ECONOMIC GROWTH CENTER

YALE UNIVERSITY

Box 1987, Yale Station
New Haven, Connecticut

CENTER DISCUSSION PAPER NO. 346

THE ESTIMATION OF WAGE ELASTICITIES IN FERTILITY DEMAND EQUATIONS

Kathryn H. Anderson*

March 1980

Notes: *Post-doctoral fellow, Economic Growth Center, Yale University. This research was supported by a post-doctoral fellowship from the National Institute of Health. Additional funding was provided by the William and Flora Hewlett Foundation grant to the Yale Economic Demography Program. I wish to thank Randall Olsen, T. Paul Schultz, and other participants of the Labor and Population Workshop, Yale University for their support in preparing this paper. All errors are my own.

The Estimation of Wage Elasticities in Fertility Demand Equations

Kathryn H. Anderson*

March 1980

*Post-doctoral fellow, Economic Growth Center, Yale University. This research was supported by a post-doctoral fellowship from the National Institute of Health. Additional funding was provided by the Flora and William Hewlett Foundation grant to the Yale Economic Demography Program. I wish to thank Randall Olsen, T. Paul Schultz, and other participants of the Labor and Population Workshop, Yale University for their support in preparing this paper. All errors are my own.

Kathryn Anderson
March 1980

Introduction

Economic models of fertility emphasize the importance of wage and income changes on demand. If children are household commodities produced with parental time and goods, then an increase in the wage of the husband or wife raises the time cost of producing children but also increases the level of real income. These two effects work in opposite directions so that the direction of the final wage effect is ambiguous without restrictions.

A great deal of empirical work on fertility demand has attempted to measure male and female wage elasticities. Some studies (Gardner (1973) and Snyder (1974)) have calculated a wage for working women only and used the actual wage as a proxy for the wife's value of time. The problem with this approach is that non-working women are excluded from the sample or, as in the Snyder paper, are excluded from the wage estimate. The variable then measures the effect of a wage change only for working women and excludes an analysis of the effect of a change in the value of time of non-working women. In countries where most married women do not work outside the home, a very significant percentage of the population is not analyzed.

To compensate for this loss, Gardner (1973), Ben-Porath (1973), and others have included the wife's schooling as a proxy for the value of time of working and non-working women. The benefit of this approach is that all women can be included in the analysis and education does affect the value of time (Heckman, 1974). One disadvantage of using only education, however, is that it does not measure only the value of time but can also proxy efficiency in production (DeTray, 1973), wealth, or tastes (Leibowitz, 1974).

An alternative to the use of actual wages or schooling is to impute a wage. In general, predicted wages have been derived from earnings functions (Mincer, 1976) for the working individuals. The predicted wage is used as an instrumental variable for the actual wage. McCabe and Rosenzweig (1976) estimated predicted wages for husbands and wives in Puerto Rico and found positive effects of changes in both on fertility. Anderson (1978) also estimated predicted wages for husbands and wives in Guatemala but found a small, positive male wage effect and a large, negative female wage effect on fertility.

The instrumental variable approach frees the wage estimate of the influence of transitory variation, reduces simultaneous equations bias, corrects the errors in variables problem, and is estimated for all individuals in the sample (Schultz, 1975). The use of imputed wages is usually preferable to the use of actual wages, but it can produce biased estimates of wage effects if the sample of working individuals is not a randomly drawn sub-sample of all individuals. This is usually a more acute problem in estimating the value of time of married women than of married men because the bias approaches zero as all individuals enter the labor market. In some countries, however, a large percentage of the married men are self-employed farmers, and existing data sets do not contain information on hours worked and other inputs to enable one to derive an estimate of their wage from reported income. Sample selection can also be a problem in a population of men, many of whom are self employed, if predicted wages are derived from earnings functions of men working in the paid labor force and hence reporting a wage.

