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Running hard and falling behind: A welfare analysis of two-earner families

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Abstract. This paper investigates the commonly asserted proposition that long term economic changes have put the family in a financial bind. Structural parameters of a family utility model are obtained by estimating simultaneous labor supply functions for a two-earner household. We find evidence indicating that the average 1990's two-earner family would prefer to receive the 1980's real wage package (were it available) instead of the real wage package it actually faces. The degree to which the 1990's family is worse off (in terms of the changes in the real wage package) is roughly equivalent to an hour of leisure per week.

JEL classification: D10, J22, C31

Key words: Family utility, welfare, joint labor supply

1. Introduction

The 1980s and early 1990s have seen tremendous progress in the equalization of wages of males and females. Although married women in 1993 still only earned about 76 cents for every dollar earned by married men, this figure represents a 15% increase in the female/male wage ratio between 1983 and 1993 (see Fig. 1).[1] Analyses in the economics literature on the size of and changes in the wage differential between men and women typically either focus on the issue of equity (i.e., equally productive men and

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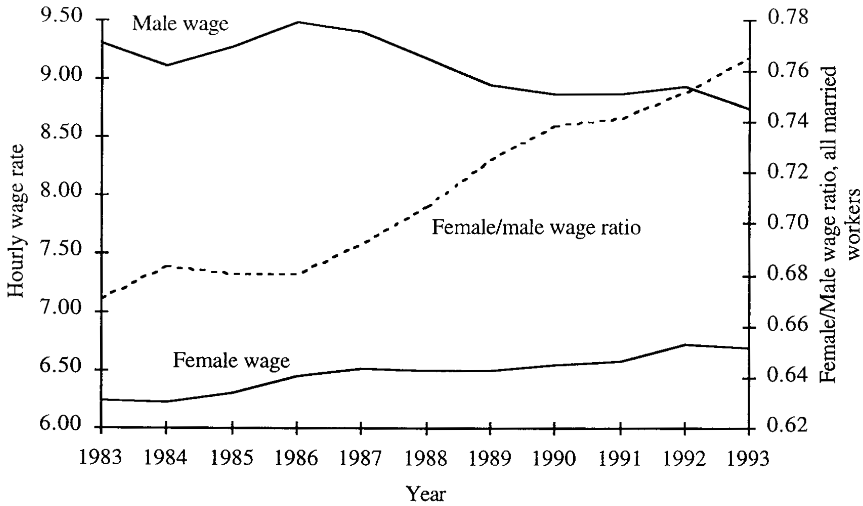

Fig. 1. Average hourly real wage for married males and females (1982–84 dollars) and the married female/male wage ratio.

women *should* receive equal compensation), or on the economic concern that an important factor of production (the human capital of women) is being mis-allocated as a result of non-economic barriers to certain (high-paying) occupations.[2] Based on both an equity and efficiency criterion, then, one could easily argue that the rise in the female/male wage ratio is a good thing.

What has not been addressed before now is how the rise in the wage ratio has impacted the welfare of the two-earner family, given that the rise is partly driven by a decline in the male real wage.[3] The analysis in this paper is directed at determining how the changes in the real wages of married men and women, taken together, have affected the two-earner family. Specifically we ask, within a family utility framework, whether the average two-earner family of the 1990s would prefer the real wage package it currently faces, or the real wage package that prevailed during the previous decade. We constrain the problem to consider only the case of two-earner families since the welfare effect of decreasing male real wages on male single-earner families is obvious, as is the effect of the rising female real wage on the well-being of female single-earner families. Clearly, results from the analysis are, therefore, only directly generalizable to families where both spouses are working in 1993. However, later in the paper, we demonstrate that the two-earner family can be considered a limiting case for the family that would choose a single earner at 1983 wages and two earners at 1993 wages.

We find convincing evidence that the average 1990s two-earner family would prefer the 1980s wage package and therefore can be said to be worse off than it would have been in the early 1980s. The degree to which the family is worse off is roughly equivalent to the (marginal) value of close to an hour of leisure *per week*, or the consumption that could be earned with a week's pay per year. Our results are consistent with popular press reports that today's family faces an ever-increasing burden in trying to maintain a middle-class standard of consumption.[4]

One might argue that the decline in family welfare is an obvious result given that the wage of the average primary wage earner (the husband) has fallen by more than the wage of the (typically) secondary wage earner (the wife) has risen. However, in spite of the fact that the husband's wage fell by more than the wife's wage rose, total real consumption of families increased over the same time period which would tend to suggest we might measure an *increase* in family utility. Both of these simple comparisons fail to take into account the relative value the family places on the two goods whose prices have changed (namely, the leisure of the husband and wife), or how much of these goods the family has sacrificed to attain the higher consumption level. The family utility framework allows us to estimate the value the family places on the husband's and wife's leisure and to take that valuation into account in calculating the impact of wage changes on family welfare.

