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## Changes in Family Welfare from 1994 to 2012: A Tale of Two Decades

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**Abstract:** The female/male average wage ratio has steadily risen from 1983 to 2012. In earlier work, we found that the falling wage gap from 1983 to 1993 was materially detrimental to the average dual-earner family. The female/male wage ratio continued to rise over the following two decades, accompanied by a growing share of households in which the wife is the principal household income generator. This paper investigates how these two developments affected family welfare. Although family welfare rose during the 1990s, the story of the 2000s is quite different.

JEL classification: I30, J22, D19

Key words: joint labor supply, family utility, micro-simulation

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## Changes in Family Welfare from 1994 to 2012: A Tale of Two Decades

### I. Introduction

The decades of the 1990s and the 2000s have provided startlingly different experiences for American families. While the 1990s were largely characterized by the continuation of the economic expansion that started in the 1980s, the experience of the “great recession” has dominated the decade of the 2000s. Our purpose in this paper is to document the changing welfare of American families, concentrating on married households.

Our choice of time periods for comparison, 1994-2003 and 2003-2012, was purposeful. Earlier analysis by Hotchkiss, Kassis, and Moore (1997) examined the period from 1983-1993 providing an initial point of comparison. Both periods, 1994-2003 and 2003-2012 begin and end during economic expansions and so one can reasonably argue that labor market disequilibrium should not be a major concern, which simplifies our analysis.<sup>1</sup> On the surface there are common underlying trends during these two time periods. First, as seen in Figure 1, and of significant interest, across both periods, wages experienced the continued trend of generally rising female/male wage ratio experienced in the 1980s.

[Figure 1 about here]

Secondly, as seen in Figure 2, both periods continue to experience the slow long gradual trend of increasing income inequality through periods of both economic expansion and contraction. Finally, both periods include parts of both republican and democratic administrations, adding to the similarities between the two decades in the political sphere.

[Figure 2 about here]

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<sup>1</sup> See Hotchkiss, Moore, and Rios-Avila, 2014 for an example of a family welfare analysis in the presence of disequilibrium in the labor market.

In other ways, these two time periods are startlingly different. The 2001 recession was relatively brief and the recovery fairly quick, while the 2008 “great recession” was much more severe and the recovery has been slower and less comprehensive. As seen in Figure 3, during the 1994-2000 period family household income was mostly rising in each quintile, but it flattened out or dropped in the 2000’s even during the expansionary part of that period prior to the great recession. The stagnation of household incomes is also born out in Cooper (2014), which reports comparisons of household income in 2000 and 2013 and finds that the earlier period has higher incomes.

[Figure 3 about here]

In terms of wages, as reported in Hotchkiss and Rios Avila (2014), while unadjusted real wages grew slightly during the 2000s, that “growth” disappears and actually begins to decline after about 2002 when accounting for changes in age and education. In contrast, the generally positive labor market factors of the 1990s brought about real wage increases.

Our primary interest is to determine, in light of all these differences and similarities over longer time periods whether the economic (or material) well being of the American family is improving. In other words, would the typical family prefer the end of period wage and non-labor income package it received or the one (in real terms) that would have been available to it at the beginning of the period of analysis. The two periods of comparison are 2012 vs. 2003 and, separately, 2003 vs. 1994.

## II. Background

In earlier work (Hotchkiss, Kassis, and Moore, 1997) it was found that the rising female/male wage ratio from 1983 to 1993 was materially detrimental to the average dual earner family and roughly equivalent to the welfare loss of an hour of leisure per week. However, in

that analysis, it was also found that, due to the wage changes of this period, families in which the wife was in a higher earning category than her husband were materially better off as, of course, were also female-headed single earner households. Further analysis found that the impact from these changes differed across the income distribution (Hotchkiss and Moore, 2002). In this second analysis it was found that there were a welfare gains for the higher income group and welfare losses for the middle and lower income group with the lower group suffering the largest loss.<sup>2</sup>

The continued decline of the gender wage gap from 1994 through 2012, along with the other changes over time discussed above, begs for an updated analysis on the welfare of the average family and how family welfare might have changed across different family typologies. There is every reason to suspect that this continued wage gap decline has contributed to the growing share of households in which the wife earns more than the husband. Indeed a recent Pew report documents the growing proportion of households with "Breadwinner Moms."<sup>3</sup> Although nearly two-thirds of these households are reportedly female-headed single earner households, the remaining one-third consists of families in which the wife earns more than her husband (where both husband and wife are present). We are interested in how family welfare has changed over time in light of these developments, and in the context of which family member is the dominant earner.

Our basic question is this: Does an average 2012 family prefer the 2012 male/female real wage package or would it prefer the 2003 real wage package? We provide a similar analysis for

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<sup>2</sup> The same methodological approach was used in Hotchkiss, Moore, and Rios-Avila (2012) to evaluate the welfare impact of the 2001 U.S. income tax cut across income levels and family sizes (number of children).

<sup>3</sup> Breadwinner Moms, see: <http://www.pewsocialtrends.org/2013/05/29/breadwinner-moms/>

the period 1994 to 2003. This combined with earlier work (which covers 1983 to 1993) allows us to discuss evidence on the changes in family welfare for the entire period of 1983 to 2012.<sup>4</sup>

### III. Methodology

To obtain estimates of the changes in family welfare, family labor supply decisions are modeled in a neoclassical joint utility framework. This can be thought of as a reduced-form specification of family decision making, and it has the advantage of giving us a clear-cut expression of family welfare that allows for cross wage effects on each member's labor supply decisions, hence effectively capturing the impact of the declining wage gap (or any other wage or non-labor income changes) on married-household families. The indirect utility function can be expressed as a function of the husband's and wife's optimal labor supply equations; thus, by estimating these joint labor supply equations, we obtain the utility function parameters necessary to evaluate the level of welfare and how it changes with wage changes.

#### *A. Family Utility Framework*

The assumption of joint family utility (or, "collective" utility) is often rejected in favor of a bargaining structure to household decisions making (for example, see McElroy 1990 and Apps and Rees 2009). However, there is evidence that the choice of structure for household decision making has very little implication for conclusions in micro simulation exercises (see Bargain and Moreau 2003). In addition, Blundell et al. (2007) find that both collective and bargaining models are consistent with their household labor supply model estimated in the U.K. The joint utility framework is used here in order to evaluate welfare changes of the family (as opposed to evaluating the utility of individuals).

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<sup>4</sup> The previous analysis only considered dual-earner families, whereas the analysis in this paper allows for the presence of a non-working spouse.

