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Non-Wage Benefits in a Simultaneous Model of Wages and Hours: Labor Supply Functions of Young Females

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ABSTRACT

This paper examines the estimation of a simultaneous model of hours and wages. We argue the relationship between weekly hours worked and the hourly wage is due to increasing marginal tax rates. As the total wage increases, due to increasing hours, employers and employees avoid taxation by substituting wages with non-taxable non-wage benefits. This is attentuated by labor legislation entitling employees to employer provided benefits. We estimate a wage that is independent of any benefit effect and employ it in the labor supply functions. An estimator is presented for the wage/hours market locus and the structural labor supply function. An application to the data examined Moffitt (1984) supports the validity of the procedure. A second application reveals that a previous study which concluded that the labor supply function of young females is downward sloping is misleading.

1. Introduction.

The conventional labor supply model features agents optimizing their hours of market work in an environment where the hourly wage rate is independent of the number of weekly hours worked. This constant hourly wage rate assumption is questioned in the work of Oi (1962) and Barzel (1973) who exposit a relationship between the hourly marginal product and hours engaged in market work. Further objections appear in the taxation\labor supply literature, see for example Rosen (1976), Burtless & Hausman (1978) and Arrufat & Zabalza (1986), which focuses on the effect of taxes upon labor supply. These theoretical expositions have motivated others, such as Moffitt (1984), Lundberg (1985) and Biddle & Zarkin (1989), to develop econometric models to estimate the relationship between hours worked and the hourly wage rate.

In this paper we approach the wage\hours relationship from a new perspective. We argue that the value of the worker's hourly remuneration is held constant over hours although the hourly gross and net wage rates are decreasing. This is due to the introduction of non-wage labor income into the employee's compensation. As workers increase their number of weekly working hours their average hourly post-tax wage decreases due to increasing marginal rates of taxation. As the employer wishes to maintain the work incentive for the employee he endeavors to keep the value of the average hourly post-tax wage constant by embellishing the gross wage with non-wage benefits. This produces an hourly net wage decreasing in hours although the true value of hourly remuneration is independent of hours. In fact, if the employer has substantial economies of scale in producing the benefits, or is compelled by labor legislation to provide substantial benefits, the pre-tax wage rate may actually decrease with hours. We argue that the negative relationship between the hourly gross wage and hours worked that results from this approach has led to incorrect conclusions that a negative relationship exists between the true level of hourly remuneration and hours worked. The observed wage is not the correct measure of an individual's remuneration but needs to be augmented by the value of the non-wage labor income.

A further objective of this paper is to introduce a simple estimating procedure for simultaneous models of hours and wages. A feature of the literature on optimization in the presence of non-linear budget constraints, of which labor supply with progressive taxation rates is a special case, is the implementation of likelihood methods for estimation. The empirical work of Burtless & Hausman (1978), Moffitt (1984) and Arrufat & Zabalza (1986), for example, all require special programming. This approach is useful as the models estimated follow directly from a well specified optimization problem. A negative aspect, however, is the models are sometimes constructed to ensure estimable labor supply functions. Further, the special programming required often makes them forbidding to others performing empirical work. We derive a simple sequential estimator which is easily implemented and addresses the relevant econometric issues.

The following section reviews the relevant theoretical and empirical evidence and presents a simple labor supply model where the observed hourly wage is decreasing in hours while the rate of hourly remuneration is constant. Section 3 presents the estimation procedure while section 4 reports the empirical results from applying our estimator to the data analyzed in Moffitt (1984). We then estimate a simultaneous model of wages and hours for Australian young females. These results are presented in section 5. These data represent an interesting focus of study for two reasons. First, previous work by Miller & Volker (1987) reported negative wage elasticities for this group. We find that after accounting for the endogeneity of wages and the influence of non-wage benefits this result does not hold. Second, the data were collected prior to the introduction of extensive fringe benefit taxes into the Australian economy. These taxes were introduced following the finding that tax avoidance of this form constituted a substantial loss of government revenue. The issue of marginal tax rates is discussed in section 6 while concluding comments are contained in section 7.

2. Wages and Hours.

Early labor supply models were characterized by individuals facing a constant hourly wage rate. More recent models, however, have incorporated some relationship between hours and hourly wages. For example, Oi (1962) argues that as labor is a quasi fixed factor the level of hourly wages should increase with the total number of hours. Barzel (1973) proposes that with start up costs and tiring the hourly wage rate should increase initially but decrease as the number of daily hours increases.

An examination of wage/hours data, and existing empirical work, reveals some, albeit unclear, relationship between the hourly wage and hours worked. Moffitt (1984) finds in an examination of data on older females taken from the 1972 wave of the National Longitudinal Survey that wages increase with hours, at approximately five cents (1972 dollars) an hour, peaking at around 34 hours a week. Lundberg (1985), analyzing longitudinal data for low income married males from the Denver Income Maintenance Experiment over the period 1972 to 1974, rejects the hypothesis that wages are exogenous to hours using Granger causality tests. She concludes that hours and wages respond positively to each other although the effect of hours upon wages is very small. Biddle & Zarkin (1989) estimate a simultaneous model of wages and hours in an implicit market model framework using data for males taken from the 1977 and 1978 panels of the PSID. They find a non linear relationship between average hourly earnings and the level of annual hours with a positive relationship existing up to approximately 2,500 hours before turning negative.