To test and correct for the presence of selectivity bias, particularly in the estimates of the wage of married women, Gronau (1973) and Heckman (1974) derived two different models. In Gronau's analysis of the housewife's value of time, the labor force participation decision indicates the relationship between her wage offer and her value of time in the home. If her wage offer exceeds her value of time, then she enters the labor force. If her value of time exceeds her wage offers, she does not enter the labor force. The rate of labor force participation, therefore, depends on the joint distribution of the wage offer and the price of time within a given age-education-income class. The joint distribution is assumed to be bivariate normal, and the wage offer and the value of time are independently distributed, although this latter assumption is not crucial, given the restrictions necessary to identify the model (Cogan, 1975). The determination of the value of time within a given age-education-income class then depends on knowledge of the means and standard deviations of the marginal distributions for the wage offer and the value of time as well as the labor force participation rate and the average wage offer for each class.

To identify the model, Gronau postulates two extreme cases. For both cases, the mean wage offer is solely a function of age and education, and the mean value of time is solely a function of the husband's income. In the first case, the variance in wage offers within each age-education cell is zero; the average wage for working women is, therefore, equal to the mean of the wage offer distribution. Differences in labor force participation within the same class are due entirely to differences in the value of time. The average wage of working women in each cell is regressed on income and Z, a standard normal variate representing the number of standard deviations between the mean wage offer and the mean value of time given the value of time distribution. The value of time for each group is determined from these regression results.

In the second case, the varianoe in the value of time within eath class is zero so that the average value of time of non-working women is equal to the mean of the value of time in distribution. Differences in labor force participation result entirely from differences in the wage offer. The average wage per cell is regressed on income and Z*, a standard normal variate describing the number of standard deviations between the value of time and the wage offer given the wage offer distribution. These results are used to estimate the value of time in each cell.

Several conceptual problems are apparent in Gronau's approach. First, the procedure relies heavily on the assumption of bivariate normality. Second, to identify the model, very rigid restrictions have to be placed on the structure of the error distributions. It is unlikely that the variance of either the value of time distribution or the wage offer distribution is zero. Third, assuming that the value of time is solely a function of husband's income and not the women's age and education as well is difficult to accept. In fact, the identification restrictions necessary in any of the selection models developed make the results less believable. Fourth, as Cogan (1975) notes, Z and Z* are used as regressors in the empirical section, but are directly derived from the theoretical model and are, therefore, endogenous. Finally, the Gronau model requires that the data be grouped into a large number of cells. A large sample size is necessary for estimating the model.

Heckman's (1974) model does not require that the average reported wage for working women be equal to the mean of the wage offer distribution or that the average value of time for non-working women be equal to the mean of the value of time distribution. In addition, his model allowed the disturbances of the wage offer and value of time distributions to be correlated. As in the Gronau approach, the wage of working women is greater than or equal to their value of time while the wage for non-working women is less than their value of time. Labor force participation is a function of the difference in the wage offer and the reservation wage. Heckman assumed that labor supply, or hours of work, and labor force participation were determined within a Tobit model. The likelihood function under the Tobit specification is the product of the probability of not working for wives outside the labor force and the probability of working for wives in the labor force times the density of hours worked. By assuming that both the hours of work and the probability of working for wives in the labor force are derived from the same model, the likelihood function is simply the product of the probability of not working for non-working wives and the standard normal density of hours worked for working wives. To correct for sample selection bias within this framework, Heckman specifies the joint distribution of the wife's wage offer and her labor supply; the errors in the wage and labor supply equations follow a bivariate normal density function. From this model, consistent estimates of the wife's wage offer and her labor supply are derived. The value of time is easily calculated from the resulting equations.

Although Gronau's restrictive assumptions are unnecessary in Heckman's model, the Heckman approach is a simplification of a more general model. The model depends on two assumptions. First, the errors are distributed with a bivariate normal distribution. This assumption is crucial to the analysis. If the residuals are not normally distributed, but this model is utilized to test for selectivity bias, the test for selection may be positive when, in fact, selection is not present. Second, the Tobit model depends on assuming that labor force participation and hours of work are derived from the same function which in the latter case is truncated at zero hours. In many instances, this assumption cannot be supporte

Olsen (1977) extends Gronau's model to the analysis of individual data. He does not assume that the hours of work and labor force participation decisions are derived from the same function. A more general Probit model is used to estimate the labor force participation decision, and the residuals of the labor force participation decision and the wage offer are jointly distributed with a normal distribution. In addition, Olsen's Probit model can be generalized to include the case in which the errors of the wage offer distribution, given labor force participation, are not normally distributed. Olsen (1979) applied this model to a sample of teenagers and found that the results were quite sensitive to the assumed form of the distribution of residuals.