Within the framework of the neoclassical family labor supply model, a family maximizes a utility function that represents the household welfare. Assuming, for simplicity, that there are only two members of the household (husband and wife), the family chooses levels of leisure for each member and a joint consumption level in order to solve the following problem:

$$\begin{aligned} \max_{(L_1, L_2, C)} U &= U(L_1, L_2, C) \\ \text{subject to } C &= w_1 h_1 + w_2 h_2 + Y . \end{aligned} \quad (1)$$

Define  $T$  as total time available for an individual;  $L_1 = T - h_1$  will be referred to as the husband's leisure, and  $L_2 = T - h_2$  will be referred to as the wife's leisure;  $h_1$  is the labor supply of the husband;  $h_2$  is the labor supply of the wife;  $C$  is total money income (or consumption with price equal to one);  $w_1$  is the husband's market wage;  $w_2$  is the wife's market wage; and  $Y$  is non-labor income. 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.<sup>5</sup>

The solution to the maximization problem in equation (1) 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:

$$\begin{aligned} V(w_1, w_2, Y) &= U\{[T - h_1^*(w_1, w_2, Y)], [T - h_2^*(w_1, w_2, Y)], \\ &\quad [w_1 h_1^*(w_1, w_2, Y) + w_2 h_2^*(w_1, w_2, Y) + Y]\} , \end{aligned} \quad (2)$$

where  $h_1^*(w_1, w_2, Y)$  and  $h_2^*(w_1, w_2, Y)$  correspond to the optimal labor supply equations (desired hours) for the husband and wife, respectively. By totally differentiating the indirect utility function, we can simulate the change in welfare that results from changes in optimal hours of

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<sup>5</sup> Apps and Rees (2009) are highly critical of family utility models that do not include measures of household production, but even they acknowledge that not much can be done without the availability of richer data (p. 108). Since the focus of the analysis in this paper is utility at the household level, the absence of home production activities is not crucial.

work and consumption in response to changes in wages and non-labor income (also see Apps and Rees 2009: 263):

$$dV = -U_1 dh_1^* - U_2 dh_2^* + U_3 dC^* , \quad (3)$$

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. Equation (3) makes it clear that the change in welfare not only depends on the individual labor supply responses, but also on the family's marginal evaluation of a change in leisure and non-labor income.

Expressed in terms of changes in wages and non-labor income, and re-arranging terms to illuminate the contribution of those changes to family welfare through their impact on husband's labor supply, wife's labor supply, and total family income, the total derivative in equation (3) becomes:

$$\begin{aligned} dV = & -U_1 \left( \frac{\partial h_1}{\partial w_1} dw_1 + \frac{\partial h_1}{\partial w_2} dw_2 + \frac{\partial h_1}{\partial Y} dY \right) \\ & -U_2 \left( \frac{\partial h_2}{\partial w_1} dw_1 + \frac{\partial h_2}{\partial w_2} dw_2 + \frac{\partial h_2}{\partial Y} dY \right) \\ & +U_3 \left[ \left( w_1 \frac{\partial h_1}{\partial w_1} + h_1 + w_2 \frac{\partial h_2}{\partial w_1} \right) dw_1 + \left( w_1 \frac{\partial h_1}{\partial w_2} + h_2 + w_2 \frac{\partial h_2}{\partial w_2} \right) dw_2 \right. \\ & \left. + \left( w_1 \frac{\partial h_1}{\partial Y} + 1 + w_2 \frac{\partial h_2}{\partial Y} \right) dY \right] . \quad (4) \end{aligned}$$

In order to construct changes in family welfare, we need to calculate changes in market wages for both husbands and wives and changes in non-labor income for the family over the time period of interest. For this, we construct average real changes in wages and non-labor income specific to the age and education of the husband and wife individually.

### *B. Estimation Issues*

The direction (sign) and magnitude of the change in utility that result from changes in the



husband's and wife's wages and family non-labor income cannot always be determined analytically; they depend on the direction of the wage changes and the size of the labor supply responses of the husband and wife to own and to spouse wage changes, as well as the relative size of the additional utility the family attains from the leisure enjoyed by the husband and wife and from changes in non-labor income.

There are many divergent empirical issues raised in the literature in relation to estimating labor supply responses to wage changes, i.e., estimates of labor supply elasticities. The goal here is to produce reasonable labor supply elasticities that are consistent with the literature. Toward that end, the methodology adopted takes the simplest approach possible while maintaining basic theoretical and empirical integrity.

The requirement of simplicity here primarily derives from the goal of quantifying the family-level utility changes from the wage and non-labor income changes. In order to obtain estimates of the pieces of the change in utility in equation (4) a specific functional form of utility must be specified. Following others (e.g., Ransom 1987, Hotchkiss et al. 1997, Heim 2009, and Hotchkiss et al. 2012), we estimate a quadratic form of the utility function:<sup>6</sup>

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

where  $Z$  is a vector with elements  $Z_1 = T - h_1$ ,  $Z_2 = T - h_2$ , and  $Z_3 = w_1 h_1 + w_2 h_2 + Y$ ;  $\alpha$  is a vector of parameters and  $B$  is a symmetric matrix of parameters. This functional form has the advantage of belonging 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  $B$  is positive definite). In addition, it is possible to produce analytical closed-form solutions for both the husband's and

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<sup>6</sup> Further details of this model are found in Appendix B.

wife's labor supply functions. Obtaining the first order conditions of this unconstrained maximization problem results in a system of equations linear in  $h$ :

$$\frac{\partial U}{\partial h_1} = \Omega_1 h_1 + \Omega_2 h_2 + \Omega_3 = 0 \quad (6)$$

$$\frac{\partial U}{\partial h_2} = \Omega_2 h_1 + \Omega_4 h_2 + \Omega_5 = 0 \quad (7)$$

This system can be solved simultaneously, and the desired hours become  $h_1^* = f(w_1, w_2, Y)$  and  $h_2^* = g(w_1, w_2, Y)$ , which represent the desired number of hours the members of a household would like to work, given the parameters that define their household utility function, given wages and non-labor income.

Observed hours ( $\tilde{h}$ ), however, might differ from the optimum hours due to stochastic errors, such that:

$$\tilde{h}_1 = \begin{cases} h_1^* + e_1 & \text{if } h_1^* + e_1 > 0 \\ 0 & \text{otherwise} \end{cases}$$

$$\tilde{h}_2 = \begin{cases} h_2^* + e_2 & \text{if } h_2^* + e_2 > 0 \\ 0 & \text{otherwise} \end{cases} \quad (8)$$

where we assume that  $(e_1, e_2)$  follows a bivariate Normal distribution with mean 0 and covariance matrix  $\Sigma$ . This model can be thought of as a simultaneous Tobit model, where we have four kinds of families: those where both spouses work, those where only one of the spouses works (2 cases), and those where neither of them work. Allowing for hours adjustment along the extensive margin for the wife when assessing labor supply responses to wage changes have been found to make a significant difference when assessing total labor supply response (for example, see Eissa et al. 2004 and Heim 2009); however, extensive margin hours adjustments appear to be unimportant for men (for example, see Blundell et al. 1988 and Heim, 2009). However, we opt for the most flexible specification, which allows for extensive margin hours adjustments for both the husband and wife.

The presence of non-working wives and husbands raises one empirical issue identified by Keane (2010) that must be addressed: market wages are not observed for family members who do not work. To obtain estimates of those wages, we take the standard approach in the literature of estimating a selectivity-corrected wage equation (Heckman 1974) on the sample of working men and women, using regressors observable for both working and nonworking individuals.<sup>7</sup> The resulting parameter estimates are then used to predict wages for nonworking men and women based on their observable characteristics.