A feature of the above papers is that they rely on simple models to motivate a non constant wage rate. Moffitt relies upon Oi/Barzel type effects while Lundberg's model focuses upon wage contracts with specified hours. Biddle & Zarkin also refer to Barzel's analysis to explain the relationship between hours and wages they uncover. An alternative approach is provided in the taxation\labor supply literature (for example see Rosen (1976), Burtless & Hausman (1978) and Arrufat & Zabalza (1986)). This argument, hereafter referred to as the "taxation approach", is that due to progressive taxation rates and income support schemes the individual's consumption set constraint is non-linear and possibly non-convex. As the individual's working hours increase the post-tax hourly wage decreases changing the rate of return to labor. The outcome is that the hourly gross wage, defined to be the hourly pecuniary remuneration before taxation, is independent of hours, while the hourly post-tax wage, referred to as the net wage, is decreasing in hours.

Consider now where the employer attempts to keep the level of hourly remuneration to the employee constant, despite the increasing taxation rates, through the payment of non-wage benefits. However, first consider why this may be an employer objective and why a hourly wage rate decreasing in hours is unappealing. First, there is no evidence that marginal productivity is dependent on the number of hours worked. Thus there is no reason to expect the hourly wage to vary on productivity grounds. Second, a constant gross wage rate produces a decreasing net wage rate creating disincentive effects for the employee as the returns to his time are effectively decreasing. These reductions in productivity will be borne by the employer who provides the same hourly wages irrespective of the marginal tax rate. It is also possible that workers facing downward sloping wage schedules from individual employers will have incentives to diversify their employment portfolio by allocating their working hours across different employers. While movement and transaction costs will reduce the profitability of such behavior it will nonetheless restrict the extent to which wages can decrease with hours. Finally consider the role of overtime payments. The fact that employers need to pay a higher hourly wage rate to induce additional labor input suggests that it is unlikely that workers are willing to accept a wage schedule which is downward sloping in hours. Note, while these arguments are against a negative relationship between hours and the hourly wage there is also no strong economic rationale for a positive relationship.

Define the hourly true wage as the sum of net hourly wage and hourly non-wage benefits. At low hours of work the gross wage is the same as in the taxation model as the effect of taxes is typically not felt until the total wage exceeds some threshold. Once the total wage is subject to taxation the gross wage rate decreases, as does the net wage rate, in an effort to avoid taxes. However the employer now endeavors to keep the value of work constant to the worker by providing benefits to the value required to expand the feasible consumption set to that encompassed by the constant wage rate.

Thus our argument is simple. As the total wage increases due to increasing hours it becomes increasingly expensive, due to increasing marginal tax rates, for a firm to compensate the worker with their true wage solely with wages. Accordingly the composition of compensation changes to include more non-taxable non-wage benefits. This produces a constant true wage rate but declining observed hourly gross and net wage rates. Furthermore since the majority of the non-wage benefits, such as paid sick leave and holiday pay, are received by full-time workers, due to labor legislation, the observed wage schedule will display a kink at the point where workers are considered full-time. In many economies this has recently become at around 35-40 hours per week.

It is possible that this negative relationship between the observed wage and hours worked is responsible for conclusions that labor supply functions are backward bending or downward sloping. The correct wage to enter into the supply functions is that which includes the value of the non-wage labor income[1]. This is an important point as it suggests that previous empirical work on labor supply that ignores this issue has produced biased labor supply elasticities. It also indicates that employers will change the mode of payment depending on the nature of the taxation system.

Note that the trade off between non-wage benefits and wages reflected by the wage/hours relationship is not only determined by the marginal rates of taxation but also by the employee's utility function, representing the individuals willingness to accept the benefits in place of wages, and the firm's cost function, capturing the firms ability to provide the benefits to its employees. When gross wages and benefits are perfect substitutes for both the firm and the employee the wage/hours relationship reflects taxation considerations. However with heterogeneous workers and firms and without perfect substitutability the wage/benefit trade off represents the market locus. Accordingly we cannot isolate the effect benefits have upon wages which is attributable to taxation and that which is due to employee's tastes and the firm's production function. This point is well established in the hedonic pricing literature (see Rosen (1974) and Biddle & Zarkin (1989)).

Let us now present a simple model of labor supply with the above features. Consider a competitive market comprising individuals with the following utility function

$$U_i=U(Y_i,L_i) \quad \partial U/\partial Y>0,\ \partial U/\partial L>0 \tag{1}$$

Y_i denotes the level of weekly consumption by individual i and L_i denotes their fraction of the week spent in leisure. Individuals maximize (1) subject to the budget constraint

$$Y_i \le GW_i[(1-t_i)](1-L_i)+N_i \tag{2}$$

where GW_i denotes the gross hourly wage received by i; t denotes the average tax rate for i; and N_i denotes their weekly non-labor income. Define the true wage as

$$TW_i=GW(1-t_i)+f_i \tag{3}$$

$$=NW_i+f_i$$

where NW_i is the observed net hourly wage rate and f_i is the hourly value of non-wage labor income. Performing the optimization problem and the comparative statics with respect to NW_i and GW_i produces the conventional results that labor supply is upward sloping with respect to wages providing the substitution effect dominates the income effect.

Now allow the hourly wage to depend on hours worked (H). That is

$$TW_i(H)=GW_i(H)(1-t_i)+f_i(H) \qquad (4)$$

Barzel (1973) asserts that $\partial GW/\partial H$, and thus $\partial NW/\partial H$, is positive at first but turns negative producing a S shaped function best captured by a polynomial. Oi (1962) proposes that $\partial GW/\partial H$ is positive. The taxation approach assumes that the gross wage is constant with $\partial NW/\partial H$ negative while the model outlined above also implies that $\partial GW/\partial H$ and $\partial NW/\partial H$ are negative and that $\partial TW/\partial H$ is zero.

