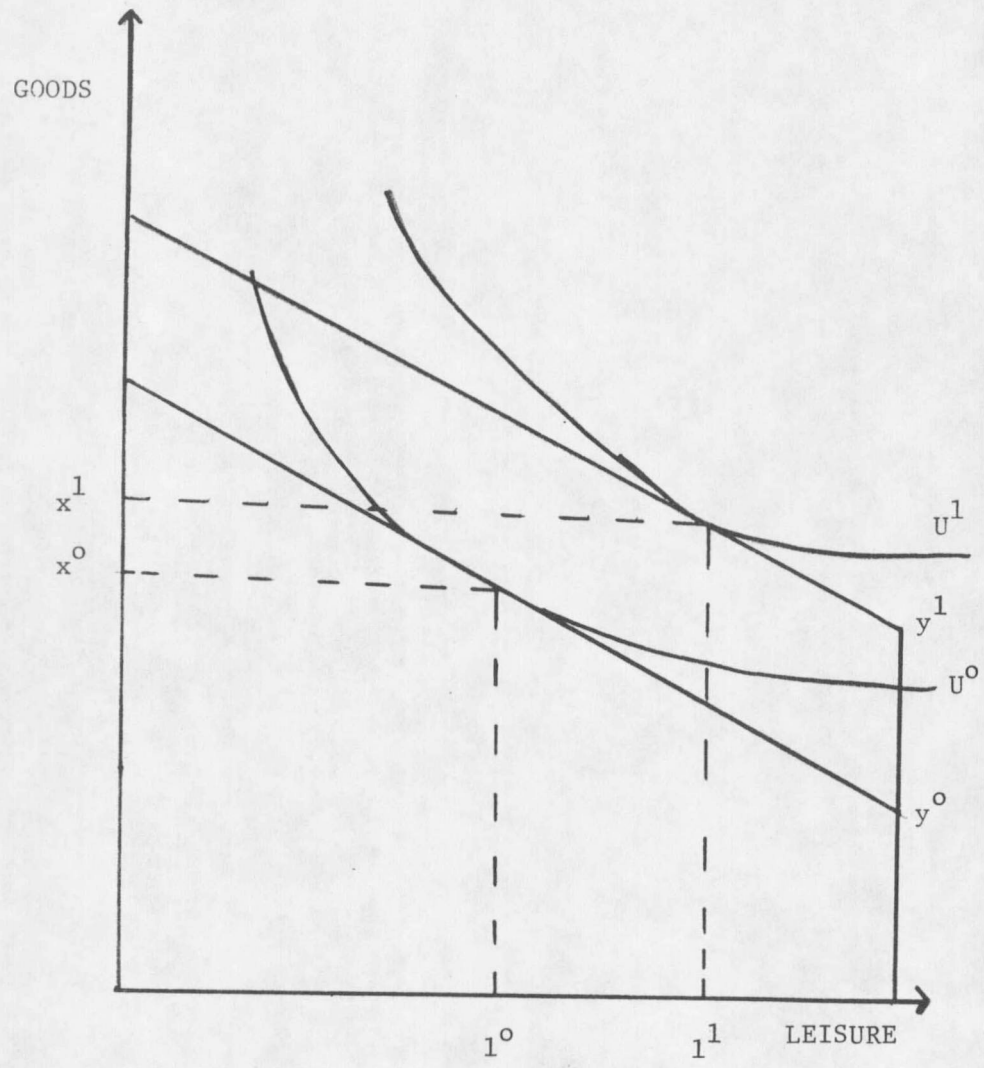

Figure 2. The effect of a change in non-labor income on leisure consumed.

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

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

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

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

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 $(\bar{l},y^o)$. 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

