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A STRUCTURAL MODEL OF WAGE DIFFERENTIALS BETWEEN MEN AND WOMEN IN PROFESSIONAL EMPLOYMENT

BY

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CHAPTER I

INTRODUCTION

The fact that women do not receive the same renumeration for labor force participation hardly needs extensive statistical documentation. This study will focus specifically on the wage differential between men and women in professional employment, using the Census Bureau's definition of professional. (see Appendix A).

The raw data on professional wages from the 1970 census shows a mean male wage of $7.30 and a mean female wage of $4.35 for the professional group. This occupational category accounts for about 4 million male workers and about 2 million female workers. Thus the observed phenomena is that both the level of employment and the wage rate for female professionals is less than that of male professionals.

The aim of this study is to formulate a structural model of the professional labor market which can account for the observed phenomena without introducing discrimination. Discrimination can be defined as occupational segregation or by a differential in demand unrelated to marginal product. The structural model consists of supply and demand functions for male and female professional labor,with equilibrium wage rates predicted by the appropriate reduced form equations.

In other studies of this topic, a wage or earnings function is estimated directly. This approach makes the interpretation of the coefficients somewhat difficult. The meaning of the signs and magnitude of the coefficients in a reduced form regression can be difficult to justify. Alternatively, estimating a supply and demand model and then calculating the reduced form can provide more insight into the meaning of the coefficients in the wage equations. The structural model approach also allows for the effect of supply changes on the wage rate which would not necessarily be included in a wage function. The calculated reduced form coefficients are then simply linear functions of the structural coefficients which are more obvious in their meaning and have a stronger theoretical foundation.

Let us consider what sort of market structure might fit the observed data. There is extensive research indicating that there is a difference between the labor supply curves of men and women. Generally, men have a higher labor force participation rate and respond to demographic variables such as children in a different fashion than women. Making the assumption that professional labor tends to conform to the pattern of all labor implies two supply curves and that the male supply curve is to the right of the female supply curve at least in some wage range.

Assuming some degree of substitutability between male and female nominal units implies two demand curves. Since these functions relate to nominal units the male demand curve will be above the female due to the fact that men have a higher overall quality level. Male education is somewhat higher than female and male job experience is considerably higher. Since a nominal unit of male labor is the embodiment of a higher quality level, the demand for a nominal unit of male labor will be greater than the demand for a nominal unit of female labor, at any wage. The resulting model can account for the observed phenomena.

The more restrictive assumption that quality differences are the sole reason for the differential in demand for nominal units, implies that quality adjusted units are perfect substitutes, and that quality adjusted wages for men and women should be identical. The less restrictive assumption of imperfect substitutability allows for differences between men and women in production and is probably more realistic.

Mincer and Polechek (1974) have shown making quality adjustments that the male wage is still greater than the female. Using the framework of a post school investment earnings function, estimated separately for men and women, and using the mean values of the male variables in the female estimated equation forecasts female earning if they had the same market characteristic as men. Using schooling and experience as quality adjustments explains a large measure of the differential.

Expected job tenure can be shown to directly effect wages and the level of on-the-job-training, which indirectly effect wages. Thus expected job tenure which differs between men and women can also be used to explain the wage differential. The level of on-the-job-training might be approximated by the level of responsibility of a job. It has been shown, using data for one firm, that adjustment for schooling, experience, and job level explains all the wage differential (Mailkiel and Mailkiel, 1973).

Before proceeding to the theoretical development of the model, a note on female quality. If quality adjusted wages are equal, why is female quality lower than male. In the presence of discrimination it would be optimal for females to invest less in quality since the rate of return to such investment would be lower. However, without discrimination we are left with the empirical phenomenon of females withdrawing from the labor force for the period of time in which they have young children, and the associated phenomenon of employer expectations of this withdrawal whether true or not. The withdrawal period limits the accumulation of job experience and through depreciation causes an erosian of market skills. This process might be viewed as a social value reflective of the economic conditions of an earlier period. As the potential wage of females increases, the opportunity cost of withdrawing from a market work and of having children increases. This should shorten the mean length of the non-work period,and presumably, the social role of women in time would change to accomodate the change in economic conditions.

The following sections will outline the formulation of a theoretical supply and demand model for male and female labor, a discussion of the empirical formulation of the variables, the empirical implimentation of the structural model and the reduced form equations.

CHAPTER II

THE THEORETICAL MODEL

Using a simplified version of the household production model (Becker, 1965) the following assumptions can be made. Let

$$U = U(Z_m, Z_f, X) \qquad (1)$$

be the family lifetime utility function. This abstracts from life cycle variations and assumes a single period function that a family with a given set of characteristics will attempt to maximize. A second implication of this function is that the maximization of family utility maximizes the utility of all family members. That is the allocation of time and resources by an individual family member will be such that it optimizes family utility. Z_m is a home produced commodity using male non-working time only and Z_f is a female home produced commodity using female non-working time only. The assumption is that Z is simply a linear function of non-working time. This leaves the utility function looking like a household production function in which U is produced with Z_m, Z_f and X with U as an argument is some other utility function such as $U^* = U^*(U)$. The simplier approach can be viewed as a modified labor leisure choice model and yields an adequate labor supply curve.

The above assumptions can be written as:

$$Z_m = a_m m \qquad \text{and}$$

$$Z_f = a_f f$$

α_m and α_f are male and female efficiency parameters respectively. The efficiency parameter is thought to be some function of schooling and experience, or more generally an index of human capitol. m is male non-working time, f is female non-working time and x is a composite market good.

Letting P equal the price of X then the households budget constraint is

$$I = PX = W_m t_m + W_f t_f + V \qquad (4)$$

where

W_m = male wage rate

W_f = female wage rate

t_m = male work time

t_f = female work time

V = non-labor income

Let the households full income S be defined as

$$S = W_m \Lambda + W_f \Lambda + V$$

Where $\Lambda = (t_m + m) = (t_f + f)$. Defining the quality adjusted wage rate

$$\pi_i = \frac{w_i}{a_i}$$ the

full income constraint can be written as

$$S = \pi_m Z_m + \pi_f Z_f + PX \qquad (5)$$

The household must maximize (1) subject to (5) which yields the following Lagrangian in which P is set equal to 1 (P=1).

$$L = U(Z_m, Z_f, X) + \lambda(S - \pi_m Z_m - \pi_f Z_f - X)$$

1st order conditions are

$$\frac{\partial L}{\partial Z_m} = U_m - \lambda \Pi_m = 0 \qquad \frac{\partial L}{\partial Z_f} = U_f - \lambda \Pi_f = 0$$

Using the 1st order conditions the derived demand for Z_m & Z_f can be found. (See Appendix B for a complete derivation of the model.)

$$EZ_m^D = \eta_m ES + K_m(\sigma_{mm} - \eta_m)E\Pi_m + K_f(\sigma_{mf} - \eta_m)E\Pi_f$$

similarly

$$EZ_f^D = \eta_f ES + K_f(\sigma_{ff} - \eta)E\Pi_f + K_m(\sigma_{mf} - \eta_f)E\Pi_m$$

where $K_m = \frac{\Pi_m Z_m}{S}$ $\qquad K_f = \frac{\Pi_f Z_f}{S}$

η_i is the full income elasticity of z_i, σ_{ii} is the own elasticity of substitution and is negative always

σ_{ij} is the cross elasticity of substitution in consumption between i and j.

Note that since the price of market goods has been set equal to one, it does not enter the demand curves for z_m or z_f, nor is a demand curve for x derived.

Since the complement of home time is the supply of hours worked in the market the following supply curves can be found (see Appendix B).

$$\begin{aligned} Et_m = & -\gamma_m \eta_m K_v EV \\ & [+\gamma_m(1-K_m)\bar{\sigma}_m - K_{tm}\gamma_m \eta_m] E\omega_m \\ & [-\gamma_m K_f \sigma_{mf} - \gamma_m \eta_m K_{tf}] E\omega_f \\ & -\gamma_m((1-K_m)\bar{\sigma}_m + K_m \eta_m - 1) Ea_m \\ & +\gamma_m K_f(\sigma_{mf} - \eta_m) Ea_f \end{aligned}$$

and symmetrically

$$
\begin{aligned}
Et_f = & -\gamma_f \eta_f K_v EV \\
& [+\gamma_f (1-K_f)\bar{\sigma}_f - K_{tf}\gamma_f \eta_f] E\omega_f \\
& [-\gamma_f K_f \sigma_{mf} - \gamma_f \eta_f K_{fm}] E\omega_m \\
& -\gamma_f ((1-K_f)\bar{\sigma}_f + K_f \eta_f - 1) Ea_f \\
& +\gamma_f K_f (\sigma_{mf} - \eta_f) Ea_m
\end{aligned}
$$

where

$$
\begin{aligned}
k_v &= \frac{V}{S} \\
k_{tm} &= w_m t_m / S \\
k_{tf} &= w_f t_f / S \\
\gamma_m &= m / t_m \\
\gamma_f &= f / t_f
\end{aligned}
$$

Before considering the empirical formulation of the labor supply curves let us consider briefly the economics behind the a priori expectations of the coefficients in the theoretical equations:

$$
\begin{aligned}
\ln t_m &= \alpha_1 \ln v + \alpha_2 \ln \omega_m + \alpha_3 \ln \omega_f + \alpha_4 \ln a_m + \alpha_5 \ln a_f \\
\ln t_f &= \beta_1 \ln v + \beta_2 \ln \omega_f + \beta_3 \ln \omega_m + \beta_4 \ln a_f + \beta_5 \ln a_m
\end{aligned}
$$

On the empirical level these equations are estimated by grouped data and include a vector of control or exogenous variables. The appropriate unit of measurement of labor supply and empirical proxies for the existing variables will be considered below.

It is necessary to specify the choice of variable for t_i, since it will effect the values of the existing coefficients. Two alternatives are the Labor Force Participation Rate or a measure of hours worked.

If the LFPR is highly correlated in any two consecutive periods, and is used as a measure of labor supply then increases in the wage rate can only increase the LFPR. That is there are no negative income effects possible, and an increase in wages will increase the number of people in the work force, i.e. the LFPR. However, the LFPR may be interpreted as the probability that an individual is in the work force in a given week or as the fraction of weeks worked per year. This interpretation would allow for a negative income effect on labor supply, and a positive coefficient on $\ln \omega$ would imply that substitution outweighted income effects. The income effect of a wage increase could be thought of as a reduction in the fraction of weeks worked per year. The interpretation of LFPR as a fraction of weeks per year worked approximates the number of hours per year work, which can be estimated. The interpretation of the income effect when hours worked per year is the dependent variable is straightforward. An increase in wages increase real full income which increase the demand for Z since the income elasticity of Z is positive. This of course has a negative effect on hours worked. The income effect may be especially important in the case of women due to their assumed high non-market productivity. Studies using LFPR as the dependent variable generally show larger values for the coefficient of own wage than studies using hours worked as the dependent variable. This casts some doubt as to whether the income effects are fully being accounted for in studies using LFPR. [Ben Porath, 1973].

Thus hours worked will be used here since it is more flexible and consistent with the general formulation of the model. Specifically, due to the nature of the data available in the 1970 Census, if hours worked during the census week were zero then hours per year will be zero. Also hours per week in the specific census week is rather narrow measure and may contain a good deal of random variation, which might not wash out in aggregation. Use of weeks per year does not differenciate part-time employment, when it is of the form of say, less than five days a week worked. Generally it appears that weeks per year is the best measure, although all three are acceptable empirical measures.

The coefficient of lnv indicates a pure income effect. That is holding all otherthings constant how would a given percentage increase in non-labor income effect the demand for leisure time and its compliment the supply of hours worked? Due to the positive income elasticity of leisure time or of Z goods we expect the percentage increase in non-labor income to cause a percentage increase in the demand for leisure or Z goods and therefore a percentage decrease in hours worked. Thus we should find a negative coefficient on lnv in the labor supply curve.

Holding all other variables constant a change in W_m will have both an income and substitution effect on t_m. A change in W_m holding V constant changes full income, which results in an income effect, which is negative with respect to leisure time or Z goods. The substitution effect is positive with respect to leisure time, since say an increase in the wage rate will increase the opportunity cost of leisure, that is the price of leisure, reducing the quantity demanded, and thus increasing hours worked. Thus the net result of a change in wages cannot be predicted a priori.

The sign of W_f on t_m is uncertain and depends on the sign of σ_{mf}. If σ_{mf} is negative this means that male leisure time and female leisure time are complements, as for example if the husband and wife are tennis partners. If σ_{mf} and $|k_f \sigma_{mf}| > |k_{tf} \eta_m|$ then an increase in $\ln w_f$ will increase $\ln t_m$. If Z_m and Z_f are complements, then they are both substitutes with market goods. An increase in $\ln w_f$ increases π_f causing a net substitution towards X, and away from Z_m. Substitution away from Z_m implies male hours worked increase.

If $\sigma_{mf} > 0$ then male leisure and female leisure are substitutes and an increase in $\ln w_f$ causes a decrease in $\ln t_m$; that is as π_f increases there is substitution towards z_m.