Unfortunately these derivatives cannot all be evaluated empirically as TW is not observed for most individuals since most employees receive part of their labor income in the form of non-pecuniary benefits. Typically researchers proxy TW with GW and, as was argued above, this will lead to a spurious negative relationship between hours and wages. While our model requires $\partial TW/\partial H$ equal to zero it does not require the components of this derivative to be individually equal to zero. Casual empiricism suggests that for individuals working one job hourly fringe benefits are positively related to hours worked[2].

Consider the optimization problem faced by individuals in this market with endogenous wages[3]. The individual now maximizes (1) subject to

$$Y_i\le[GW(H)(1-t)]+f_i(H))(1-L_i)+N_i$$

producing the first order condition

$$U_L = NW_i(H_i) + f_i(H_i) + [\partial NW_i/\partial H_i + \partial f_i/\partial H_i]L \quad (5)$$

where U_L denotes the marginal utility of leisure. As the competitive model implies U_L=TW the term in square brackets must equal zero. As the above discussion suggests that $\partial f/\partial H$ is positive we require $\partial NW/\partial H$ to be negative implying a negative relationship between observed wages and non-wage benefits. Such a relationship was found by Vella (1989) in an investigation of the benefit/wage trade off using data constructed from matching the 1977 Quality of Employment Survey with the 1977 Employer Expenditures for Employee Compensation Survey.

3. An Estimator.

The agent solving the above optimization problem will allocate him or herself on the optimal point of the budget constraint between, and including, 0 and 24 hours of work per day. However if the relationship between hours and wages varies at each hour of work an unique analytical solution is difficult to attain[4]. Accordingly we follow Moffitt (1984) and construct the budget constraint in a piece wise linear fashion. We break the number of hours into m mutually exclusive and exhaustive categories with separation points $\mu_0, \mu_1, \ldots \mu_{m-1}$. An individual i will work the number of hours in the j^{th} category if $U(Y_{ij}, L_{ij}) > U(Y_{ik}, L_{ik})$ for all j not equal to k. We now have at most m different slopes in our budget line noting that the slope will not only vary with changes in the marginal tax rate but also at hours of work where shifts in benefits occur. We can approximate any non-linear budget constraint satisfactorily through a large value of m and by choosing the μ's accordingly.

As individuals sort into hours categories the issue of selection bias arises. This exists even if the entire sample is working as the estimation of the wage equation must account for the bias resulting from individuals systematically optimizing their number of hours[5]. To overcome this we employ the methodology of Vella (1989). We estimate a model similar to Moffitt (1984) although employing the sequential approach imposes piece wise linearity while avoiding the complications of the likelihood framework[6]. While this may lead to some efficiency loss the estimator's simplicity makes it attractive.

Assume that the supply functions and wage equations have the following linear representations.

$$H_i=\alpha' X_{1i}+\delta' w^*_i+u_i \tag{6}$$

$$w_i=\beta' X_{2i}+\gamma(H_i)+v_i \tag{7}$$

where H_i denotes a latent variable measuring individual i's optimal market work hours ; w^*_i is the value of i's true wage; w_i denotes the observed wage ; the X's represent exogenous variables; α,β, and δ are parameters to be estimated; γ is a function to be estimated; u and v are bivariate normal error terms with zero means, variances σ^2_u,σ^2_v and covariance σ_{uv}. The value of w^*_i is $\beta' X_{2i}$ and the manner in which the non-wage benefits decrease the hourly wage rate is captured by the γ function. We can employ either the gross or net wage for w as this only alters our interpretation of the effect of hours on wages. At low hours of work, which is our control group in the empirical work, the net wage is equal to the gross wage.

Equation (6) is a structural labor supply function which is a linear approximation to the solution to the labor supply problem. Equation (7) should be interpreted as the wage/hour market locus representing the market evaluation, in the Rosen (1974) sense, of the trade off between wages and benefits.

To facilitate estimation create the following binary indicator functions

$D_{1i}=1$ if $H_i<=\mu_1$; $D_{1i}=0$ otherwise

$D_{2i}=1$ if $\mu_1<H_i<=\mu_2$; $D_{2i}=0$ otherwise

.. .. ..

$D_{mi}=1$ if $H_i>\mu_m$; $D_{mi}=0$ otherwise

Also, construct the following ordinal variable indicating hours of work

$H_i^* =0$ if $D_{1i}=1$; $H_i^*=1$ if $D_{2i}=1$;...$H_i^*=m-1$ if $D_{mi}=1$.

Write the new system as

$$H_i=\alpha' X_{1i}+\delta' w_i^* +u_{1i} \tag{6}$$

$$w_i=\beta' X_{2i}+\sum_{j=2}^{m} \gamma_j D_{ji}+e_{2i} \tag{8}$$

$$H_i^*= h(H_i) \tag{9}$$

where u_{1i} and e_{2i} are bivariate normally distributed; γ is now a m-2 vector of parameters to be estimated; and h is the censoring function producing H_i^* from H_i. Note neither (6) nor (8) can be directly estimated due to i) the simultaneity of wages and hours; and ii) values of w are not observed for those individuals for systematically choose H=0.

Express the restricted reduced form for H_i^* as

$$H_i^* = f(\Pi' X_i + \eta_i) \tag{10}$$

where f is the function which maps H_i into H_i^*;Π are parameters to be estimated;X is a non singular matrix containing the elements of X_1 and X_2 which are weakly exogenous to hours; and the error term η retains the normality property. As e_{2i} and η_i are jointly normal we rewrite equation (9) as

$$w_i = \beta' X_{2i} + \sum_{j=2}^{m} \gamma_j H_{ji} + \lambda\eta_i + \varepsilon_i \tag{11}$$

where η_i is the error term from (10) which is included as an additional regressor to adjust for the endogeneity of the hours variables; λ is the coefficient capturing the correlation between e_{2i} and η_i and the new error term is uncorrelated with the regressors by construction. The system now comprises equation, (11), and a restricted-reduced form equation, (10), where the regressors are uncorrelated with the error terms allowing consistent estimation of the parameters Π, β, γ and λ. Furthermore the t-test on λ is a test of wages being weakly exogenous to hours (see Vella (1989)). As equation (10) has an ordinal qualitative dependent variable and a normally distributed error term we estimate Π by ordered probit.