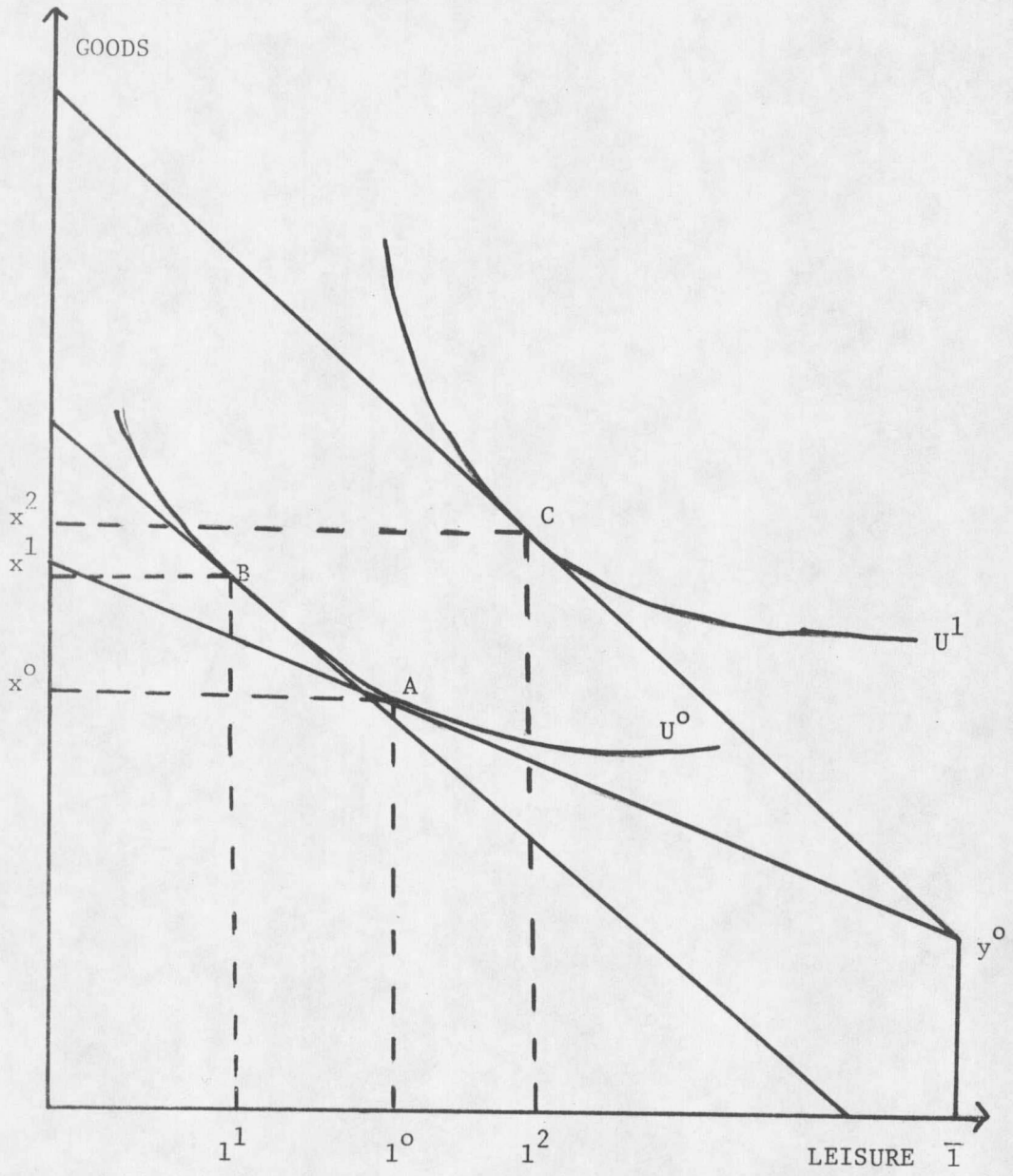

Figure 3. Income and substitution effects from a change in the wage.