The coefficient of $\ln a_m$ in male labor supply is also uncertain depending on whether $(1-k_m)\bar{\sigma}_m + k_m\eta_m \gtrless 1$, which depends on whether the increased supply of z_m due to the increased productivity is greater or less than the increased demand for z_m due to the decrease in the price of z_m. If the expression is positive then supply is not sufficient to meet demand unless hours worked go down and the output of z_m is increased by increasing m. That is

$$z_m = a_m m$$

$$EZ_m = Ea_m + Em \text{ so that}$$

if hours worked are held constant a given percentage increase in a_m yields the same percentage increase in Z_m supplied i.e.

From the demand curve for Z_m

$$\frac{EZ_m^D}{Ea_m} = ((1-k_m)\bar{\sigma}_m + k_m\eta_m) = \alpha_2'$$

Thus, if hours worked remained constant and supply equaled demand then

$$((1-k_m)\,\sigma_m + k_m\eta_m) = 1$$

If increased demand excedes the increased supply, then hours worked must decline, and conversely.

The effect of an increase in $\ln a_f$ on $\ln t_m$ is uncertain and also depends on the sign and relative magnitude of σ_{mf}, as shown above.

Due to the symmetric development of the female labor supply curve the a priori expectations regarding the signs of the coefficients would follow the reasoning presented for the male labor supply curve.

2.2 Labor Demand

Assume the following linear homogenous aggregate production function for professional output q to be

$$q = F(P_m, P_s, K) \quad ,$$

where P_m, P_f are quality adjusted units of male and female labor respectively and

$$P_m = a'_m t_m$$

$$P_f = a'_f t_f$$

Also π'_m is the quality adjusted price of a unit of professional male labor, and similarly for π'_f.

$$\pi'_m = \frac{W_m}{a'_m} \qquad \pi'_f = \frac{W_f}{a'_f}$$

a'_i is again an index of quality in market work.

Let the price of capital be 1 and total cost can be written as

$$C = K + \pi'_m P_m + \pi'_f P_f$$

To minimize cost subject to a fixed output level yields the following Lagrangian equation:

$$C^* = K + \pi'_m P_m + \pi'_f P_f + \lambda(x - F(P_m, P_f, K)$$

with 1st order conditions

$$\frac{\partial C^*}{\partial P_m} = \pi_m - \lambda \frac{\partial F}{\partial P_m} = 0$$

$$\frac{\partial C^*}{\partial P_f} = \pi_f - \lambda \frac{\partial F}{\partial P_f} = 0$$

$$\frac{\partial C^*}{\partial \lambda} = X - F(P_m, P_f, K) = 0$$

From the first order conditions the following demand curves can be derived (see Appendix C).

$$EP_m = S_m(\sigma_{mm} - n)E\pi'_m + S_f(\sigma_{mf} - n)E\pi'_f + n_G EG$$

$$EP_f = S_f(\sigma_{ff} - n)E\pi'_f + S_m(\sigma_{mf} - n)E\pi'_m + n_G EG$$

where G is a vector of shift parameters.

In the production function P_m is differentiated from P_f, which implies that quality adjusted male and female labor inputs are not perfect substitutes. I.E. σ_{mf} is less than infinite.

The demand curve can be rewritten in terms of nominal units as

$$Et_m = S_m(\sigma_{mm} - n)\ EW_m + S_f(\sigma_{mf} - n)\ EW_f$$

$$+[S_m(\sigma_{mm} - n) + 1]\ Ea_m$$

$$-S_f\ (\sigma_{mf} - n)\ Ea_f + n_G\ EG$$

and symmetrically

$$Et_f = S_f(\sigma_{ff} - \eta)\ EW_f + S_m(\sigma_{mf} - \eta)\ EW_m$$

$$-[S_f(\sigma_{ff} - \eta) + 1]\ Ea_f - S_m(\sigma_{mf} - \eta)\ Ea_m - \eta_g EG$$

which yields the following regression equations:

$$\ln t_m = \alpha_6 \ln w_m + \alpha_7 \ln w_f + \alpha_8 \ln a_m + \alpha_9 \ln a_f + \alpha_{10} \ln G$$

$$\ln t_f = \beta_6 \ln w_f + \beta_7 \ln w_m + \beta_8 \ln a_m + \beta_9 \ln a_f + \beta_{10} \ln G$$

Before describing the empirical formulation of the demand curves, a few comments on the a priori expectations of the theoretical variables. An increase in W_m will reduce t_m since $\sigma_{mm} < 0$ and η enters with a negative sign, that is ceteris paribus an increase in own price reduces the quantity of the factor demanded. An increase in W_f will probably increase the demand for t_m since male and female labor are likely to be substitutes. It is unlikely that $\sigma_{mf} < \eta$ since a high degree of substitutabliity between t_m and t_f is likely and there are no close substitutes for aggregate professional output making η small. An increase in a_m will have an uncertain effect on t_m demanded.

$$\frac{Et_m}{Ea_m} = -[S_m(\sigma_{mm} - \eta) + 1]$$

The sign depends on whether

$$-S_m \sigma_{mm} + S_m \eta \lesseqgtr 1$$

An increase in a_f will probably reduce demand for t_m since σ_{mf} is probably greater than η thus $\alpha_9 < 0$. Letting G stand for a shift parameter in the demand for final output then an increase in G will increase t_m demanded making α_{10} positive.

The female demand curve is completely symmetric.

An alternative assumption is that quality adjusted units of male and female labor are perfect substitutes and then there would be no distinction between them as inputs. The production function could be written as

$$q = F(P,K) \quad \text{where}$$

$$p = a't \;\; ; \;\; a' \text{ is the quality index and}$$

$$t \text{ is a nominal unit of labor.}$$

Where a' is now defined as including not only schooling and experience but also the level of firm specific training.

It could be argued that in professional employment different forms of training whether formal or acquired on other jobs, would substitute highly with any training that might be specific to a firm. That is that specific training may not be relatively important in professional work. For example we might move a doctor from one hospital to another and expect relatively little firm (hospital) specific training to be necessary.

Alternatively consider first the cost to a firm hiring a new professional worker. There are direct costs of simply making the appropriate bookkeeping or payroll entries for the new worker. Also the cost of search may be higher for professional workers than for workers in general due to perhaps the need to search a larger geographic region and greater difficulty in ascertaining the applicants quality characteristics. An applicant might go through a multiple interviewing procedure and references might be more carefully examined for professional workers. These hiring costs will be included as specific training.

Also there is a cost to the firm in acquainting a new worker with the firm's specific operational procedures and technology. For example, a new research economist might have to learn the local computer facilities idiosyncrasies. Another cost of hiring a new professional worker could be the time required to intergrate a new worker into existing work teams. That is for a new person to become acquainted with whatever specific projects are underway. All of these costs we will consider specific training. If all training is undertaken in period 1, then the extent of the benefits of this training to the firm vary directly with the expected length of employment. Variations in expected length of employment would thus effect quantity of training provided by the firm, which might be interpreted as a differential in a job level assignment by the firm. Also the wage and quantity of any class of workers would vary directly with their expected length of employment.

To develop these concepts somewhat more formally let us assume the following production function

$$q = f(p) \qquad \text{where}$$

$$P = \acute{a}t$$

Total cost to the firm, excluding training is $C_x = \dot{\pi}P = \frac{\omega}{\alpha}\acute{a}t = \omega t$

Total cost of training is

$C_t = C(a', I)$, where I is the number of new workers hired in any period.

Let ρ be the probability that a worker employed in any period remains on the job into the next period. Therefore

$$I = t - \rho t \quad , \text{ the}$$

number of new hirings equals the number of workers needed minus those who remain on the job. We assume that this relationship holds in all periods.

Thus $\qquad t = \frac{I}{(1-\rho)}$ since

$$P = a't = a' \frac{I}{(1-\rho)} \qquad \text{or}$$

$$X = f\left(\frac{a'I}{1-\rho}\right)$$ the firm must minimize the following constrained function

$$L = \frac{\omega I}{1-\rho} + c(a', I) + \lambda\left(X - f\left(\frac{a'I}{1-\rho}\right)\right)$$

The firm has discretion over I and a′ so let us consider the following 1st order conditions.

$$\frac{\partial L}{\partial I} = \frac{\omega}{1-\rho} + C_I(a', I) - \lambda \frac{\partial f}{\partial\left(\frac{a'I}{1-\rho}\right)} \frac{\partial\left(\frac{a'I}{1-\rho}\right)}{\partial I} = 0$$

or

$$\frac{\omega}{1-\rho} + \frac{\partial c}{\partial I} = \lambda m P_p \left(\frac{a'}{1-\rho}\right)$$

or

$$\omega = \lambda m P_p (a') - \frac{\partial c}{\partial I}(1-\rho)$$

differentiating with respect to ρ

$$\frac{\partial \omega}{\partial \rho} = + \frac{\partial c}{\partial I} > 0$$

or as expected job tenure

increase, so does the wage.

Consider a second condition for cost minimization

$$\frac{\partial L}{\partial \alpha'} = \frac{\partial c}{\partial \alpha'} - \lambda \frac{\partial f}{\partial \left(\frac{\alpha' I}{1-\rho}\right)} \frac{\partial \left(\frac{\alpha' I}{1-\rho}\right)}{\partial \alpha'} = 0$$

or

$$\frac{\partial c}{\partial \alpha'} = \lambda m p_\rho \left(\frac{I}{1-\rho}\right)$$

differentiating with respect to ρ

$$\frac{\partial \left(\frac{\partial c}{\partial \alpha'}\right)}{\partial \rho} = \frac{\lambda m p_\rho I}{(1-\rho)^2} > 0$$

which indicates that as expected job tenure increase so does the marginal cost of training due to the fact that there is more training being given. That is as job tenure increase, the level of training increases.

Since it is well known that during certain years of the female life cycle of labor force participation the expected length of job tenure is lower than for males, ceteris paribus. Also ρ is smaller for married females than for single females, ceteris paribus. Thus the rational firm would offer a unit of labor adjusted for schooling and experience a lower wage if ρ for the group is lower.

The demand curves can be respecified to include some measure of expected job tenure. The a priori expectation of the sign of the coefficient is positive.

CHAPTER III
THE EMPIRICAL SPECIFICATION

3.1 INTRODUCTION

The data set selected for the empirical implementation of the model is the one in a hundred 1970 county group census. The county group was chosen in order to define local labor markets. That is this sample contains a county variable that allows for aggregation to the SMSA level. Since the data set is restricted to professional workers, the one in a hundred sample is necessary in order to provide a reasonable number of observations from which the various cell means described below can be calculated.

The initial empirical work will be restricted to the white urban labor market. Since the aim of this study is to explore some of the determinants of wage differentials between men and women, the addition of another labor grouping and set of differentials only complicates the analysis. Alternative possibilities for controlling the race is an additional set of sex-race equations or the inclusion of a race dummy in the existing equations. Since non-whites comprise a relatively small percentage of the professional work force and may face a different set of economic conditions than the remaining professional work force, it is preferable to use a racially homogenous sample.

Similarly the non-urban professional labor market is relatively small and might be expected to respond in a different fashion to changes in economic variables. Presumably for a labor market to exist there must be some centralization of economic activity such as in a city. The use of urban refers to the Census definition of an SMSA which is essentially the larger metropolitan areas of the U. S. The most straightforward way of controlling for non-urban differentials is to restrict the dataset to SMSA's.

The most suitable unit of observation for an urban labor market is the Standard Metropolitan Statistical Area or SMSA as defined by the Census Bureau. What the census has tried to accomplish is the geographic definition of an urban labor market, by defining an area in which the majority of people who work also live. Thus aggregation of the individual observations by SMSA produces a data point which is a good approximation of a self contained submarket and is well suited for cross-section analysis. In one sense, all of the exogenous variables can be thought of as controls for heterogeniety of these sub-markets in the cross-sectional regression of the endogenous variables.

Thus the value of the variables used in the regressions will be the means or percentages for each SMSA. For example the hours worked variable is the mean number of hours worked for all workers, in the labor force grouping, in the SMSA. This raises two issues; one is the effect on the assumption of homoscedastisity in the data. The appropriate GLS procedures to correct for this will be discussed in a later section. The second issue is the effect on transitory deviations from permanent levels in the income variables. The census week of 1969 is generally thought to have been one of below average economic activity. The SMSA means can be thought of as approximations to permanent levels of the income variables [Mincer, 1962]. The SMSA mean will contain a transitory deviation from the SMSA permanent level.

If we assume that the magnitude of this deviation is the same for all SMSA's, it will not effect the cross-section regression. We are assuming that the use of SMSA means washes out the effect on an individual's deviation from their permanent level and that the SMSA deviation from its permanent level is the same for all SMSA's.

The model as outlined in the theoretical section contains four equations in four endogenous variables; the supply and demand for male labor and the supply and demand for female labor. The four endogenous variables are the male and female wage rates and hours worked variables. The inclusion of additional exogenous variables in the model can be rationalized on the grounds of controlling for individual variance in the shape of the utility function, or for the necessity to control for heterogeneity across SMSA's in variables that are thought to effect the climate of the local labor market.