We require an estimate of the error η_i and this is obtained through the methodology in Vella (1989). Rewrite (11) in terms of it's conditional expectation where the conditioning set is H_i^*.

$$E(w_i|H_i^*) = E(\beta' X_{2i}|H_i^*) + E(\lambda\eta_i|H_i^*) + E(\varepsilon_i|H_i^*) \tag{11a}$$

and an estimate of $E(\eta_i|H_i^*)$ is given by

$$\hat{\eta}_i=D_{ji}\pi_{ji}\Pi_{ji}^{-1}(1-\Pi_{ji})^{-1}(D_{ji}-\Pi_{ji}) \tag{12}$$

where Π_{ji} is the estimated probability that individual i is in the j^{th} category while π_{ji} is the value of the density evaluated at that point[7]. We obtain parameter estimates from (11) by ordinary least squares.

With these estimates we predict values of w_i^* which are independent of hours worked as $\hat{\beta}'X_{2i}$, where $\hat{\beta}$ is OLS estimate of β from (11), for the entire sample. This is the wage an individual receives for their first hour of work and can be interpreted as the wage an individual would receive in the absence of any benefits[8]. Inserting this predicted wage in equation (6) gives

$$H_i=\alpha'X_{1i}+\delta'\hat{w}^*_i+\nu_i \tag{13}$$

where $\upsilon_i=u_i+\delta(\hat{w}^*_i-w^*_i)$ is normally distributed allowing us to estimate (13) by Tobit to obtain the structural parameters of the hours equation. Alternatively, as the error term has been purged of the selection bias inherent in the original model we obtain unbiased and consistent estimates of α and δ by estimating (13) over the sample of workers by OLS.

Replacing H_i with dummy variables has advantages in this framework. Including H_i in the wage equation restricts the hours effect on wages to be strictly linear and monotonic. This does not encompass the hypotheses of Barzel and restricts the Oi type effects to be very specific. Furthermore the empirical findings of Moffitt (1984) and Biddle & Zarkin (1989) indicate a higher order relationship exists between hours and wages. Dummy variables allow a flexible relationship and enable the relationship to differ depending on which segment of the wage function the individual is located. Note the choice of categories and the separation points is crucial. For example if the true relationship between hours and wages is linear we need to employ the appropriate series of dummy variables. Accordingly in implementing this method it is necessary to ensure the series of dummies is sufficiently liberal to capture the true relationship.

4. An Application to Moffitt's Study.

To evaluate the performance of the estimator we employ the data examined in a study by Moffitt (1984) of the relationship between hours and wages for older women from the 1972 wave of the National Longitudinal Survey[9]. While Moffitt employs a likelihood approach we employ our sequential estimator. In this section we estimate a model consistent with Moffitt's theoretical model to enable a comparison of the estimates.

We first create H_i^*. We employed several alternatives and selected the one which produced the highest value for the ordered probit likelihood function. The variable chosen ranges from 0-6 where the first group comprises those working zero hours while the remaining observations are in the categories 1-10, 11-20, 21-30, 31-40, 41-50, 50+ hours. We also construct dummy variables for each of the five latter categories.

The ordered probit results for H_i^* are given in column 1 of Table 1. Using these results we compute the generalized residuals which adjust for the endogeneity of hours in the wage equation. The wage equation parameters are then estimated over the sample of workers by including the generalized residuals as a regressor and the five hours of work dummy variables. The results confirm Moffitt's finding that hours affect the hourly wage rate and that hours are not, at around the 15% level, weakly exogenous to wages. While the hours dummies are not individually highly significant the F-test, with a value of 2.21, indicates their joint significance.

We now estimate a supply equation employing the observed wage as the wage variable and without accounting for the possibility of selection bias. These results are reported in column 3 of table 1. Their major feature is the small value of the coefficient on the wage variable which is very different from the estimates reported by Moffitt (see Appendix A). We now estimate the supply function accounting for the endogeneity of wages. We compute a predicted wage which is free of selection bias and estimate the hours equation over the sample of workers. To remain consistent with Moffitt's theoretical framework we do not remove the effect of hours on the hourly wage rate. These results are reported in Column 4 of table 1 and an inspection reveals their similarity to Moffitt's. The coefficient on wages is similar in magnitude to that reported by Moffitt indicating that the sequential estimator produces results similar to those of the more complicated procedures.

Before continuing we should discuss why this data set does not support the theoretical model in section 2. First, unlike the Australian market, the US labor market has a more limited role for fringe benefits as a means of payment[10]. A second probable cause is the relatively small increases in the marginal rates of taxation imposed in the period relating to the data. The system in operation in the U.S at the period from which Moffitt's data are drawn is characterized by relatively small increases in the marginal tax rates (see Pechman

(1971)) while the Australian system typically features fewer, but substantially greater, jumps in the tax rates. Finally the higher hours of work categories in this data set have a relatively small number of observations making it difficult to reliably estimate the wage hours profile.