No attempt has been made to correct for selectivity bias in wage estimating equations with a Gronau, Heckman, or Olsen model and to use these equations to estimate wage effects in fertility analysis. In this paper, I examine the sensitivity of the wage elasticity in fertility regressions to the choice of the wage inputing procedure. Four procedures are used to estimate the value of time in fertility regressions: (1) education; (2) imputation from an earnings function; (3) imputation from a Probit model correcting for selectivity bias; and (4) imputation from a Probit model correcting for non-normality of the residuals and selectivity bias. The four estimates are compared to determine the sensitivity of the wage elasticity to the value of time estimation procedure chosen.

Empirical procedure

The data source is the 1974-75 Longitudinal Guatemala survey of five villages conducted by the Rand Corporation and the Institute for Nutrition in Centra America and Panama (INCAP). The household is the unit of observation. Only those households containing a male head, a female head, and at least one child are included. Legal marriage is not a requirement for inclusion in the sample.

The dependent variable is the number of live births. Households with incompleted fertility are included by adjusting the number of live births for the mother's current age according to a biological supply function fitted from the sample data.[1]

Exogenous variables are wealth, education of the parents, village location, and wages. Wealth is the index of owned land, producer durables, housing, and livestock valued at current prices and is undoubtedly measured with much error.

Education is the number of years of schooling of the male and female head. The location variables are dummy variables for the four more rural villages. TOWN1 is the farthest from Guatemala City - approximately

---

[1]For more detailed information on this procedure, see Anderson (1979).

80 kilometers; TOWN2, TOWN3, and TOWN4 are approximately 30 to 40 kilometers from the city. The omitted village is the most urban of the villages and is located just outside of Guatemala City. Variables used in the analysis are defined in Table 1 with summary statistics.

Sixty percent of all male household heads and seven percent of all female household heads in the survey are engaged in wage employment. The majority of males not working for wages are self-employed farmers. The females not working for wages primarily work in the home. To limit the analysis to families with both heads reporting wages reduces the sample size dramatically and produces inconsistent estimates (Olsen, 1977). Estimates of the value of time are necessary.

The first procedure for estimating the value of time is to estimate an earnings function from a sample of wage-earners and to impute a wage to all individuals based on the estimated coefficients. The natural log of daily wages for male and female heads is regressed on postschooling experience, experience squared, schooling, and village location.[2] The wage is predicted to increase at a decreasing rate with experience, to increase with schooling, and to be lower the farther the village is from Guatemala City. Table 2 presents these estimated earnings functions.

In the male regression, the log of wages does increase at a decreasing rate with experience and increases with schooling. In addition, residence in a rural village reduces the log of wages, and the town farthest from Guatemala City (TOWN1) has the smallest expected wage. All coefficients, with the exception of experience, are statistically significant at the five percent level. A wage is imputed to all males using

[2] Experience is measured as current age-schooling-7.

Table 1. Summary statistics for variables used in the regressions

Variables	Definition	Mean	Standard Deviation
LCEB	Log of children ever born	1.279	.719
EPH	Schooling of the husband	2.562	2.780
EPW	Schooling of the wife	1.865	2.413
WEALTH divided by 1000	Value of land, durables, livestock	1.101	1.863
REG_WAGE	Imputed log of the husband's wage derived from earnings function	.692	.406
PROBIT_WAGE	Imputed log of the husband's wage derived from Probit model	.317	.407
OLSEN_WAGE	Imputed log of the husband's wage derived from non-normality model	.692	.440
TOWN1	Santo Domingo-rural	.127	
TOWN2	Cornacoste-rural	.148	
TOWN3	Espiritu Santo-rural	.147	
TOWN4	San Juan-rural	.093	
EXPH	Experience (age-schooling-7)	31.907	13.750
LFPH	Husband's participation in the paid labor force	.520	
TOTWEEKH	Total weeks per year worked in the paid labor force by the husband	19.975	24.004
AGEW	Wife's current age	36.972	13.773

Table 2. Estimation of the earnings functions for husbands and wives.[a]