It is well known that marital status has an impact on individual decisions regarding hours worked, especially for females. This suggests that the married and single groups may respond differently to changes in wages and other variables and that separate estimating equations should be used. This implies an eight equation model, four equations for married people and four equations for single people, and eight endogenous variables. This formulation may be stretching the data beyong its limitations, therefore estimation procedure is the simplier alternative of a marital status variable in a four equation model.

The dependent variable, as stated above can be formulated as annual hours worked. This is a desirable formulation since it gives the greatest variance. Some cross-sectional data sets do not show a great deal of variance in hours worked. There are perhaps institutional arrangements, which change overtime, that influence the hours worked variable. We can assume that the individual, given an expected wage, chooses a job situation that most nearly complies with his desired number of hours worked.

The initial construction of the variable from the census data is to multiply the hours worked in the census week times the weeks worked per year variable. Weeks worked per year include all weeks that were paid for regardless of whether the individual actually worked that week. On the aggregated level the mean number of annual hours worked by SMSA appears.

Since the dependent variable is measured in hours, the wage rate per hour should be used as a dependent variable. Individual hourly wage rates do not appear in the census, however, they may be calculated by dividing annual income by annual hours worked. This division is calculated on the individual level for people actually employed and then aggregated to find the mean SMSA wage rate.

Since not every male or female professional is married to a professional, the spouse's wage rate is calculated independently of occupation. All zero values of the variables are excluded and the mean value for the SMSA calculated.

An interesting distinction develops here in the interpretation of spouse's wage in the supply and demand curve. In the supply functions the relevant variable is spouses wage rate regardless of spouse's occupation. However in the demand functions, the wage rate of professionals of the opposite sex is the relevant variable. Therefore, for example, the male supply equation will use spouse's wage rate and the male demand equation will use female professional wage rate. Spouse's wage rate is then considered exogenous and not explained by the model.

One unusual problem in calculating the wage rate of professional workers is the treatment of earnings from self employment, that is such things as private practice, consulting work, etc. Usually this form of income is excluded from the calculation of wages. However, in the case of professional workers such deletion would produce a significant bias in the calculation of wage rates. The percentage of total income from self-employment is approximately twice as large for professionals than all workers. Deletion of individuals with earnings from self employment is rather restrictive. As an alternative wage rates are calculated including earnings from self employment and another variable, the percent self-employed by SMSA is included to control for variation in self-employment across SMSA's.

3.2 THE SUPPLY OF MALE PROFESSIONAL LABOR

The Unemployment Rate:

Generally it is thought [Mincer, 1966] that increases in the rate of unemployment will have a discouraging effect on male labor force participation. Two issues must be distinguished here, one the interpretation of unemployment in a cross section is not the same as in a time series and second the LFPR although similar to hours worked is not completely symmetric.

Cross sectional variation in the unemployment rate may reflect a more permanent phenomenon such as a chronically depressed labor market. The unemployment rate should still correlate inversely with labor force for participation and correlate positively with measures of out migration from an area. In the case of primary workers the expectation is that they would move rather than withdraw from the labor force.

The empirical measure of this variable can be computed along the following line. Census asks whether an individual was employed, unemployed or not in the labor force. Taking the subset of all male professionals in the labor force and defining the unemployment rate as those unemployed over the total yields a measure of the male professional unemployment rate. This formulation appears to have some merit, however, it does not allow for the possibilities of substitution. That is certain occupations along the margin of the professional grouping are substitutable with non-professional occupations either by the individual or the firm. The overall unemployment rate in an SMSA may be a better measure of unemployment. In any event, all measures of unemployment move together.

The effect of the unemployment rate on male professional hours worked, if any, is less clear than the effect on LFPR. It might be argued that the individual, knowing the unemployment rate to be high increases hours worked in order to insure his hold on his position. That is the individual reduces his own hourly wage rate by working more and thus reduces the probability that the employer will lay him off.

Since the dependent variable in the labor supply curve is mean number of hours worked, for those people who are working, the discouragement effect, or people withholding their services from the market, would not be observed. It might be argued that increases in the unemployment rate would cause an increase in part-time unemployment, as workers are unable to find adequate full-time employment. This would produce a negative regression coefficient. Another possibility is that since labor force participation among males, especially among high education males, tends to the over 95% level, that an increase in the unemployment rate will have no effect on male hours worked. Therefore we will postulate no a priori expectation about the sign of the unemployment rate variable.

Marital Status:

Marital status may effect male labor supply in the following manner. We might think of hours worked as a measure of labor force attachment, or hours worked may effect skill level and the amount of firm specific training acquired, and thus future wage levels. If so, it can be argued that married men will work more. This might be rationalized as a greater taste for market income resulting from a larger number of expected dependents. Or, as argued by Bowen and Finnegan, marriage may be a proxy for some sort of vector of responsibility type characteristics. Men who are married might be more of the responsible type and thus likely to take their work more seriously and work longer hours. The a priori expectation is then that marriage has a positive effect on male labor supply.

The empirical formulation of this variable could be of the dummy variable form on the level of individual observations where the dummy takes on the value 0 if single and 1 if married. On the SMSA level the percent of male professionals who are married becomes the relevant variable.

Children:

The presence of children is usually thought to have a significant effect on male labor supply. The effects of this variable are rather similar to the marriage variable. In fact the two variables are so closely correlated that it became necessary to drop the marriage variable. As the mean number of children per SMSA increase, the probability of an individual being married increases. The child variable then can be interpreted as including the effects of marriage when the marriage variable is excluded. The child variable can also be formulated as a continuous variable rather than as a percentage. It is generally assumed that male home production is relatively less efficient and that men attempt to increase money income by increasing hours worked while women reduce hours worked in favor of home responsibilities. The inclusion of a child variable can also be rationalized by the fact that increases in the number of children usually are associated with increases in home productivity especially for women.

The variable is constructed as follows. Taking the subset of male professionals, the mean number of children by SMSA is calculated, and the expected sign is positive.

Human Capital:

Consider now the empirical implementation of the quality variables a_m and a_f appearing in the previous section. These variables as noted earlier are of uncertain sign, and therefore we will not postulate any a priori expectations for their empirical proxies.

Following along the lines of the post school investment model developed by Mincer (1974) quality can be thought of as a function of schooling and experience. Mincer shows using several specifications a relatively high R^2 in the regression of earnings on schooling and experience.

Let

s = years of schooling

j = years of experience.

Note that j may capture a reduction of hours worked over the life cycle due to a positive difference between the rate of time preference and the rate of interest.

A suggested method for dealing with j_m is to compute j_m = age - s_m - 6 on the individual level of observation and then aggregate to the SMSA level by computing the mean experience level.

Since a_f appears in male labor supply curve, it will be discussed now. The development of a_f is similar to a_m with the only difference being in the calculation of j. It is well known then labor force participation for married women is approximately on M shaped function over age. This is due to the withdrawal of women for a few years around age 30, for specialization in child and homework. This phenomenon both does not add to experience, but also causes depreciation to exceed investment in skills, such that the skill level may decline. The specific nature of this relationship for professional women will differ from all women, and can be estimated from the cross section data. As an approximation j_f can be calculated as follows:

$$\text{let} \quad j = A - (S+6) \quad \text{for } A < 27$$
$$j = 27 - (S+6) \quad \text{for } 27 \leq A \leq 35$$
$$j = A - (S+14) \quad \text{for } A > 35$$

This is for currently married women only. Never married women's experience can be calculated in the same fashion as men. The divorced and separated group are placed in the single category. This formulation is the same as the male except it adds no additional experience for the ages between 27 and 35.

Non-Labor Income:

On the empirical level non-labor income is defined as income from sources other than work that is received by the individual. The labor supply model suggests that an increase in non-labor income will reduce hours worked and therefore the coefficient of this term should be negative. The effects of changes in income due to changes in the wage rate are picked up in the coefficient of the wage term. The variable is computed as total income minus labor income for the individual and then aggregated.

3.3 THE SUPPLY OF FEMALE PROFESSIONAL LABOR

The following is a discussion of the variables which effect female labor supply. Those variables which are the same as in the male labor supply curve will be discussed in relation to their expected sign and not in regards to their construction.

The Unemployment Rate:

The effects of unemployment on female labor supply maybe somewhat different than male labor supply. Overall women have a lower LFPR than men and are sometimes called secondary workers. Response to unemployment by secondary workers is usually divided into a discouragement effect and an added worker effect. Briefly, the discouraged worker withdraws from the labor force as the unemployment rate rises, and the added worker enters the labor force in order to maintain family consumption. The added worker effect is most noticeable in low income families. Also the added worker is more of a response to transitory deviations in family income, while cross-sectional unemployment rate variations are more of a permanent phenomenon. In the supply of professional female labor the expectation is that the discouragement effect will dominate. Although left to empirical verification, the sign of the regression coefficient is expected to be negative.

Marriage:

It is well known that the effect of marriage on female labor supply is negative. The reasoning applies to hours worked of professional females in the following manner. Holding all other things equal, a married professional female would have more home responsibilities and reduce hours worked. However, due to the high opportunity cost of not working in the market, it is possible that she would seek part-time employment. The expectation, due partly to the non-economic phenomenon is of a negative coefficient and probably for the effect of marriage to be greater absolutely for the female then the male, ceteris-paribus. Since it is observed that male wages exceed female, the rational choice for reduction of market work in favor of homework within the family is the individual with the lower expected market wage.

Children:

The effects of children on female labor supply are analagous to the effects of marriage since the number of children is a measure of the degree of home responsibilities. It is usually assumed that young children are more time intensive and in order to highlight the effect of small children, two child variables are used. One is the number of children under six and the other the total number of children. The use of two child variables illuminates the effect of an increase in young children on labor supply while holding constant the total number of children. The expectation is that an increase in the number of young children will reduce hours worked, older children will probably also reduce hours worked but the effect may not be as strong. Collinearity between the marriage variables and the child variables is so high that it became necessary to drop the marriage variable, so that the child variables here also can be interpreted to include the effects of marriage.

The interpretation of the quality variables has already been discussed and is fully parallel for females. Similarly for non-labor income.

Domestic Help:

An additional variable to be added to the female labor supply curve is a measure of the price of domestics. It is assumed that the more available, that is the lower the wage rate of domestic help and the more easily a woman will be able to divert her time from the home to the market.

The variable is constructed by dividing annual income of domestics by their annual hours worked and computing the SMSA mean value. The expected sign of this variable is negative.

3.4 THE DEMAND FOR MALE LABOR

Again the construction of the previously mentioned variables will not be reviewed in this section. The dependent variable is male hours worked and is empirically the same as in the supply equation. Similarly the male professional wage is the same measure as in the supply curve. The relevant female wage here is the female professional wage rate, rather than spouse's wage.

The Unemployment Rate:

One of the factors expected to influence the demand for labor across SMSA's is the unemployment rate. Unemployment can be viewed as the difference between the size of the labor force and the number of people employed and will change as either of these variables change. This difference may be due to some form of market imperfection or lag phenomenon. One reason for a higher unemployment rate is a relatively lower demand for labor in a given SMSA, ceteris paribus. Therefore the unemployment rate should enter the demand function to control for SMSA differentials, with the expected sign negative.

It can also be noted here that in and out migration from a local area reflects the local labor market demands. Since no adequate measure of SMSA migration can be constructed from census county group data, the unemployment rate variable can be assumed to be positively correlated with male migration. This is so since in areas with high unemployment there is an incentive for male professionals to migrate elsewhere, rather than not work.

SMSA Income:

To the extent that professional output is consumed locally, SMSA income should enter the demand curve. Professional output is a somewhat nebulous concept, and may be composed largely of services consumed in regional or national markets. SMSA income will enter the demand curve, its significance dependent on the extent of local consumption of output, and the expected sign is positive.

Government Employment:

Another possible cause for variance in SMSA demand for male professional labor is equal employment laws. That is, it is possible that certain industries may feel more inclined to hire women due to the existence of equal employment laws. As a possible control for this the percent of local professionals who are government employees will be used as an exogenous variable. Government employment is chosen since the likelihood of conformity to equal employment laws is higher in government agencies and the data for this is readily available.

Expected Job Tenure:

Extending the discussion of the expected job tenure variable presented earlier, the professional male labor force participation rate by SMSA could be used as a proxy. People leave a job for a number of reasons, one being to leave the labor force in favor of home responsibilities. In the context of differentiating male labor demand from female, females would leave jobs for all reasons a male might and in addition for home responsibilities. Thus on an aggregate level, the percent of people in the labor force can approximate job tenure. The expected sign of the variable is positive.

Human Capital:

Using the empirical construction of the quality variables defined earlier, an increase in a, that is schooling and experience may or may not increase the demand for male professional labor, ceteris paribus. Therefore the sign of s_m and j_m is uncertain. Similarly, increases in quality of female labor will have an uncertain effect on the demand for male labor, leaving no a priori expectation.

3.5 THE DEMAND FOR FEMALE PROFESSIONAL LABOR

The suggested exogenous variables for the female demand equation are the same as the male, with expected signs the same except for the percent of government employees. The expectation is the higher this value the higher the relative demand for women, and thus a positive sign on the regression coefficient. The signs of the remaining exogenous variables are not necessarily the same as in the male demand curve, however there is no other a priori conclusions that can be made. The signs and significance await empirical testing to which we now turn.