5. Labor Supply Functions of Young Australian Females.

We now analyze the hours of work decisions of young Australian females. The data relate to school leavers with one job taken from the 1985 panel of the Australian Longitudinal Survey for females aged 15 to 26 years. A list of the variables employed and their summary statistics are shown in Table 2. These data are an interesting focus of study for two reasons. First, a recent study by Miller & Volker (1987) using the same data set obtained the odd conclusion that an increase in the offered wage rate decreased the number of hours worked. The result is also unusual as previous work on the teenage labor market has found that this age group has typically responded in a more conventional manner when confronted by changes in the relative price of their leisure[11]. Second, the Australian labor market is notorious for its use of fringe benefits to avoid taxation. This appears to be attributable to the high marginal rates of taxation and the large increases in the tax rates across brackets. The problem became of sufficient concern to the Australian Government that legislation was introduced soon after this data set was collected to reduce the amount of tax avoidance due to payments of wages through fringe benefits.

Table 3 lists average hourly pay, average educational level, average age, and marginal tax rate by various hours of work categories. These variables are chosen due to their established relationships with wages while the tax rate is included to illustrate the sizable increases.[12] Table 3 indicates that wages are decreasing in hours and is consistent with the arguments outlined above. It is possible however that those working the longest hours are also the least productive. To investigate this we tabulate these groups' average education and ages as previous empirical work has established their positive relationship with wages. Table 3 reveals no pattern for age across hours categories while the lowest paid are the most educated. This may indicate that work experience is important as those with less education must have, all other things constant, less work experience but the differences appear to be unlikely to explain the difference in wages.

Table 3 appears to support our arguments that observed wages and hours are inversely related despite workers with the most productive characteristics working longer hours. Furthermore, the magnitude of the marginal tax rates indicates there is a substantial incentive to avoid the next highest bracket. Table 4, taken from the Australian Bureau of Statistics survey Employment Benefits 1985, tabulates fringe benefits by hours worked[13]. These figures also suggest a positive relationship exists between fraction of wage received in fringe benefits and weekly hours worked. It also appears that a large proportion of those in the lower hours groups receive substantial benefits suggesting the effect of benefits is introduced at low hours of work. This does not create difficulties for the empirical work as it only affects our interpretation of the coefficients.

To employ our estimation procedure we first create a variable corresponding to H^*_i. We generated several alternatives before choosing one with the following outcomes. These were $H_i=0$; $0<H_i<=15$; $15<H_i<=30$; $35<H_i<=40$; and $H_i>40$. The specification of the restricted reduced form was the following

$$H^*_i=f(\alpha_0+\alpha_1*AGE1+\alpha_2*AGE2+\alpha_3*AGE3+\alpha_4*EDUC+\alpha_5*ENG+\alpha_6*CHLD+\alpha_7*MAR+\alpha_8*MAR +\alpha_9*HLT+\alpha_{10}*SPINC+\alpha_{11}*INC) \qquad (14)$$

and the results are reported in Table 5. The parameter estimates from (14) appear reasonable in sign and magnitude although the income variables display the unexpected sign. We now compute the generalized residuals, $\hat{\eta}_i$, shown in equation (12) and estimate the wage equation, shown in (15), by ordinary least squares over the sub-sample of workers including $\hat{\eta}_i$ as regressor.

$$HOURLY\ WAGE=\beta_0+\beta_1*AGE1+\beta_2*AGE2+\beta_3*AGE3+\beta_4*EDUC+\beta_5*ENG+\beta_6*UNION+\beta_7*GOVT+ \beta_8*CIT+\beta_9*\hat{\eta}_i+\sum_{k=2}^{5}\beta_{10k}*D_k \qquad (15)$$

The generalized residuals account for the endogeneity of the dummy variables proxying hours of work and the control group is the 0-15 hours category. This group is expected to have an observed wage close to its true wage. Our interpretation of the β_{10} 's is the rate at which benefits decrease the hourly wage rate.

We estimate (15) with both hourly wage and log of the hourly wage as the dependent variable and the results are reported in Table 6. The explanatory variables display the expected signs and are of reasonable magnitude for both models. The generalized residuals are statistically significant at conventional levels of significance indicating the presence of selection bias and rejecting the hypothesis that hours are weakly exogenous to wages. Focus now on the hours of work dummy variables. They display a trend indicating a decreasing wage rate is associated with increasing hours. This suggests that an increasing proportion of the total compensation is comprised of benefits. The coefficients indicate that after 35 hours per week the observed wage decreases by over 12 percent. Furthermore, although the lower hours of work show lower rates of pay than the control group the major effects are observed at the traditional full-time/part-time break.

We now predict a wage rate for the entire sample as $\hat{\beta}'X_{2i}$ where $\hat{\beta}$ denotes the estimates from equation (15). We exclude the hour dummy variables to obtain the wage rate which is independent of hours worked and thus represents the wage received in the absence of any benefits. We now estimate the structural hours equation, shown as equation (16), by OLS over the sample of workers and by including this predicted wage as the actual price of labor. These results are reported in Table 7. We estimate the model with hours worked and log of the hours worked as the dependent variables using the corresponding predicted wage to give a linear form of the model and the double log specification.

$$HOURS=\gamma_0+\gamma_1*PWAGE+\gamma_2*MAR+\gamma_3*CHLD+\gamma_4*EDUC+\gamma_5*ENG+\gamma_6*CIT+\gamma_7*HLT+\gamma_8*SPINC+\gamma_9*INC \quad (17)$$

Before examining these results consider those shown in columns (1) and (3) of this table. These represent the results from estimating the supply function by least squares over the sample of workers using the observed wage as the real price of labor. These correspond to the labor supply functions of Miller & Volker (1987) and these results support their findings that the supply function of labor is downward sloping.