The maximum likelihood function corresponding to the joint labor supply optimization problem can be written as follows:

$$\begin{aligned}
L = & \prod_{i=1}^N \left[ \left( \frac{1}{\sigma_1 \sigma_2} \right) \psi \left( \frac{\tilde{h}_1 - h_1^*}{\sigma_1}, \frac{\tilde{h}_2 - h_2^*}{\sigma_2}, \rho \right) \right]^{(H=1, W=1)} \\
& * \left[ \frac{1}{\sigma_1} \varphi \left( \frac{\tilde{h}_1 - h_1^*}{\sigma_1} \right) \left\{ 1 - \Phi \left( \frac{\sigma_1 h_2^* - \rho \sigma_2 (\tilde{h}_1 - h_1^*)}{\sigma_2 \sigma_1 \sqrt{1 - \rho^2}} \right) \right\} \right]^{(H=1, W=0)} \\
& * \left[ \frac{1}{\sigma_2} \varphi \left( \frac{\tilde{h}_2 - h_2^*}{\sigma_2} \right) \left\{ 1 - \Phi \left( \frac{\sigma_2 h_1^* - \rho \sigma_1 (\tilde{h}_2 - h_2^*)}{\sigma_2 \sigma_1 \sqrt{1 - \rho^2}} \right) \right\} \right]^{(H=0, W=1)} \\
& * \Psi \left( \frac{-h_1^*}{\sigma_1}, \frac{-h_2^*}{\sigma_2}, \rho \right)^{(H=0, W=0)}
\end{aligned} \tag{9}$$

Where  $\varphi$  and  $\Phi$  correspond to the probability density and cumulative distribution functions of a univariate normal, and  $\psi$  and  $\Psi$  represent the probability density and cumulative distribution functions of the bivariate normal. Also,  $H=1$  if the husband is working and  $W=1$  if the wife is working (0 otherwise),  $\sigma_i$  ( $i=1,2$ ) represents the standard deviations of  $(e_1, e_2)$  and  $\rho$  is the correlation between the stochastic errors.

The stochastic errors accounted for in equation (8) represent errors in optimization -- observed hours do not exactly reflect desired hours. Keane (2010) points out that there may exist

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<sup>7</sup> For purposes of identification, the Heckman selection equation uses non-labor income, number of children in the household, and spouse education as exclusion restriction variables.

measurement error in observed wages and non-labor income. This classical measurement error may bias elasticity estimates toward zero. Heim (2009), using a methodology most similar to the one used here, presents results showing that accounting for measurement error produces elasticities practically identical to when it is not accounted for. A typical strategy to mitigate the introduction of measurement error on wages per hour has been to restrict the sample to hourly paid workers. Unfortunately, this estimation strategy requires a lot of the data and is just not estimable with the restricted sample size of hourly workers only. Instead, if the person is not paid by the hour, we use information available about usual weekly earnings (including business income for the self-employed) and usual hours worked per week. This means our wage estimate might suffer from what Keane refers to as "denominator bias," which will have the tendency of biasing labor supply elasticities downward.

Keane (2010) also identifies two potential sources of endogeneity. First, it is reasonable to expect that observed wages and non-labor income are correlated with a person's taste for work (reflected through hours of work). Both fixed effects and instrumental variables have been used to resolve this issue but are simply not possible in this case since we do not have panel data and because of the non-linear nature of the labor supply functions to be estimated. In addition to the inclusion of variables expected to affect the taste for work (e.g., children), we expect that the inclusion of spousal variables (through the estimation of joint labor supply) will help to remove additional sources of correlation from the error term (i.e., because of positive assortative mating, people with similar taste for work will be married to each other; see Lam 1988 and Hernstein and Murray 1994). In addition, we abstract from the implications of income taxes for the shape of the budget constraint, which amounts to "linearizing" the budget constraint (see Hall 1970), and is

valid if preferences are strictly convex.<sup>8</sup> Also, since we are focusing on the impact of relatively small changes in real wages and real non-labor income, this assumption will only have implications for those few families for which the changes mean a movement across tax brackets.

An additional concern Keane (2010) identifies in the literature is making sure the hours/wage combinations observed in the data are coming off workers' labor supply curve, rather than off employers' labor demand curve. Identification of the labor supply relationship boils down to including regressors (determinants of hours) that reflect the demand for a person's skills (thus determine the observed wage) that are not reflective of that person's taste for work. Toward that end, we include an indicator for race that could affect observed wage through employer discrimination, but, *ceteris paribus* should not affect taste for work.

Further, we only marginally control for the presence of fixed costs of working raised by Apps and Rees (2009) by including the presence of children in the determination of hours. However, Heim (2009) presents results showing that once demographics are controlled for, additional consideration of fixed costs only very slightly impacts estimates of the parameters of the utility function (Heim, Table 3).

#### IV. Data

The Current Population Survey (CPS) is administered by the U.S. Bureau of Labor Statistics each month to roughly 60,000 households. The survey has a longitudinal aspect in that households are interviewed for four consecutive months, not interviewed for eight months, then interviewed again for four months. Households, families, and individuals can be matched across these survey months if they remain in the same physical location. In survey months four and

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<sup>8</sup> This assumption of strictly convex preferences is supported by a positive definite B matrix. As it will be seen, all the eigenvalues of the estimated B matrices are positive, indicating the matrix itself is positive definite.

eight, the household is said to be in the "outgoing rotation" group and members of the household are asked more detailed questions about their labor market experience, such as wages and hours of work.

We make use of the CPS outgoing rotation groups in March, April, May, and June from 2012 and 2003 in order to construct the samples for which the family labor supply model is estimated at each time period's end point. Detailed non-labor income is obtained by matching each family to the March supplement, which is the month in which this information is collected. Multiple months of outgoing rotation groups are used in order to expand the sample size. We restrict the sample in the following ways:

- include only households with husband and wife present and between 18-64 years of age
- households with unmarried same- or opposite sex adults/partners are excluded
- exclude observations whose reported non-zero wages are in the bottom or top one percent
- exclude observations whose reported hours are greater than 100 per week
- exclude observations with zero hours of work but positive wages
- exclude families with self-employed members<sup>9</sup>

Based on husbands' and wives' hourly wages, families are placed in one of three groups: (1) husband and wife have similar wages (within 0.2 log points, or 20 percent, of one another), (2) the husband's wage is greater (0.2 log points higher) than his wife's wages, and (3) the wife's wage is greater (0.2 log points higher) than her husband's wage.<sup>10</sup> Separate utility function parameters are estimated for families in each of these groups, as we would expect relative marginal utilities to differ depending on which member earns more. For those cases where husband or wife is not working, their imputed wages are used to classify them with respect to the

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<sup>9</sup> It is difficult to estimate market hourly earnings (wage) for someone who is self-employed. Given the nature of their activities, in a short period of time, reported earnings can be negative, even if, in the long term, the market value of a self-employed worker's time would be positive. The welfare gains of the self-employed are left for future work.