CHAPTER IV

THE REGRESSION RESULTS

The model can now be viewed as four structural equations of a simultaneous equation system. The four equations are the supply and demand for male professional hours and the supply and demand for female professional hours. The four endogenous variables are the male professional wage and hours worked per year, and the female professional wage and hours worked per year. Since not every male professional is married to a female professional and similarly for women, the spouses' wage rate in the supply equations are exogenous. For example, in the male professional supply equation the spouses wage rate is calculated by finding the mean wage of working females married to male professionals, regardless of their occupation. Thus the male professional's spouse's wage is not the female professional wage rate and is exogenous. Spouse's wage is the relevant variable since supply decisions are based on household conditions. In the demand curves, however, male professional and female professional wage rates appear. These are the relevant variables for demand since demand decisions depend on factor prices, where male professional and female professional labor are relevant factors in the production of professional output.

Since more than one endogenous variable appears in each structural equation ordinary least squares would produce biased estimators. In addition it can be shown that each equation is over-identified, thus two stage least squares is an appropriate single equation estimating technique [Johnston, p. 342]. Two stage least squares is used to estimate each equation, where the endogenous wage variable is estimated by the first stage equation. The use of a predicted wage tends to eliminate theproblem of bias in using estimated wage rates as pointed out by Borjas and Aigner. The estimated wage consists of dividing annual labor income by annual hours worked. If any measurement errors exists, this variable tends to produce coefficients biased towards -1. Thus the many backward bending supply curves may be in part due to bias. The predicted wage is formed by regressing estimate wages on a set of principle components from the model and then predicting the dependent variable. The R^2 on the first stage equations were good averaging between .50 and .80. The difficulty in predicting hours worked eliminates the possibility of using the inverted demand curve in a two stage context.

In TSLS the distribution of the coefficients is unknown in small samples and can be assumed normal in large samples. Assuming that the coefficients are distributed normally then the reported test statistics appearing in the regression results are standardized normal variates (z). Significance levels are found from the normal distribution assuming a one tail test.

Another econometric problem is the assumption of homoscedastity. If this is assumed to hold in the microdata then grouping will cause heteroscedasticity if the groups are of unequal size. Since the group size is a function of SMSA size which are generally not equal, then heteroscedastity will exist in the aggregaged data set. It can be shown that the square root of the cellsize is the appropriate weight to correct for this problem. All of the following specifications are thus weighted by the square root of the cellsize.

In the following regressions several empirical measures of the variables are available. Specifications 1 to 7 use for the wage rates the log of the mean labor income by SMSA divided by the mean hours worked by SMSA. Similarly for hours worked the variable is calculated by taking the log of the mean number of hours by SMSA. This approach can also be seen in terms of identifying the supply and demand functions. Since the data set is aggregated then each data point is an equilibrium in a local labor market, with a local supply and local demand curve passing through it. The problem is to identify the single demand and supply curve that represents all local markets except for variations unique to the local market. The SMSA mean hours and wage as specified above would be the appropriate empirical choice for these variables.

TABLE 4.1

ESTIMATES OF WEIGHTS

Estimate of weights from mean values of the variables from the male variables

$$\gamma_m = 3.9$$
$$K_{tm} = .13$$
$$K_m = .49$$
$$K_{tf} = .06$$
$$K_f = .32$$
$$K_v = .006$$

from the female variables

$$\gamma_f = 5.8$$
$$K_{tm} = .09$$
$$K_m = .49$$
$$K_{tf} = .06$$
$$K_f = .36$$
$$K_v = .003$$

Note that the male and female variables reflect two different sets of households, thus the difference in the estimated weights.

MALE LABOR SUPPLY

Specifications 1 to 4 are weighted two stage regressions of the male labor supply curve.

The log of non-labor income [LNLY1MPE] has the expected negative sign, but its significance level is low. Non-labor income shows a strong correlation with wage rates which may account for the low significance level. The theoretical expectation is that an increase in non-labor income, holding wages constant increases the demand for leisure reducing hours worked. The coefficient from the theoretical model is:

$$\frac{E_{tm}}{EV_m} = -\gamma_m \eta_m K_Y \approx -.009$$

Using the estimates from Table 4.1

$-(3.9)\ (\eta_m)(.006) \approx - .009.$ Solving for η_m

$\eta_m \approx .4$. Note that since the share of non-labor income in full income is relatively small, the coefficient is rather small. A 100% increase in non labor income would reduce hours worked by 9%.

Own wage (LWAG2MPE) is endogenous and predicted by a first stage equation. The sign is positive and the variable is significant at the 1% level. The positive sign indicates that the substitution effect dominates the income effect. Since the specifications used hold non-labor income constant the own wage coefficient contains both a substitution and income effect.

The coefficient of own wage from the theoretical model is:

$$\frac{E_{tm}}{EW_m} = \gamma_m(1-K_m)\bar{\sigma}_m - K_{tm}\gamma_m\eta_m \approx .33$$

Substituting from Table 4.1

(1.989) $\bar{\sigma}_m$ - (.507) $\eta_m \approx .33$, Using the estimate of η_m, $\bar{\sigma}_m$ can be solved for

$$\bar{\sigma}_m \approx .27$$

While the estimates of the elasticities, η_m and $\bar{\sigma}_m$ show the income elasticity to excede the elasticity of substitution, the weights are sufficient to alter the sign of the coefficient. That is the weighted average of the elasticities yields a positive coefficient.

Some studies (Hall, 1973, Hill 1973) show negatively sloped labor supply functions for men, while others (Borjas) using wage instruments have shown the substitution effect to dominate.

Also among professional men a relatively large number are self employed which may imply a relatively larger increase in hours worked for a given change in wages. The self employment variable, however, failed to capture any effect.

The log of the spouses wage (LSW2MPE) is significant at 5% and has a negative coefficient. The theoretical coefficient is

$$\frac{E_{tm}}{EW_s} = -\gamma_m K_f \sigma_{mf} - \gamma_m \eta_m K_{tf} \approx -.129$$

Substituting from Table 4.1

$$-1.24\,\sigma_{mf} \quad - .23\,\eta_m \approx \; - .129$$

While both elasticities enter with negative signs the elasticity of substitution between male and female non market time has no a priori expectation and can change the sign of the coefficients. Using the estimates from Table 4.1 and solving for σ_{mf}, σ_{mf} for men is found to be .03. This indicates for families with a male professional home time between spouses is weakly substitutable. Using the weights:

$-.037 \quad - \quad .092 \approx -.129$, so that both elasticities imply a reduction of male hours. That is an increase in spouses wage, through an income effect increases the male demand for home time and thus reduces market work and since the substitution effect is positive, the family shifts toward more male home time also reducing male hours worked.

The empirical proxy for male quality, a_m is the log of male education and the log of male experience (LEDMPE, LJMMPE). Because the exact functional interrelationship between these three variables is unknown the coefficients should be interpreted in sign only and not in magnitude. This is so since the choice of functional form will alter the size of the coefficients but not their sign. Also since there is no constraint on the regression coefficients in general, the estimated elasticities from the quality proxies will differ from those estimated from the wage and income coefficients. Since the specification of the wage and income terms is more exact than the quality variable, the estimates of the substitution and income elasticities are made from the wage and income coefficients.

The log of male education is negative and significant at 5% and the log of male experience is negative and significant at 10%. The difference in the ratio of the coefficient to its standard error might be interpreted as the probability that education effects male hours is higher than the probability the experience effects male hours. This result is rationalized by the fact that experience is almost exactly correlated with age (the correlation coefficient is .97) and the relationship between age and hours worked is known to be parabolic. That is, over the life cycle men may at first increase hours worked and then at latter ages reduce hours of work due to a positive difference between the rate of interest and rate of time preference.

Since the regression yields a negative sign for male quality then from the theoretical model:

$$\frac{E_{tm}}{E_{am}} = -\gamma_m\left(\left((1-K_m)\bar{\sigma}_m + K_m\eta_m - 1\right)\right) < 0$$

Where the sign of the coefficient will depend on whether $(1-K_m)\bar{\sigma}_m + K_m\eta_m \gtreqless 1$. That is an increase in male quality increases the demand for Z_m, but also the supply of Z_m. The sign of the coefficient depends on which is increased more. Since the sign is negative, then an increase in male quality increases male demand for Z_m more than supply, hours worked will then decline.

The empirical implimentation of female quality, a_f is similar to the male. The variables used are spouse's education and experience. The standard error is too large to draw any conclusion from the regression results. However using the estimates from Table 4.5 the sign should be negative. The low significance level may be due to collinearity with male education and experience. The spouse's experience variables (LSJFMPE) is positive and significant at 10%.

This may again bedue to life cycle effects.

The child variable (KID18MPE) has the expected positive sign and is significant at 5%. This variable can be thought of as also standing for the effects of marriage and may control for variations in the assumed utility function due to family responsibilities. That is men with more children may have a greater need for money income.

The unemployment rate variable (UNEMPRAA) is negative and significant at 5%. Use of the overall unemployment rate variable rather than any specific group rate is rationalized due to occupational substitution along the group margin due to across group variation in unemployment rates. Since the unemployment rate across SMSA's is interpreted as reflecting local variations of a more permanent nature than time series unemployment, then the negative coefficient implies an adjustment on the part of individuals to local conditions. That is a relatively high local permanent level of unemployment indicates a depressed area and individuals, who do not migrate out of the region adjust by lowering their labor supply i.e. the discouragement effect dominates. The decrease in hours worked might also be interpreted as a job rationing device, where less people work or each person works less hours.

TABLE 4.2

MALE LABOR SUPPLY

	1	2	3	4
VARIABLE	LHYMPE	LHYMPE	LHYMPE	LHYMPE
LNLY1MPE	-.00943 -.6397	-.00924 -.6310	-.00654 -.4644	-.00863 -.6440
LWAG2MPE	.3382 3.151	.3372 3.161	.2963 2.991	.2464 2.865
LSW2MPE	-.1282 -2.871	-.1272 -2.880	-.1138 -2.720	-.1031 -2.632
UNEMPRAA	-.6600 -2.374	-.6550 -2.377	-.6655 -2.477	-.6874 -2.675
KID18MPE	.06659 2.357	.06677 2.377	.06255 2.305	.0689 2.706
LEDMPE	-.8560 -2.615	-.8212 -2.940	-.7088 -2.384	-.0202 -2.248
LSEDMPE	.046 .20		-.074 -.37	.0075 .04
LJMMPE	-.3101 1.681	-.3012 -1.688	-.089 -1.187	
LSJFMPE	.2258 1.32	.2114 1.36		
CONSTANT	9.4 11.5	9.4 11.8	9.3 11.8	8.7 15.5

FEMALE LABOR SUPPLY

Specifications 5 to 8 are weighted two stage regressions of the female labor supply curve.

The log of non-labor income (LNLY1FPE) has the expected negative sign and is significant at 10%. The coefficient from the theoretical model is

$$\frac{E_{tf}}{E_v} = -\gamma_f \eta_f K_v \approx -.049$$

Using the estimated weights from Table 4.1

$$-(5.8)(\eta_f)(.004) \approx -.049 \quad \text{or}$$

$$\eta_f \approx 2.8$$

While the male weights excede the female, the estimated income elasticity for women excedes that of men yielding a coefficient for women that excedes that of men in absolute value.

The estimated income elasticity of non-market time for women is considerably larger than the same elasticity estimated for men. This may be rationalized by the familiar assumption that the relevant alternative to market work for men is leisure activities while for women it is leisure and home responsibilities. This phenomenon may be changing over time, however the data set is a cross section taken in 1969. The effect of home responsibilities of women is further illustrated by the strong negative correlations between children, domestic wage rates and hours of work for professional women, while the correlation between children and hours of work for men is positive. Thus the estimated income elasticity of non-market time for women excedes that of men.

Own wage (LWAG2FPE) is endogenous and predicted by a first stage equation. The sign is negative and the variable significant at about 10%. The negative sign indicates that the income effect dominates the substitution effect. From the theoretical model

$$\frac{E_{tf}}{EW_f} = \gamma_f(1-K_f)\bar{\sigma}_f - K_{tf}\gamma_f\eta_f \approx -.18$$

Using the estimated weights from Table 4.1 and the estimated income elasticity, the elasticity of substitution can be solved for:

$$\bar{\sigma}_f \approx .2135.$$

Comparison of this coefficient with the own wage coefficient for male supply shows that the weighted substitution elasticities and the weight on the income elasticity do not vary much between the male and female coefficients.

male	(.537) - (.507) η_m	$\approx$ .33
female	(.777) - (.348) η_f	$\approx$ -.18

The reason then for the negative sloped female labor supply function seems to be the much larger income elasticity for non-market time, which of course enters with a negative sign. The income elasticity of non-market time can be thought of as a weighted average of income elasticities of alternative uses of non-market time. Assuming that leisure and homework are the alternatives for non-market time, then the estimated elasticity could be divided between these two components.

There are, however, no data to make this distinction. Were it possible, income elasticities of leisure time for women of up to 1.8 would yield positively sloped labor supply curves. If over time the income elasticity of homework declined as such responsibilities were distributed between spouses or as the weight declines if for instance family size declined, then the expectation is that female labor supply curve would become positive with respect to own wage.