2. Method

We choose the neoclassical framework in order to obtain a clear-cut specification of family welfare. Although a household bargaining model might tell us more about how the behaviors of individual household members respond to wage changes (and, particularly, changes in non-labor income), it does not readily lend itself to evaluation of the welfare of the *family*. Some analyses suggest that a household bargaining framework better describes the allocation of leisure (i.e., supply of labor) within the family (e.g., Horney and McElroy 1988), yet these models provide no way to gauge the welfare of the family as a unit, and hence can not be used to answer the question we ask (How have wage changes affected the family as a whole?). Note that our reason to estimate individual labor supply below is because as first order conditions of the family utility maximization problem its estimation reveals the values of critical parameters in the indirect family utility function needed to determine the effect of price (wage) changes on welfare. The bargaining models, because the family is not the unit of analysis (rather each spouse in the family is), do not reveal parameter values for a *family* utility function.[5]

Within the framework of the neoclassical family labor supply model, a family maximizes a utility function that is a function of the husband's leisure, the wife's leisure, and their joint consumption, subject to a single budget constraint:

$$\underset{\{L_1\ L_2\ X\}}{\text{Max}} \quad U = U(T - h_1, T - h_2, X) \tag{1}$$

$$\text{Subject to } X = \mathrm{w}_1 h_1 + \mathrm{w}_2 h_2 + \mathrm{Y}.$$

T is total time available for an individual, $L_1 = T–h_1$ is the husband's leisure, $L_2 = T–h_2$ is the wife's leisure, h_1 is the labor supply of the husband,

h_2 is the labor supply of the wife, X is total money income (or consumption with price equal to one), Y is non-labor income, w_1 is the husband's market wage and w_2 is the wife's market wage. Although we refer to L_1 and L_2 as the "leisure" of the husband and wife, respectively, they actually correspond to all uses of non-market time, including home production activities. Since we are limiting the analysis to families where both spouses work, h_1 and h_2 are also constrained to be positive.

The solution to the above maximization problem can be expressed in terms of the indirect utility function, which is solely a function of the wages of the husband and wife and non-labor income of the family:

$$\begin{aligned} \mathrm{V}(\mathrm{w}_1, \mathrm{w}_2, \mathrm{Y}) =& U\{[T - h_1^*(\mathrm{w}_1, \mathrm{w}_2, \mathrm{Y})], [T - h_2^*(\mathrm{w}_1, \mathrm{w}_2, \mathrm{Y})], \\ & [\mathrm{w}_1 h_1^*(\mathrm{w}_1, \mathrm{w}_2, \mathrm{Y}) + \mathrm{w}_2 h_2^*(\mathrm{w}_1, \mathrm{w}_2, \mathrm{Y}) + \mathrm{Y}]\}, \end{aligned} \tag{2}$$

where $h_1^*(\mathrm{w}_1, \mathrm{w}_2, \mathrm{Y})$ and $h_2^*(\mathrm{w}_1, \mathrm{w}_2, \mathrm{Y})$ correspond to the optimal labor supply equations for the husband and wife, respectively. In order to capture the total effect of the wage changes observed during the 1980s on family utility at each member's optimal leisure choice, we totally differentiate the indirect utility function:

$$\mathrm{dV} = -U_1 \mathrm{d}h_1 - U_2 \mathrm{d}h_2 + U_3 \mathrm{d}X, \tag{3}$$

where U_1 is the family's marginal utility of the husband's leisure, U_2 is the family's marginal utility of the wife's leisure, and U_3 is the family's marginal utility of consumption. Expressed in terms of changes in non-labor income and wages, the total derivative becomes:

$$\begin{aligned} \mathrm{dV} =& \left\{ -U_1 \frac{\partial h_1}{\partial \mathrm{w}_1} - U_2 \frac{\partial h_2}{\partial \mathrm{w}_1} + U_3 \left[\mathrm{w}_1 \frac{\partial h_1}{\partial \mathrm{w}_1} + h_1 + \mathrm{w}_2 \frac{\partial h_2}{\partial \mathrm{w}_1} \right] \right\} \mathrm{dw}_1 \\ & + \left\{ -U_1 \frac{\partial h_1}{\partial \mathrm{w}_2} - U_2 \frac{\partial h_2}{\partial \mathrm{w}_2} + U_3 \left[\mathrm{w}_1 \frac{\partial h_1}{\partial \mathrm{w}_2} + h_2 + \mathrm{w}_2 \frac{\partial h_2}{\partial \mathrm{w}_2} \right] \right\} \mathrm{dw}_2 \\ & + \left\{ -U_1 \frac{\partial h_1}{\partial \mathrm{Y}} - U_2 \frac{\partial h_2}{\partial \mathrm{Y}} + U_3 \left[\mathrm{w}_1 \frac{\partial h_1}{\partial \mathrm{Y}} + 1 + \mathrm{w}_2 \frac{\partial h_2}{\partial \mathrm{Y}} \right] \right\} \mathrm{dY} \end{aligned} \tag{4}$$