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

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

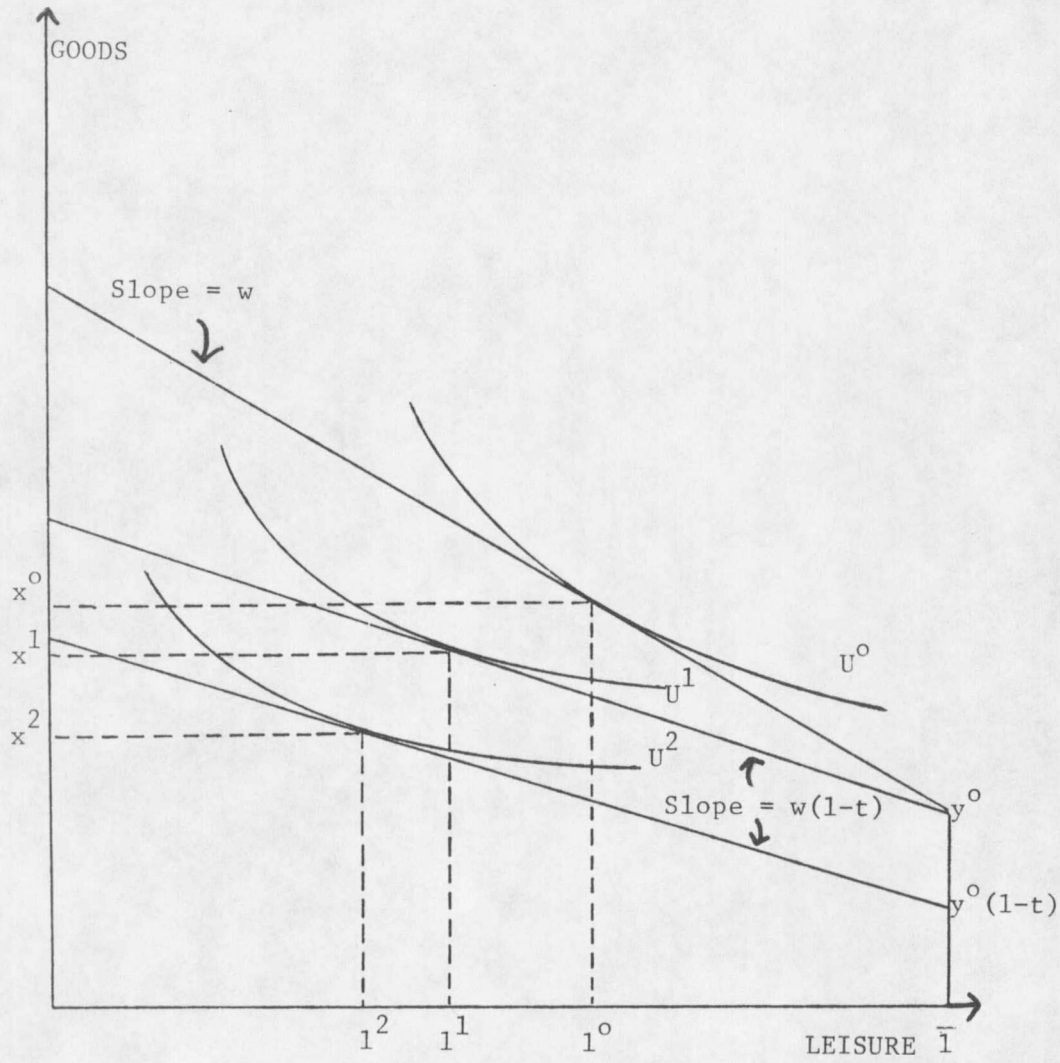

Figure 4. The effect of a proportional tax on labor supply.

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

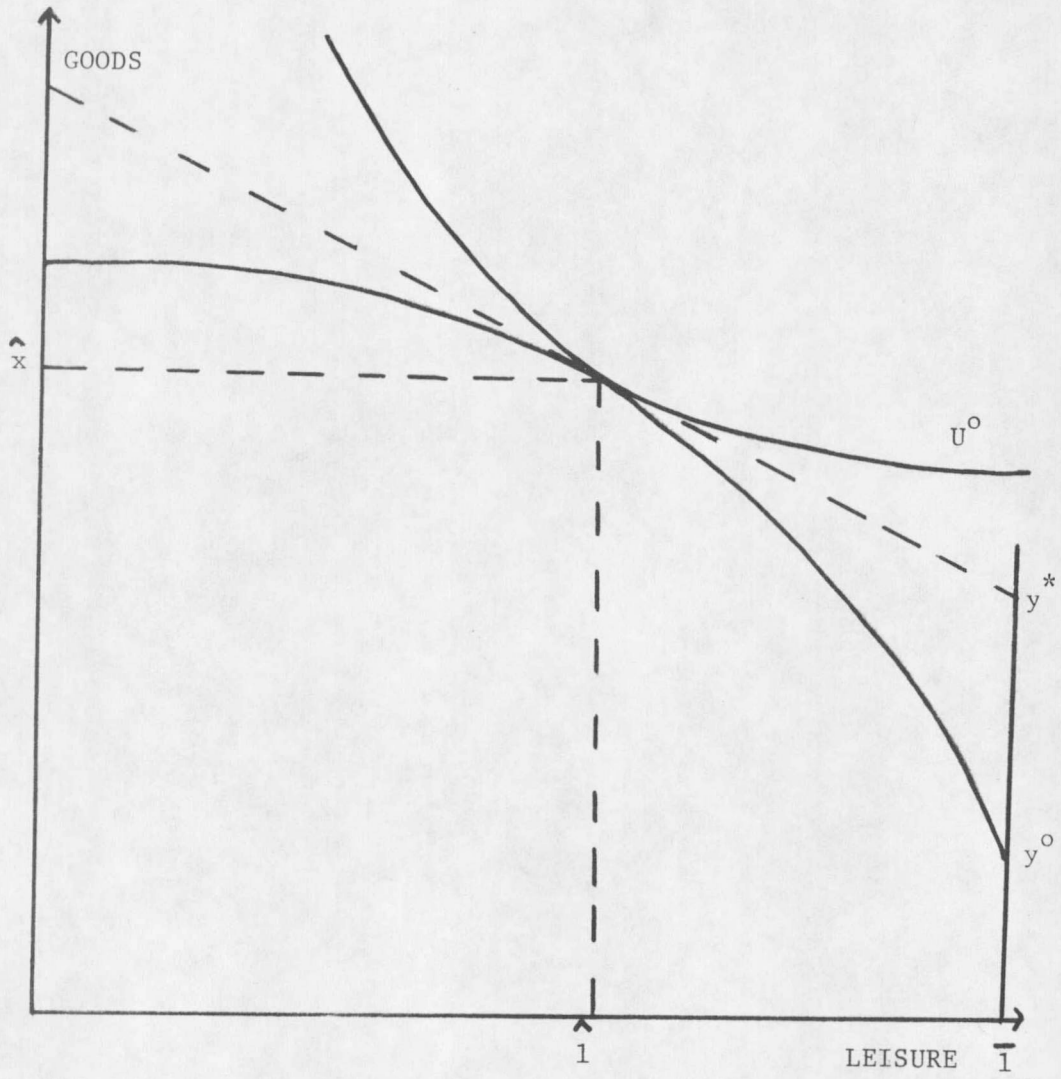

Figure 5. Non-linear budget constraint arising from marginal tax rates.