Consider now the results in the remaining two columns of this table noting that the results in column 2 are those with the predicted wage from the log wage equation while column 4 are those from the wage equation. Their major feature is the positive coefficient on the predicted wage variables indicating that the labor supply functions are upward sloping. It should be noted that the coefficients are not only marginally positive but represent a strong positive response to wages. As we have employed the double log specification in column 3 the wage coefficient can be interpreted as an elasticity. The coefficient of .22 indicates that the supply responses are significant. The linear form of the model produces a supply elasticity of approximately .13 when evaluated at the mean values of the explanatory variables.

It was noted above that the period over which this data is collected is particularly relevant for analyzing the effects of fringe benefits upon supply elasticities. This was due to the impression given by the Australian Government that tax avoidance of this form was a major problem. Following the collection of this data set legislation was introduced to extend taxation on fringe benefits. This has clear implications for the above model as it suggests that similar analyses on subsequent cross sections should produce smaller absolute values on the coefficients on the hours dummies in the market locus equation. To explore this possibility we examined data from the 1988 wave of the Australian Longitudinal Survey and re-estimated the model over the available sub-sample, comprising 911 observations, remaining from 1985.

While we do not report all of the results we present the coefficients for the hours dummies from the corresponding wage regressions in Table 6. The coefficients for 1988 for the hourly wage regression (in 1988 dollars) are 15-29 hours, -.16; 30-34 hours, .04; 35-40 hours,-.44; and 41+ hours, -.28. The respective values for the log wage specification are 15-29 hours, -.017; 30-34 hours, .07; 35-40 hours, -.007; and 41+

hours, -.03. A comparison of these estimates with Table 6 indicates that the impact of hours on wage rates decreased dramatically over the period 1985- 1988 following the introduction of the fringe benefit tax and provides strong support for the above model. It should also be noted that the estimation of supply functions with the 1988 data also produced negative supply elasticities when the observed wage was employed although the sign was reversed when the above methodology was employed.

6. Tax Rate Considerations.

It was noted in several places throughout the paper that the use of the gross wage rather than the marginal wage only affects our interpretation of the coefficients. To explore the effect of marginal tax rates we employed two approaches. First we employed the marginal tax rate as a regressor in the wage equation. The result of this, not unexpectedly, was to increase the magnitude of the absolute value coefficients of the hours dummies. The second approach was to employ the marginal hourly rate of pay as the dependent variable in the wage equation. This had a similar impact as the hours dummies coefficients again increased in absolute value indicating a more dramatic decrease in the hourly wage rate. However, while these approaches produced larger decreases in the coefficients for the hours dummies the effect upon the labor supply elasticities from using the marginal wage was negligible in both instances.

7. Conclusions.

In this paper we introduce an alternative interpretation of the wages/hours literature and develop a simple procedure to estimate the parameters of a simultaneous system of wages and hours. A simple labor supply model is presented which features a constant relationship between the true hourly wage and hours worked but a negative relationship between hours worked and the observed wage rate. This negative relationship is caused by the progressive nature of the taxation system and the payment of non-wage benefits. It is argued that previous empirical work has focused upon the observed wage/hours relationship resulting in misleading inferences regarding labor supply behavior.

We employ the estimation procedure to examine the hours of work decision of young Australian females. The procedure indicates that hours and wages are simultaneously determined and employing the observed wage as the price of labor produces inaccurate estimates of supply responses. Contrary to prior evidence we find that the labor supply responses to wages are positive and of reasonably large magnitude.

Finally, while the estimating procedure is robust to changes in the theoretical model our interpretation of the coefficients is not. The results strictly rely on the rate of hourly compensation remaining independent of hours worked. While this assumption is somewhat questionable the empirical evidence produced under such an approach are significantly more satisfying than that produced under the alternative model of decreasing wages. Of course it is also plausible that the true value of remuneration is increasing in hours which implies our supply elasticities are under estimates.

TABLE 1: Results from Analysis on Moffitt's (1984) Data

	Dependent Variable			
	H*	Wages	Hours	Hours
Constant	1.822* (.705)	1.800 (1.551)	52.703* (9.067)	35.979* (7.893)
Marital Dummy	-.268* (.124)	-----	-1.932 (1.596)	-1.481 (1.376)
Age	-.034* (.015)	.021 (.017)	-.354 (.194)	-.495* (.167)
Race	-.027 (.121)	-.085 (.124)	-2.742 (1.502)	.111 (1.330)
Years of schooling	-----	.197* (.020)	-----	----
No of family members	-.014 (.052)	----	.388 (.680)	.511 (.581)
No of children in household	----	----	-.975 (.757)	-.851 (.645)
No of children aged < 6 years	-.149 (.148)	----	-----	----
No of children aged > 6 years	-.026 (.056)	----	----	----
Size of local labor force	-----	.186* (.683)	----	----
Regional manufacturing fraction	--	-2.929 (1.788)	----	----
Regional government fraction	----	-9.260* (4.477)	----	----
10-19 hours	----	-.180 (.305)	-----	----
20-29 hours	----	.511 (.324)	----	----
30-39 hours	----	.499 (.360)	----	----
40-49 hours	----	1.118 (.676)	----	----

50+ hours	----	1.556 (1.013)	----	----
Wage	----	----	1.132 (.602)	----
Predicted Wage	----	----	----	8.100* (.793)
Non-Wage Income	----	----	-.178* (.068)	-.168* (.058)
Generalized Residuals	----	-.539 (.366)	----	----
μ_1	.050* (.143)	-----	----	----
μ_2	.190* (.027)	-----	----	----
μ_3	.286* (.033)	-----	----	----
μ_4	1.450* (.080)	-----	----	----
μ_5	2.337* (.164)	-----	----	----
Log-likelihood	-772.54	-----	-----	----
$\bar{R}^2$		.310	.051	.295
Observations	610	297	297	297

Notes: i) See Moffitt (1984) for summary statistics of data.
ii) Standard errors reported in parentheses.
iii) * denotes statistical significance at 5% level.
iv) H denotes censored hours variable.
v) Wage denotes predicted wage from column (2) after omitting the selection bias effect.
vi) The standard errors in columns (2),(3) & (4) are adjusted for the heteroskedasticity introduced by the generalized residuals by using White's procedure.

