NBER WORKING PAPER SERIES

WAGE AND EMPLOYMENT UNCERTAINTY AND THE LABOR FORCE PARTICIPATION DECISIONS OF MARRIED WOMEN

Francine D. Blau

Adam J. Grossberg

Working Paper No. 3081

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
August 1989

This paper is based on portions of several chapters of author Grossberg's Ph.D. thesis completed at the University of Illinois at Urbana-Champaign. The authors wish to thank Lawrence Kahn, Roger Koenker, John Graham and John Mullahy, for many helpful comments, and are grateful to the Research Board of the University of Illinois at Urbana-Champaign for financial support of this project. The authors, of course, retain responsibility for any remaining errors. This paper is part of NBER's research program in Labor Studies. Any opinions expressed are those of the authors not those of the National Bureau of Economic Research.

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ABSTRACT

Over the past 30 years, research on married women's labor force participation has concluded virtually without exception that the principal source of labor force participation rate growth for married women has been the concurrent growth of women's real wages. The experience of the 1970's suggests, however, that real wage growth cannot account for the increase in participation rates that occurred during that period. This paper argues that an important determinant of married women's current participation decisions is the level of uncertainty associated with expectations of future wages, and that high levels of uncertainty during the 1970's may have contributed substantially to the growth in participation that occurred during that time. Engle's model of autoregressive conditional heteroscedasticity (ARCH) is applied to aggregate time series data covering the years 1956-1986 to measure the level of uncertainty at each point in time. Our estimates indicate support for the basic hypothesis that the level of uncertainty is an important determinant of labor force participation decisions for married women.

Francine D. Blau
Institute of Labor and
Industrial Relations
University of Illinois
504 East Armory Avenue
Champaign, IL 61820

Adam J. Grossberg
Department of Economics
Trinity College
Hartford, CT 06106

Over the past 30 years, the economic literature on the growth of married women's labor force participation, from Jacob Mincer's (1962) seminal work of the early 1960's through the more recent analysis of James P. Smith and Michael P. Ward (1984), has concluded virtually without exception that the principal source of participation rate growth for married women has been the concurrent growth of women's real wages. The experience of the 1970's suggests, however, that real wage growth cannot account for the increase in participation rates that occurred during the period. As Table I shows, while the rapid real wage rate growth of the 1950's and 60's virtually disappeared during the 1970's, participation rates grew steadily throughout the period.[1] Clearly, there must exist -- or at least there must have existed during the 1970's -- some other important source of participation rate growth for married women. This paper suggests such a source.

The 1970's were characterized by stagflation so that both the employment prospects and the prices that families faced were subject to uncertainty. Price uncertainty, in turn, resulted in uncertainty with respect to real wages. Moreover, as the variability of the rate of inflation changed over the course of the decade (a phenomenon which has been discussed by Robert F. Engle (1982, 1983) and others) the level of

[1] A complete series of hourly wage rates for married women covering the period from the 1950's to present does not exist. The proxy that is used throughout this paper is median annual incomes of all women who are full-time year-round workers. Note that in later years when both median earnings and median incomes of full-time year-round workers are available for this group the two series are very similar.

Table I: Participation Rate and Real Wage Rate Growth*

	Average Annual Percentage Change in:	
	Real Wages	Participation Rate
1956-1960	1.75%	2.39%
1961-1965	2.13	1.95
1966-1970	2.51	3.21
1971-1975	0.49	2.12
1976-1980	-0.57	2.70
1981-1985	1.30	1.80

*Real wage and the participation rate are calculated as the fixed-weight averages of the age specific rates. See Section II for details.
Sources: See Appendix B for all data sources.

price (and hence wage) uncertainty that families faced also changed. This paper claims that the level of economic uncertainty is an important determinant of married women's participation decisions, and that the unstable economic conditions of the 1970's contributed substantially to the growth in participation that occurred during that time.

In the model developed below, married women's participation decisions are influenced by forecasts of future economic conditions as well as by current economic conditions. Both future employment and future real wages are assumed to be uncertain. The model predicts that lower future employment probabilities and lower expected real wages encourage current participation. Further, the expectation of a more variable (more uncertain) real wage distribution also encourages current participation, as married women have an incentive to shift their labor supply to the current period, whose conditions are known, rather than waiting to supply labor in the more uncertain future.

The application of the principal of intertemporal substitution to the participation decisions of married women has received little attention since Mincer (1962). At that time, Mincer suggested that variations in transitory income may affect the timing of married women's participation decisions. Since then, this literature has focused on the effects of intertemporal substitution upon the population as a whole. Robert E. Lucas and Leonard A. Rapping (1970), Joseph G. Altonji (1982), and Kim B. Clark and Lawrence H. Summers (1982) and Adam J. Grossberg (1989) have estimated the effects of expectations on current overall labor supply. With the exception of Grossberg, their analyses ignore the influence of changes in the expected variances of the uncertain variables, and look instead only at their means.

While these recent empirical analyses have, as a whole, not produced strong results (in either direction), the participation decisions of married women may well be more elastic with respect to short-term economic fluctuations than are those of the population as a whole; it is well known that married women's labor supply is considerably more elastic with respect to wages than is men's. This paper applies the principal of intertemporal substitution to the participation decisions of married women by allowing for the possibility that people react to levels of anticipated uncertainty (as measured by the variances of anticipated distributions), as well as to the mere presence of uncertainty (as measured by the means of the expected distributions).

Section I presents a theoretical model that illustrates the potential effects of wage and employment uncertainty upon married women's participation decisions. Section II discusses estimating procedures and the data used to obtain estimates, while Section III includes empirical estimates based on aggregate time series data covering the years 1956-1986. Estimates of the variances of expected distributions are based on application of Engle's ARCH model. The estimates indicate support for our basic hypotheses. Our conclusions are contained in Section IV.

I. Theoretical Model

The principal objective of the theoretical model is to illustrate how expectations about unemployment and inflation may influence labor force participation by married women. The expected unemployment rate is assumed to influence labor market behavior by signaling the future probability of finding and/or keeping a job. The primary influence of expected inflation upon labor supply is assumed to be through its impact on real wages. Specifically, we assume that inflation makes future real wages more difficult to forecast. This would be the case if, for example, individuals know what their nominal wages are going to be next year, but are uncertain about the rate of inflation. Thus we focus our theoretical and empirical analyses on the effects upon participation of real wage forecasts rather than forecasts of inflation.

The model presented here is an extension of the basic model of labor supply under uncertainty described in Mark R. Killingsworth (1983). This model, unlike Killingsworth's, includes the potential for contributions to family income from a woman's spouse, and takes into account unemployment as well as real wage uncertainty, while focusing upon the participation decision, rather than on hours of work.

We consider a two-period model in which a married woman maximizes her expected lifetime utility subject to budget, time and employment constraints. In period 1 she is employed with certainty if the real wage she is offered, W(1), exceeds her reservation wage, $W^{*}(1)$. If she works, H(1) is the proportion of her available time spent working. Wages, consumption and saving are all expressed in real terms throughout the model.

In period 2 she anticipates facing both employment and real wage uncertainty. Real wage uncertainty occurs in the sense that her expected period 2 wage offer is given only by a known probability density function (pdf), f[W(2)], with minimum W_a and maximum W_b. She will not know the actual value of the period 2 wage offer, W(2), until the start of period 2. The woman's reservation wage in period 2 may exceed W_a, so that she may choose to decline a job offer if the wage is not sufficiently high. Employment uncertainty exists in that the woman anticipates that should she desire to enter the labor force in period 2 there is a probability $n < 1$ that she will find employment. Hence, there are two potential sources of "unemployment" for the woman in period 2: 1) she may not receive a job offer; or 2) she may receive an offer whose wage is lower than her reservation wage. Whether she actually finds an acceptable period 2 job offer will not be known to her until after she enters the period 2 labor force.[2]

The woman's husband enters the problem by providing her with non-wage income, $I_h(1)$ and $I_h(2)$, in periods 1 and 2 respectively. His income is subject to uncertainty in period 2, and his expected period 2 income is given only by a known pdf, $f[I_h(2)]$, with minimum I_{ha} and maximum I_{hb}.