Independent Variables	Dependent Variables	
	Husband's Wage	Wife's Wage
Intercept	.607	-.830
	(.158)	(.411)
Experience (age-schooling-7)	.011	.040
	(.009)	(.025)
Experience squared divided by 1000	-.240	-.500
	(.130)	(.360)
Schooling	.091	.158
	(.0010)	(.033)
TOWN1	-.788	.032
	(.079)	(.262)
TOWN2	-.274	.270
	(.077)	(.338)
TOWN3	-.263	.007
	(.081)	(.391)
TOWN4	-.338	.668
	(.108)	(.493)
F	45.29	3.77
R^2	.366	.248
Sample size	566	87

[a]Standard errors are in parentheses.

these estimated coefficients (REG_WAGE).

In the female head regression, the log of wages increases at a decreasing rate with experience and increases with additional schooling. Wages are higher in the rural villages. However, only schooling is significantly different from zero. An F-test comparing regressions with and without the town dummy variables indicates no significant contribution of village location to the results. Because of the insignificant results and the small sample size, no further attempt is made to estimate the value of time for women. Schooling will proxy for the value of time of all women in the sample.

The imputed male wage is a biased estimate of the value of time of non-wage-earners if the males excluded from the regressions do not constitute a random subsample of the entire sample of males. Systematic differences can exist between wage-earners and non-wage-earners with the same experience and training. In this sample, most of the non-wage-earners are self-employed farmers. To test and correct for sample selection bias among males, the Heckman (1974) Tobit model or the Olsen (1977) Probit model can be used. Labor force participation and labor supply are examined to determine which model is preferred for these data. Labor force participation is defined as working for wages. A male works for wages if his wage is greater than his value of time in self-employment; labor force participation is a linear function of all variables affecting the wage and the value of time in self-employment. Labor supply is defined as the number of weeks per year worked for wages and is a function of the variables determining the wage and the value of time in self-employment. Regressions of labor force participation and labor supply are presented in Table 3.

The Heckman Tobit model that functionally restricts the participation and labor supply equations is preferable if the residuals of the decision to work for wages and the number of weeks worked are derived from the same normal distribution. Whenever the assumption is not valid and different models are assumed to determine labor supply and the probability of working, the Probit model for participation and the regression model for labor supply is preferable. Examining Table 3, several differences are apparent between the estimates of the two models. First, experience has a negative effect on participation and a positive effect on labor supply although neither effect is significant. Second, schooling has an insignificant negative effect on participation and a significant positive effect on labor supply.

Third, TOWN4 has the largest negative effect on participation followed by TOWN3, TOWN2, and TOWN1. TOWN4 also has the largest negative effect on labor supply but is followed by TOWN2, TOWN1, and TOWN3.

These differences are in no way definitive. A second test to determine whether to use a Tobit or Probit model is to analyze the ratio of the mean to the standard deviation of the labor supply variable. A large value of the ratio (greater than 3) indicates that truncation is not a problem and that the Heckman Tobit model can be used. A small value (1.25 or less) supports the use of the Probit model. The theoretical basis for this procedure is the Pearson-Lee (1908) analysis modified

Table 3. Estimation of the husband's participation in the paid labor force and the number of weeks the husband works for wages

Independent Variables	Dependent Variables: Participation	Dependent Variables: Weeks Worked
Intercept	.933	44.000
	(.099)	(3.993)
Experience	-.003	.232
	(.005)	(.233)
Experience squared divided by 1000	-.078	-.004
	(.073)	(.003)
Schooling	-.003	.728
	(.007)	(.264)
Wealth divided by 1000	-.032	-.096
	(.008)	(.0360)
TOWN1	-.098	- 23.755
	(.051)	(2.152)
TOWN2	-.184	- 26.167
	(.047)	(2.106)
TOWN3	-.203	-20.080
	(.049)	(2.201)
TOWN4	-.380	-31.729
	(.055)	(2.977)
F	19.85	53.33
R^2	.146	.438
Sample size	941	557

for the analysis of selection (Olsen, 1979). The ratio for the sample of wage-earning men is .83.