TABLE 2: **Variables used in Empirical Analysis of Australian Females**

Variable	Definition	Mean	Std. Dev
AGE1	Individual aged 15-17 years	.125	.330
AGE2	Individual aged 18-20 years	.328	.469
AGE3	Individual aged 21-23 years	.344	.475
CIT	Lives in city	.761	.427
MAR	Has legal of defacto spouse	.317	.465
HLT	Has work limiting disability	.103	.304
EDUC	Years of schooling	11.43	1.91
ENG	Speaks english well	.914	.280
CHLD	Has child/children	.207	.405
SPINC^{+}	Spouse's weekly income ($)	283.5	161.1
TINC	Total family weekly non-wage income ($)	192.4	745.5
WORK	Does Individual work ?	.663	.473
UNION^{++}	Is union member	.291	.454
GOVT^{++}	Is government employee	.433	.496
HOURS^{++}	Weekly hours worked	35.56	9.27
PAY^{++}	Hourly wage rate	6.61	2.35

+ - For MAR=1

++ - For WORK=1

TABLE 3: **Selected Variables by Hours of Work**

Hours	Age (years)	Education (years)	Hourly Pay ($)	Marginal tax rate (%)	Obs
0-5	20.89	11.68	8.63	0	19
6-10	20.20	11.68	7.73	0	69
11-15	20.76	11.48	6.83	25	33
16-20	20.63	11.46	7.00	25	80
21-25	20.75	11.95	6.77	25	56
26-30	21.02	11.65	8.10	25	65
31-35	21.24	12.40	7.73	30	181
36-40	20.68	11.74	6.33	30	1203
41-45	20.60	12.27	5.99	30	114
46-50	20.78	12.67	5.38	30	27
51+	21.63	12.83	5.81	30	30

Note: The marginal tax rate is that paid if the individual a) earned the average rate of that hour's category, b) worked the midpoint of the hours category, and c) was paid for 52 weeks of the year.

TABLE 4: Proportion of Female Employees Receiving Fringe Benefits by Benefit Type and Weekly Hours of Work

Benefit Type	Hours						
	>20	20-29	30-34	35-39	40	41+	Total
Holiday Expenses	.02	.02	.03	.03	.03	.03	.02
Low interest Finance	.01	.02	.03	.03	.02	.01	.02
Goods& Services	.17	.21	.20	.18	.22	.28	.20
Housing	.02	.02	*	.01	.01	.04	.02
Electricity	.01	*	*	*	.01	.03	.01
Telephone	.04	.03	.03	.02	.03	.07	.04
Transport	.02	.03	.03	.02	.03	.07	.03
Medical	.02	.03	.03	.02	.04	.04	.03
Entertainment	.01	*	*	*	.01	.05	.01
Study Assistance	.01	*	*	.02	.01	.02	.01
Superannuation	.11	.17	.28	.38	.26	.33	.24
Sick Leave	.35	.58	.80	.92	.93	.93	.72
Annual Leave	.35	.58	.80	.92	.93	.93	.72
Long Service Leave	.28	.45	.64	.75	.68	.69	.56
At Least One Benefit	.55	.74	.89	.96	.96	.96	.82
Sample Size ('000s)	575	292	220	463	430	235	2214

Note: * denotes that the accompanying sampling error is sufficiently large to remove any confidence in the estimate.

Source: Australian Bureau of Statistics Employment Benefits 1985

TABLE 5: **Reduced Form Ordered Probit**

CONSTANT	-.362*
	(.165)
AGE1	-.336*
	(.084)
AGE2	-.150*
	(.068)
AGE3	-.233*
	(.110)
CIT	.229*
	(.054)
MAR	-.470*
	(.094)
HLT	-.527*
	(.070)
ENG	.217*
	(.074)
EDUC	.090*
	(.012)
CHLD	-1.740*
	(.078)
SPINC	.001*
	(.0002)
TINC	.0001*
	(.00003)
MU(1)	.160*
	(.014)
MU(2)	.409*
	(.022)

MU(3)	.617*
	(.025)
MU(4)	2.395*
	(.048)
Log-Likelihood	-3377.8
Observations	2815

Note: Actual frequencies

0 hours	.337
1-14	.043
15-29	.071
30-34	.064
35-40	.428
41+	.057

TABLE 6: Wage Regressions

	Dependent Variable	
	Hourly Wage	Log of Hourly Wage
CONSTANT	7.513*	1.924*
	(.566)	(.071)
AGE1	-3.683*	-.649*
	(.143)	(.023)
AGE2	-2.217*	-.320*
	(.134)	(.018)
AGE3	-.509*	-.055*
	(.139)	(.017)
EDUC	.141*	.018*
	(.027)	(.004)
ENG	-.395*	-.055*
	(.200)	(.021)
GOVT	.711*	.097*
	(.108)	(.014)
UNION	.209*	.031*
	(.081)	(.012)
CIT	.282*	.052*
	(.089)	(.014)
15-29 HOURS	-.917*	-.060
	(.386)	(.048)
30-34 HOURS	-.471	-.033
	(.445)	(.051)
35-40 HOURS	-1.316*	-.127*
	(.370)	(.042)
41^{+} HOURS	-1.686*	-.210*
	(.399)	(.048)

$\hat{\eta}$	-.420*	-.511*
	(.099)	(.013)
$\bar{R}^2$	.454	.510
Observations	1866	1866

Note: i) The standard errors are adjusted for the heteroskedasticity introduced by the generalized residuals by using White's procedure.