<sup>10</sup> Using wage differentials between husband and wife of 0.15 and 0.25 log points resulted in practically identical results and conclusions.

three family types. Wages and non-labor income are in values, reflecting the end-point of each decade.

The first half of Table 1 contains selected sample averages across family types for the two years used for estimation. As expected, labor supply is lower for both husbands and wives across all family types in 2012 and 2003.<sup>11</sup> Families in which the wife earns the higher wage have the fewest children; the highest non-labor income; and the highest education, wages, and age among wives. Comparison of the raw sample average wages (w1 and w2) with the estimated changes in wages used for the simulation (dw1 and dw2), which are estimated wage changes based on a family member's age and education, illustrate the finding in Rios-Avila and Hotchkiss (2014) -- much of the observed raw average wage growth over this time period was the result of the aging and the rising education level of the workforce. Generally, real wages and non-labor income were rising in the 1990s (more so for women, as mentioned earlier) and declining in the 2000s (less so for women).

[Table 1 about here]

## V. Results

The maximum likelihood estimates are reported in Appendix A. The labor supply parameter estimates are as expected. For example, across all family types, hours increase at a decreasing rate with age (for men and for women in the full sample and where the husband earns a higher wage); the presence of children increases the labor supply of husbands (when significantly different from zero), but decreases labor supply of wives; black husbands work fewer hours and black wives work more hours (than their white counter-parts); and hours of work is generally increasing in education for the family member earning the lesser amount.

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<sup>11</sup> See Hotchkiss and Rios-Avila (2013) for an analysis of the decline in labor force participation over this time period.

The estimated marginal utilities and labor supply elasticities of interest are shown in the bottom half of Table 1. The family's marginal utility of the husband's leisure is larger than the family's marginal utility of the wife's leisure, reflecting the fact that regardless of family type, the husband is working a greater number of hours, on average, than the wife. In addition, the marginal utility of income is lowest among families where the wife earns a higher wage (in both time periods). As expected, income elasticities (on both the intensive and extensive margins) are negative for both husbands and wives; cross-wage (intensive-margin) elasticities are negative, except in a couple instances of the wife's cross-participation wage elasticity; and own wage elasticities (both intensive and extensive) are positive, except for a couple of instances for the husband in the earlier time period, when his own intensive-margin wage elasticity is a very small negative number.

The estimated own wage hours elasticities for husbands are consistent with estimates reported by Kaiser et al (1992) for Germany; and Ransom (1987), MaCurdy et al. (1990), and Pecanvel (2002) using U.S. data.<sup>12</sup> In addition, the estimates for wives' labor supply elasticities are mostly within the range reported in the literature using U.S. data. For example, the range of estimates found in Cogan (1981), Hausman (1981), Triest (1990), Ransom (1987), Hotchkiss et al. (1997), and Blau and Kahn (2005) is 0.12 to 0.97.<sup>13</sup> Furthermore, the estimated negative cross-wage elasticities across all family types indicate that husbands and wives view their leisure time as substitutes; this is consistent with cross-elasticities estimated in Hotchkiss et al. (2014), Hotchkiss et al. (2012), Heim (2009), Ransom (1987). The following sections discuss how these

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<sup>12</sup> Similar to Ransom (1987), while the uncompensated wage elasticity can be negative, the corresponding compensated own wage elasticity for husbands is always positive.

<sup>13</sup> Also see Killingsworth (1983:107).



estimation results and changes in wages and non-labor income translate into changes in family welfare over time.

*A. Changes in Family Welfare, 1994-2003*

With regard to changes in family welfare, the results for the two different time periods are dramatically different from one another. These changes are illustrated in Figure 4. The 1994-2003 period is characterized by generally rising wages and non-labor incomes with the female wage rising more than the male wage for both the full sample and all sub groups (see Table 1). In the full sample, unsurprisingly, this leads to a significant rise in family welfare equivalent to about \$204 per week for the average family (in 2012 dollars). This indicates that the average 2003 family is better off with the 2003 wage and non-labor income package than it would have been with the 1994 wage and income package.

We divide the sample into three sub groups: families where the husband earns a higher wage, families where the wife earns a higher wage, and families where the husbands' and wives' wages are similar. The group with the largest dollar equivalent welfare gain during this period was the group in which the wives earned more than their husbands. Their typical family rise in welfare was equivalent to about \$254 per week. The families in which husbands and wives have similar earnings had the next largest welfare gain equivalent to \$212 per week, while the group in which husbands earn more come in at \$197, which is still a substantial welfare gain. In short, the period from 1994-2003 was good for all family types considered, but families in which women earned more than their husbands experienced the greatest improvement in welfare.<sup>14</sup>

[Figure 4 about here]

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<sup>14</sup> All of these welfare gains are statistically significantly different from zero, as well as being statistically significantly different from one another based on a standard Z-test.

To isolate the impact of the rising female/male wage ratio we also calculate the welfare change holding non-labor income constant. This amounts to setting all  $dY$  terms in equation (4) to zero and re-calculating  $dV$ . This separates the impact of wage changes on family welfare and illustrates that the wage changes alone had a smaller impact on family welfare compared to the non-labor income changes. For the typical family in the full sample, the wage changes for this period were responsible for approximately 36% ( $\$74/\$204$ ) of the welfare change, implying that the larger share of the welfare gain was due to non-labor income increases.

The ordinal ranking of welfare changes of the sub groups was not changed by setting non-labor income to zero. In the group in which the wife has the higher wage, the wage change only welfare gain was equivalent to \$94 (37% of the total gain for that family type), for the wife and husband similar earnings group it was \$87 (41% of the gain), and for the husband high earner group it was \$67 (34% of the gain).

#### *B. Changes in Family Welfare, 2003-2012*

While average real hourly wages are modestly rising during this later period, once we control for age and experience, the calculated real wage changes for men and women are mostly negative (see Table 1, and Hotchkiss and Rios-Avila 2014 for an illustration of this phenomenon more generally). The exception is that the calculated wage change for women in families where they earn a higher wage than their husbands is positive. In the full sample, with the larger wage decline being for males, the female/male wage ratio continues to rise during this period. This, along with the declining non-labor income results in declines in calculated family welfare for the full sample of about \$105 per week (also in 2012 dollars). In this period, the welfare loss to families in which the husband was the higher wage earner was slightly less (at \$102 per week) than for those in which the spouses wages are similar (at \$109 per week) or those in which the

wife was the higher wage earner (at \$111 per week). Regardless of subgroup, all families experience welfare losses that fit within a fairly narrow band of \$102-\$111 per week. These differences are substantively rather small, although they are statistically different from one another, based on a standard z-test.