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,

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

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

thus,

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

and

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

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

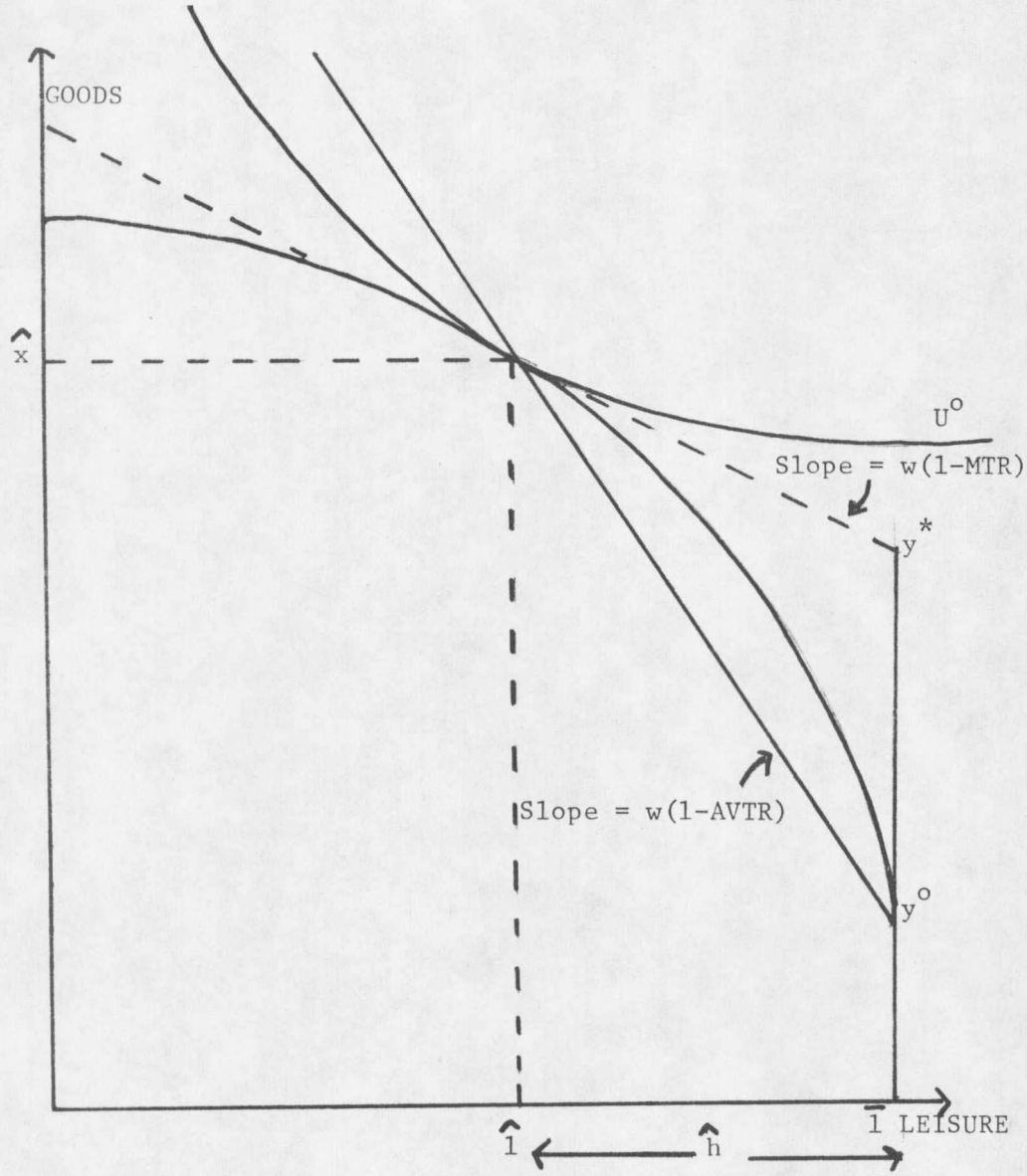

Figure 6. Calculation of "additional" income term from progressive taxation.

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.