The direction (sign) of the change in utility at the optimal leisure choices that results from changes in the husband's and wife's wage and changes in non-labor income cannot be determined analytically; it depends on the relative size of labor supply responses of the husband and wife to own and to spouse wage changes, as well as on the relative size of the additional utility the family attains from an additional unit of leisure enjoyed by the husband and wife. Consequently, in order to obtain estimates of the pieces of the total derivative in Eq. (4) a family labor supply model is estimated empirically.

The impact of the wage changes on family utility is isolated from changes in non-labor income by calculating the change in family utility that occurs when the wages change, but non-labor income does not. This is accomplished by evaluating Eq. (4) when $dY = 0$.

3. Empirical estimation

To obtain estimates to use in evaluating Eq. (4), we appeal to the family utility framework presented by Ransom (1987). He specifies a quadratic form of the utility function:

$$U(Z) = \boldsymbol{\alpha}(Z) - (1/2)Z'\boldsymbol{\beta}Z, \tag{5}$$

where Z is a vector with elements $Z_1 = T\text{–}h_1$, $Z_2 = T\text{–}h_2$ and $Z_3 = w_1h_1+w_2h_2+Y$; $\boldsymbol{\alpha}$ is a vector of parameters and $\boldsymbol{\beta}$ is a matrix of parameters. This utility function belongs to the class of flexible functional forms in the sense that it can be thought of as a second order approximation to an arbitrary utility function when $\boldsymbol{\beta}$ is positive definite.[6]

The first order conditions, the labor supply equations, and the likelihood function estimated to obtain structural parameter estimates are found in Ransom (1987, p. 467–8).[7] The specification of the likelihood function allows for simultaneous labor supply decisions of the husband and wife.

The March 1993 Current Population Survey (CPS) was used to construct the sample for which the family labor supply model is estimated. Only families in which both the husband and wife are hourly wage earners are included in the sample, so the wage variables reflect actual (gross) hourly earnings of the respondents.[8] Non-labor income reflects total family income minus total family earnings during the previous year.[9] Table 1 contains the mean and standard deviations of the variables for the sample. The responses correspond to work behavior during March 1993.[10] The wage and non-labor income are reported in real (1982–84) dollar values. On average, husbands (wives) work about 44 (about 35) hours per week and earn \$7.91 (\$6.02) per hour. Families receive about \$39 of non-labor in-

Table 1. Means and standard deviations of variables for sample used in estimation ($N=1072$ families)

Variable	Mean	Standard deviation
h_1	40.44	(6.20)
h_2	34.88	(9.33)
w_1	\$7.91	(3.72)
w_2	\$6.02	(3.05)
Y	\$38.76	(94.58)
$\text{Black}_1 = 1$	0.08	(0.27)
$\text{Black}_2 = 1$	0.08	(0.27)
Age_1	40.07	(10.76)
Age_2	37.75	(10.07)
$\text{HS}_1 = 1$	0.84	(0.37)
$\text{HS}_2 = 1$	0.87	(0.34)
$\text{COL}_1 = 1$	0.08	(0.27)
$\text{COL}_2 = 1$	0.08	(0.27)
NKIDS	2.29	(2.36)
PRESCHL = 1	0.29	(0.46)

Notes: Subscript 1 identifies husband characteristics and subscript 2 identifies wife characteristics. Wages and non-labor income are in real terms (1982–84 CPI = 1.445). h_1 and h_2 are in terms of hours per week. Y is in terms of dollars per week.

come per week. Husbands are slightly older than wives and both have about the same level of education.