As with the earlier time period, we set non-labor income to zero ( $dY=0$  in equation 4) in order to isolate the impact of wage changes alone. For the full sample, wage changes alone only account for 10% ( $\$11/\$105$ ) of the welfare decline. Families were much more negatively impacted during this period by non-labor income changes than by wage changes. When we look at the three subgroups holding non-labor income to zero, we find, not surprisingly, that families in which the wife earns more than the husband experience the smallest welfare decline (due to the modestly increasing female wage for this group). This group's welfare loss from wage changes alone only amounts to the equivalent of a little more than \$2 per week or about 2% of its total welfare loss, although this amount is not statistically significantly different from zero. The group in which husbands are the high earner had the second smallest dollar equivalent welfare loss from wage changes, about \$8 per week or 8% of the total welfare decline during the period. The group in which the husbands' and wives' earnings were similar suffered the largest loss due to wage changes at about \$15/week, which amounted to about 14% of this group's welfare decline.

Based on our results from the full sample and all three subgroups, the typical 2012 family would be better off if it had the 2003 wage and non-labor income package available to it in 2012. Even if they could get just the 2003 wage package (holding non-labor income constant), they would be modestly better off than they were with the 2012 wage package. In short, this time period has been one of declining material well-being for families.

## VI. Conclusion

Our findings confirm that even though these two time periods (1994-2003 and 2003-2012) are in many ways different, the continued closing of the female/male wage gap has allowed families in which the wife earns a higher wage than her husband to fare relatively better, in terms of welfare improvements over time due to these wage changes, than families in which the husband and wife have similar wages or those in which the husband earns the higher wage. However, in the latter period, families in which the wife had the higher wage lost more ground due to non-labor income losses than families in which the husband earned more.

The 1994-2003 period, being one of generally rising wages and non-labor income, allowed all families to experience welfare gains. By contrast, the predominantly declining wages and non-labor income of the 2003-2012 period left all families worse off, as would be expected. And, unlike the earlier time period, which family member earned the higher wage didn't make as much of a difference in the dollar equivalent loss in welfare.

Looking at our results along with those found for the 1983-1993 period in Hotchkiss, Kassis, and Moore (1997) we find that the material well being of the American family has been in decline for two-thirds of the entire period of 1983-2012.<sup>15</sup> The expansion of the 1990's, captured in our data in the 1994-2003 period, was the only period in recent decades in which the American family has experienced material welfare gains from changes in wages and non-labor income. No matter a person's political leaning, this can't be good news. Across all three time periods, change in non-labor income only exacerbates the impact of changes in wages. This means that for the majority of the time period, and for the majority of families, since the early eighties, real wage declines have significantly negatively impacted family welfare. If we are

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<sup>15</sup> Hotchkiss and Moore (2002) found a modest rise in welfare during the 1980s among families in the very top of the income distribution.

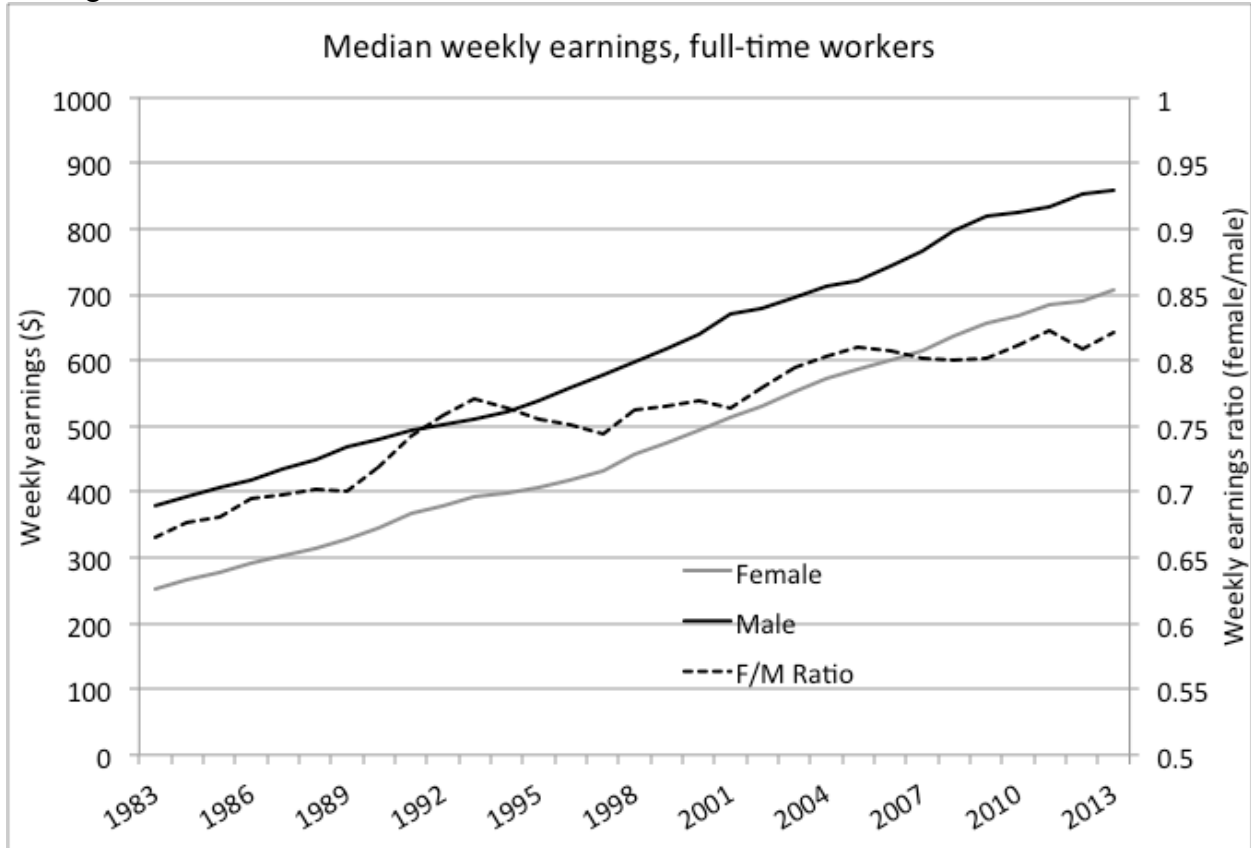
concerned about the welfare of working families, considerable effort needs to be undertaken to identify the cause of declining real wages in the American labor force.