Assume that the woman's utility function in each period, $u(t) = u[C(t),L(t)]$, where $C(t)$ = consumption of a composite commodity in period t and $L(t)$ = the proportion of available time spent at leisure in period t, is additively separable over time, and is concave in all arguments so that the woman is risk averse. The woman's period 1 problem can then be stated as

(1)
$$\max_{\{C(1),L(1)\}} \quad u(1) = u[C(1),L(1)]$$

$$\text{s.t.} \quad C(1) + Z(1) = V + I_h(1) + W(1)H(1)$$

$$H(1) + L(1) = 1$$

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2 Search theory suggests that the reservation wage should increase if the level of wage uncertainty rises, as it does here when moving from period 1 to period 2, and that it should decrease when the probability of locating an acceptable job offer declines, as is the case here (Mortensen, 1986). Hence, the change in the woman's reservation wage from the first to the second period is indeterminate in our model.

where V = initial wealth, Z(1) = period 1 saving and the other variables are as defined above. The first constraint says that consumption expenditures plus saving must equal non-wage plus wage income, and the second constraint says that all available time must be split between market work and leisure (which is assumed to include non-market work). Note that period 1 choices of consumption and leisure may affect period 2 utility indirectly by affecting the amount of saving that is carried over from the first period.

Since wages are known at the outset of the second period, the problem in period 2 can be written as

$$(2) \qquad \underset{\{L(2)\}}{\text{Max}} \quad E[U(2)] = nu^e[C^e(2),L(2)] + (1-n)u^u[C^u(2),1]$$

$$\text{s.t. } C(2) = (1+r)Z(1) + I_h(2) + W(2)H(2)$$

$$H(2) + L(2) = 1$$

where $C^e(2)$ = the woman's consumption if she is employed in period 2, $C^u(2)$ = the woman's consumption if she is unemployed in period 2, r = the rate of interest, and the remaining variables are simply the period 2 counterparts of the variables described above.[3] Note that the first term in the expected utility function, $nu^e[C^e(2),L(2)]$, gives the level of utility if the woman is employed, while the second term, $(1-n)u^u[C^u(2),1]$, gives her level of utility if she is unemployed (i.e., if L(2) = 1). For notational simplicity, we set the interest rate r to zero, and the woman's subjective rate of time preference to 1. The woman's lifetime problem at

[3] The second period choices of consumption and leisure are simultaneous. Hence, this problem could be stated equivalently as a choice of C(2) rather than L(2).

the outset of period 1, then, is to choose the labor supply-saving combination that maximizes her expected lifetime utility. In terms of the indirect expected utility functions, the problem can be written as

$$(3) \qquad E\{U^*(1)\} = \max_{\{H(1),Z(1)\}} [u\{V + I_h(1) + W(1)H(1) - Z(1), 1-H(1)\} + E\{U^*(2)\}],$$

where, since period 2 wage and husband's income are unknown at this point,

$$(4) \quad E\{U^*(2)\} = \int_{I_{ha}}^{I_{hb}} \int_{W_a}^{W_b} \{nu^e[Z(1) + I_h(2) + W(2)H(2), 1-H(2)\} + (1-n)u^u\{Z(1) + I_h(2), 1\}\}f[I_h(2)]f[W(2)]dW(2)dI_h(2).$$

To facilitate investigation of the effects of changes in the period 2 wage distribution, we follow M. K. Block and J. M. Heineke (1973) and Killingsworth in redefining the period 2 wage variable. Let the woman's second period wage be written as W'(2), where

$$(5) \qquad W'(2) = vW(2) + m.$$

By definition then,

$$(6) \qquad E\{W'(2)\} = \int_{W_a}^{W_b} [vW(2) + m]f[W(2)]dW(2) = v\mu_{W(2)} + m, \text{ and}$$

$$(7) \qquad V\{W'(2)\} = v^2\sigma^2_{W(2)},$$

so that the mean of the W'(2) distribution is a function of both the parameters v and m, while the variance is a function only of v, assuming that $\mu_{W(2)}$ and $\sigma^2_{W(2)}$ are constant. When v = 1 and m = 0, W(2) and W'(2) are the same distribution. Changes in v of amount dv and/or in m of amount dm will cause the distributions to differ. For example, a variance-constant change in the mean of W'(2) means that

(8) $$dE\{W'(2)\} = \mu_{W(2)}dv + dm \neq 0, \text{ and}$$

(9) $$dV\{W'(2)\} = 2v\sigma^2_{W(2)}dv = 0.$$

Thus, dv = 0 and dm ≠ 0. Alternatively, a mean-constant change in the variance of W'(2) is one where

(10) $$dE\{W'(2)\} = \mu_{W(2)}dv + dm = 0, \text{ and}$$

(11) $$dV\{W'(2)\} = 2v\sigma^2_{W(2)}dv \neq 0.$$

Hence, $dm = -\mu_{W(2)}dv$.[4] Similarly, let $I_h'(2)$ be defined as

(13) $$I_h'(2) = v'I_h(2) + m',$$

so that a variance-constant change in the expected value of the husband's income requires that dv' = 0 and that dm' ≠ 0, while a mean-constant change in the variance means that $dm' = -\mu_{Ih(2)}dv'$.

Substituting W'(2) and $I_h'(2)$ for W(2) and $I_h(2)$, the period 2 indirect expected utility function at the outset of period 1 can be rewritten as

(14) $$E\{U^*(2)\} = \int_{I_{hb}}^{I_{ha}} \int_{W_a}^{W_b} \{nu^e\{Z(1) + I_h'(2) + W'(2)H(2), 1-H(2)\}$$
$$+ (1-n)u^u\{Z(1) + I_h'(2), 1\}\}f[I_h(2)]f[W(2)]dW(2)dI_h(2)$$

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[4] Note that developing a parallel framework for the analysis of changes in the employment distribution is not possible, since the employment distribution in each period is Bernoulli, and is thus characterized by a single parameter, n. Any variation in n necessarily changes both the mean and the variance of the employment distribution, so that the two effects cannot be examined independently.

it is now relatively straightforward to solve for the comparative static results of the model.[5] Specifically, we find that

$$\frac{dZ(1)}{dn},\ \frac{dZ(1)}{dm},\ \text{and}\ \frac{dZ(1)}{dm'} \leq 0.$$

When the probability of being employed in period 2 increases, and when the mean of either the woman's period 2 wage distribution or her husband's period 2 income distribution increases with the variance held constant, the woman saves less in period 1.

To see how these derivatives relate to the woman's current labor force participation decision, it is important to understand that saving is the key variable that ties together current and future periods. The model predicts that a diminished probability of second period employment (that is, a decline in n) encourages current saving. If the utility function is homothetic, then the desire to save more in turn lowers the woman's period 1 reservation wage, thus increasing the probability that she will participate in the labor force at a given real wage rate. In the aggregate, we expect an increase in the typical anticipated rate of unemployment to have a positive effect upon married women's current overall participation rates.

Similarly, declines in the mean of the woman's anticipated wage distribution and in the mean of her husband's anticipated income distribution encourage current saving, thus lowering the woman's reservation wage, and increasing the probability of current participation. These results, which describe predicted participation responses to changes

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5 These results are derived in Appendix A.

in the means of the anticipated employment, wage and (husband's) income distributions, correspond to the predictions which have been tested in the extant literature.