The parameter estimates are reported in Table 2. Unlike Ransom (1987) we include children regressors in the labor supply equation of the husband, as well as the wife. (Excluding these regressors from the husband's labor supply equation did not alter the conclusions of the paper.) Estimates of the marginal utilities of leisure and consumption, as well as the own and cross wage elasticities are also reported in Table 2.[11] The coefficients on the vari-

Table 2. Estimated parameter values for quadratic family utility function

Parameter	Coefficient	(S.E.)
Elements of $\boldsymbol{\alpha}_1^*$		
Intercept	32.837**	(2.702)
$\text{Black}_1 = 1$	–1.312*	(0.672)
$\text{HS}_1 = 1$	0.671	(0.611)
$\text{COL}_1 = 1$	–1.225*	(0.714)
AGE_1	–0.070**	(0.020)
NKIDS	0.070	(0.113)
PRESCHL = 1	0.321	(0.563)
Elements of $\boldsymbol{\alpha}_2^*$		
Intercept	15.274**	(4.595)
$\text{Black}_2 = 1$	2.060**	(2.117)
$\text{HS}_2 = 1$	–1.037	(0.644)
$\text{COL}_2 = 1$	–1.374**	(0.681)
AGE_2	–0.038	(0.026)
NKIDS	–0.423**	(0.119)
PRESCHL = 1	–0.657	(0.491)
$\boldsymbol{\alpha}_3^*$	1.111**	(0.143)
$\boldsymbol{\beta}_{11}$	1.000	
$\boldsymbol{\beta}_{22}$	0.649**	(0.122)
$\boldsymbol{\beta}_{33}$	0.0001**	(0.00005)
$\boldsymbol{\beta}_{12}$	–0.226**	(0.065)
$\boldsymbol{\beta}_{13}$	–0.006**	(0.001)
$\boldsymbol{\beta}_{23}$	0.004**	(0.001)
$1/\boldsymbol{\sigma}_1$	0.151**	(0.003)
$1/\boldsymbol{\sigma}_2$	0.159**	(0.029)
$\boldsymbol{\rho}$	0.807*	(0.063)
Log likelihood	–3,358.66	
U_1	5.208[a]	
U_2	3.939[a]	
U_3	0.675[a]	
Husband's own wage elasticity	0.066[a]	
Wife's own wage elasticity	0.121[a]	
Husband's cross wage elasticity	–0.017	
Wife's cross wage elasticity	–0.044	
Husband's income elasticity	–0.007[a]	
Wife's income elasticity	–0.009[a]	

Notes: Standard errors are in parentheses. * = > significant at the 90% level; ** = > significant at the 95% level (two-tail test).
[a] = > significant at the 95% level based on bootstrapping techniques. $\boldsymbol{\beta}_{11}$ is assumed to equal 1 for identification purposes (see Ransom, 1987, p. 469). $\boldsymbol{\rho}$ is the correlation between the error terms in the husband's and wife's labor supply equations.

ables included in the labor supply equation are mostly of the expected sign and significance; black men tend to work fewer hours than white men, black women work more hours than white women, and the number of children significantly reduces the number of hours for women. The result that college-educated men and women and older men work fewer hours than their counterparts is unusual, but may simply be a function of the sample being comprised of only hourly wage earners.[12] The marginal utilities are all positive and significantly different from zero. Both the husband's and wife's own wage elasticities are positive and significantly different from zero. The cross-wage elasticities are insignificant, but both the husband's and wife's income elasticities are of the appropriate sign and significantly different from zero.[13]

Inserting the parameter estimates and the mean values for h_1, h_2, w_1, w_2, and Y into Eq. (4), we have:

$$dV = 27.32*dw_1 + 23.62*dw_2 + 0.67*dY. \quad (6)$$[14]

The evaluation of Eq. (6), tells us how the 1990s family utility is affected by any changes in wages and non-labor income experienced through dw_1, dw_2, and dY. To determine how wage changes over the last 10 years affect the utility of the 1990s family, dw_1 (dw_2) was calculated as the difference between the average real wage of husbands (wives) who have a working spouse in 1983 and 1993.[15] The average wages were calculated using hours and earnings information from the *Employment and Earnings* publication.[16] dw_1 was calculated as -\$0.50 per hour and dw_2 was calculated as \$0.41 per hour (in 1982–84 dollars). The change in non-labor income (dY) was calculated using the (weighted) average non-labor income reported by families in the 1983 and 1993 Current Population Surveys and is \$2.79 per week (in 1982–84 dollars).

4. Interpretation of results

Isolating the change in wages

Setting $dY = 0$ in Eq. (6) yields a picture of the actual impact on utility resulting solely from the trade-off of wives' for husbands' earnings through changes in their respective wages. The simulated decline in the husband's wage along with the simulated increase in the wife's wage alone result in a decline of total utility of 3.98.[17] This –3.98 change in utility is equivalent (given the estimated marginal utilities of the husband's and wife's leisure) to a loss of 0.76 hours of leisure per week for the husband or a loss of 1.01 hours of leisure per week for the wife (which translates into almost 40 hours per year for the husband and just over 52 hours per year for the wife).[18]

Total change in utility

This reduction in utility holds even when we account for the estimated increase in non-labor income; total family utility decreased by a magnitude of 2.10.[19] This is equivalent to a loss of 0.40 of an hour of husband's leisure per week and a loss of 0.53 of an hour of wife's leisure per week (this translates into about 21 hours per year for the husband and about 28 hours per year for the wife).