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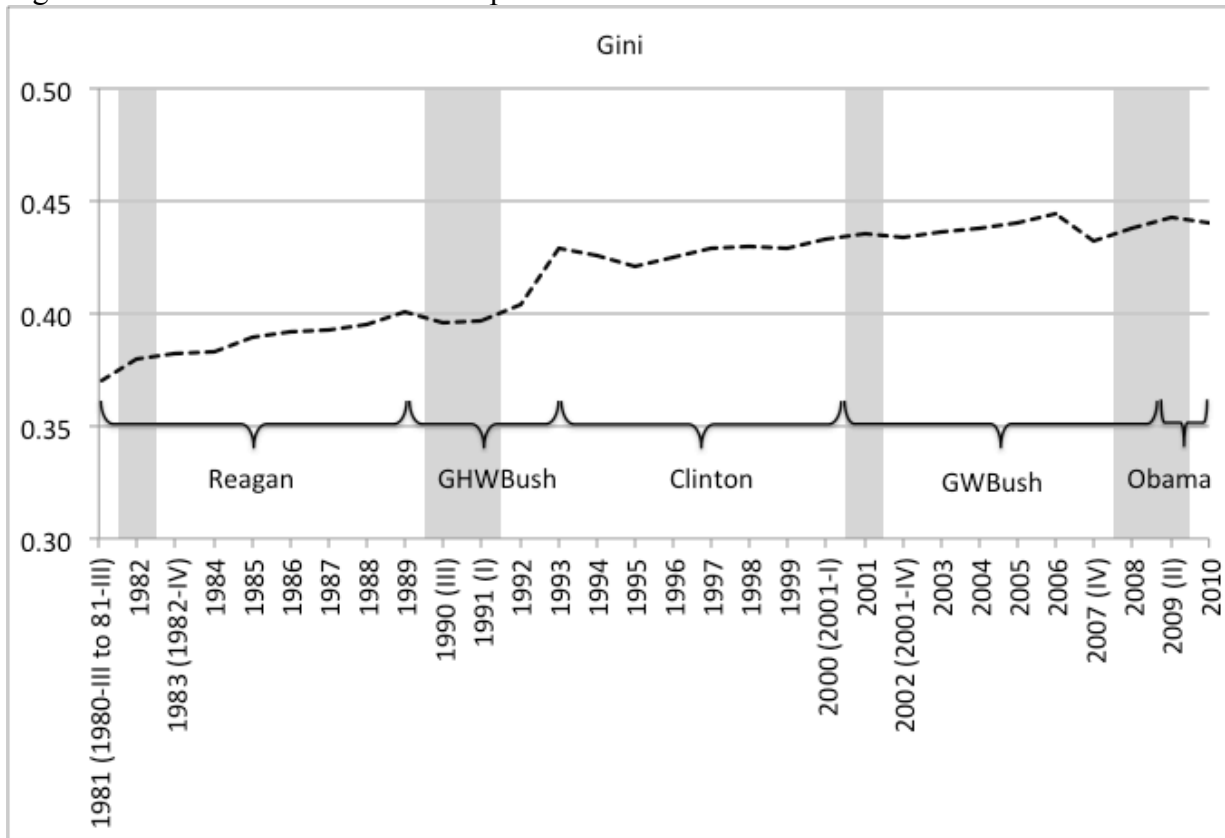
Figure 1. Median male and female weekly earnings of full-time workers and the female/male earnings ratio.



Note: Authors' calculations, U.S. Bureau of Labor Statistics, Current Population Survey (<http://www.bls.gov/cps/earnings.htm#demographics>)

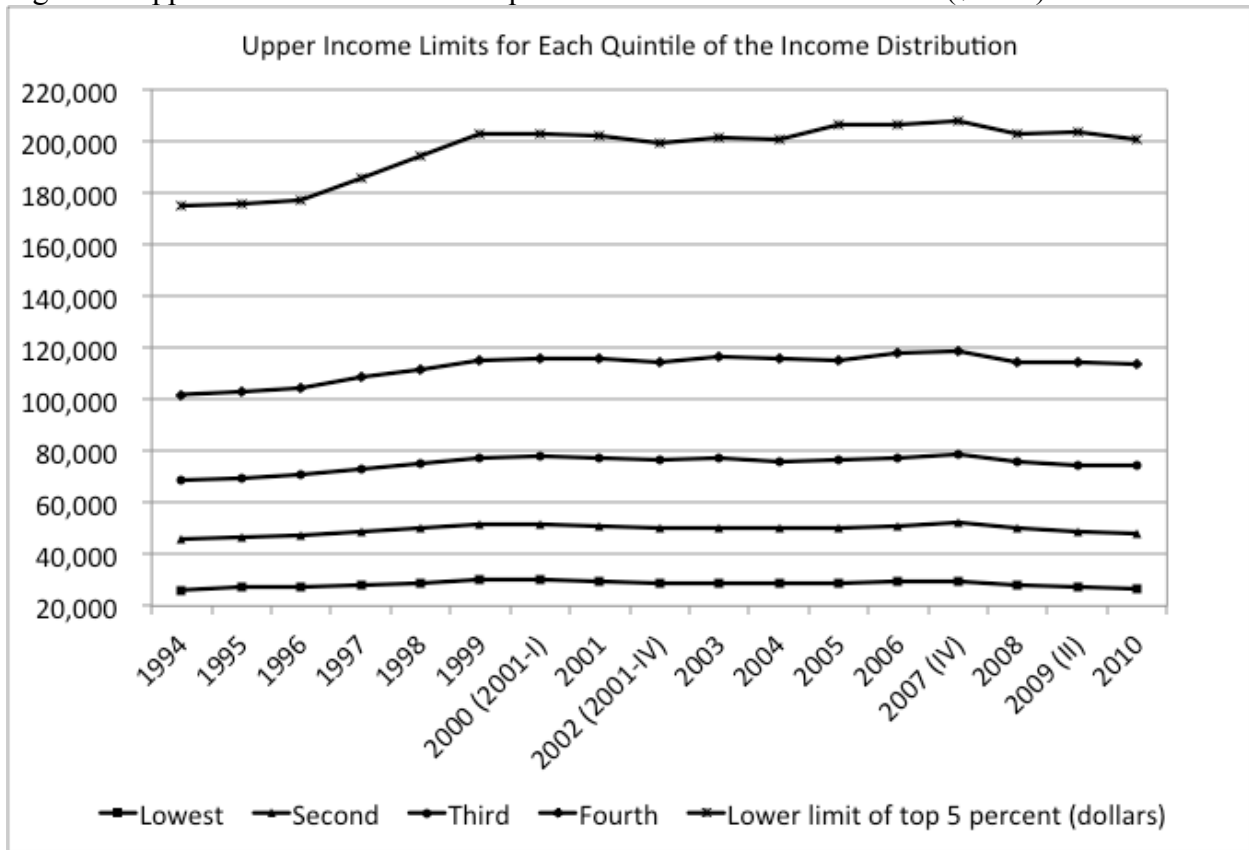


Figure 2. Gini coefficient and federal political administrations.