The log of the spouses wage (LSW2FPE) is negative, and the significance level is low, which maybe due to collinearity with own wage. Since the theoretical coefficient is:

$$\frac{E_{tf}}{EW_s} = -\gamma_f K_m \sigma_{mf} - \gamma_f \eta_f K_{tm} \approx .075$$

Using the estimated weights from Table 4.1 and the estimated value of η_f, σ_{mf} for women is found to be -.487. The relationship between female and spouse's home time is found to be complimentary. However the coefficients of spouses wage for males and for females is very similar. This is due to the difference in income elasticities Recall for the male

$$-1.24\,\sigma_{mf}^{m} - .23\eta_m = -.129$$

for the female

$$-2.84\,\sigma_{mf}^{f} - .52\eta_f = -.075$$

and that these coefficients are based on two different sets of households. For the female the substitution elasticity yields a positive effect, but the income effect which is negative is relatively stronger yielding a negative coefficient. For the male both effects were negative.

Again the empirical proxies for female quality will be interpreted in sign only. Female education (LEDFPE) is positive and significant at about 10% and female experience is positive and significant at about 1%. The coefficient from the theoretical model is:

$$-\gamma_f((1-K_f)\bar{\sigma}_f + K_f\eta_f - 1)$$

and its sign depends on whether

$(1-k_f)\bar{\sigma}_f + K_f\eta_f \gtrless 1$ Since the regression yields a positive sign then it appears that

$(1-K_f)\bar{\sigma}_f + K_f\eta_f < 1$, that is the increase in female quality increase the supply of Z more than the demand for Z, which releases more time for market work. This seems to concur with the time series phenomena of increases in female education and increases in female labor force interaction. However in the cross section as wages increase we observe a reduction of hours.

The empirical proxies for spouse's quality, LSEDFPE and LSJMMFPE, vary in significance level from about 15% to 1%, with the exclusion of one case, most likely simply due to collinearity. The sign of spouse's quality is negative. The theoretical coefficient is:

$\gamma_f K_m(\sigma_{mf} - \eta_f) < 0$, thus η_f exceeds σ_{mf}. That is the income effect of an increase in spouses quality acts to reduce female hours and since for female professionals home time for husband and wife are compliments, the substitution elasticity also reduces hours worked.

The unemployment rate (UNEMPRAA) is significant at about 15% and is negative in sign. This indicates that in relatively depressed local labor markets, female professionals tend to supply less hours. This may be due to such things as taking part-time jobs when full-time work is unavailable.

The child variables (KID6FPE, KID18FPE) have the expected negative signs and are significant at 10% for total number of children and 1% for children under six. The higher significance level for small children can be interpreted as the probability that small children reduce hours worked exceeds the probability that all children reduces hours. This is a well documented phenomena [Bowen and Finnigan 1969] and also agrees with the relatively high income elasticity of non market time.

The effect of this variable for males was reversed and presumably, in the face of increased home responsibilities men with higher wages attempt to increase family income and women reduce hours worked in order to produce home commodities.

The wage rate of domestics is significant at 5% and as expected negative. That is as the cost of domestic services increase women tend to reduce hours worked to take care of home responsibilities. Lower domestic wages rates would allow for more market work. Since children are being held constant in the specification the effect of domestics is evident for non child homework. Generally domestic labor is considered a poor substitute for mother's time in caring for children.

TABLE 4.3

FEMALE LABOR SUPPLY

	5	6	7	8
VARIABLE	LHYPPE	LHY1PE	LHYPPt	LHYFPE
LWAG2FPE	-.1819 -1.329	-.1277 -1.113	-.2605 -2.076	-.1659 -1.441
UNEMPRAA	-.3777 -.8378	-.4791 -1.046	-.4151 -.9434	-4834 -1.049
LSW2FPE	-.07547 -.8422	-.06152 -.7963	.0146 .2248	-.0246 -.2962
LNLY1FPE	-.0496 -1.839	-.0394 -1.722	-.0288 -1.347	-.0288 -1.291
WGMDOM	-.01031 -2.087	-.01154 -2.405	-.0096 -2.002	-.0113 -2.35
KID18FPE	-.07908 -1.834	-.07865 -1.771	-.0855 -2.021	-.082 -1.867
KID6FPE	-.3386 -2.677	-.3498 -2.730	-.3177 -2.705	-.03637 -2.809
LEDFPE	.4480 1.072		.4339 1.129	
LSEDFPE	.1245 .6635		-.2582 -2.274	-.1928 -1.73
LJFMFPE	.1353 2.484	.09001 2.754		
LSJMMFPE	-.06452 -1.014	-.07524 -1.247		-.063 -1.036
CONSTANT	6.193 5.26	7.74 32.88	7.233 8.002	8.36 27.62

MALE LABOR DEMAND

Specifications 9 through 12 are weighted two stage regressions of the male labor demand function.

Own wage (LWAG2MPE) has the expected negative coefficient and is significant at about 10%.

From the theoretical model:

$$\frac{E_{tm}}{EW_m} = S_m\,(\sigma_{mm} - \eta)$$

There is insufficient data to estimate the component elasticities, however, since the price elasticity (η) is defined as positive then for a negative coefficient $\sigma_{mm} < \eta$ and σ_{mm} is by definition negative. In any event both elasticities have a negative effect, thus ceteris paribus, an increase in male wage reduces the quantity of male labor demanded.

The log of the female wage (LWAG2FPE) is positive and significant at about 15%. From the theoretical model:

$$\frac{E_{tm}}{EW_f} = S_f\,(\sigma_{mf} - \eta)$$

Since S_f and η are positive, σ_{mf} must be positive and greater than η . Thus male and female time are substitutes in the production of professional output, and an increase in the female wage rate will increase the demand for male hours.

The empirical proxies for male quality are again the log of male education and the log of male experience. Neither variable is remotely significant. This might be interpreted as a zero coefficient, however, from the theoretical model this would imply that the wage coefficient should be one, which it is not. Alternatively this result may be due to multicollinearity with the wage variables which is rather high. Another possibility is that the wage coefficient is not one due to specification error and in fact changes in male quality are reflected by changes in the nominal wage. The model assumes that nominal wages and quality can vary independently, which is in some sense a market imperfection situation. The more organized the labor market, the less likely that an increase in quality could go unrewarded by an increase in nominal wages. This is supported by the 1st stage regressions. In the first stage wages are regressed on quality and other variables. When male wages are regressed on male quality the coefficient of determination is somewhat larger than when female wages are regressed on female quality. That is the percent of wage variation unexplained by quality is greater for women than men.

The female quality variables also did rather poorly. Female education showed strong collinearity with the predicted wage rates and was dropped. Female experience, has a negative sign and is significant at about 15% in specification 10. On the theoretical level the coefficient of female quality is simply the negative of the female wage rate. Since female wages enter with a positive sign, then female quality should enter with a negative sign, which it does. This could also be interpreted as further evidence of the positive elasticity of substitution between male and female time in market production.

The unemployment rate is significant at 5% and has a negative sign. This implies that the demand for male hours worked goes down as the unemployment rate goes up. If unemployment is interpreted as the difference between the quantity of labor supplied and the quantity of labor demanded at a given wage rate, then an increase in unemployment could result from a shift to the left of the demand curve.

The percent of male professionals working for the government (GOVWKMPE) is significant at 5% and has a negative sign. The negative sign may in part be due to the fact that the government is not a profit maximizer and is less likely to favor groups with longer expected job tenure. Also the government may be more subject to equal employment laws and as the total SMSA mix of employers shifts towards more government employment, it is likely that there will be a decrease in the demand for men relative to women.

The labor force participation rate is significant at about 10% and is positive in sign as expected. Although this variable is sometimes used as the dependent variable in labor supply models, the role here is to capture the effects of expected job tenure. The labor force participation rate may also be a proxy for own quality in the sense that higher rates imply a more extensive interface with the labor force and thus more experience. Use of this variable as a proxy for job tenure is rationalized as follows. On an aggregated level, people may leave a job for a number of reasons, however, women are more likely to leave a job and the labor force for domestic responsibilities than men. That is the probability, excluding leaving the labor force, of a man or woman leaving a given job may be equal.

However, when including the fact that women also leave jobs for home duties, the expected job tenure declines. Across SMSA variations in LFPR then reflect expected duration of participation in the labor force or on any given job. These variations in part reflect age, marital and family size variations across SMSA's. For example, a city with higher mean age for women would be expected to have a higher LFPR and longer expected job tenure. On the theoretical level, the higher the expected job tenure the greater the demand for that group's labor, thus the positive coefficient.

City Income (CYINAA) is significant at about 10% and is positive. Mean SMSA income is reflective of industry mix and city size. Some cities will have a relatively larger percent of high paying industries, or high paying occupations. This is generally correlated with city size to the extent that larger cities have more sophisticated industries that pay higher wages. Since men are assumed to have a higher quality level, then as mean city income increases, and presumably the sophistication of local industry increases, then the demand for relatively high quality labor would increase.

Also as a demand curve, to the extent that local professional output is consumed locally (i.e. services) increases in local income increase the demand for professional output and therefore the demand for professional labor.

TABLE 4.4

MALE LABOR DEMAND

	9	10	11	12
VARIABLE	LHYMPE	LHYMPE	LHYMPE	LHYMPE
LWAG2MPE	-.1504 -1.851	-.1353 -1.050	-.1553 -1.892	-.2134 -2.671
LWAG2FPE	.078 1.015	.0467 .4201	.08788 1.123	.08432 1.082
UNEMPRAA	-.5650 -2.17	-.5060 -1.687	-.5767 -2.195	-.5368 -2.03
GOVWKMPE	-.0788 -2.499	-.0842 -2.118	-.082 -2.56	-.069 -2.25
LFPMP	.2227 1.484	.2388 1.394	.1982 1.290	.1255 .8540
LEDMPE		.0002 .0006		
LJMMPE		.04075 .44		
LJFMFPE		-.019 -1.043	-.015 -.90	-.0102 -.594
CYINAA				.000008 1.8
CONSTANT	7.49 41.11	7.4 7.87	7.55 39.09	7.6 40.

FEMALE LABOR DEMAND

Specification 13 through 17 are weighted two stage regressions of the female labor demand function.

The log of own wage (LWAG2FPE) is significant at 1% and negative as expected. The larger coefficient in the female demand curve implies that the female demand curve is somewhat more wage elastic than the male demand curve. The price elasticity is defined as positive, but enters with a negative sign yielding a negative effect and similarly the own elasticity is defined as negative, thus the negative coefficient of own wage.

The log of the male wage (LWAG2MPE) is positive and significant at about 15%. From the theoretical model:

$$\frac{E_{tf}}{EW_m} = S_m (\sigma_{mf} - \eta)$$

Since S_m and η are positive, σ_{mf} must be positive and greater than η. Thus again σ_{mf} is shown to be positive and an increase in the male wage rate causes substitution towards female labor.

The empirical proxies for female quality are the log of female education (LEDFPE) and the log of female experience (LJFMFPE). The significance levels for female education is about 10% and for female experience about 1%. The signs in all cases are positive.

From the theoretical model:

$- (S_f (\sigma_{ff} - \eta) + 1) > 0$. Since the estimated coefficient is positive this implies that

$S_f\ (\sigma_{ff} - \eta) < -1$. From the demand for quality adjusted units, an increase in quality lowers the quality adjusted price increasing the quantity demanded. The increase in quality also increases the number of quality adjusted units, for a fixed number of nominal units. The increased demand is greater than the increased supply increasing the demand for nominal units.

The empirical proxies for male quality are the log of male education (LEDMPE) and the log of male experience (LJMMPE). Significance levels vary with specification but in several cases is about 10%. The signs of both variables, regardless of significance levels is in all cases negative. Since the coefficient is the negative of the male wage coefficient, which empirically is positive, a negative sign is appropriate.

From the theoretical model:

$$\frac{E_{tf}}{Ea_m} = S_m\ (\sigma_{mf} - \eta)$$

Since this is found to be negative, then

$S_m\ (\sigma_{mf} - \eta) > 0$ or $\sigma_{mf} > \eta$, and η is defined as positive. An increase in male quality ceteris paribus, reduces the quality adjusted price of male labor, increasing the demand for male labor and reducing the demand for female labor.

The unemployment rate variable is significant at 10% and negative in sign. Cross sectional increases in the unemployment rate reduces the demand for female labor, the effect appears to be symmetric with male labor demand. In the male and female demand curves, the coefficients are of thesame sign and magnitude.

The percent of female professionals working for the government (GOVWKFPE) is significant at about 5% and positive in sign. The comparable variable for men had a negative effect. This suggests that as the SMSA employment mix shifts towards more government employment the demand for females increases relative to males. This may be due to the stricter observation by government agencies of equal employment laws. Also as a non profit maximizer government can offer equal wages, or employment to any group regardless of their expected job tenure. For example, at a given wage, the demand for female labor, with a shorter expected job tenure, would be less than the demand for male labor. If government employers were not concerned with this phenomena or unable to respond to it by law, then as SMSA mix moves towards more government employment, the demand for female labor, relative to male labor would rise. Thus the negative sign for males and the positive sign for females.