The observed differences in the effects of the independent variables on participation and weeks worked for wages as well as the small size of the ratio of the mean of labor supply to the standard deviation suggest that different models are explaining the decision to work for wages and the number of weeks worked. The Heckman model may not be appropriate with these data. The husband's offered wage and reservation wage are estimated with the Probit model.[3] The results of the procedure are presented in Table 4. The experience variable is excluded from the reservation wage equation to identify the model.

The results are generally as expected. All variables are significant and the signs are in the expected directions. The offered wage increases at a decreasing rate with experience. Schooling raises the offered wage and the reservation wage; the effect is stronger on the offered wage. The implication is that more highly educated men work for wages. Living in a rural village lowers the offered wage and the reservation wage. The reduction in the offered wage is greater than the reduction in the reservation wage indicating that men are less likely to work for wages in rural villages. Finally, wealth (mainly land) does increase the value of time in self-employment as indicated by the positive coefficient on wealth in the reservation wage equation. The log of the likelihood function assuming selection is 1290.794, and the log of the likelihood function assuming no selection is 1316.275. The likelihood ratio test is significant at the one percent level indicating the presence of selectivity bias in the wage regression in Table 2. A second wage variable

[3]See Olsen (1977) for details on the derivation of the likelihood function for this model.

is derived for males from Table 4. The offered wage coefficients are used to impute wages to men currently working for wages, and the reservation wage coefficients are used to impute wages to self-employed men (PROBIT_WAGE).

In these selection models, the assumption of normality of the residuals is crucial, for the results are very sensitive to the presence or absence of normality (Olsen, 1979). If the normality assumption is incorrect, the likelihood test can still be significant, but the significance may not be due to selectivity bias, but to non-normality. To determine whether the normality assumption is violated in the data, the sample of males is sorted by the predicted probabilities of participation estimated from the linear probability function in Table 3. A subsample of the 200 males (approximately one-quarter of the sample) with the highest predicted probabilities of participation is selected for analysis. The average probability of participation is .8. These men are more likely to be working for wages than the sample as a whole and selection is less likely to confound the test of normality. A distribution fit to the residuals of the wage offers of these 200 men approximates the distribution of the entire sample in the absence of selectivity bias.[4]

---

[4]Various convolutions of a standard normal and a truncated normal distribution are fit to the subsample data. The convolution resulting in the lowest log-likelihood is the best fit. This occurs where a density is formed by the convolution of a standard normal density with point of truncation at 14 standard deviations and a normal density with a standard deviation of .002. The log of the likelihood function assuming normality is 168.79, and the log of the likelihood function assumnon-normality is 151.12. The likelihood ratio test is significant at the .005 level indicating that the residuals of the wage offer equation are not normally distributed.

Table 4. Estimation of the offered wage and the reservation wage for husbands correcting for selectivity bias.[a,b]

Independent Variables	Dependent Variables: Offered Wage	Dependent Variables: Reservation Wage
Constant	.205	.319
	(.027)	(.033)
Experience	.021	-
	(.005)	
Experience squared divided by 1000	-.460	-.041
	(.083)	(.150)
Schooling	.094	.074
	(.010)	(.014)
TOWN1	-.858	-.674
	(.852)	(.117)
TOWN2	-.480	-.334
	(.081)	(.107)
TOWN3	-.451	-.263
	(.084)	(.114)
TOWN4	-.600	-.300
	(.107)	(.151)
Wealth divided by 1000	-	.038
		(.011)

[a] Asymptotic standard errors are in the parentheses.

[b] The computing procedure required a just identified model. Experience excluding its square was used to identify the model. However, the coefficient on experience squared in the reservation wage equation is not significantly different from zero. It has essentially been omitted as well.

The Probit procedure is rerun adjusting for non-normality (Olsen, 1979). The test of no selection given the distribution produces a Chi-squared of 3.14 which is significant at the 10 percent level but not the 5 percent. The hypothesis of selectivity bias is only marginally supported once the distribution of the errors is changed. The coefficients derived from the probit selection model are, therefore, not satisfactory for imputing a value of time to males. The least squares coefficients are consistent estimates of the value of time for wage earners, and the reservation wage coefficients for non-wage earners are derived from the Probit model of labor force participation. These coefficients are presented in Table 5; the third imputed wage variable is derived from these coefficients (OLSEN_WAGE).