This analysis proceeds a step further by asking how mean-constant changes in the anticipated variances of the wage and (husband's) income distributions may affect current decisions.[6] While the actual signs of the derivatives can only be determined empirically, they are likely to be as follows:

$$\left.\frac{dZ(1)}{dv}\right|_{dm=-\mu_{W(2)}dv} \geq 0, \quad \text{and} \quad \left.\frac{dZ(1)}{dv'}\right|_{dm'=-\mu_{W(2)}dv'} \geq 0.$$

Intuitively, when the level of uncertainty associated with the woman's own anticipated earnings or with those of her spouse increases, she is likely to save more of her current earnings.[7] As above, this is likely to lower her current reservation wage and to enhance the probability of current participation.

Thus, the principal predictions of the theory are that when the typical married woman expects her probability of employment to fall, or when she expects the mean of her own anticipated wage distribution or that of her husband's income distribution to fall then the probability of

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[6] Recall from above that a mean-constant change in the variance of the woman's wage distribution implies that $dm = -\mu_{W(2)}dv$, while a mean-constant change in the variance of the husband's income distribution implies that $dm' = -\mu_{Ih(2)}dv'$.

[7] In Appendix A, it is shown that increased uncertainty with respect to the woman's own wage increases her level of saving if hours of labor supplied is a positive function of the wage rate, and if the covariance of $W(2)$ and $u_{CC}^{e}(2)H(2)$ is positive. Increased uncertainty with respect to spouse's income increases saving if the covariance of $\{nu_{CC}^{e}(2) + (1-n)u_{CC}^{u}(2)\}$ and $I_h(2)$ is positive. We demonstrate in Appendix A that these conditions are likely to hold under reasonable assumptions.

current labor force participation is increased. Moreover, it is likely that when higher levels of her own wage uncertainty or her spouse's income uncertainty are anticipated, her probability of participating in the labor force rises.

II. Estimating Procedures and Data

The theory outlined in Section I of this paper is tested through the use of aggregate annual time-series data for the years 1956-1986. The dependent variable, the annual average labor force participation rate of all married women with spouses present is calculated as the fixed-weight average of the age-specific rates, so that the overall measure is for a population with a fixed age composition.[8] Since this variable is a fraction varying between zero and one, application of ordinary least squares would amount to estimation of a linear probability model, which has the well known characteristic that fitted values of the dependent variable may lie outside the unit interval. This being the case, it is appropriate to replace the labor force participation rate ($LFPR_t$) with its log odds ratio, $\ln(LFPR_t/(1-LFPR_t))$. Estimation of the resulting equation yields the aggregated data analog of logit analysis. Joseph Berkson (1944, 1953, 1955) has shown that this model has heteroscedastic residuals, so that weighting of the data is required. The weighting procedure used here is one suggested by Takeshi Amemiya and Frederick Nold (1975). Amemiya and Nold show that an equation error term should be included on the right hand side as a proxy for omitted independent variables so that the estimating equation will be of the form

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[8] See Appendix B for means, standard deviations and sources of all variables used in the analysis. Mean proportions of the populations in each age group were used for the weights.

(15) $$\ln\left(\frac{LFPR_t}{1-LFPR_t}\right) = \beta' x_t + v_t + u_t$$

where β is a vector of unknown parameters, x_t is a vector of explanatory variables, v_t is the equation error -- a random variable with mean zero and variance s^2 -- and u_t is an error term with mean zero and variance $[(N_t)(LFPR_t)(1-LFPR_t)]^{-1}$, where N_t is the number of observations from which LFPR is computed in year t. If frequencies used to construct the log odds ratio (in this case, $LFPR_t$) are assumed to be drawn from independent binomial populations, then the asymptotic variance of the estimator of the actual log odds ratio can be defined as

(16) $$z_t = s^2 + [(N_t)(LFPR_t)(1-LFPR_t)]^{-1},$$

and s^2 can be estimated consistently as

(17) $$\hat{s}^2 = (1/T)\{\sum_t (l_t - \hat{\beta}' x_t)^2 - \sum_t [1/((N_t)(LFPR_t)(1-LFPR_t))]\}$$

where T is the total number of time periods, and l_t is the log odds ratio for observation t. $\hat{z}_t$ is then obtained by substituting $\hat{s}^2$ for s^2 in (16), and all variables (including the constant) are divided by $(\hat{z}_t)$ to obtain parameter estimates which are efficient, with consistent standard errors. For the estimates here, N_t was set equal to the number of married women in the U.S. in year t.[9]

Married women's own real wage rates are proxied by median real incomes of women who are year-round, full-time workers, while spouse's

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[9] Since actual sample sizes for each year are not available, the size of the population of married women is used as a proxy. If similar fractions of the population are sampled in each year then this should provide a good estimate of the sample size.

overall income is measured by median overall real income of all men, and is intended to incorporate the impact of the husband's expected employment probability. Both of these variables are calculated as fixed-weight averages of the age-specific values, so that, for women the age composition of the labor force is held constant, and for men the age composition of the population is held constant.

Means and variances of the expected real wage and (husband's) income distributions are derived through application of the autoregressive conditional heteroscedasticity (ARCH) model introduced by Robert F. Engle (1982, 1983).[10] The intuition behind the ARCH model is that at any point in time the typical individual has expectations about the mean and variance of a series which have been formed using information available at that time. Estimates of the expected mean are formed autoregressively, while estimates of the expected variance are formed using information contained in the residuals from the last p periods. Once p has been estimated, the expected mean and variance of the series conditional on current information can be computed.

As outlined by Engle (1982), a general pth order ARCH model can be expressed as

$$
\begin{aligned}
& y_t \mid \psi_{t-1} \sim N(\beta' x_t, h_t) \\
(18) \qquad & h_t = \alpha^2{}_0 + \alpha^2{}_1 \epsilon^2{}_{t-1} + \alpha^2{}_2 \epsilon^2{}_{t-2} + \cdots + \alpha^2{}_p \epsilon^2{}_{t-p} \\
& \epsilon_t = y_t - \beta' x_t ,
\end{aligned}
$$

where y_t is the dependent variable, ψ_{t-1} includes all information

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10 The discussion here focuses on application of the ARCH model to the woman's real wage series. Application of the ARCH model to the men's real income series follows along similar lines.

available as of time t, x_t is a vector of explanatory variables included in ψ_{t-1}, h_t is the conditional variance of y_t, and α_i and the vector β are parameters. Stability requires that $\Sigma\alpha^2_i < 1$, for $i = 1,\ldots,p$. Squaring the alphas constrains the coefficients to be nonnegative, so that negative fitted values of the conditional variance are avoided.

As may be seen in Table II, three specifications were used for the vector x_t, including various combinations of past wage rates, the level of aggregate demand (which is proxied by real GNP) and, in two specifications, the quality of the female workforce (which is proxied by the proportion of the female workforce with four or more years of college education). Quarterly observations of the wage and education series were approximated through interpolation, while quarterly values of real GNP were observed directly. The ARCH model was then applied to these quarterly observations.[11] To identify p, the number of lagged quarters which provide significant information in the creation of the conditional variance, h_t, the Lagrange multiplier test described in Engle (1982) was employed. A variety of specifications indicated rejection of the null hypothesis of a constant variance. (Under the null hypothesis, the test statistic has a chi-square distribution with p degrees of freedom.) The three specifications that we use in our estimates are shown in Table II. These equations were estimated through use of the maximum likelihood techniques described in Engle (1982)[12].

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[11] Quarterly values of the nominal wage series were deflated using the corresponding quarterly Consumer Price Index (CPI) series.

[12] Results of the ARCH estimation are detailed below in Appendix C.