The labor force participation rate (LFPFP) is significant at about 10% with the expected positive sign. The role of this variable is again to capture the effects of expected job tenure. As tenure increases, reflected by increases in LFPR, then the demand for that group's labor will increase. The coefficients in both the male and female demand curves are of the same sign and approximate magnitude.

City income (CYINAA) is negative and significant at 5%. The negative sign differs from the male demand curve. To the extent that professional output is consumed locally, it would be expected that increases in local income would increase the demand for both male and female professional labor. This may be offset however by the tendency for higher mean SMSA income to reflect a perponderance of high paying male dominated occupations. For females, this would reduce the demand for their labor. The sum of both effects for women would be negative if the mix effect outweights the income effect. For men both effects are positive.

TABLE 4.5

FEMALE LABOR DEMAND

	13	14	15	16	17
VARIABLE	LHYFPE	LHYFPE	LHYFPE	LHYFPE	LHYFPE
LWAG2FPE	-.3270 -3.346	-.3686 -2.206	-.3014 -2.920	-.53456 -2.23	-.5008 -2.740
LWAG2MPE	.1640 1.283	.2353 1.017	.1401 1.020	.39676 1.66	.7023 2.366
UNEMPRAA	-.5248 -1.262	-.4730 -1.070	-.4799 -1.086	-.48569 -1.15	-.7995 -1.648
GOVWKFPE	.2039 2.294	.1333 1.294	.1288 1.604	.20475 2.017	.1771 1.573
LFPFP	.1779 1.263	.2369 1.591.	.2388 1.604	.15096 1.052	.074 .45
LEDMPE		-.3268 -.5112		-.88021 -1.305	-1.315 -1.710
LEDFPE		.2263 .4287	.0484 .1221	.96841 1.804	1.104 1.856
LJMMPE	-0.0372 -.37			-.0789 -.712	-.2301 -1.643
LJFMFPE	.1244 3.694			.14775 4.056	.1448 3.605
CYINAA					-.00002 -2.211
CONSTANT	6.94 23.1	7.29 6.2	6.9 7.09	6.66 5.11	7.59 5.07

TABLE 4.6

VARIABLE LIST

LHY	ln of hours per year
LWAG2	ln of wages
UNEMPRAA	Unemployment rate
LED	ln of education
LNLY1	ln of non labor income
LSW2	ln of the spouses wage
KID18	mean number of children
KID6	mean number of children under six
LSEDN	ln of spouses education
LJMMPE	ln of male experience
LSJFMPE	ln of wife's experience
LJFMFPE	ln of female experience
LSJMMPE	ln of husbands experience
WGMDOM	wage of domestics
FOVWK	percent working for the government
LFP	labor force participation rate
CYINAA	mean SMSA income

VARIABLE SUFFIX

MPE = from the male professionals employed samplr

FPE = from the female professionals employed sample

CHAPTER V

THE REDUCED FORM

The structural model contains four equations in four endogenous variables and twenty-three exogenous variables including the intercept term. The solution to this simultaneous equation system for the four endogenous variables yields the reduced form coefficients. The reduced form equations are thus solutions for the endogenous variables using the estimates obtained from the structural model. Since each equation is overidentified, this procedure does not work in reverse, that is, direct estimation of the reduced form would not produce a unique structural model. The values of the endogenous variables generated by the reduced form equations are the equilibrium values of hours and wages in the structural system.

The reduced form coefficients are then linear functions of the structural coefficients, and have some associated density function. see[Appendix D] Point estimates are calculated in Table 5.1. Since the reduced form yields equilibrium values of endogenous variables, in general the sign of a reduced form coefficient depends on the signs in the structural model as well as how many structural equations the variable enters. For example, if a variable enters both the supply and demand curve the effect on the equilibrium wage depends on the relative magnitude of the coefficients.

The use of a four equation system implies that the labor markets for males and females are interactive. There is a direct effect of the variables that simultaneously enter both supply and demand equation sets and an indirect effect of variables that enter only one market, effecting the equilibrium wage in that market which in turn effects the equilibrium in the other market.

An example of an indirect effect is an increase in the wage of domestics. This variable presumably will have a negative effect on female labor supply and no effect on male labor supply. The reduction of female supply will tend to raise the equilibrium wage of females. The higher the equilibrium wage of females would then cause substitution toward male labor increasing the male wage. This effect is seen in the reduced form coefficients in Table 5.1. A one dollar increase in domestic wages raises female professional wage by approximately 4% which in turn raises male wages by .4%, ceteris paribus.

A direct effect is a change in city income which is shown to have an opposite effect on female and male demand. This effect probably results from cross sectional differences in the industry and occupational mix associated with cross sectional variations in mean city income, and would not necessarily be the same in times series analysis. However, in the reduced form an increase in city income is shown to increase both male and female wage rates. This is due to the fact that the increased demand for male labor raises the male wage which increases the demand for females more than the increase in city income reduces the demand for females. The reduced form coefficients in Table 5.1 for CYINAA show these effects. As a generality the prices of substitute factors tend to move together.

TABLE 5.1

REDUCED FORM COEFFICIENT

	W_m	W_f	Means	
Intercept	-5.53	-9.91	1	
LNLY1MPE	.025	.05	2.88	
LFPFP	.032	.30	.665	
LSW2MPE	.34	.78	1.39	
UNEMPRAA	.28	-.38	.031	
KID18MPE	-.185	.406	1.5	
LEDMPE	1.82	-.08	2.72	
LSEDMPE	-.13	.28	2.56	
LJMMPE	.88	1.21	2.94	
LSJFMPE	-.62	-1.35	2.66	
GOVWKFPE	.08	.73	.49	
GOVWKMPE	-.24	-.52	.282	
LFPMP	.65	1.41	.958	
LJFMFPE	.03	.51	2.16	
CYINAA	.24	.20	1.18	
LSW2FPE	.03	.27	1.81	
LNLY1FPE	.02	.16	1.32	
WGMDOM	.004	.04	2.02	
KID18FPE	.035	.327	1.12	
KIDGFPE	.15	1.34	.26	
LEDFPE	.29	2.69	2.69	
LSEDFPE	-.06	-.53	2.51	
LSJMMFPE	.03	.27	2.89	
				Predicted by Reduced Form
LWAG2MPE			1.99	2.24
LWAG2FPE			1.47	1.48

TABLE 5.2

REDUCED FORM COEFFICIENT TIMES MEAN OF VARIABLE

	W_m	W_f
Intercept	-5.534	-9.92
LNLY1MPE	.073	.16
LFPFP	.022	.20
LSW2MPE	.5	1.09
UNEMPRAA	.009	- .01
KID18MPE	- .278	- .609
LEDMPE	4.95	- .224
LSEDMPE	- .33	.724
LJMMPE	2.6	3.56
LSJFMPE	-1.65	-3.6
GOVWKFPE	.039	.36
GOVWKMPE	- .066	- .145
LFPMP	.619	1.35
LJFMFPE	.072	1.10
CYINAA	.28	.244
LSW2FPE	.056	.52
LNLY1FPE	.023	.216
WGMDOM	.009	.083
KID18FPE	.039	.366
KID6FPE	.074	.70
LEDFPE	.78	7.25
LSEDFPE	- .143	-1.33
LSJMMFPE	.09	.83

Of particular interest are the reduced form coefficients of education, experience and labor force participation. These variables were shown on the theoretical level to influence the relative wage. There are six variables, three male and three female, and although the coefficients are derived from cross sectional data there is no immediately apparent reason why these coefficients might differ substantially in a time series model.

The labor force participation rates are shown to have a positive effect on male and female demand functions. An increase in the female labor force participation rate increases the demand for women, which raises the female wage rate, which would increase the demand for male labor. It is uncertain whether a change in female labor force participation has any direct effect on male demand. Assume that any direct effect of a change in female labor force participation is at least compensated for by the effect of higher female wages.

The female education level enters the female supply and demand curves. Any direct effect on the male labor is unknown and again will be assumed to be compensated for by wage changes. In the reduced form female education has a positive coefficient since the demand effect exceeds the supply effect. An increase in the female wage would tend to also raise male wages, but only by at most 10% of the female increase.

Female experience also has a positive effect in the reduced form female wage equation, and a relatively small positive effect on male wages. In general assume that male wages are unaffected by changes in these three female variables.

Using the reduced form coefficients and the mean values of the exogenous variables equilibrium values of male and female wages can be predicted as shown in Table 5.2. The predicted wage rates have some probability distribution associated with them and in general the reduced form need not be as accurate a predictor of mean wages as a least squares regression of the same variables since least squares regression functions are forced through the means of the variables.

Converting to the linear form of wages, the wage differential is defined as:

$$1 - \frac{W_f}{W_m}$$

where W_f = female wage and

W_m = male wage

The wage differential predicted by the reduced form wage equations is .53.

An estimate of the effect of differential levels of labor force participation, education and experience between males and females on the relative wage can be found by substituting the values of the relevant male variables into the female reduced form wage equation. That is to what extent is the above wage ratio explainable in terms of differences in human capital and job tenure.

In Table 5.3 the male mean values for male education and experience are substituted into the female wage equation and the predicted wage differential is .24. That is 64% of the unadjusted wage differential is accounted for by the differences in human capital level.

In addition the male labor force participation can be used in the female wage equation. As shown in Table 5.3 the estimated wage differential is .16 which is a 77% reduction of the original wage gap.

That is about 77% of the wage differential is attributable to differences between men and women in their education experience and labor force participation rates. Overtime if these variables tend to equate as women participate more in the labor force than the wage differential will narrow. The remaining 16% can be attributed to other factors such as discrimination.

The fact that women have lower labor force participation rates and lower levels of human capital may not be simply exogenous. It could be argued that in anticipation of discrimination women optimally invest less in schooling and experience. The wage differential estimates of .53 to .16 might be thought of as upper and lower bounds on the extent of discrimination.

Since experience which is also reflected by the LFPR variable has a large impact on observed wage levels the effect of equal wage laws is to crowd women into occupations that have low levels of on-the-job training and consequently pay less. Since the expected payoff period from on-the-job-training for women is shorter than for men, employers would provide training to women only if they could shift a larger part of the cost on to women. Equal wage laws prevent this and women are hired only for low training type of jobs. Equal opportunity laws combined with equal wage laws creates a disequilibrium situation in which employers lose unless women extend their term of employment.

TABLE 5.3

ESTIMATED FEMALE WAGE

	Female Coefficient Times Female Mean	Female Coefficient Times Male Mean	
LFPFP	.20		.3
LJFMFPE	1.1	1.5	1.5
LEDFPE	7.25	7.33	7.33
Predicted Wage	4.43	7.16	7.82
Wage Differential	.53	.24	.16

TABLE 5.4

RESULTS FROM PREVIOUS STUDIES[a]

Author	Unadjusted Wage Differential	Adjusted[b] Wage Differential
Sanborn	.42	.12
Suter & Miller	.57	.31
Malkeil & Malkeil	.35	. 0
Mincer & Polachek	.34	.10
Saffer	.53	.16

[a] each study uses a different cross sectional or special longitudinal dataset running from 1950-1970.

[b] adjustments made for schooling, experience, occupation, turnover, varying somewhat in each study.

Alternatively some form of direct incentives to employers to minimize the need for labor force withdrawal could lower the cost of employing women. In the professional category women largely dominate occupations with shorter annual hours required or with relatively flexible work schedules. Nursing and teaching, largely done by women are representative of occupations with institutional arrangements that minimize the extent of the withdrawal period. Policy directed at employers to provide for men and women more flexible working schedules, part-time continuation of employment and return to work after some given length of time away could allow more women to stay in the labor force,shorten the length of withdrawal time, and reduce the wage differential.

APPENDIX A

1970 CENSUS OF POPULATION

OCCUPATION CLASSIFICATION

Census Code	PROFESSIONAL, TECHNICAL, AND KINDRED WORKERS
001	Accountants
002	Architects
	Computer specialists
003	Computer programmers
004	Computer systems analysts
005	Computer specialists, n.e.c.
	Engineers
006	Aeronautical and astronautical engineers
010	Chemical engineers
011	Civil engineers
012	Electrical and electronic engineers
013	Industrial engineers
014	Mechanical engineers
015	Metallurgical and materials engineers
020	Mining engineers
021	Petroleum engineers
023	Sales engineers
024	Farm management advisors
025	Foresters and conservationists
026	Home management advisors
	Lawyers and judges
030	Judges
031	Lawyers
	Librarians, archivists, and curators
032	Librarians
033	Archivists and curators
	Mathematical specialists
034	Actuaries
035	Mathematicians
036	Statisticians
	Life and physical scientists
042	Agricultural scientists
043	Atmospheric and space scientists
044	Biological scientists
045	Chemists
051	Geologists
052	Marine scientists
053	Physicists and astronomers
054	Life and physical scientists, n.e.c.