In summary, estimation of the husband's value of time is usually straight-forward in comparison to estimation of the wife's value of time. Legally or consensually married men are usually employed for wages and errors in variables is the major problem in estimating their wage. The wage rate is calculated as total earnings divided by total hours. Inaccurate reporting of hours or earnings as well as transitory variation in earnings results in an inconsistent estimate of the wage effect if actual wages are used. Married women, on the other hand, are primarily engaged in home production rather than market work. In estimating the value of time of married women, the issue of sample selection bias is important because working women are not likely to be a random sample of all married women. In the Guatemala data, however, the estimation of the husband's value of time has some of the same problems as estimation of the wife's value of time. A large percentage of all husbands report no wage income, but it is apparent that they are engaged in labor market activity by working on their own farms or in their own small businesses. The sample of non-wage earning husbands may not be a randomly selected

Table 5. Wage offer and reservation wage equations for husbands corrected for non-normality of the residuals.

Independent Variables	Dependent Variables: Offered Wage	Dependent Variables: Reservation Wage
Constant	.772	.784
Experience	.002	-
Experience squared divided by 1000	-.113	-.083
Schooling	.080	.079
TOWN1	-.737	-.722
TOWN2	-.308	-.293
TOWN3	-.246	-.264
TOWN4	-.331	-.306
Wealth divided by 1000	-	.004

sample of all husbands so that testing for selection is an important issue.

The results of the estimation do not support the hypothesis that sample selection bias is present among the males in this sample; however, the sample is still censored. A preferable procedure to imputing a male wage from an earnings function is to derive a wage offer equation for wage-earners and a reservation wage equation for the self-employed. The value of the self-employed husband's time responds postively to wealth, essentially a measure of the value of land. An increase in the amount of land or its quality increases the marginal productivity of the farmer's labor and raises the value of his time. If the income effect in the wage elasticity of demand for children dominates the substitution effect, then this increase in wealth raises the demand for children. If the income effect is small relative to the substitution effect, implying that his time is an important input into the production of children, then this increase in wealth lowers the demand for children. In either case, the demand elasticity should be larger if the self-employed wage is estimated from a reservation wage equation than if it is estimated from an earnings function derived from a sample of wage earners.

Empirical Results

The results of the non-linear estimation of fertility demand are presented in Table 6. The log of children ever born to women aged

14 to 50 is regressed on maternal and paternal education, wealth, the husband's wage, village location, and mother's age. The wage variable used in the column 1 regression (REG_WAGE is imputed from the earnings function in Table 1. The wage variable used in the column 2 regression (PROBIT_WAGE) is imputed from the wage offer and reservation wage equations in Table 4. These estimates assume normality of residuals and correct for selectivity bias. The wage estimate in column 3 (OLSEN_WAGE) is derived from the wage offer and reservation wage equations in Table 5. This wage estimate corrects for censoring after determining that selectivity bias is not a serious problem with these data. In the column 4 regression (NOWAGE) no wage variable is included. The husband's schooling proxies for his value of time in this case as does the wife's schooling her value of time.

Wealth elasticities are positive but insignificantly different from zero in all four regressions. Almost no variation in the magnitude of the elasticities is discernable across equations. The wife's schooling elasticities also remain unchanged across equations, and the coefficients are significant. If the wife's schooling doubles from the sample mean of 1.87 to 3.73 years, fertility falls by 5.6 percent.

The magnitude and sign of the coefficients on husband's schooling and the town variables depend on the specification of the wage. The husband's schooling is an insignificant negative determinant of fertility if no wage variable is included in the regression; the elasticity is -.021. In this regression, schooling is capturing the effect of a change in his

Table 6. Estimation of the logarithm of children ever born[a,b,c]