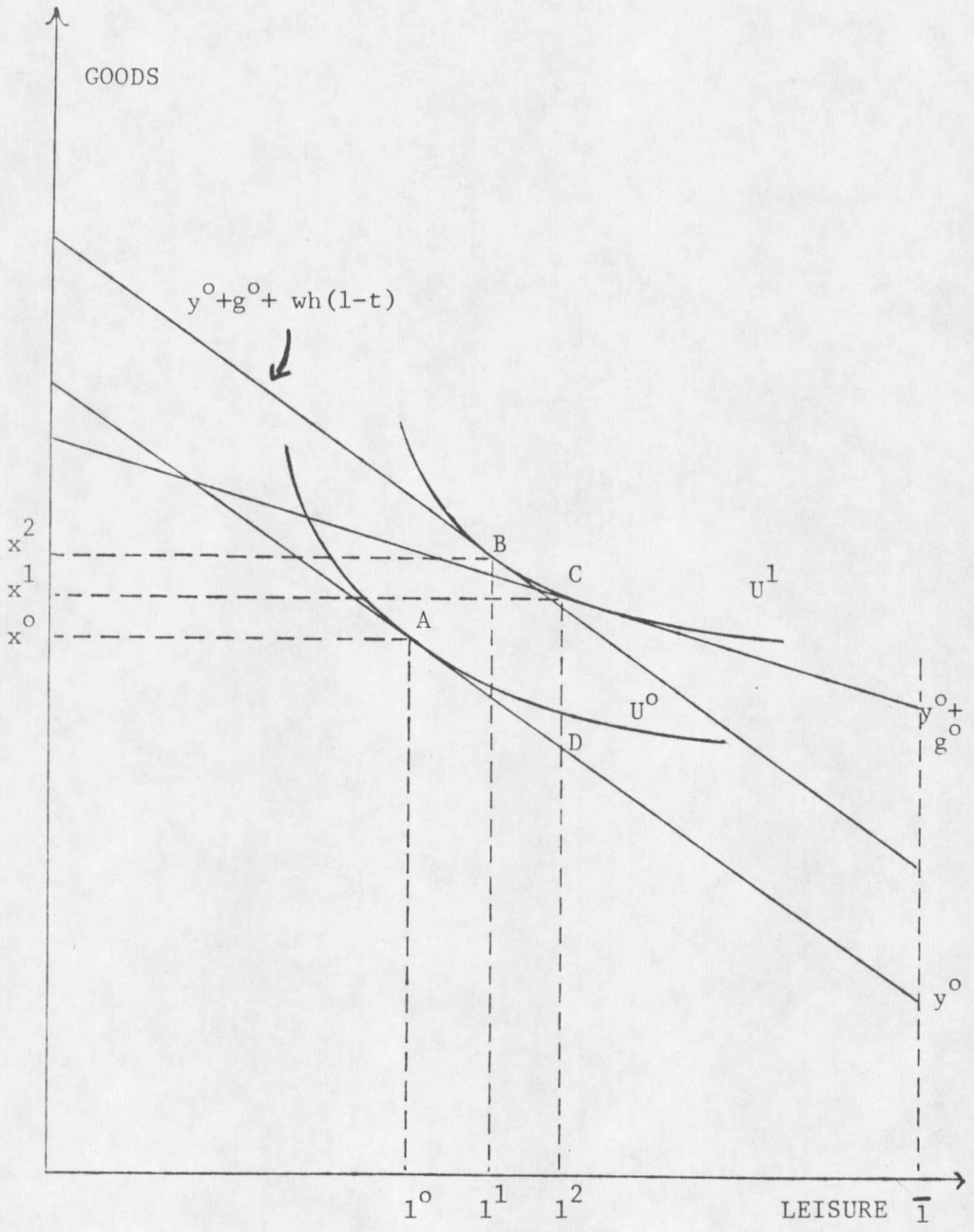

Figure 7. Effect of NIT program on leisure demand/labor supply.

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.,

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[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).