From Eq. (6) we can also determine how much the wife's wage would have to rise in order to offset (in terms of utility) the decline in the husband's wage. With no change in non-labor income, the wife's wage would have to have risen by $0.58 to fully offset the $0.50 decline in the husband's wages. Taking the increase in non-labor income into account, the wife's wage would have had to increase only $0.50 to offset the $0.50 decline in the husband's wage.

Utility impact across wage categories

The utility impact reported above corresponds to the family that would exhibit the average characteristics in the sample. While this is the most theoretically appropriate "family" for whom we can interpret the results, it is also clear that not all families are expected to have experienced the same

Table 3. Utility impact of wage changes for the average family in different husband and wife wage categories.

Husband's wage category	Low wage ($0.69 – $5.91)	Middle wage ($5.94 – $9.00)	High wage ($9.00 – $37.07)	Row sum
Wife's wage category				
Low wage ($0.69 – $4.29)	$dV\|_{dY=0}$ = –1.77 dV = –0.03 $dw\|_1$ = –$0.27 dw_2 = $0.24 N = 171 (16%)	$dV\|_{dY=0}$ = –7.18 dV = –5.54 dw_1 = –$0.45 dw_2 = $0.24 N = 113 (10.5%)	$dV\|_{dY=0}$ = –15.39 dV = -13.19 dw_1 = –$0.74 dw_2 = $0.25 N = 73 (6.8%)	357
Middle wage ($4.32 – $6.30)	$dV\|_{dY=0}$ = 0.82 dV = 2.55 dw_1 = -$0.29 dw_2 = $0.36 N = 116 (10.8%)	$dV\|_{dY=0}$ = –4.15 dV = –2.56 dw_1 = -$0.46 dw_2 = $0.36 N = 135 (12.6%)	$dV\|_{dY=0}$ = –11.23 dV = –9.16 dw_1 = –$0.71 dw_2 = $0.37 N = 107 (10%)	358
High wage ($6.33 – $31.14)	$dV\|_{dY=0}$ = 6.82 dV = 9.51 dw_1 = –$0.28 dw_2 = $0.56 N = 70 (6.5%)	$dV\|_{dY=0}$ = 1.82 dV = 3.95 dw_1 = –$0.47 dw_2 = $0.59 N = 110 (10.3%)	$dV\|_{dY=0}$ = –4.38 dV = –2.63 dw_1 = –$0.78 dw_2 = $0.69 N = 177 (16.5%)	357
Column sum	357	358	357	1072

Notes: This table compares the impact on utility of a 6.29% decrease in the husband's wage, a 6.87% increase in the wife's wage, and (when dY is not set to equal zero) a 7.2% increase in nonlabor income. These are the actual percentage changes experienced between 1983 and 1993 and were kept constant across wage categories to provide a consistent basis for comparison; the resulting level wage changes simulated are given in the cells of the table (the level changes in nonlabor income are not reported in the table to save space). While it is possible to use bootstrapping techniques to generate standard errors for the utility changes in each cell, we do not want to suggest that degree of accuracy; see Endnote 20.

utility impact.[20] In order to illustrate that while the average family clearly suffers a utility loss facing the 1990s wage package versus the 1980s wage package, not all families would choose the 1990s wage package.

Table 3 contains the calculated utility impact for the average family for each of nine husband and wife wage combinations. As one would expect, those families in which the husband is in the top third wage category suffer the largest loss in utility facing the 1990s wage package. In addition, only families in which the wife is in a higher wage category than the husband experience higher utility facing the 1990s wage package versus the 1980s wage package. Thus, in calculating the welfare changes for each of the nine groups we found that six of the nine groups (representing 72.4% of the data set) are worse off with 1993 wages instead of 1983 wages. While it was interesting to see the welfare change calculation for each of the nine groups, it also confirms that results found for the “average” family are, at least qualitatively, a reliable gauge for the bulk of the sample.