Census Code	PROFESSIONAL, TECHNICAL, AND KINDRED WORKERS (Continued)
055	Operations and systems researchers and analysts
056	Personnel and labor relations workers
	Physicians, dentists, and related practitioners
061	Chiropractors
062	Dentists
063	Optometrists
064	Pharmacists
065	Physicians, medical and osteopathic
071	Podiatrists
072	Veterinarians
073	Health practitioners, n.e.c.
	Nurses, dietitians, and therapists
074	Dietitians
075	Registered nurses
076	Therapists
	Health technologists and technicians
080	Clinical laboratory technologists and technicians
081	Dental hygienists
082	Health record technologists and technicians
083	Radiologic technologists and technicians
084	Therapy assistants
085	Health technologists and technicians, n.e.c.
	Religious workers
086	Clergymen
090	Religious workers
	Social scientists
091	Economists
092	Political scientists
093	Psychologists
094	Sociologists
095	Urban and regional planners
096	Social scientists, n.e.c.
	Social and recreation workers
100	Social workers
101	Recreation workers
	Teachers, college and university
102	Agriculture teachers
103	Atmospheric, earth, marine, and space teachers
104	Biology teachers
105	Chemistry teachers
110	Physics teachers
111	Engineering teachers
112	Mathematics teachers
113	Health specialties teachers
114	Psychology teachers
115	Business and commerce teachers
116	Economic teachers

Census Code	
	PROFESSIONAL, TECHNICAL, AND KINDRED WORKERS (Continued)
	Teachers, college and university (Continued)
120	History teachers
121	Sociology teachers
122	Social Science teachers, n.e.c.
123	Art, drama, and music teachers
124	Coaches and physical education teachers
125	Education teachers
126	English teachers
130	Foreign language teachers
131	Home Economic teachers
132	Law teachers
133	Theology teachers
134	Trade, industrial, and technical teachers
135	Miscellaneous teachers, college and university
140	Teachers, college and university, subject not specified
	Teachers, except college and university
141	Adult education teachers
142	Elementary school teachers
143	Prekindergarten and kindergarten teachers
144	Secondary school teachers
145	Teachers, except college and university, n.e.c.
	Engineering and science technicians
150	Agriculture and biological technicians, except health
151	Chemical technicians
152	Draftsmen
153	Electrical and electronic engineering technicians
154	Industrial engineering technicians
155	Mechanical engineering technicians
156	Mathematical technicians
161	Surveyors
162	Engineering and science technicians, n.e.c.
	Technicians, except health, and engineering and science
163	Airplane pilots
164	Air traffic controllers
165	Embalmers
170	Flight engineers
171	Radio operators
172	Tool programmers, numerical control
173	Technicians, n.e.c.
174	Vocational and educational counselors
	Writers, artists and entertainers
175	Actors
180	Athletes and kindred workers
181	Authors
182	Dancers
183	Designers
184	Editors and reporters

Census Code	
	PROFESSIONAL, TECHNICAL AND KINDRED WORKERS (Continued)
	Writers, artists and entertainers (Continued)
185	Musicians and composers
190	Painters and scultors
191	Photographers
192	Public relations men and publicity writers
193	Radio and television announcers
194	Writers, artists, and entertainers, n.e.c.
195	Research workers, not specified
196	Professional, technical, and kindred workers -- allocated

APPENDIX B

THE DERIVATION OF THE SUPPLY CURVE

Assume the following family life time utility function

$$U = U(Z_m, Z_f, X) \qquad (1)$$

and household budget constraint

$$I = P_x = W_m t_m + W_f t_f + V$$

and $Z_m = \alpha_m m$ and

$$Z_f = \alpha_f f$$

where

W_m = male wage

W_f = female wage

t_m = male work time

t_f = female work time

V = non labor income

Z_m = male income produced commodity using non working time only

Z_f = female home produced commodity using non working time only

α_m = male quality index

α_f = female quality index

M = male non working time

F = female non working time

S = households full income

I = money income

let $\Lambda = m + t_m$ and

$$\Lambda = f + t_f$$

define

$$S = W_m \Lambda + W_f \Lambda + V \qquad \text{thus}$$

$$S = W_m(t_m + m) + W_f(t_f + f) + V$$

$$S = W_m t_m + W_f t_f + V + W_m m + W_f f$$

$$S = P_x + W_m m + W_f f$$

Since Z_i is produced solely with time (i = m,f)

$$W_m m = \frac{W_m}{a_m} a_m m = \pi_m Z_m$$

where π_m is the marginal cost and price of Z_m. Since total cost of Z_m is

$$C = \pi_m Z_m \qquad \text{then}$$

$$\frac{dC}{dZ_m} = \pi_m = \frac{W_m}{a_m}$$

thus

$$S = \pi_m Z_m + \pi_f Z_f + P_x \tag{2}$$

The household must maximize (1) subject to (2) which yields the following Lagrangian in which P is set equal to 1.

$$L = U(Z_m, Z_f, X) + \lambda(S - \pi_m Z_m - \pi_f Z_f - PX)$$

with 1st order conditions

$$\frac{\partial L}{\partial Z_m} = U_m - \lambda \pi_m = 0$$

$$\frac{\partial L}{\partial Z_f} = U_f - \lambda \pi_f = 0$$

$$\frac{\partial L}{\partial \lambda} = S - \pi_m Z_m - \pi_f Z_f - PX = 0$$

$$\frac{\partial L}{\partial x} = U_x - \lambda P = 0$$

This is a set of four simultaneous equations for which solutions for Z_m, Z_f, X and λ can be found in terms of π_m, π_f, P. and S.

Since there is no interest here in the solutions for x or λ they will be excluded.

Totally differentiating with respect to S, π_m, π_f and defining

$$D = \begin{vmatrix} 0 & -\pi_m & -\pi_f & -P \\ -\pi_m & U_{mm} & U_{mf} & U_{mx} \\ -\pi_f & U_{mf} & U_{ff} & U_{fx} \\ -P & U_{xm} & U_{xf} & U_{xx} \end{vmatrix}$$

and

and

$$Y = \begin{vmatrix} \partial \lambda \\ \partial Z_m \\ \partial Z_f \\ \partial X \end{vmatrix}$$

$$d_1 = \begin{vmatrix} -1 \\ 0 \\ 0 \\ 0 \end{vmatrix} \qquad d_2 = \begin{vmatrix} Z_m \\ \lambda \\ 0 \\ 0 \end{vmatrix} \qquad d_3 = \begin{vmatrix} Z_f \\ 0 \\ \lambda \\ 0 \end{vmatrix}$$

then totally differentiating the 1st order conditions WRT S is

$$D\ Y = d_1$$

WRT Π_m as $D\ Y\ d_2$ and

WRT Π_f as $D\ Y\ d_3$

Using Cramer's rule the solutions for ∂Z_m and ∂Z_f from each of the three systems can be found.

$$\frac{\partial Z_m}{\partial S} = \frac{\mu_{mf}\,\mu_{fx}\,P - (\mu_{xf}^2\,\Pi_m)}{D} = \frac{Z_m}{S}\eta_m$$

and

$$\frac{\partial Z_m}{\partial \Pi_m} = \frac{-Z_m\,\mu_{mf}\,\mu_{fx}\,P - \Pi_f^2\,\lambda\,\mu_{\lambda x} + \mu_{fx}^2\,\Pi_m Z_m}{D} =$$

$$\frac{-Z_m^2}{S}\eta_m + \frac{Z_m^2}{S}\sigma_{mm}$$

and

$$\frac{\partial Z_m}{\partial \Pi_f} \frac{-Z_f\,\mu_{mf}\,\mu_{fx}\,P + \Pi_m\lambda\,\mu_{xf}\,P - P^2\lambda\,\mu_{mx} + \mu_{xf}^2\,Z_f\Pi_m}{D} =$$

$$\frac{-Z_f Z_m}{S}\eta_m + \frac{Z_m Z_f}{S}\sigma_{mf}$$

Since

$$dZ_m = \frac{\partial Z_m}{\partial S}dS + \frac{\partial Z_m}{\partial \Pi_m}d\Pi_m + \frac{\partial Z_m}{\partial \Pi_f}d\Pi_f$$

then

$$dZ_m = \frac{Z_m}{S}\eta_m dS + \frac{Z_m^2}{S}(\sigma_{mm} - \eta_m)d\Pi_m$$

$$+ \frac{Z_m Z_f}{S}(\sigma_{mf} - \eta_m)$$

or

$$\frac{dZ_m}{Z_m} = \frac{Z_m S}{Z_m S}\eta_m\frac{dS}{S} + \frac{Z_m^2\,\Pi_m}{S\,Z_m}(\sigma_{mm} - \eta_m)\frac{d\Pi_m}{\Pi_m}$$

$$+ \frac{Z_m Z_f \Pi_f}{S\,\Pi_m}(\sigma_{mf} - \eta_m)\frac{d\Pi_f}{\Pi_f}$$

defining E as an elasticity operator i.e. $EX = \frac{dx}{X}$

then

$$EZ_m = \eta_m ES + k_m(\sigma_{mm} - \eta_m) E\Pi_m$$

$$+ k_f(\sigma_{mf} - \eta_m) E\Pi_f$$

Similarly

$$Ez_f = \eta_f ES + k_f(\sigma_{ff} - \eta_f) E\Pi_f$$

$$+ k_m(\sigma_{mf} - \eta_m) E\Pi_m$$

where $k_m = \frac{\Pi_m Z_m}{S}$ and $k_f = \frac{\Pi_f Z_f}{S}$

η_i is the full income elasticity of z_i

σ_{ii} is the own elasticity of substitution and is always negative

σ_{ij} is the cross elasticity of substitution in consumption between Z_m and Z_f.

Note that since the price of market goods has been set equal to one, it does not enter the demand curves for Z_m or Z_f.

Since $Z_m = a_m m$ and $Z_f = a_f f$ then

$EZ_m = Ea_m + Em$ and $EZ_f = Ea_f + Ef$

and $m + t_m = \Lambda$ and $f + t_f = \Lambda$ then

$$\frac{m}{\Lambda} Em + \frac{t_m}{\Lambda} Et_m = E\Lambda \text{ and}$$

$$\frac{f}{\Lambda} Ef + \frac{t_f}{\Lambda} Et_f = E\Lambda \text{ but}$$

$E\Lambda = 0$ then

$Et_m = -\frac{m}{t_m} Em$ amd $Et_f = \frac{-f}{t_f} Ef$

let $\frac{m}{t_m} = \gamma_m$ and $\frac{f}{t_f} = \gamma_f$

Making the appropriate substitutions

$$Et_m = -\gamma_m \eta_m ES - \gamma_m k_m (\sigma_{mm} - \eta_m) E\pi_m$$

$$-\gamma_m k_f (\sigma_{mf} - \eta_m) E\pi_f + \gamma_m E a_m$$

Since $\pi_m = \frac{w_m}{a_m}$ $\quad E\pi_m = Ew_m - Ea_m$

and $\pi_f = \frac{w_f}{a_f}$ $\quad E\pi_f = Ew_f - Ea_f$

thus $Et_m = -\gamma_m \eta_m ES - \gamma_m k_m (\sigma_{mm} - \eta_m)(Ew_m - Ea_m)$

$$-\gamma_m k_f (\sigma_{mf} - \eta_m)(Ew_f - Ea_f) + \gamma_m E a_m$$

rearranging

$$Et_m = -\gamma_m \eta_m ES - \gamma_m k_m (\sigma_{mm} - \eta_m) Ew_m$$

$$-\gamma_m k_f (\sigma_{mf} - \eta_m) Ew_f$$

$$+\gamma_m (k_m \sigma_{mm} - k_m \eta_m + 1) Ea_m$$

$$+\gamma_m k_f (\sigma_{mf} - \eta_m) Ea_f$$

Note the following definition

$$k_m \sigma_{mm} + k_f \sigma_{mf} + k_f \sigma_{mx} = 0$$

where $k_x = \frac{px}{S}$ then

$$k_m \sigma_{mm} = -[k_f \sigma_{mf} + k_x \sigma_{mx}]$$

let $(1-k_m)\bar{\sigma}_m = [K_f\sigma_{mf} + K_x\sigma_{mx}]$

therefore $\bar{\sigma}_m = \frac{K_f}{1-K_m}\sigma_{mf} + \frac{K_x}{1-K_m}\sigma_{mx}$

So $\bar{\sigma}_m$ is a weighted average of σ_{mx} and σ_{mf}

where the weights sum to one

$$\frac{K_f}{1-K_m} + \frac{K_x}{1-K_m} = \frac{K_f + K_x}{K_f + K_x} = 1$$

note

$-(1-k_m)\bar{\sigma}_m = k_m\sigma_{mm}$ which can be substituted into the labor supply curve