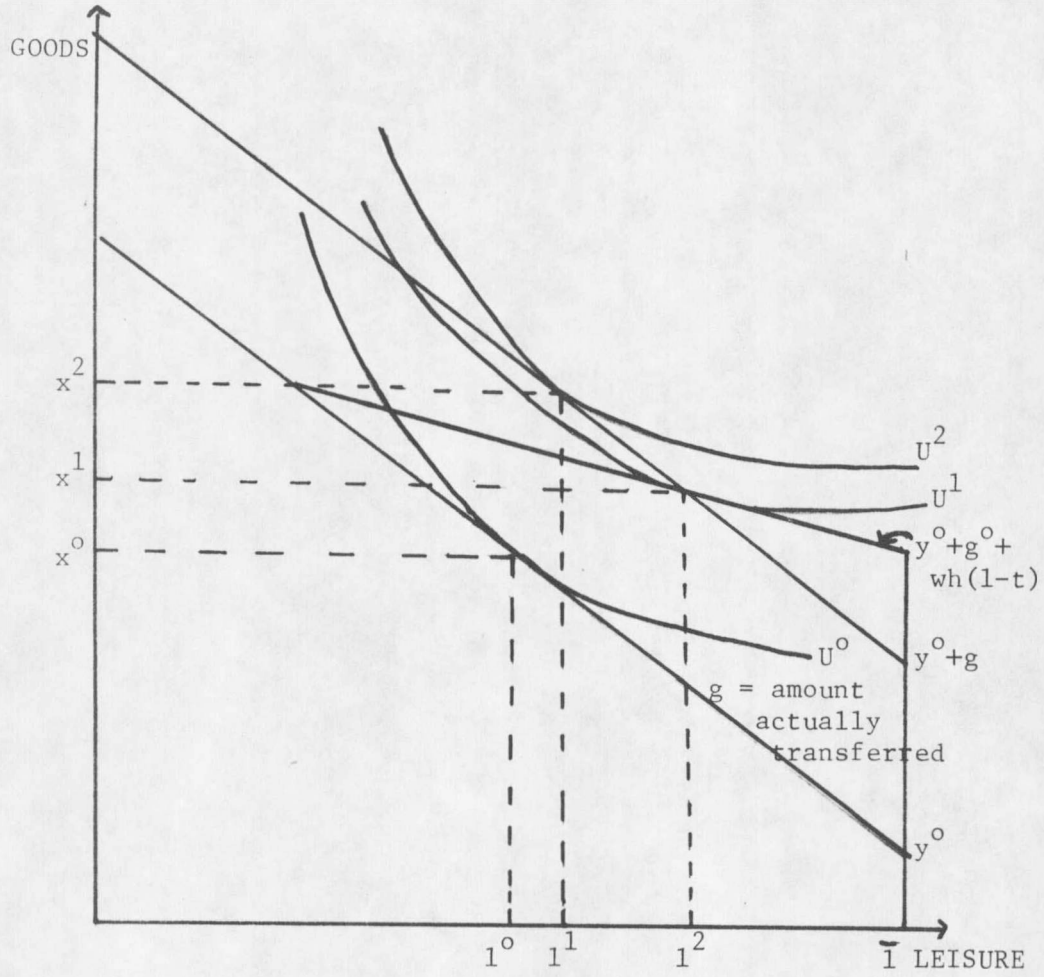

Figure 8. Understatement of the effect of transfer problems on leisure consumed/labor supply.

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

[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,

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

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

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

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

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

As Figure 9 shows, an increase in the level of education (i.e., s_1, s_2, . . .), holding the wage and non-labor income constant serves to decrease "as if" non-labor income (i.e., $\hat{y}_1$, $\hat{y}_2$, . . .) 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