The two-earner family as a limiting case

Although our sample only contains families where both spouses work in 1993, we are able to provide a limiting case for how welfare has changed for the average family when the wife works when facing the 1990s wage, but may choose to not work when facing the lower 1980s wage. What we know from the above analysis is that the family’s indirect utility is higher under the 1980s wage package than under the 1990s wage package when both spouses work:

$$V(w_1^{83}, w_2^{83}, Y) > V(w_1^{93}, w_2^{93}, Y), \tag{8}$$

where w_i^{93} ($i=1, 2$) represent the 1993 wages and w_i^{83} ($i=1, 2$) represent 1983 wages. We also know that if the wife would choose not to work under the 1983 wage, her reservation wage (the value of her leisure at zero hours of work) is greater than the 1983 market wage ($w_2^R > w_2^{83}$), and since the indirect utility function is monotonically increasing in wages,

$$V(w_1^{83}, w_2^R, Y) > V(w_1^{83}, w_2^{83}, Y), \tag{9}$$

where w_2^R represents the wife’s reservation wage. Equations (8) and (9) imply:

$$V(w_1^{83}, w_2^R, Y) > V(w_1^{93}, w_2^{93}, Y). \tag{10}$$

In other words, since the average two-earner family of 1993 is better off facing the 1983 wages when both members are working, the average two-earner family of 1993 must necessarily also be better off facing the 1983 wages when the wife chooses not to work under the 1983 wages.

5. Conclusions

For several years now the popular media has been lamenting the financial plight of the family. Anecdotes abound of the difficulty families have in making ends meet.[21] Our study is the first to empirically document the financial squeeze on the two-earner family and to estimate its magnitude. We find that the average two-earner family has suffered a loss of welfare roughly equivalent to 1 hour of leisure per week when accounting for the changes, over the last decade, in real average male and female wages alone. While adding in the effect of the change in non-labor income reduces the loss, it is still equivalent to about half hour of leisure per week.

Furthermore, we demonstrate that this analysis provides a limiting (best) case for the change in utility for a family that has two earners under 1993 wages and would have only one earner under 1983 wages. This family is at least as well off under 1983 wages as is a family with two earners under 1983 wages. Therefore, the only family *type* that is better off under 1993 (versus 1983 wages) is the single-earner, female-headed household.[22]

We also illustrate that a two-earner family's experience will vary across wage categories of the husband and wife. Families in which the husband is in the highest wage category and the wife in the lowest wage category experience the greatest utility loss facing 1990s wages. Only families in which the wife is in a higher wage category than the husband (three of the possible nine family categories) would prefer the 1980s wage package.

Possible limitations of this study include our inability to control for changes in non-wage benefits, taxes, and fixed costs of working over the decade examined. Accounting for the rise in benefits as a proportion of total compensation may dampen our results.[23] We expect that being able to incorporate the generally rising taxes over the decade (e.g., social security, property, and sales taxes) would amplify our results. In addition, incorporating any changes in fixed costs of participating in the labor force that has occurred would also affect our results.[24] In the absence of measures for the changes in these (and perhaps other) factors affecting labor supply decisions, our simulations take place in an environment where these factors are assumed to be unchanged.

This research may be extended in a number of ways. For example, we are not suggesting by our results that *all* families are worse off facing 1993 wages; given the theoretical construct, we are only able to draw firm conclusions about the welfare of the *average* family. However, the average family is arguably a good indicator for the well-being of the "middle class" family. With a larger data set (which contained more observations) it would be of interest to estimate utility functions separately across income classes (although the method by which families would be categorized by income or earnings would create its own problems). Our analysis of the welfare of the average two-earner family in 1993, however, does reflect the sentiment being reported by the popular press: many (particularly middle class) families feel like they are losing ground in the economic race.

Appendix A

First order conditions of utility maximization problem, labor supply equations, and likelihood function estimated.

As presented by Ransom (1987), the first order conditions set equal to zero that result from maximizing the utility function in Eq. (5) in the text are:

$$\begin{aligned} \mathrm{m}_1 = {} & \boldsymbol{\alpha}_1^* + \boldsymbol{\alpha}_3^* \mathrm{w}_1 - \boldsymbol{\beta}_{11} h_1 - \boldsymbol{\beta}_{33} \mathrm{w}_1 (\mathrm{w}_1 h_1 + \mathrm{w}_2 h_2 + \mathrm{Y}) - \boldsymbol{\beta}_{12} h_2 \\ & + \boldsymbol{\beta}_{13} (2\mathrm{w}_1 h_1 + \mathrm{w}_2 h_2 + \mathrm{Y}) + \boldsymbol{\beta}_{23} \mathrm{w}_1 h_2 \end{aligned} \tag{A1}$$

$$\begin{aligned} \mathrm{m}_2 = {} & \boldsymbol{\alpha}_2^* + \boldsymbol{\alpha}_3^* \mathrm{w}_2 - \boldsymbol{\beta}_{22} h_2 - \boldsymbol{\beta}_{33} \mathrm{w}_2 (\mathrm{w}_1 h_1 + \mathrm{w}_2 h_2 + \mathrm{Y}) - \boldsymbol{\beta}_{12} h_1 \\ & + \boldsymbol{\beta}_{23} (\mathrm{w}_1 h_1 + 2\mathrm{w}_2 h_2 + \mathrm{Y}) + \boldsymbol{\beta}_{13} \mathrm{w}_2 h_1. \end{aligned} \tag{A2}$$