Independent Variable	REG_ WAGE (1)	PROBIT_ WAGE (2)	OLSEN_ WAGE (3)	NO WAGE (4)
Intercept	2.751	2.668	3.139	2.610
	(.263)	(.192)	(.280)	(.193)
EPH	.012	.007	.074	-.008
	(.038)	(.019)	(.039)	(.008)
	[.032]	[.018]	[.189]	[-.021]
EPW	-.031	-.030	-.030	-.029
	(.009)	(.009)	(.009)	(.009)
	[-.057]	[-.056]	[-.057]	[-.055]
Wealth divided by 1000	.005	.007	.007	.004
	(.011)	(.011)	(.011)	(.010)
	.005	.007	.007	.004
REG_WAGE	[-.232]			
	(.399)			
	-.232			
PROBIT_WAGE		-.185		
		(.195)		
		[-.185]		
OLSEN_WAGE			-.983	
			(.455)	
			[-.983]	
TOWN1	-.281	-.249	-.824	-.082
	(.324)	(.172)	(.342)	(.060)
TOWN2	-.040	-.060	-.272	.037
	(.121)	(.103)	(.147)	(.057)
TOWN3	-.100	-.113	-.291	-.025
	(.120)	(.098)	(.132)	(.062)
TOWN4	-.075	-.081	-.308	.018
	(.150)	(.110)	(.158)	(.065)
AGEW	.046	.045	.051	.044
	(.010)	(.009)	(.010)	(.009)
Sample size	638	638	638	657

[a]Asymptotic standard errors are in parentheses.

[b]Elasticities evaluated at the sample means are in brackets.

[c]REG_WAGE is derived from a wage offer regression; PROBIT_WAGE corrects for selection using the Probit model; OLSEN_WAGE corrects for censoring given non-normal residuals.

value of time plus an efficiency or taste effect; these effects are at cross-purposes with each other and appear to cancel each other out. In the regressions containing a wage estimate, husband's schooling is a positive determinant of fertility. The size of the schooling elasticity varies across equations, however. If wages are estimated from a labor demand function (REG_WAGE), the elasticity is .03. The size of the elasticity is smaller if the wage is estimated from a Probit model correcting for selectivity bias (PROBIT_WAGE). Adjusting only for censoring in the wage given that the residuals of the participation model are non-normal (OLSEN_WAGE) increases the schooling elasticity to .19. This elasticity is more than six times the size of the other elasticities.

If no wage estimate is included, only TOWN1 and TOWN3 reduce fertility; fertility increases in TOWN2 and TOWN4. An F-test comparing this regression to a regression excluding the town variables indicates that these variables do not contribute significantly (at the 5 percent level) to the explanatory power of the regression. In the three regressions including a wage, fertility is lower in all the urban villages. The coefficients on the village variables are largest in the OLSEN_WAGE regression. Only slight differences in the size of the coefficients are apparent between the REG_WAGE and PROBIT_WAGE regressions.

The choice of wage variable does not affect the sign of the wage elasticities in any of the regressions. An increase in the male wage causes fertility to fall. However, the magnitude of these elasticities crucially depends on the form of the imputing equation. In the REG_WAGE regression with the wage imputed from an earnings function, doubling the husband's wage reduces fertility by 23 percent. If the wage is corrected for selectivity bias as in the PROBIT_WAGE regression, doubling the wage reduces fertility by 19 percent. Correcting the wage only for censoring (OLSEN_WAGE), however, after discovering that non-normality, and not selection, is a problem, a doubling of wages reduces fertility by 98 percent. The correct elasticity is more than four times the size of the earnings function elasticity and five times the size of the selection elasticity. The form of the wage function appears to be important in determining the extent of fertility responsiveness to a change in the male wage or his value of time.

Conclusions

The wage or value of time is widely believed to be an important determinant of the demand for children. Many procedures have been utilized in the literature to measure an individual's value of time. Education is one common proxy of the wage. It is conceptually appealing, however, to be able to identify the effect of education apart from its role of enhancing the market value of time. But this requires further restrictive assumptions about what determines wages and necessitates systematic treatment of the potential problem of selectivity of wage recipients. If a wage is derived from an earnings function, the estimate can be biased if the sample of wage-earners is not randomly drawn. To test and correct for possible sample selection bias, Heckman and Gronau have developed maximum likelihood models. The test for selection using these models can be positive if the residuals of the joint participation and wage offer distribution are not normally distributed. In this case, selectivity bias may not be present if the model is adjusted for the correct distribution of residuals. The reservation wage and wage offer estimates are then easily derived from a regression of the wage offer and a Probit model of participation

In this paper, using data from rural Guatemala, I estimate three wage equations for husbands. The first wage estimate is derived from an earnings function for males in the wage-earning labor force. The second derives wage offer and reservation wage equations from a Gronau Probit model and corrects for selectivity bias. The likelihood ratio test for the presence of selection is positive. To estimate the third wage equation, I test the residuals of the wage offer equation for normality and am able to infer that the residuals are not normally distributed. Adjusting for non-normality, the Gronau model is reestimated. The test for the presence of selection indicates no selectivity bias. The wage offer is, therefore, derived from a linear regression and the reservation wage from a Probit model of participation.