Table II: ARCH Specifications

SPECIFICATION 1:

WOMEN'S WAGE:

$$WAGE_t = \beta_0 + \beta_1 WAGE_{t-1} + \beta_2 EDUC_{t-1} + \beta_3 GNP_{t-1} + \epsilon_t$$

$$h_t = \alpha^2{}_0 + \alpha^2{}_1 \epsilon^2{}_{t-1}$$

MEN'S INCOME:

$$INCOME_t = \beta_0 + \beta_1 INCOME_{t-1} + \beta_2 EDUC_{t-1} + \beta_3 GNP_{t-1} + \epsilon_t$$

$$h_t = \alpha^2{}_0 + \alpha^2{}_1 \epsilon^2{}_{t-1}$$

SPECIFICATION 2:

WOMEN'S WAGE:

$$WAGE_t = \beta_0 + \beta_1 WAGE_{t-1} + \beta_2 EDUC_{t-1} + \beta_3 GNP_{t-1} + \beta_4 GNP_{t-2} + \epsilon_t$$

$$h_t = \alpha^2{}_0 + \alpha^2{}_1 \epsilon^2{}_{t-1}$$

MEN'S INCOME:

$$INCOME_t = \beta_0 + \beta_1 INCOME_{t-1} + \beta_2 EDUC_{t-1} + \beta_3 GNP_{t-1} + \beta_4 GNP_{t-2} + \epsilon_t$$

$$h_t = \alpha^2{}_0 + \alpha^2{}_1 \epsilon^2{}_{t-1}$$

SPECIFICATION 3:

WOMEN'S WAGE:

$$WAGE_t = \beta_0 + \beta_1 WAGE_{t-1} + \beta_2 GNP_{t-1} + \beta_3 GNP_{t-2} + \epsilon_t$$

$$h_t = \alpha^2{}_0 + \alpha^2{}_1 \epsilon^2{}_{t-1} + \alpha^2{}_2 \epsilon^2{}_{t-2}$$

MEN'S INCOME:

$$INCOME_t = \beta_0 + \beta_1 INCOME_{t-1} + \beta_2 GNP_{t-1} + \beta_3 GNP_{t-2} + \epsilon_t$$

$$h_t = \alpha^2{}_0 + \alpha^2{}_1 \epsilon^2{}_{t-1} + \alpha^2{}_2 \epsilon^2{}_{t-2}$$

The fitted values from the estimated equations are the conditional mean and variance of the expected real wage. These quarterly series are then averaged to obtain annual values for each year, and the resulting annual series of expectations are discounted back to the present period through use of the average corporate bond rate (Moody's Aaa) for each year. The resulting variables, are interpreted respectively as the present discounted values of the expected mean and variance of the typical married woman's future real wage distribution. Characteristics of the husband's expected real income distribution are also estimated using the ARCH model.

Since the future employment distribution is characterized by a single parameter, it can be represented by the expected rate of employment, which is equal to the expected probability of being employed if expected employment status in any period t is independent of expected employment status in period t-j, j > 0. A conventional adaptive expectations specification is approximated here by an eight-period linear distributed lag on the unemployment rate for adult women.[13] One minus the forecast unemployment rate gives the expected rate of employment.

Given the aggregate data used for our estimates, it is likely that values of women's current wages and married women's current participation rates are determined simultaneously. Since structural estimates of the participation equation that don't account for this simultaneity may be biased, we present all estimates both with and without accounting for the endogeneity of women's wages. When the wage is taken as exogenous, we

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13 As above, the unemployment rate is calculated for a population with a fixed age composition.

estimate a single equation model by weighted least squares with a maximum likelihood correction for serial correlation. When the wage is taken as endogenous, we estimate by weighted two-stage least squares with a maximum likelihood correction for serial correlation.[14] The list of exogenous variables in the structural wage equation includes the percentage of the female workforce with four or more years of college education and GNP.[15]

III. Estimates

Table III reports weighted maximum likelihood estimates of the participation equation in which all expectations variables are omitted. The coefficients of women's wages and men's incomes for these equations have the expected signs in all cases and are significant at the one percent level of significance in three of the four cases.[16] These estimates of the "traditional" specification of the participation function support the most important conclusions of the existing literature in that the women's wage elasticity clearly dominates the men's income elasticity.[17] For example, when the wage is endogenous, the women's wage

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14 While these estimators are obviously somewhat ad hoc and are hence used with caution, it is appropriate to note that the effects of the weighting procedure described above are quite small. Appendix D contains unweighted versions of all estimates given in the paper.

15 As above, we use education as a proxy for labor quality, and GNP as a measure of aggregate demand. We believe that in the aggregate, wages are determined by current levels of education and GNP. In the context of the ARCH model, however, wage expectations are conditional on information available at the time the expectations are made.

16 The persistent serial correlation of the error term when the wage is exogenous causes us to view with some caution the estimates here that do not account for simultaneity.

17 Note that our estimation focuses on the ultimate effects of the economic variables on participation, some of which may operate through fertility. Since men's current incomes and women's current wages are the key exogenous determinants of fertility in the time series context (see

Table III: Weighted Maximum Likelihood Estimates of the Traditional Participation Equations, 1956-86; Dependent Variable is the Log Odds Ratio of the Labor Force Participation Rate for Married Women (t-ratios in parentheses)

	Wage Exogenous	Wage Endogenous
Men's Current Income	-.00002 (-1.1166)	-.00013[a] (-4.0166)
Women's Current Wage	.00009[a] (2.8573)	-
Predicted Value of Women's Current Wage	-	.00041[a] (8.3306)
Constant	-1.07342	-3.33070
Durbin-Watson	.54680	1.49570
Adjusted R^2	.03019	.80873
n	31	31

[a]Significant at the 1 percent level, one tail test;

Sources: See the Appendix B for all data sources.

William P. Butz and Michael P. Ward (1979)), the specifications of the participation function presented here may be considered as reduced forms with respect to this potentially endogenous variable.

elasticity is 3.03, while the men's income elasticity is -1.32.[18]

We now inquire as to how, in the uncertain world outlined above, expectations about future economic conditions have affected participation rates. The theory predicts that the coefficients of the expected employment rate, the women's expected wage and the husband's expected income will each have negative signs. While the sign of the variance of the women's expected wage, which represents the expected level of labor market uncertainty associated with the woman's own earnings, is theoretically ambiguous, it is expected to be positive under reasonable assumptions, as is the coefficient of the variance of the men's income distribution, which represents the expected level of labor market uncertainty associated with the husband's income. Severe collinearity between women's actual and expected wages and between men's actual and expected incomes precludes inclusion of all variables in the estimated equations.[19] Hence, weighted maximum likelihood estimates are presented with the women's expected wage and the men's expected income omitted.

Table IV gives estimates of the equations which do not account for changes in the variance of men's expected income. The coefficients of all expectations variables in these regressions have the expected signs. When the wage is endogenous the coefficient of the expected rate of employment is always significant at the ten percent level or better. The variance of

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18 Elasticities are calculated from the derivatives of the probability of participation with respect to the independent variables. Following Takeshi Amemiya (1981), the derivative with respect to the kth independent variable is computed as $(\exp(\beta'x)/(1+\exp(\beta'x))^2)\cdot\beta_k$, where each series in the vector x is evaluated at its mean.

19 The simple correlations between women's current and expected wages are about .998, and those between men's current and expected incomes are about .997.

Table IV: Weighted Maximum Likelihood Estimates of the Participation Equations, Omitting the Variance of Men's Expected Incomes 1956-86: Dependent Variable is the Log Odds Ratio of the Labor Force Participation Rate for Married Women (t-ratios in parentheses)

	ARCH Specification 1		ARCH Specification 2		ARCH Specification 3	
	Wage Exogenous	Wage Endogenous	Wage Exogenous	Wage Endogenous	Wage Exogenous	Wage Endogenous
Expected Rate of Employment	-.46599 (-.7013)	-1.61800[c] (-1.5812)	-.71768 (-1.1519)	-1.60550[c] (-1.6929)	-1.25300[b] (-1.9693)	-2.60410[a] (-2.9605)
Variance of Women's Expected Wage	.00004[a] (5.8802)	.00006[a] (7.8025)	.00005[a] (6.8996)	.00006[a] (6.8690)	.00004[a] (7.4204)	.00005[a] (6.7063)
Men's Current Income	-.00004[a] (-3.4427)	-.00004[b] (-2.3630)	-.00003[a] (-3.2855)	-.00002 (-1.2114)	-.00003[a] (-2.4456)	-.00002 (-.7547)
Women's Current Wage	.00012[a] (5.2484)	-	.00010[a] (4.6520)	-	.00009[a] (4.3644)	-
Predicted Value of Women's Current Wage	-	.00014[a] (3.7129)	-	.00009[b] (2.0000)	-	.00008[c] (1.5488)
Constant	-.96902	-.26607	-.63014	-.07764	-.21740	.89091
Durbin-Watson	1.27600	1.56820	1.37100	1.48610	1.39750	1.49850
Adjusted R^2	.52423	.96255	.64417	.96431	.71502	.97518
n	31	31	31	31	31	31

[a]Significant at the 1 percent level, one tail test; [b]Significant at the 5 percent level, one tail test; [c]Significant at the 10 percent level, one tail test.