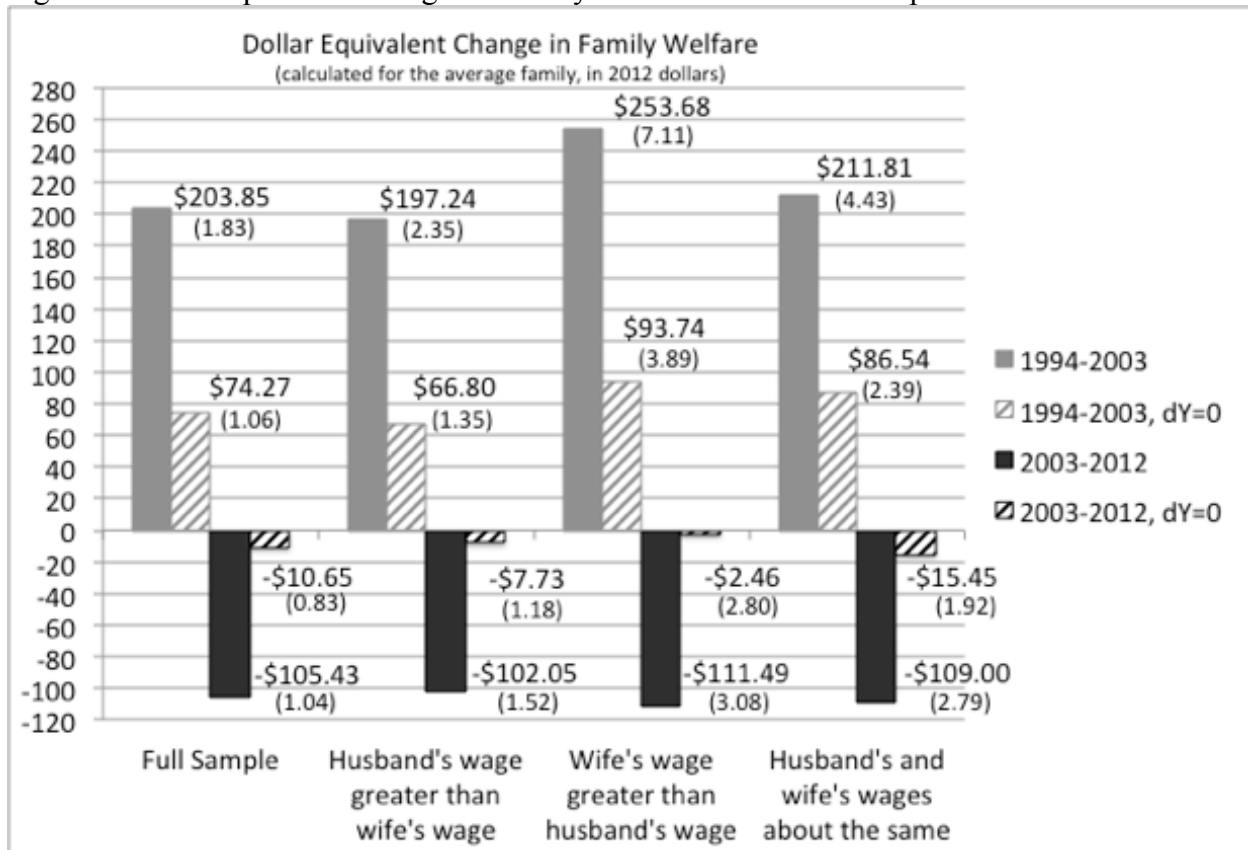
Notes: Shaded bars reflect recessionary periods. Authors' calculations from aggregate data reported by the U.S. Census Bureau, <http://www.census.gov/hhes/www/income/index.html>

Figure 3. Upper income limit for each quintile of the income distribution (\$2010).



Notes: From the U.S. Census Bureau, <http://www.census.gov/hhes/www/income/index.html>.

Figure 4. Dollar equivalent changes in family welfare across two time periods.



Note: Husband and wife have similar wages means they are within 0.2 log points of one another; the husband's wage being greater (less than) the wife's wage means that his wage is more (less) than 0.2 log points of his wife's wage. Bootstrapped (250 iterations) standard errors in parentheses.

Table 1. Estimated utility function parameters and labor supply elasticities.

	2003				2012			
	Full Sample	Husband wage > wife wage	Wife wage > husband wage	Similar wages	Full Sample	Husband wage > wife wage	Wife wage > husband wage	Similar wages
<i>Husband Average Characteristics</i>								
Husband working = 1	0.79	0.81	0.73	0.78	0.78	0.80	0.73	0.77
Husband wage (w1), incl. imputed	23.40	27.13	15.27	19.17	24.31	28.24	16.17	19.99
Husband hours (h1), if working	42.76	43.07	42.16	42.58	42.52	42.89	41.73	42.43
Husband age	44.63	44.37	46.17	44.28	46.28	46.03	47.31	46.14
Husband black = 1	0.06	0.05	0.09	0.08	0.07	0.05	0.10	0.09
Husband college graduate = 1	0.32	0.36	0.26	0.27	0.36	0.41	0.28	0.31
<i>Wife Average Characteristics</i>								
Wife working = 1	0.65	0.54	0.88	0.79	0.64	0.53	0.87	0.75
Wife wage (w2), incl. imputed	16.34	12.81	26.35	18.83	17.30	13.33	28.17	19.62
Wife hours (h2), if working	36.74	35.18	38.72	38.25	37.04	35.64	38.77	38.40
Wife age	42.51	42.31	43.81	42.20	44.34	44.15	45.35	44.08
Wife black = 1	0.06	0.04	0.08	0.07	0.06	0.04	0.09	0.08
Wife college graduate = 1	0.30	0.25	0.45	0.33	0.38	0.32	0.56	0.41
<i>Family Average Characteristics</i>								
Family non-labor income (Y)	651.31	587.90	989.28	591.03	625.31	642.18	668.63	546.83
Number of children less than 18	1.03	1.14	0.81	0.91	0.97	1.07	0.77	0.84
Number of families	16,606	10,097	2,593	3,916	16,644	10,045	2,861	3,738
Change in husband's wage (dw1)	\$1.08	\$1.25	\$0.73	\$0.87	-\$0.24	-\$0.17	-\$0.36	-\$0.35
Change in wife's wage (dw2)	\$1.27	\$1.22	\$1.41	\$1.29	-\$0.16	-\$0.27	\$0.22	-\$0.15
Change in family non-labor income (dY)	\$101.94	\$101.47	\$114.56	\$94.81	-\$92.99	-\$91.28	-\$102.56	-\$90.25
Husband own wage elasticity	0.1841	0.3163	-0.0020	-0.0028	0.1807	0.3103	0.0110	0.0226
Husband cross wage elasticity	-0.0471	-0.0269	-0.0331	-0.0361	-0.0428	-0.0148	-0.0276	-0.0154
Husband income elasticity	-0.0140	-0.0143	-0.0185	-0.0266	-0.0121	-0.0119	-0.0121	-0.0169
Husband participation own wage elasticity	0.0659	0.0930	0.0064	0.0090	0.0689	0.0967	0.0123	0.0177
Husband participation cross wage elasticity	-0.0132	-0.0034	-0.0142	-0.0052	-0.0130	-0.0012	-0.0127	0.0022
Husband participation income elasticity	-0.0141	-0.0129	-0.0304	-0.0344	-0.0124	-0.0121	-0.0166	-0.0208
Wife own wage elasticity	0.4699	0.3758	0.3796	0.4539	0.4034	0.2606	0.4048	0.3995