The fertility results indicate significant differences in the magnitudes of husband's wage elasticities with different wage imputing equations. Although the signs on the elasticities are consistently negative, the size of the elasticity is .23 using an earnings function, .19 using the Gronau model, and .98 correcting only for censoring. These differences are substantial.

Differences are apparent in the signs and magnitudes of other variables if the wage variable is changed. If no wage is estimated, male and female schooling are negative determinants of fertility. Male schooling elasticities are positive if an estimate of the husband's wage is included; female schooling elasticities are negative and consistently equal to .05. The male schooling elasticity is much larger if the wage offer and reservation wage are not corrected for selection. The town variables also display some variation depending upon the wage variable.

It is apparent from these results that not including an estimated wage in the regression of fertility can lead to a miscalculation of the substitution effect. In addition, if a wage is estimated, the form of the wage equations can affect the magnitude of the wage elasticities. Further testing with other data sets of these alternatives methods for wage imputing should prove useful.

REFERENCES

Anderson. Kathryn H., "Determination of Fertility, Child Quality, and Child Survival in Guatemala," Economic Growth Center Discussion Paper No. 332, New Haven, December 1979.

Anderson, Kathryn H., Effects of Child Mortality on the Quantity and Quality of Children in Guatemala, Ph.D. dissertation, Department of Economics, N.C. State University, 1978.

Ben-Porath, Yoram, "Economic Analysis of Fertility in Israel: Point and Counterpoint," Journal of Political Economy 81 (March/April 1973, Part II), S202-S233.

Cogan, John, Labor Supply and the Value of Housewife's Time, R-1461-OEO/EDA/RF, The Rand Corporation, Santa Monica, April 1975.

DeTray, Dennis N., "Child Quality and the Demand for Children," Journal of Political Economy 81 (March/April 1973, Part II), S70-S95.

Gardner, Bruce, "Economics of the Size of North Carolina Rural Families," Journal of Political Economy 81 (March/April 1973, Part II), S99-S122.

Gronau, Reuben, "The Intrafamily Allocation of Time: The Value of the Housewife's Time," American Economic Review 63 (September 1973), 634-651.

Heckman, James, "Shadow Prices, Market Wages, and Labor Supply," Econometrica 42 (July 1974), 679-694.

Leibowitz, Arlene, "Education and Home Production," American Economic Review 64 (May 1974), 243-350.

McCabe, James and Mark Rosenzweig, "Female Employment Creation and Family Size," in R. Ridker (ed.), Population and Development: The Search for Selective Interventions (Baltimore: The Johns Hopkins Press, 1976).

Mincer, Jacob, Schooling, Experience, and Earnings (New York: Columbia University Press, National Bureau of Economic Research, 1974).

Olsen, Randall J., An Econometric Model of Family Labor Supply, Ph.D. dissertation, Department of Economics, University of Chicago, 1977.

Olsen, Randall J., "A Least Squares Correction for Selectivity Bias," Institution for Social and Policy Studies Working Paper No. 819, New Haven, May 1979.

Olsen, Randall J., "Tests for the Presence of Selectivity Bias and their Relation to Specifications of Functional Form and Error Distribution," Institution for Social and Policy Studies Working Paper No. 812, New Haven, June 1979.

Pearson, Karl and Alice Lee, "Generalized Probable Error in Multiple Normal Correlation," Biometrika 6 (March 1908), 59-68.

Schultz, T. Paul, Estimating Labor Supply Functions for Married Women, R-1265-NIH/AID, The Rand Corporation, Santa Monica, February 1975.

Snyder, Donald W., "Economic Determinants of Family Size in West Africa," Demography 11 (November 1974), 613-625.