Sources: See the Data Appendix for all data sources.

the women's expected wage is significant at the one percent level in all cases. There is no indication here that either the magnitude or the significance of this effect is sensitive to alternative ARCH specifications.

Table V gives estimates with the variance of men's expected income included. Focusing on the theoretically preferred specifications in which the wage is endogenous, we find that the coefficient of the variance of men's expected income has the expected sign in all three cases, and is statistically significant in two of the three cases. Similarly, the variance of women's expected wages always has the expected effect upon participation, and is statistically significant in two of the three cases in which the wage is endogenous. The coefficient of the expected rate of employment always has the expected sign, and is always statistically significant when the wage is treated as endogenous. The traditional economic variables, men's current income and women's current wages, maintain their significance in the expected directions, with the elasticity of the women's wage still dominant. Results for the specifications in which the wage is exogenous are quite similar, as may be seen in Tables IV and V.

These results give clear support to the hypothesis that the parameters of the expected wage and employment distributions are relevant determinants of married women's labor force participation rates. Moreover, our findings suggest that expectations may supplement the effects of traditional economic variables in married women's participation decisions.

To understand the magnitude of the effect of expected variances upon

Table V: Weighted Maximum Likelihood Estimates of the Participation Equations, Including the Variance of Men's Expected Incomes 1956-86: Dependent Variable is the Log Odds Ratio of the Labor Force Participation Rate for Married Women (t-ratios in parentheses)

	ARCH Specification 1		ARCH Specification 2		ARCH Specification 3	
	Wage Exogenous	Wage Endogenous	Wage Exogenous	Wage Endogenous	Wage Exogenous	Wage Endogenous
Expected Rate of Employment	-.55000 (-.7264)	-2.52130[b] (-2.2640)	-.70552 (-1.0019)	-2.51570[b] (-2.3936)	-1.07010[c] (-1.5130)	-2.79270[a] (-2.7799)
Variance of Women's Expected Wage	.00004[b] (2.4546)	.00003[c] (1.5734)	.00005[b] (2.1217)	.000006 (.2509)	.00004[a] (3.3073)	.00003[b] (2.1232)
Variance of Men's Expected Income	.000001 (.22186)	.000007[b] (1.75540)	-.0000002 (-.03563)	.00001[b] (1.8829)	-.000001 (-.6195)	.000002 (.8685)
Men's Current Income	-.00004[a] (-2.8953)	-.00006[a] (-4.2397)	-.00004[a] (-2.8664)	-.00005[a] (-3.3086)	-.00003[b] (-2.2323)	-.00003[b] (-2.2384)
Women's Current Wage	.00012[a] (5.1928)	-	.00010[a] (4.5573)	-	.00010[a] (4.2669)	-
Predicted Value of Women's Current Wage	-	.00018[a] (6.3792)	-	.00016[a] (4.6786)	-	.00013[a] (3.9194)
Constant	-.91283	.32944	-.63139	.42282	-.35154	.80587
Durbin-Watson	1.31080	1.77880	1.36300	1.78740	1.30420	1.68590
Adjusted R^2	.53375	.96932	.62529	.97356	.69978	.97261
n	31	31	31	31	31	31

[a]Significant at the 1 percent level, one tail test; [b]Significant at the 5 percent level, one tail test; [c]Significant at the 10 percent level, one tail test.

Sources: See the Data Appendix for all data sources.

labor force participation rates of married women, it is useful to examine the elasticities of the expectations variables with respect to participation. This step is helpful because of the difficulty inherent in interpreting the effect of a one-unit change in a variance. Table VI gives the elasticities associated with the expected variances for the regressions in Table V, which include the variance of men's expected incomes. For the three ARCH specifications, the mean elasticity for the variance of women's expected wages is .1057 when the wage is endogenous, while the mean elasticity for the variance of men's expected incomes is .1243. During the years 1976-80, the variance of women's expected wages increased by an average of 8.44% per year, thus causing a potential increase in the participation rate of as much as .89% per year, ceteris paribus, while the average increase in the variance of men's expected incomes of 8.22% during the same period may have been responsible for an average annual increase in the participation rate of as much as 1.02%.

IV. Conclusions

This paper outlines and tests a theory of labor force participation of married women under real wage, (husband's) income and employment uncertainty. Annual time series data from 1956 through 1986 are used to test the hypothesis that expectations matter in the current participation decisions of married women. Expectations of future employment and real wage and (husband's) income distributions are derived and tested as determinants of labor force participation rates for married women over the sample period. Our estimates indicate that decreases in the expected probability of employment and increases in the expected level of wage rate uncertainty and (husbands') income uncertainty both encourage current

Table VI: Elasticities of the Expectations Variables for Regressions that Include the Varian of Men's Expected Incomes

	ARCH Specification 1		ARCH Specification 2		ARCH Specification 3	
	Wage Exogenous	Wage Endogenous	Wage Exogenous	Wage Endogenous	Wage Exogenous	Wage Endogenous
Variance of Women's Expected Wage	.152	.107	.212	.029	.262	.181
Variance of Men's Expected Income	.011	.104	-.003	.197	-.040	.072

participation.

Overall, we find the results to be quite encouraging, and we believe they indicate that explanations of participation growth of married women which incorporate both the effects of real wage growth and the effects of uncertainty are likely to be superior to those which omit the effects of uncertainty, particularly during unstable periods such as the 1970's.

Appendix A: Theory

First order conditions, which are found after substitution of (14) into (3), are

(A1) $$[W(1)u_C(1) - u_L(1)]H(1) = 0$$

and

(A2) $$-u_C(1) + E[nu_C^e(2) + (1-n)u_C^u(2)] = 0.$$

The first condition says that either labor will be supplied up to the point where the marginal rate of substitution between leisure and consumption equals the wage, or, if the wage is sufficiently low, no labor will be supplied at all. The second condition states that saving should occur up to the level at which the present values of the expected marginal utility of consumption are equal in the two periods.

These conditions are totally differentiated to allow the comparative static results of the model to emerge. The total differential of (A1) is

(A3) $$\begin{aligned} H(1)s(1)dH(1) - H(1)g(1)dZ(1) = &-H(1)g(1)dV \\ &- H(1)g(1)dI_h(1) - [H(1)]^2g(1)dW(1) \end{aligned}$$

where $s(1) = u_{CC}(1)[W(1)]^2 - 2u_{CL}(1)W(1) + u_{LL}(1)$ is negative due to the concavity of the utility function, and $g(1) = u_{CC}(1)W(1) - u_{LC}(1)$ is negative if leisure is a normal good.[20]

Total differentiation of (A2) gives:

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[20] The effect of an increase in initial wealth upon H(1) is given by $dH(1)/dV = -[g(1)/s(1)]$. If leisure is a normal good then $dH(1)/dV < 0$, so $g(1) < 0$.

$$-g(1)dH(1) + \phi dZ(1) = u_{CC}(1)dV + u_{CC}(1)dI_h(1) + u_{CC}(1)H(1)dW(1)$$

(A4) $$- E[\epsilon dI_h'(2) + nvu_{CC}^{e}(2)H(2)dW(2) + nu_{CC}^{e}(2)H(2)dm$$

$$+ nu_{CC}^{e}(2)H(2)W(2)dv + ng'(2)dH(2) - \tau dn],$$

where $\phi = u_{CC}(1) + 2\cdot E(nu_{CC}^{e}(2) + (1-n)u_{CC}^{u}(2)) < 0$

$\epsilon = nu_{CC}^{e}(2) + (1-n)u_{CC}^{u}(2) < 0$

$g'(2) = u_{CC}^{e}(2)(vW(2) + m) - u_{CL}^{e}(2) < 0$, and

$\tau = u_C^{e}(2) - u_C^{u}(2)$.