TABLE 7: Structural Hours Equations

	Dependent Variable			
	Log Hours		Hours	
	(1)	(2)	(3)	(4)
CONSTANT	3.661*	3.199*	35.760*	31.594*
	(.078)	(.094)	(1.502)	(1.642)
WAGE	-.159*	----	-.831*	----
	(.030)		(.095)	
PWAGE	----	.222*	-----	.751*
		(.048)		(.175)
MAR	.035	-.001	.463	.050
	(.052)	(.010)	(1.099)	(1.121)
CHLD	-.505*	-.551*	-10.624*	-12.046*
	(.045)	(.045)	(.949)	(.962)
EDUC	-.014*	-.001	.449*	-.152
	(.006)	(.001)	(.115)	(.129)
ENG	.018	.030	-.431*	.795
	(.036)	(.040)	(.123)	(.789)
CIT	-.015	-.024	.934	.001
	(.024)	(.024)	(.503)	(.512)
HLT	-.106*	-.097*	-2.301*	-2.105*
	(.036)	(.036)	(.767)	(.778)
SPINC	.00004	-.0001	.002	-.002
	(.0001)	(.0001)	(.003)	(.003)
INC	.00002	.0001	.001*	.0003
	(.00001)	(.0001)	(.0002)	(.0003)
$\bar{R}^2$	.092	.089	.121	.094
Observations	1866	1866	1866	1866

Notes: i) In columns 1 and 2 the wage variable is the log of the wage and the predicted log of the wage respectively. For columns 3 and 4 the wage variable is the actual hourly wage and the predicted hourly wage.
ii) The standard errors are adjusted for the heteroskedasticity introduced by the generalized residuals by using White's procedure.

Appendix: Summary of Moffitt (1984) Results

	15 points	20 points	10 points	Linear Budget Constraint
Labor Supply Equation				
Wage	5.95*	5.58*	6.11*	10.91*
Non Labor Income	-.70	-.72	-.67	-.10
Wage Equation				
Hours	.053*	.054*	.054*	0
Hours Squared	-.00078*	-.00079*	-.00081*	0

Notes: i) The asterisks denote significance at 10 % level.

ii) The number of points reflects the number of different hour categories.

iii) The variables included in the supply equation are a) Marital Dummy b) Age c) Race d) Number of family members e) Number of children in household.

iv) The variables included in the wage equation are a) Years of schooling b) Age c) Race d) Size of local labor force e) The fraction of total employment in manufacturing in the census region of residence d) The fraction of total employment in government in the census region of residence.

Footnotes:

1 A similar issue has been explored by Decker (1987) who identified the need to adjust the observed wage by the value of the job's attributes when estimating labor supply functions.

2 This is supported by the data reported in Table 4 which are discussed in section 5.

3 We use the term endogenous to reflect that the proportion of the true wage received in pecuniary payments is a function of hours worked. It is not intended to imply that the individual's marginal productivity is endogenous.

4 For a full discussion of this point see Burtless & Hausman (1978) and Hausman (1979).

5 This characterization of the labor market captures a feature of labor supply highlighted in Cogan (1980,1981). He shows that increasing the entry and working cost of labor supply increases the individual's minimum or reservation number of market work hours at a given wage rate. Thus for particular wage levels some individuals will exclude themselves from some of the lower hours categories.

6 While the estimator that is employed requires likelihood estimation, in that ordered probit and Tobit equations are estimated, it does not require special programming and can be implemented with existing programs.

7 Vella (1989) employs the results from Gourieroux, Monfort, Renault & Trognon (1987) to show that the generalized residuals for the ordered probit model are represented by equation (12). Gourieroux et. al (1987) illustrate that for models in the exponential family the generalized residuals are simply the value of the score for the intercept evaluated at the estimated parameters. Vella (1989) illustrates how these generalized residuals can be employed to obviate the inconsistency caused by sample selectivity and endogeneity.

8 We do not include $\hat{\lambda}\hat{\eta}_i$ in the predicted wage, as in Vella (1988), as we wish to remove the effect of selection bias operating through wages when estimating the supply function.

9 The data set I received from Professor Moffitt had an additional eight observations increasing the sample size to 610. These additional eight observations only marginally influenced the summary statistics. However while Moffitt reports an observation of 68 hours of work the maximum value in the data set I received is 60 hours.

[10] The evidence in Smeeding (1983) and Leibowitz (1983) illustrating the extent to which fringe benefits are used as a means of employee compensation suggests that in comparison to the Australian labor market, for which the comparable figures are reported in table 4, the role of non-pecuniary payments is relatively limited in the U.S.

[11] Gregory & Duncan (1980), for example, report in a study of participation rates for Australian teenagers that labor supply displayed positive responses to increases in the level of teenage wage rates and unemployment benefits.

[12] For the period from which the data are drawn the marginal rates of taxation were as follows-i)0-$4595 (0%) ii)$4596-$12500 (25%) iii)$12501-$19500 (30%) iv)$19501-$28000 (46%) v)$28001-$35000 (48%) vi)$35001+ (60%).

[13] The difference in the distribution of individuals across hours of categories in tables 4 and 5 is due to the age compositions of the respective samples.

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