There is no need to specify a time endowment in order to estimate the labor supply functions because $\boldsymbol{\alpha}_1^*$, $\boldsymbol{\alpha}_2^*$, and $\boldsymbol{\alpha}_3^*$ are re-parameterized functions of T, $\boldsymbol{\alpha}$s, and $\boldsymbol{\beta}$s. This re-parameterization is necessary for identification of the labor supply equations. It is through these starred parameters that differences in tastes across families are allowed to enter. Specifically,

$$\boldsymbol{\alpha}_1^* = \boldsymbol{X}_1 \Gamma_1 + \varepsilon_1, \tag{A3}$$

and

$$\boldsymbol{\alpha}_2^* = \boldsymbol{X}_2 \Gamma_2 + \varepsilon_2, \tag{A4}$$

where $\boldsymbol{X}_1$ and $\boldsymbol{X}_2$ are vectors of individual and family characteristics, Γ_1 and Γ_2 are parameters to be estimated, and ε_1 and ε_2 are normally distributed error terms with means zero and covariance matrix Σ.

The likelihood function estimated, then, is

$$L = \prod \mathrm{f}^*(h_1, h_2), \tag{A5}$$

where $f^*(.,.)$ is obtained through the transformation of ε_1 and ε_2:

$$\mathrm{f}^*(h_1, h_2) = \mathrm{abs}\,(\mathrm{J})\,\mathrm{f}\,(\varepsilon_1, \varepsilon_2),$$

where

$$\begin{aligned} \varepsilon_1 = {} & \boldsymbol{X}_1 \Gamma_1 + \boldsymbol{\alpha}_3^* \mathrm{w}_1 - \boldsymbol{\beta}_{11} h_1 - \boldsymbol{\beta}_{33} \mathrm{w}_1 (\mathrm{w}_1 h_1 + \mathrm{w}_2 h_2 + \mathrm{Y}) - \boldsymbol{\beta}_{12} h_2 \\ & + \boldsymbol{\beta}_{13} (2\mathrm{w}_1 h_1 + \mathrm{w}_2 h_2 + \mathrm{Y}) + \boldsymbol{\beta}_{23} \mathrm{w}_1 h_2, \end{aligned} \tag{A6}$$

and

$$\varepsilon_2 = \boldsymbol{X}_2\Gamma_2 + \boldsymbol{\alpha}_3^* w_2 - \boldsymbol{\beta}_{22}h_2 - \boldsymbol{\beta}_{33}w_2(w_1h_1 + w_2h_2 + Y) - \boldsymbol{\beta}_{12}h_1 + \boldsymbol{\beta}_{23}(w_1h_1 + 2w_2h_2 + Y) + \boldsymbol{\beta}_{13}w_2h_1, \quad (A7)$$

and the Jacobian, J, has the form:

$$J = (-\boldsymbol{\beta}_{11} - \boldsymbol{\beta}_{33}w_1^2 + 2\boldsymbol{\beta}_{13}w_1)(-\boldsymbol{\beta}_{22} - \boldsymbol{\beta}_{33}w_2^2 + 2\boldsymbol{\beta}_{23}w_2) - (-\boldsymbol{\beta}_{33}w_1w_2 - \boldsymbol{\beta}_{12} + \boldsymbol{\beta}_{13}w_2 + \boldsymbol{\beta}_{23}w_1)^2. \quad (A8)$$

The Jacobian is restricted to be positive for internal consistency to ensure that a unique solution exists. Further details can be found in Ransom (1987, p. 467–8).

In order to obtain estimates for dV (Eq. (4) in text), we require expressions for the partial derivatives of the labor supply equations (h_1 and h_2) with respect to w_1, w_2, and Y. This is accomplished by setting equations A1 and A2 equal to zero and solving the equations simultaneously for explicit expressions for h_1 and h_2, respectively. These explicit functions are then differentiated accordingly. These manipulations were performed with the help of Mathematica® (Wolfram Research, version 2.2) for the Macintosh. The derivatives are then evaluated at the sample means and the estimated coefficients.

Appendix B

Functions of estimated parameters and their 95% confidence intervals generated by standard bootstrapping techniques.