The sign of τ depends upon the relative magnitudes of $u_C^{e}(2)$ and $u_C^{u}(2)$ at the optima. The two possible cases are illustrated in Figure A1. In Figure A1a, if the woman chooses to enter the period 2 labor force but cannot find a job then she is constrained to point B at the intersection of the budget constraint and indifference curve u^u. If she decides to enter the labor force and she finds employment, then she will be at a point of tangency such as point A. Comparison of the marginal utilities of consumption at points A and B requires an assumption about one of the second cross-partial derivatives of the utility function. Specifically, if it is assumed that $u_{CL}(2) > 0$, then marginal utility at point C must be less than at point B.[21] Since concavity requires that the marginal utility of consumption at point A be less than at point C, then marginal utility at point A must be less than at point B. Thus, if the woman chooses to enter the labor force, then at the optima, $u_C^{e}(2) - u_C^{u}(2) < 0$. On the other hand, if, as in Figure A1b, the woman would choose not to participate at the current wage, then she must be at point B, so that

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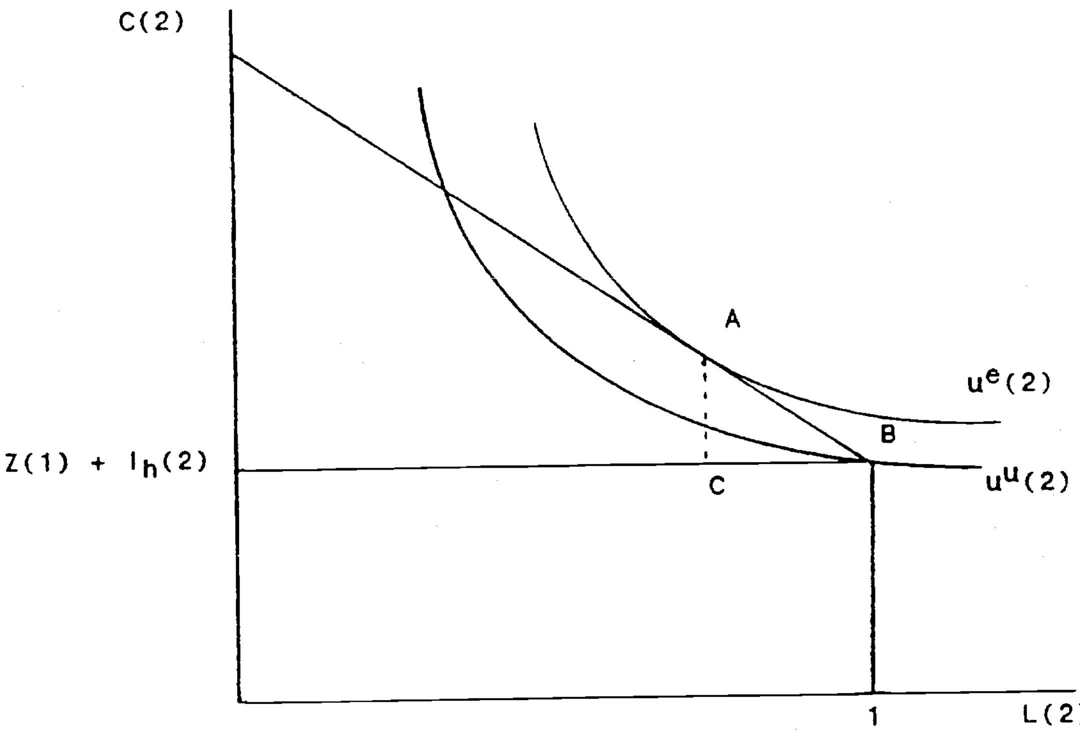
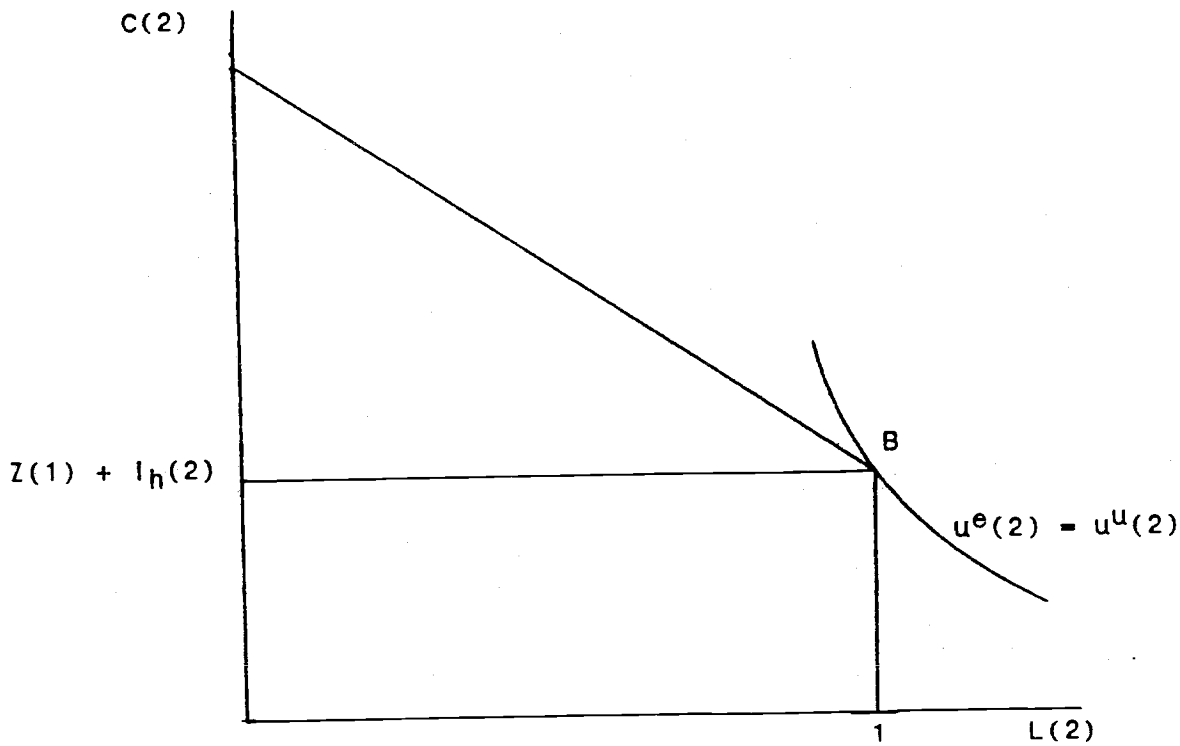
[21] Note that this is a standard result in the case of a Cobb-Douglas utility function, $u = C^{\alpha}L^{\beta}$, with $\alpha,\beta > 0$. In this case $\partial^2 u/\partial C\partial L = \alpha\beta C^{\alpha-1}L^{\beta-1} > 0$.

Figure A1: Period 2 Optima



(a) Interior Solution



(b) Corner Solution

$u_C^e(2) - u_C^u(2) = 0$, since $u^e(2) = u^u(2)$. Hence, $\tau = u_C^e(2) - u_C^u(2) \leq 0$.