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

a change in the wage results in,

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

$$= l_1^* + l_2 \cdot (\bar{l} - \hat{s} - 1)$$

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

(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

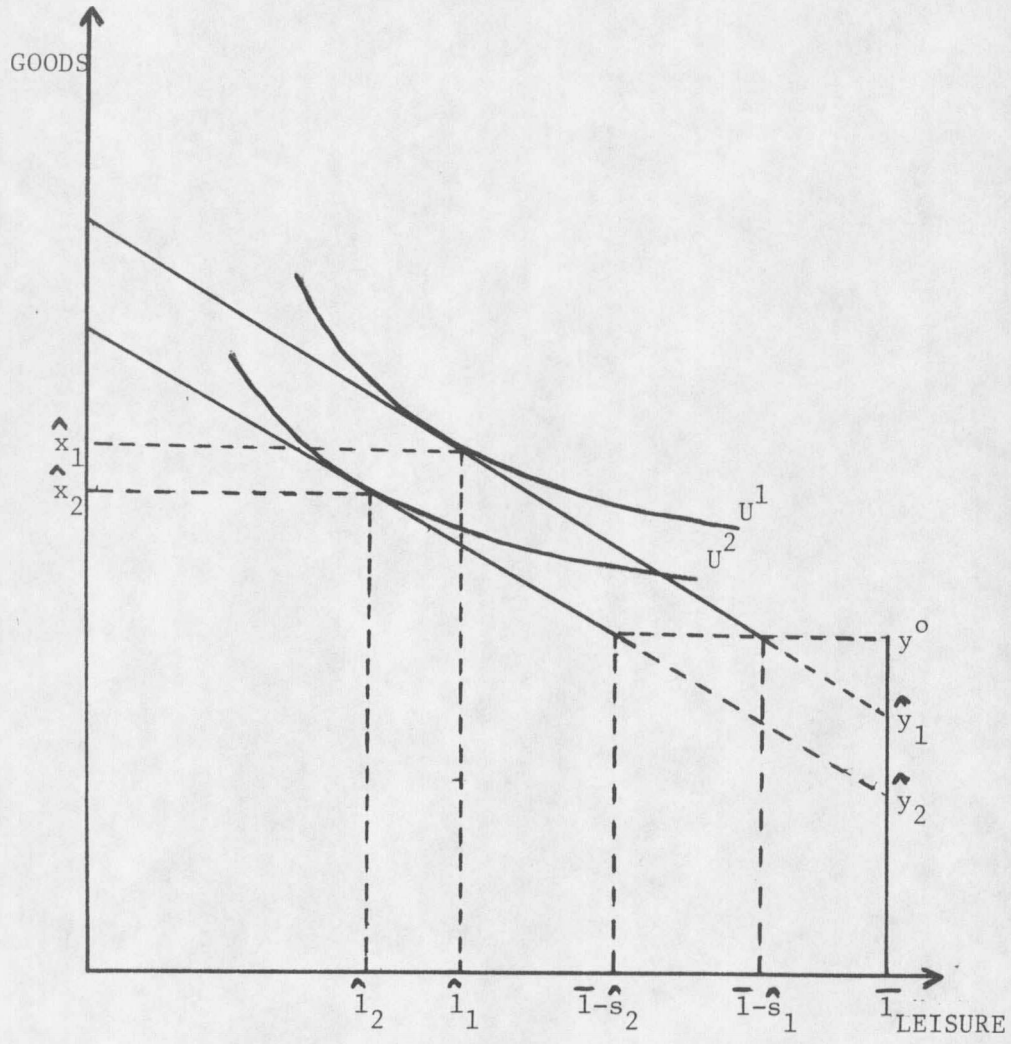

Figure 9. The effect of different levels of schooling on leisure demand, given the wage and non-labor income.

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

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.