Calculated variable	Estimate	95% Confidence interval
U_1	5.208	(3.2085, 8.0254)
U_2	3.939	(2.4725, 6.0629)
U_3	0.675	(0.4323, 1.0447)
Husband’s own wage elasticity	0.0662	(0.0431, 0.0967)
Wife’s own wage elasticity	0.1210	(0.0753, 0.1726)
Husband’s cross wage elasticity	–0.0174	(–0.044, 0.0048)
Wife’s cross wage elasticity	–0.0442	(–0.091, 0.0071)
Husband’s income elasticity	–0.0069	(–0.0122, –0.0032)
Wife’s income elasticity	–0.0091	(–0.0171, –0.0039)
dX	–2.8176	(–4.3175, –1.6424)
$dV\|_{dY=0}$	–3.9763	(–6.1846, –2.5355)
dV	–2.0984	(–3.2841, –1.3333)

Endnotes

[1] Note that the wage ratio had remained roughly constant for decades prior 1980 (see Gunderson 1989). Average wages were computed using annual national averages reported in *Employment and Earnings* and correspond to husbands and wives whose spouses are working.
[2] See, for example, Gunderson (1989) and Bound and Johnson (1992).
[3] Kaestner (1993) explores how labor supply of married couples is affected by wage changes and the addition of children and how those labor supply responses have changed over time, but he does not explore how these changes have affected family welfare.
[4] For example, see Hewlett (1990), Otten (1994), and Uchitelle (1994).
[5] See McElroy (1990, p. 560) for a description of neoclassical and Nash-bargained models of household behavior.
[6] The estimation performed resulted in a positive definite $\boldsymbol{\beta}$ matrix.
[7] These are repeated in Appendix A for the convenience of the reader. Appendix A also contains details on obtaining estimates for Eq. (4).
[8] Salary earners are excluded from the analysis because hourly wages constructed from annual salary and reported hours are known to contain measurement error (for example, see Rodgers et al. 1993). An identical analysis using a sample that included both hourly wage earners and salaried workers led to the same conclusions as those reported in this paper.
[9] Since the CPS only allows for identification of non-labor income in the previous year, it must be considered a proxy for current family non-labor income.
[10] Respondents from the outgoing rotation groups only were included in the sample, allowing for more accurate accounting of labor market behavior and job characteristics. Those in the outgoing rotation groups are asked questions corresponding to their labor market experience in the previous week; data which are known to be more reliable than those corresponding to previous year experience.
[11] 95% confidence intervals for all functions of the estimated parameters were generated using standard bootstrapping techniques. 200 repetitions were performed and the results are reported in Appendix B. Details of bootstrapping techniques can be found in Efron (1982).
[12] Most labor supply studies report results generated by data that contain both hourly wage and salary wage earners, making cross-study comparison of these results problematic.
[13] If the *source* of non-labor income matters in the labor supply response of the husband and wife, as suggested by Schultz (1990), the very similar effect of non-labor income on the husband's and wife's respective labor supply could be suggesting that the family's non-labor income is generated equally by the husband and wife.
[14] The 95% confidence intervals (generated via bootstrapping techniques) for each of these numerical pieces are, respectively, (17.50, 42.33), (15.14, 36.64), and (0.43, 1.04); each piece is significantly different from zero.
[15] Our focus on the most recent decade incorporates the majority of the time period over which the rise in the female/male real wage ratio has been the most dramatic. See Endnote 1.
[16] *Employment and Earnings* is a monthly publication produced by the United States Bureau of Labor Statistics which reports numerous statistics describing the labor market participants and non-participants such as numbers of individuals by labor market status; hours, earnings, occupation, industry, race, gender, and marital status of the employed. This is considered one of the most complete, long-running, and reliable sources for information about the national U.S. labor market and its participants.
[17] This estimate is significantly different from zero at the 95% confidence level. The confidence interval is reported in Appendix B.
[18] $dL_1 \approx (dV/U_1) = (-3.98/5.21) = -0.76$ and $dL_2 \approx (dV/U_2) = (-3.98/3.94) = -1.01$.
[19] This estimate is also significantly different from zero at the 95% confidence level. The confidence interval is reported in Appendix B.
[20] The average family is the most theoretically appropriate because it is at the average values of the variables used to generate the parameter coefficients that we can be sure the first order conditions for the utility maximization problem are satisfied.
[21] For example, see Hewlett (1990), Otten (1994), and Uchitelle (1994).
[22] Since the male real wage has declined, single-earner, male-headed households are obviously worse off (as the indirect utility function is monotonically increasing in wages).

[23] The contribution of benefits to the growth of total compensation (wages plus benefits) has averaged 0.4% annually between 1983 and 1991 (*Economic Report of the President*, January 1993, Table B43).

[24] It is of interest to note that two of the most frequently cited fixed costs (travel time to work and the cost of child care) have really not changed much over the past ten years. The average travel time to work has *declined* a minuscule amount from 20.4 min in 1983 to 19.7 min in 1990 (Pisarski 1992). The most recent estimates and projections of child care costs also indicate very little change in the average cost of care for children outside the home (Connelly 1991).

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