We can now use Cramer's rule to solve for the important comparative static results of the model. Specifically, we find that

$$\text{(A5)} \quad dZ(1)/dn = \frac{\begin{vmatrix} H(1)s(1) & 0 \\ -g(1) & -E[\tau] \end{vmatrix}}{|H|}$$

where the Hessian matrix |H| must be positive for a maximum, so that

$$\text{(A6)} \quad dZ(1)/dn = -\underset{+}{H(1)s(1)}\cdot \underset{-}{E[\tau)]}/\underset{+}{|H|} \leq 0.$$

Also,

$$\text{(A7)} \quad dZ(1)/dm = \frac{\begin{vmatrix} H(1)s(1) & 0 \\ -g(1) & -E[u_{CC}^e(2)H(2)] \end{vmatrix}}{|H|} = -\underset{+}{H(1)s(1)}\cdot \underset{-}{E[u_{CC}^e(2)H(2)]}/\underset{+}{|H|} \leq 0, \text{ and}$$

$$\text{(A8)} \quad dZ(1)/dm' = \frac{\begin{vmatrix} H(1)s(1) & 0 \\ -g(1) & -E[\epsilon] \end{vmatrix}}{|H|} = -\underset{+}{H(1)s(1)}\cdot \underset{-}{E[\epsilon]}/\underset{+}{|H|} \leq 0.$$

To derive the effects of changes in the variances of the woman's expected wage distribution and the husband's expected income distribution, recall that a mean-constant change in the variance of the woman's wage distribution implies that $dm = -\mu_{W(2)}dv$. This means that the terms in (A4) involving dm and dv can now be combined as

(A9) $$-E[((nu_{CC}^{e}(2)H(2))(W(2) - \mu_{W(2)}))dv],$$

where the expectation of the term inside the brackets, $(nu_{CC}^{e}(2)H(2))(W(2) - \mu_{W(2)})$, is the covariance of $nu_{CC}^{e}(2)H(2)$ and $W(2)$,[22] so that the expression becomes

(A10) $$-[Cov\{nu_{CC}^{e}(2)H(2),W(2)\}]dv.$$

Evaluation of $dZ(1)/dv$ at $dm = -\mu_{W(2)}dv$ now gives

(A11)
$$\left.\frac{dZ(1)}{dv}\right|_{dm=-\mu_{W(2)}dv} = \frac{\begin{vmatrix} H(1)s(1) & 0 \\ -g(1) & -[Cov\{nu_{CC}^{e}(2)H(2),W(2)\}] \end{vmatrix}}{|H|}$$
$$= -\underset{+}{H(1)s(1)}\cdot[Cov\{nu_{CC}^{e}(2)H(2),W(2)\}]/|H|.$$

Clearly, the sign of $dZ(1)/dv$ depends upon the sign of $Cov\{nu_{CC}^{e}(2)H(2),W(2)\}$. While the actual sign of the derivative is an empirical issue, one can speculate as to its likely sign. The wage level in period 2 affects both the level of utility and the number of hours of labor supplied. One might presume that, as is typically the case for married women, hours supplied is a positive function of the wage rate. Further, it is likely that as $W(2)$ rises, the value of $u_{CC}^{e}(2)$ becomes less negative. This would be the case if, as Killingsworth speculates (p. 260), the level of risk aversion falls with higher expected wages. It would also be true in the case of a utility function with constant absolute risk aversion. With this type of utility function, the ratio

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[22] In general, the covariance of two random variables x and y can be stated as $Cov(x,y) = E\{x[y - \mu_y]\}$.

u_{CC}/u_C remains fixed as the level of consumption varies. Hence, if an increase in the wage rate encourages labor supply, then it must also encourage consumption, so that when wages rise, u_C declines. For u_{CC}/u_C to remain constant $|u_{CC}|$ must fall, which means that u_{CC} must become less negative. Assuming that one of these conditions holds, and that n is fixed, then

$$\text{(A12)} \qquad \mathrm{Cov}\{nu_{CC}{}^{e}(2)H(2), W(2)\} > 0,$$

and

$$\text{(A13)} \quad \left.\frac{dZ(1)}{dv}\right|_{dm=-\mu_{W(2)}dv} = \underset{+}{-H(1)s(1)}\cdot \underset{+}{\mathrm{Cov}[nu_{CC}{}^{e}(2)H(2), W(2)]}/\underset{+}{|H|} > 0.$$

The effect of a mean-constant increase in the variance of the husband's income distribution is also ambiguous. To see this, note that

$$\left.\frac{dZ(1)}{dv'}\right|_{dm'=-\mu_{Wh(2)}dv'} = \frac{\begin{vmatrix} H(1)s(1) & 0 \\ -g(1) & -E[\epsilon\cdot(I_h(2)-\mu_{Ih(2)})] \end{vmatrix}}{|H|}$$

$$\text{(A14)} \qquad = \underset{+}{-H(1)s(1)}\cdot E[\epsilon\cdot(I_h(2)-\mu_{Ih(2)})]/\underset{+}{|H|}.$$

As above, the term inside the brackets, $E[\epsilon\cdot(I_h(2)-\mu_{Ih(2)})]$ is the covariance of ϵ and $I_h(2)$, so that

$$\text{(A15)} \qquad \left.\frac{dZ(1)}{dv'}\right|_{dm'=-\mu_{Wh(2)}dv'} = -H(1)s(1)\cdot \mathrm{Cov}\{\epsilon, I_h(2)\}/|H|.$$

While the actual direction of this effect is an empirical issue, intuition suggests that, as above, the effect is likely to be positive, since more uncertain future income should induce current labor force participation, regardless of the source of that income. Specifically, when $I_h(2)$ is relatively low the woman's level of consumption is likely to be low as well, so that ϵ, which is a weighted average of the second partial derivative of the woman's utility function, may become very negative. Thus the covariance between the two terms is likely to be positive, and our expectation is that

(A16) $$\left.\frac{dZ(1)}{dv'}\right|_{dm'=-\mu_{Wh(2)}dv'} = -\underset{+}{H(1)s(1)}\cdot \underset{+}{\mathrm{Cov}\{\epsilon, I_h(2)\}}/|H| \geq 0.$$

Appendix B: Data

Table BI: Means and Standard Deviations of the Variables

	Mean	Std. Dev.
Labor Force Participation of Married Women with Spouses Present	44.941	9.565
Men's Current Income	18937.566	2349.898
Women's Current Wage	13448.285	1544.192
Percent of Women in the Civilian Labor Force With Four or More Years of College Education	12.332	3.506
Gross National Product	2519.988	670.970
Expected Employment Rate	0.932	0.010
ARCH Specification 1		
Women's Expected Wage	13548.024	1577.940
Variance of Women's Expected Wage	7399.020	3894.889
Men's Expected Income	19077.728	2402.429
Variance of Men's Expected Income	26413.755	14016.969
ARCH Specification 2		
Women's Expected Wage	13544.959	1576.506
Variance of Women's Expected Wage	8350.953	4301.219
Men's Expected Income	19070.779	2397.970
Variance of Men's Expected Income	24759.948	13215.622
ARCH Specification 3		
Women's Expected Wage	13532.924	1576.506
Variance of Women's Expected Wage	10839.526	5587.550
Men's Expected Income	19052.287	2402.206
Variance of Men's Expected Income	57412.762	30811.910

Table BII: Data Sources

Labor Force Participation Rate of Married Women With Spouses Present:

Derived from labor force participation rate of married women with spouses present, by age (Handbook of Labor Statistics, 1985, and Employment and Earnings, various issues), and female labor force by age (Handbook of Labor Statistics, 1985, and Employment and Earnings, various issues).

Expected rate of employment:

Derived from the actual numbers of women unemployed (Labor Force Statistics Derived From the Current Population Survey, 1948-87), and female labor force by age (Handbook of Labor Statistics, 1985, and Employment and Earnings, various issues).

Men's Current Income:

Derived from annual median incomes of men by age (Current Population Reports, Series P-60, various issues), and civilian population of men by age (Handbook of Labor Statistics, 1985, and Employment and Earnings, various issues). Nominal income is deflated using consumer price index, 1982-1984=100.