$\bar{\sigma}_m$ is a positive valve

Note also the following definitions. Since

$$S = \Pi_m Z_m + \Pi_f Z_f + PX \quad \text{. then}$$

$$1 = K_m + K_f + K_x \quad \text{also}$$

$$S = W_m M + W_f F + W_m t_m + W_f t_f + V$$

then

$$1 = K_m + K_f + K_{tm} + K_{tf} + K_v$$

also $S = W_m\Lambda + W_f\Lambda + V$ then

$$1 = K_{\Lambda m} + K_{\Lambda f} + K_v$$

where $K_{\Lambda m} = K_m + K_{tm}$

The labor supply curve can now be written as:

$$Et_m = -\gamma_m\eta_m ES + \gamma_m((1-K_m)\bar{\sigma}_m + K_m\eta_m)EW_m$$

$$- \gamma_m K_f (\sigma_{mf} - \eta_m) E W_f$$

$$- \gamma_m ((1 - K_m) \bar{\sigma}_m + K_m \eta_m - 1) E a_m$$

$$+ \gamma_m K_f (\sigma_{mf} - \eta_m) E a_f$$

consider again

$$ES = K_{\Lambda m} EW_m + K_{\Lambda f} EW_f + K_V EV$$

then

$$-\gamma_m \eta_m ES = -\gamma_m \eta_m [K_{\Lambda m} EW_m + K_{\Lambda f} EW_f$$

$$+ K_V EV]$$

$$Et_m = -\gamma_m \eta_m K_V \, EV$$

$$[+\gamma_m (1-K_m) \bar{\sigma}_m + \gamma_m K_m \eta_m - \gamma_m \eta_m K_{\Lambda m} \quad] \, EW_m$$

$$[-\gamma_m K_f \sigma_{mf} + \gamma_m K_f \eta_m - \gamma_m K_{\Lambda f} \eta_m] \, EW_f$$

$$- \gamma_m ((1-k_m) \bar{\sigma}_m + K_m \eta_m - 1) \, E a_m$$

$$+ \gamma_m K_f \, (\sigma_{mf} - \eta_m) \, E_{af}$$

now $k_m - K_{\Lambda m} = - K_{tm} = - \dfrac{W_m t_m}{S}$

and

$$k_f - K_{\Lambda f} = - K_{tf} = \frac{W_f t_f}{S}$$

thus

$$Et_m = -\gamma_m \eta_m K_V \, EV$$

$$[+\gamma_m (1-K_m) \bar{\sigma}_m - K_{tm} \gamma_m \eta_m \quad] \, EW_m$$

$$[\ -\gamma_m K_f \sigma_{mf} - \gamma_m \eta_m K_{tf} \qquad]\ EW_f$$

$$-\ \gamma_m ((1-K_m)\bar{\sigma}_m + K_m \eta_m - 1 \qquad)\ E_{am}$$

$$+\ \gamma_m K_f (\sigma_{mf} - \eta_m)\ Ea_f$$

The reason for the coefficients of the quality variables remaining unchanged when ES is removed from the equation may not be intuitively obvious. The reason is that full income does not depend directly on quality, but rather through the effect of quality on the wage rate, which in turn effects full income.

Since

$$\frac{ES}{E_{am}} = K_{\lambda m} \frac{EW_m}{Ea_m} + K_{\lambda f} \frac{EW_f}{Ea_m} + K_v \frac{EV}{Ea_m}$$

where $\frac{EW_f}{Ea_m}$ and $\frac{E_V}{Ea_m}$ can be assumed

to be zero then

$\frac{ES}{Ea_m} = K_{\lambda m} \frac{EW_m}{Ea_m}$. Thus the effect of a change in quality on full income depends on the effect of a quality change on the wage rate. If wages are held constant the elasticity becomes zero.

APPENDIX C

THE DERIVATION OF THE DEMAND CURVE

Assume the following linear homogeneous production function for professional output q to be

$$q = F(P_m, P_f, K)$$

where

$$P_m = a_m t_m$$

$$P_f = a_f t_f$$

and π_i is the quality adjusted price of a unit of professional labor.

$$\pi_i = \frac{w_i}{a_i} \qquad (i = m, f)$$

and a_i is an index of quality.

Let the price of capital (k) be 1 and total cost can be written as (r=1)

$$C = rK + \pi_m P_m + \pi_f P_f$$

Maximizing output subject to a Fixed Cost constraint which is equivalant to minimizing the cost subject to a fixed output level, the following Lagrangian can be written as:

$$L = F(P_m, P_f, K) + \lambda\,(C - rK - P_m \pi_m - \pi_f P_f)$$

with 1st order conditions:

$$\frac{\partial L}{\partial P_m} = f_m - \lambda \pi_m = 0 \qquad \frac{\partial L}{\partial P_f} = f_f - \lambda \pi_f = 0$$

$$\frac{\partial L}{\partial K} = f_K - \lambda r = 0 \qquad \frac{\partial L}{\partial \lambda} = C - rK - P_m \pi_m - P_f \pi_f = 0$$

totally differentiating with respect to Π_m and Π_f and defining the following:

$$D = \begin{vmatrix} 0 & -\Pi_m & -\Pi_f & -\gamma \\ -\Pi_m & f_{mm} & f_{mf} & f_{mK} \\ -\Pi_f & f_{fm} & f_{ff} & f_{fK} \\ -\gamma & f_{Km} & f_{Kf} & f_{KK} \end{vmatrix}$$

and

$$d_m = \begin{vmatrix} P_m \\ \lambda \\ 0 \\ 0 \end{vmatrix} \qquad d_f = \begin{vmatrix} P_f \\ 0 \\ \lambda \\ 0 \end{vmatrix}$$

and

$$Y = \begin{vmatrix} \partial\lambda \\ \partial P_m \\ \partial P_f \\ \partial K \end{vmatrix}$$

The total derivatives can be wirtten as

$$\mathbf{D}Y = d_m \quad \text{and} \quad \mathbf{D}Y = d_f$$

Using Cramer's rule the solutions for ∂P_m and ∂P_f can be found:

$$\frac{\partial P_m}{\partial \Pi_m} = \frac{P_m f_{mf} f_{Kf} \gamma + f_{Kf}^2 P_m \Pi_m - \Pi_f^2 \lambda f_{KK}}{D}$$

which can be identified as:

$$\frac{P_m^2}{C}(\sigma_{mm} - \eta)$$

and

and

$$\frac{\partial P_m}{\partial \Pi_f} = \frac{-P_f f_{mf} f_{fk} r + r \Pi_m \lambda f_{kf} - r^2 \lambda f_{mf} + f_{fk}^2 \Pi_m P_f}{D}$$

Which can be identified as

$$\frac{P_m P_f}{C} \quad (\sigma_{mf} - \eta)$$

Since

$$dP_m = \frac{\partial P_m}{\partial \Pi_m} d\Pi_m + \frac{\partial P_m}{\partial \Pi_f} d\Pi_f + \frac{\partial P_m}{\partial G} dG$$

where G is a shift parameter then defining E as an elasticity operator

$$\frac{dP_m}{P_m} = EP_m \quad \text{then}$$

$$EP_m = S_m(\sigma_{mm} - \eta) \; E\Pi_m + S_f \; (\sigma_{mf} - \eta) \; E\Pi_f + \eta_g EG$$

and similarly

$$EP_f = S_f(\sigma_{ff} - \eta) \; E\Pi_f = S_m \; (\sigma_{mf} - \eta) \; E\Pi_m + \eta_g EG$$

where $S_m = \frac{\Pi_m P_m}{C}$ and $\frac{\Pi_f P_f}{C} = S_f$

and η = the price of elasticity of demand for q

σ_{ii} is the own elasticity of substitution in production.

σ_{ij} is the elasticity of substitution between m and f.

Since $P_m = a_m t_m$

$EP_m = Ea_m + Et_m$ and since

$\Pi_m = \frac{W_m}{a_m}$ $\quad E\Pi_m = EW_m - Ea_m$

thus

$$Et_m = S_m(\sigma_{mm}-\eta)(EW_m - Ea_m) + S_f(\sigma_{mf}-\eta)(EW_f - Ea_f) - Ea_m + \eta_g E\,G$$

or

$$Et_m = S_m(\sigma_{mm}-\eta)\,EW_m + S_f(\sigma_{mf}-\eta)\,EW_f - [S_m(\sigma_{mm}-\eta)+1]\,Ea_m - S_f(\sigma_{mf}-\eta)\,Ea_f + \eta_G\,EG$$

symmetrically

$$Et_f = S_f(\sigma_{ff}-\eta)\,EW_f + S_m(\sigma_{fm}-\eta)\,EW_m - [S_f(\sigma_{ff}-\eta)+1]\,Ea_f - S_m(\sigma_{mf}-\eta)\,Ea_m + \eta_G\,EG$$

APPENDIX D

DERIVATION OF THE REDUCED FORM

Using the following definitions the structural model may be written as follows:

t_m = LHYMPE

W_m = LWAG2MPE

t_f = LHYFPE

W_f = LWAG2FPE

X_{i1} = A vector of exogeneous variables in male supply

X_{i2} = A vector of exogeneous variables in male demand

Z_{i1} = A vector of exogeneous variables in female supply

Z_{i2} = A vector of exogeneous variables in female demand

α_{i1} = A vector of coefficients of the exogeneous variables in X_{i1}

α_{i2} = A vector of coefficients of the exogeneous variables in X_{i2}

β_{i1} = A vector of coefficients of the exogeneous variables Z_{i1}

β_{i2} = A vector of coefficients of the exogeneous variables in Z_{i2}

The male supply curve can be written as:

$$t_m = \alpha_{01} + \alpha_{11} w_m + \alpha_{i1} X_{i1}$$

The male demand curve can be written as:

$$t_m = \alpha_{02} + \alpha_{12} w_m + \alpha_{22} w_f + \alpha_{i2} X_{i2}$$

The female supply curve can be written as:

$$t_f = \beta_{01} + \beta_{11} w_f + \beta_{i1} Z_{i1}$$

The female demand curve can be written as:

$$t_f = \beta_{02} + \beta_{12} w_f + \beta_{22} w_m + \beta_{i2} Z_{i2}$$

assuming supply equals demand

$$(1)\ \alpha_{01}+\alpha_{11}W_m+\alpha_{i1}X_{i1}=\alpha_{02}+\alpha_{12}W_m+\alpha_{22}W_f+\alpha_{i2}X_{i2}$$

or

$$(2)\ \alpha_{11}W_m-\alpha_{12}W_m=\alpha_{02}-\alpha_{01}+\alpha_{22}W_f+\alpha_{i2}X_{i2}-\alpha_{i1}X_{i1}$$

or $$(3)\ W_m=\frac{1}{\alpha_{11}-\alpha_{12}}\left[(\alpha_{02}-\alpha_{01})+\alpha_{22}W_f+\alpha_{i2}X_{i2}-\alpha_{i1}X_{i1}\right]$$

and $$(1')\ \beta_{01}+\beta_{11}W_f+\beta_{i1}Z_{i1}=\beta_{02}+\beta_{12}W_f+\beta_{22}W_m+\beta_{i2}Z_{i2}$$

or $$(2')\ \beta_{11}W_f-\beta_{12}W_f=\beta_{02}-\beta_{01}+\beta_{22}W_m+\beta_{i2}Z_{i2}-\beta_{i1}Z_{i1}$$

or $$(3')\ W_f=\frac{1}{\beta_{11}-\beta_{12}}\left[(\beta_{02}-\beta_{01})+\beta_{22}W_m+\beta_{i2}Z_{i2}-\beta_{i1}Z_{i1}\right]$$

multiplying $3'$ by α_{22} substituting in 3 and rearranging yields.

$$(4)\ W_m=\frac{\beta_{11}-\beta_{12}}{\gamma}\left[(\alpha_{02}-\alpha_{01})+\alpha_{i2}X_{i2}-\alpha_{i1}X_{i1}\right]+\frac{\alpha_{22}}{\gamma}\left[(\beta_{02}-\beta_{01})+\beta_{i2}Z_{i2}-\beta_{i1}Z_{i1}\right]$$

where $= \gamma=(\alpha_{11}-\alpha_{12})(\beta_{11}-\beta_{12})-(\alpha_{22}\beta_{22})$

Similarly multiplying 3 by β_{22} substituting in $3'$ and rearranging yields.

($$(4')\ W_f=\frac{\alpha_{11}-\alpha_{22}}{\gamma}\left[(\beta_{02}-\beta_{01})+\beta_{i2}Z_{i2}-\beta_{i1}Z_{i1}\right]+\frac{\beta_{22}}{\gamma}\left[(\alpha_{02}-\alpha_{01})+\alpha_{i2}X_{i2}-\alpha_{i1}X_{i1}\right]$$

TABLE D.1

THE VECTOR OF EXOGENOUS VARIABLE COEFFICIENTS

	ms x_{i1}	md x_{i2}	FS Z_{i1}	FD Z_{i2}
Intercept	9.4	7.4	6.2	6.9
LNLY1MPE	-.009	0	0	0
LFPFP	0	0	0	.074
LSW2MPE	-0.128	0	0	0
UNEMPRAA	- .66	- .51	- .38	- .7
KID18MPE	.066	0	0	0
LEDMPE	- .85	.0002	0	-1.3
LSEDMPE	.046	0	0	0
LJMMPE	- .3101	.04	0	- .23
LSJFMPE	.22	0	0	0
GOVWKFPE	0	0	0	.18
GOVWKMPE	0	- .084	0	0
LFPMP	0	.23	0	0
LJFMFPE	0	- .01	0	.14
CYINAA	0	.1	0	- .1
LSW2FPE	0	0	- .07	0
LMLY1FPE	0	0	- .04	0
WGMDOM	0	0	- .01	0
KID18FPE	0	0	- .08	0
KID7FPE	0	0	- .33	0
LEDFPE	0	0	.44	1.1
LSEDFPE	0	0	.13	0
LSJMMFPE	0	0	- .07	0

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