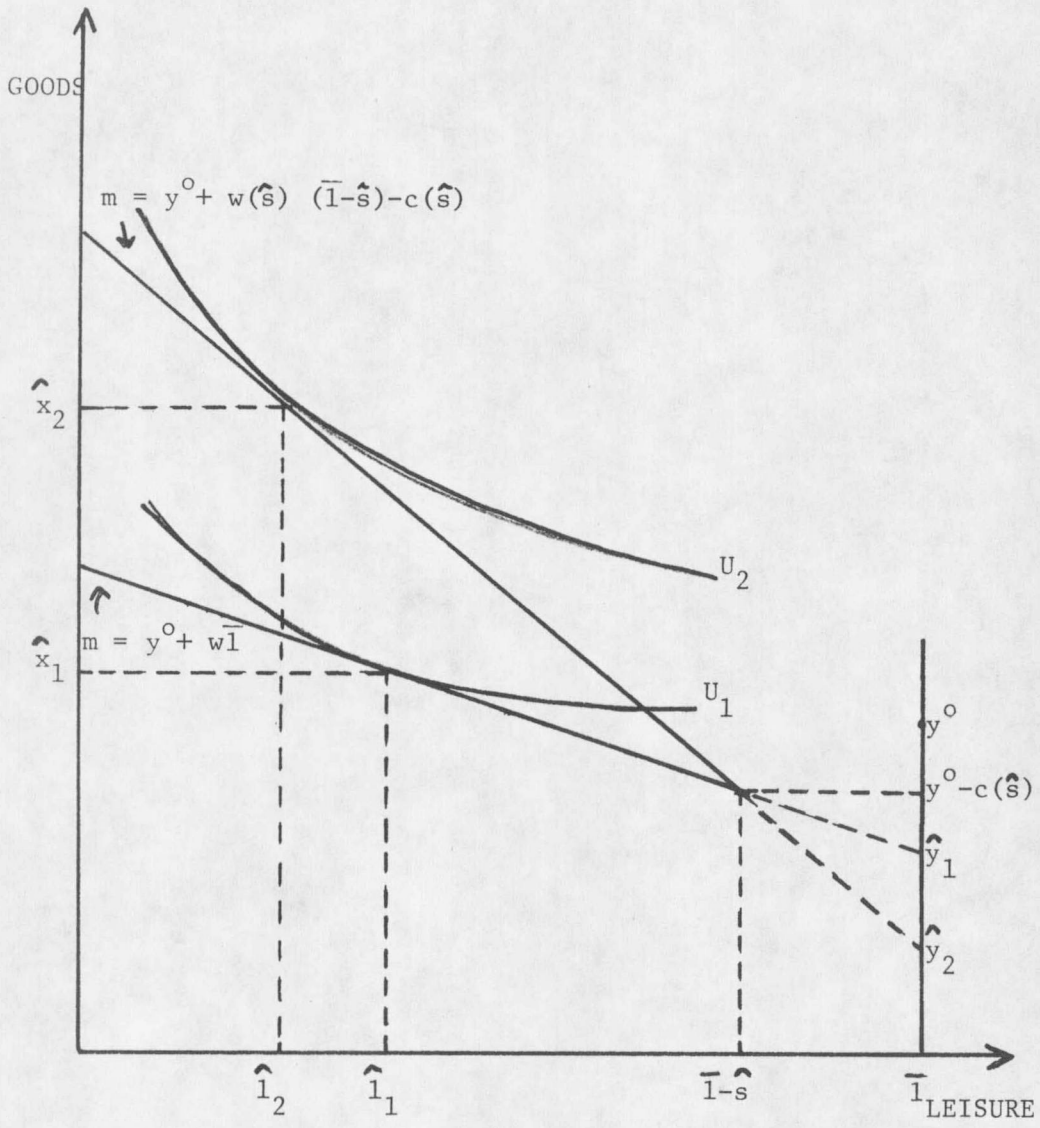

Figure 10. The effect of a change in the wage on leisure demand, given some level of schooling.

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.

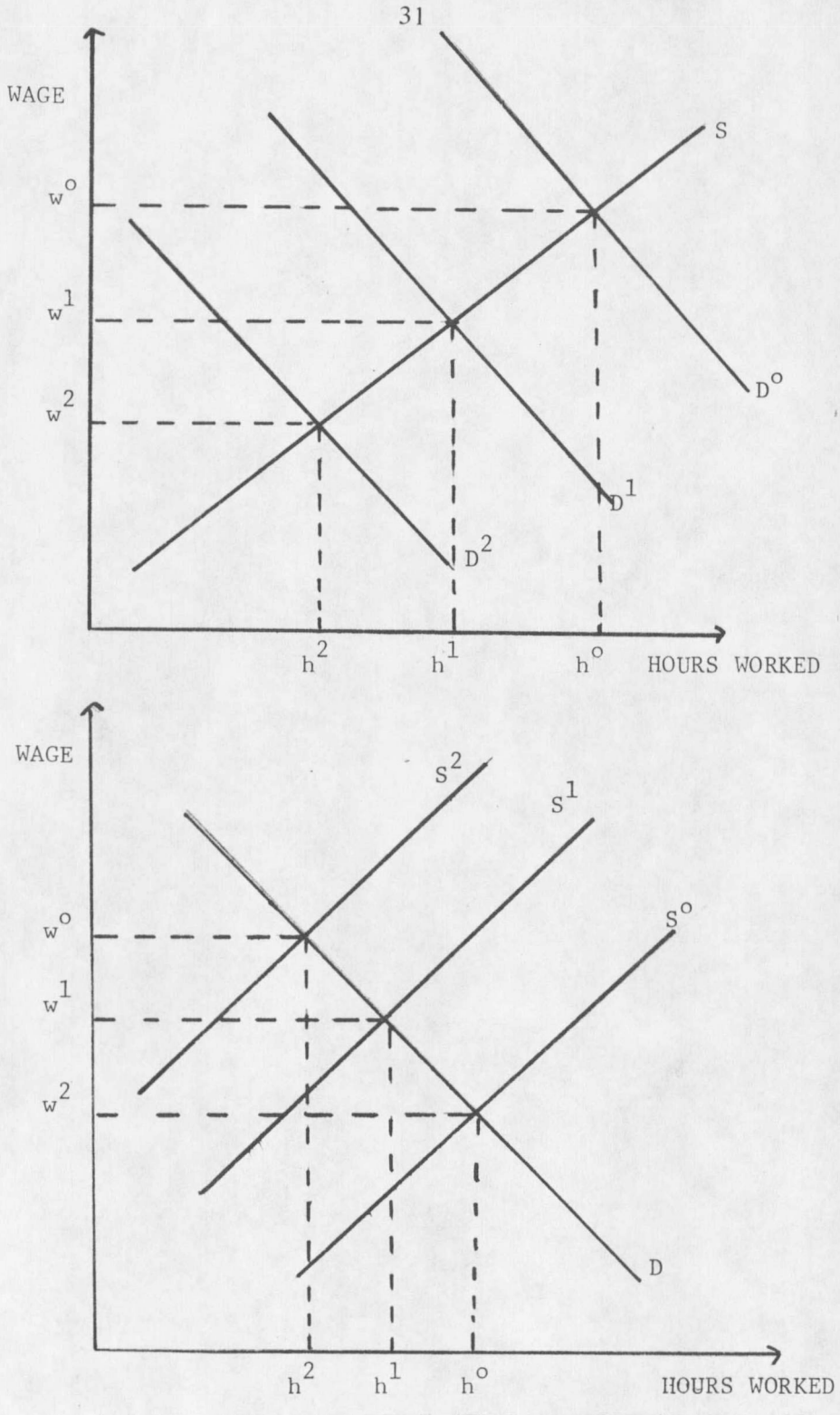

Figure 11. Effect on changes in demand and supply on leisure/labor supply.

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 nonlabor 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.

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[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		Total Income Elasticity[2]
		Compensated	Uncompensated	
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*