Women's Current Wage:

Derived from annual income of women who are year-round full-time workers, by age (Current Population Reports, Series P-60, various issues), and female labor force by age (Handbook of Labor Statistics, 1985, and Employment and Earnings, various issues). Nominal wage is deflated using consumer price index, 1982-1984=100.

Real gross national product for the United States:

Nominal GNP deflated through use of the implicit price deflator for GNP, 1982=100: Economic Report of the President, January 1987.

Percent of Women in the Civilian Labor Force With Four or More Years of College Education:

1956-1958: Current Population Reports, Series P-50, No. 78; 1959-1984: Handbook of Labor Statistics, 1985; 1985: Statistical Abstract of the United States, 1986; 1986: Statistical Abstract of the United States, 1988.

Appendix C: ARCH Regression Results

Table CI: ARCH Regression Results for Aggregate Data on Women's Wages 1956-86 (t-ratios in parentheses)

	Specification 1	Specification 2	Specification 3
Variance Function			
Constant	.022735 (.00001)	.785244 (.00033)	20.545369 (.006198)
ϵ^2_{t-1}	.001140 (2.74184)	.000322 (2.48998)	.0000003 (.00009)
ϵ^2_{t-2}	-	-	.000424 (.14514)
Wage Function			
Constant	87.14300 (.5190)	48.24100 (.2514)	-223.81000 (-1.3602)
$WAGE_{t-1}$	.99619 (47.1030)	1.00200 (41.8860)	1.04300 (50.7030)
$EDUC_{t-1}$	-10.46800 (-.6859)	-9.60300 (-.5303)	-
GNP_{t-1}	.05442 (.48217)	.17006 (.44636)	.29223 (.6116)
GNP_{t-2}	-	-.13811 (-.3496)	-.42717 (-.91684)
LM	21.816	22.163	23.765

Table CII: ARCH Regression Results for Aggregate Data on Men's Income 1956-86 (t-ratios in parentheses)

	Specification 1	Specification 2	Specification 3
Variance Function			
Constant	1692.746449 (.31937)	.360853 (.000006)	48.462482 (.00263)
ϵ^2_{t-1}	.003762 (3.32513)	.000949 (2.95410)	.000000 (.0000005)
ϵ^2_{t-2}	–	–	.002243 (.19369)
Wage Function			
Constant	-21.29900 (-.1449)	-32.85800 (-.2371)	-46.17000 (-.2316)
INCOME_{t-1}	1.02530 (71.0540)	1.02690 (78.1300)	1.03520 (63.5180)
EDUC_{t-1}	33.66900 (.8847)	45.87100 (1.3674)	–
GNP_{t-1}	-.37172 (-1.3274)	1.97290 (2.8687)	1.98660 (1.4456)
GNP_{t-2}	–	-2.44880 (-3.6716)	-2.24110 (-1.6261)
LM	41.282	46.082	46.401

Appendix D: Unweighted Regression Results

Table DI: Maximum Likelihood Estimates of the Traditional Participation Equations, 1956-86: Dependent Variable Is the Log Odds Ratio of the Labor Force Participation Rate for Married Women (t-ratios in parentheses)

	Wage Exogenous	Wage Endogenous
Men's Current Income	-.00002 (-1.1049)	-.00013 (-4.0283)[a]
Women's Current Wage	.00010 (2.8719)[a]	-
Predicted Value of Women's Current Wage	-	.00041 (8.3469)[a]
Constant	-1.11130	-3.32880
Durbin-Watson	.54650	1.49850
Adjusted R^2	.04375	.81147
n	31	31

[a]Significant at the 1 percent level, one tail test.

Sources: See the Appendix B for all data sources.

Table DII: Maximum Likelihood Estimates of the Participation Equations, Omitting the Variance of Men's Expected Incomes 1956-86: Dependent Variable is the Log of the Odds Ratio of the Labor Force Participation Rate for Married Women (t-ratios in parentheses)

	ARCH Specification 1		ARCH Specification 2		ARCH Specification 3	
	Wage Exogenous	Wage Endogenous	Wage Exogenous	Wage Endogenous	Wage Exogenous	Wage Endogenous
Expected Rate of Employment	-.47204 (-.7102)	-1.61380 (-1.5827)[c]	-.72405 (-1.1623)	-1.59870 (-1.6928)[c]	-1.23750 (-1.9550)[b]	-2.58770 (-2.9598)[a]
Variance of Women's Expected Wage	.00004 (5.8987)[a]	.00006 (7.7935)[a]	.00005 (6.9352)[a]	.00006 (6.8619)[a]	.00004 (7.3533)[a]	.00005 (6.6948)[a]
Men's Current Income	-.00004 (-3.4289)[a]	-.00004 (-2.3657)[b]	-.00003 (-3.2735)[a]	-.00002 (-1.2138)	-.00003 (-2.4268)[a]	-.00002 (-.7587)
Women's Current Wage	.00012 (5.2695)[a]	-	.00010 (4.6711)[a]	-	.00009 (4.3463)[a]	-
Predicted Value of Women's Current Wage	-	.00014 (3.7158)[a]	-	.00009 (2.0030)[b]	-	.00008 (1.5536)[c]
Constant	-.97845	-.27172	-.63757	-.08565	-.23211	.87360
Durbin-Watson	1.28120	1.56870	1.37640	1.48640	1.39090	1.49830
Adjusted R^2	.54015	.96317	.65914	.96497	.70785	.97563
n	31	31	31	31	31	31

[a]Significant at the 1 percent level, one tail test; [b]Significant at the 5 percent level, one tail test; [c]Significant at the 10 percent level, one tail test.

Sources: See the Appendix B for all data sources.

Table DIII: Maximum Likelihood Estimates of the Participation Equations, Including the Variance of Men's Expected Incomes 1956-86; Dependent Variable is the Log of the Odds Ratio of the Labor Force Participation Rate for Married Women (t-ratios in parentheses)

	ARCH Specification 1		ARCH Specification 2		ARCH Specification 3	
	Wage Exogenous	Wage Endogenous	Wage Exogenous	Wage Endogenous	Wage Exogenous	Wage Endogenous
Expected Rate of Employment	-.54179 (-.7206)	-2.50120 (-2.2586)[b]	-.69818 (-.9981)	-2.49610 (-2.3905)[b]	-1.06110 (-1.5150)[c]	-2.76710 (-2.7817)[a]
Variance of Women's Expected Wage	.00004 (2.4338)[b]	.00003 (1.5881)[c]	.00005 (2.1173)[b]	.000007 (.2675)	.00004 (3.2931)[a]	.00003 (2.1412)[b]
Variance of Men's Expected Income	.000001 (.22161)	.000007 (1.73540)[b]	-.0000002 (-.03932)	.00001 (1.8657)[b]	-.000001 (-.6148)	.000002 (.8566)
Men's Current Income	-.00004 (-2.8470)[a]	-.00005 (-4.2289)[a]	-.00003 (-2.8330)[a]	-.00005 (-3.2982)[a]	-.00003 (-2.2077)[b]	-.00003 (-2.2383)[b]
Women's Current Wage	.00012 (5.1435)[a]	-	.00010 (4.5357)[a]	-	.00010 (4.2560)[a]	-
Predicted Value of Women's Current Wage	-	.00018 (6.3588)[a]	-	.00016 (4.6616)[a]	-	.00013 (3.9140)[a]
Constant	-.92786	.31035	-.64377	.40498	-.36934	.78233
Durbin-Watson	1.30730	1.77970	1.36000	1.78860	1.30010	1.68620
Adjusted R^2	.51441	.97006	.61558	.97425	.69464	.97347
n	31	31	31	31	31	31

[a]Significant at the 1 percent level, one tail test; [b]Significant at the 5 percent level, one tail test; [c]Significant at the 10 percent level, one tail test.

Sources: See the Appendix B for all data sources.

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