	2003				2012			
	Full Sample	Husband wage > wife wage	Wife wage > husband wage	Similar wages	Full Sample	Husband wage > wife wage	Wife wage > husband wage	Similar wages
Wife cross wage elasticity	-0.0957	-0.1119	-0.0117	-0.0358	-0.0757	-0.0696	-0.0085	-0.0145
Wife income elasticity	-0.0274	-0.0260	-0.0192	-0.0269	-0.0194	-0.0220	-0.0063	-0.0132
Wife participation own wage elasticity	0.3049	0.4063	0.0458	0.1674	0.2721	0.2872	0.0476	0.1864
Wife participation cross wage elasticity	-0.0636	-0.1088	-0.0004	0.0011	-0.0529	-0.0671	0.0001	0.0066
Wife participation income elasticity	-0.0474	-0.0792	-0.0108	-0.0273	-0.0352	-0.0628	-0.0007	-0.0138
MU wrt husband's leisure	14.58	21.41	5.15	5.23	14.30	20.10	5.68	5.91
MU wrt wife's leisure	10.55	13.87	1.53	2.68	10.66	14.70	2.52	3.40
MU wrt income	0.65	0.90	0.08	0.18	0.48	0.64	0.09	0.17

Notes: Dollar values are in real 2012 dollars for comparison. Simulated change in wages are gender, age, and education specific and correspond to wage changes from 1994 to 2003 and from 2003 to 2012. Husband and wife have similar wages means they are within 0.2 log points of one another; the husband's wage being greater (less than) the wife's wage means that his wage is more (less) than 0.2 log points of his wife's wage.

## Appendix A. Maximum Likelihood Utility Parameter Estimates

Variable	1994-2003				2003-2012			
	Full Sample	Husband wage > wife wage	Wife wage > husband wage	Similar wages	Full Sample	Husband wage > wife wage	Wife wage > husband wage	Similar wages
a1								
black1	-3.2456	-2.2784	-7.1910	-4.8746	-3.5641	0.6911	-5.1872	-10.8927
	(0.0001)	(0.0475)	(0.0001)	(0.0010)	(0.0000)	(0.5472)	(0.0021)	(0.0000)
lesshs1	-3.9655	0.3099	-12.7665	-8.2684	-4.5014	0.6149	-16.3253	-7.9051
	(0.0000)	(0.7279)	(0.0000)	(0.0000)	(0.0000)	(0.5321)	(0.0000)	(0.0000)
scoll1	1.4263	0.4383	2.8021	2.3827	1.8812	-0.8477	3.7978	4.5099
	(0.0047)	(0.5065)	(0.0306)	(0.0136)	(0.0004)	(0.2262)	(0.0025)	(0.0000)
coll1a	3.2847	-1.6815	10.8704	11.4204	4.1240	-1.8824	10.7849	12.0771
	(0.0000)	(0.0182)	(0.0000)	(0.0000)	(0.0000)	(0.0119)	(0.0000)	(0.0000)
age1	2.3701	0.9858	5.3845	3.5673	2.2045	0.6226	4.9475	3.8611
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0061)	(0.0000)	(0.0000)
age1sq	-0.0328	-0.0157	-0.0687	-0.0469	-0.0296	-0.0102	-0.0620	-0.0490
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.0000)	(0.0000)
nkids	0.0099	0.2577	0.1747	1.1285	0.4240	0.9774	0.7206	0.4763
	(0.9590)	(0.2971)	(0.7527)	(0.0070)	(0.0307)	(0.0001)	(0.1858)	(0.2789)
preschl	-0.3696	1.0935	1.1859	-1.9365	1.5184	2.8147	1.8352	-0.4293
	(0.7371)	(0.3924)	(0.7408)	(0.4421)	(0.1939)	(0.0460)	(0.5711)	(0.8610)
_cons	-15.0516	5.7135	-67.0543	-32.2682	-14.9489	10.4299	-64.1573	-43.6644
	(0.0000)	(0.1764)	(0.0000)	(0.0000)	(0.0000)	(0.0268)	(0.0000)	(0.0000)
a2								
black2	0.8486	2.9894	-0.0394	0.0875	0.4236	1.9821	0.1173	0.3685
	(0.0124)	(0.0000)	(0.7951)	(0.6163)	(0.2462)	(0.0290)	(0.5264)	(0.2040)
lesshs2	-1.9835	-4.4087	0.6884	1.6585	-3.6417	-9.6145	1.3691	1.9076
	(0.0000)	(0.0000)	(0.0059)	(0.0000)	(0.0000)	(0.0000)	(0.0034)	(0.0083)
scoll2	-0.0853	0.8421	-0.5827	-0.5149	0.5465	2.7243	-0.7473	-1.0043
	(0.6614)	(0.0229)	(0.0001)	(0.0003)	(0.0199)	(0.0000)	(0.0019)	(0.0058)
coll2a	-1.4228	-0.9248	-0.9359	-0.9315	-0.4499	2.1631	-1.3515	-1.6168
	(0.0000)	(0.0313)	(0.0000)	(0.0000)	(0.0728)	(0.0013)	(0.0002)	(0.0043)
age2	0.7273	1.5566	-0.0585	-0.1709	0.7819	2.0823	-0.0820	-0.2002
	(0.0000)	(0.0000)	(0.1202)	(0.0004)	(0.0000)	(0.0000)	(0.1054)	(0.0242)
age2sq	-0.0102	-0.0209	0.0007	0.0019	-0.0105	-0.0264	0.0009	0.0022
	(0.0000)	(0.0000)	(0.1430)	(0.0007)	(0.0000)	(0.0000)	(0.1437)	(0.0313)
nkids	-1.3162	-2.3409	-0.0740	-0.1562	-1.2182	-2.5888	-0.0865	-0.1731
	(0.0000)	(0.0000)	(0.1073)	(0.0073)	(0.0000)	(0.0000)	(0.1680)	(0.0730)
preschl	-3.7114	-6.1503	-0.2911	-0.1484	-2.4551	-4.5131	-0.6088	-0.8956
	(0.0000)	(0.0000)	(0.3090)	(0.6034)	(0.0000)	(0.0001)	(0.1048)	(0.0799)

Variable	1994-2003				2003-2012			
	Full Sample	Husband wage > wife wage	Wife wage > husband wage	Similar wages	Full Sample	Husband wage > wife wage	Wife wage > husband wage	Similar wages
_cons	-10.1085	-27.7254	2.5560	0.9465	-11.5103	-38.9074	4.2767	2.6211
	(0.0000)	(0.0000)	(0.0047)	(0.2597)	(0.0000)	(0.0000)	(0.0040)	(0.1314)
a3								
_cons	0.7994	1.0424	0.1537	0.3768	0.5734	0.7268	0.1410	0.2694
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
b12								
_cons	0.0014	-0.0468	-0.0591	-0.1236	0.0044	-0.0619	-0.0501	-0.1205
	(0.8709)	(0.0042)	(0.0000)	(0.0000)	(0.6385)	(0.0041)	(0.0000)	(0.0002)
b13								
_cons	-0.0018	-0.0024	-0.0022	-0.0046	-0.0013	-0.0016	-0.0013	-0.0023
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
b22								
_cons	0.3485	0.4038	0.1205	0.1366	0.3810	0.5228	0.1703	0.1749
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0051)
b23								
_cons	-0.0009	-0.0021	0.0000	0.0003	-0.0007	-0.0017	0.0001	0.0002
	(0.0000)	(0.0000)	(0.4966)	(0.0224)	(0.0000)	(0.0000)	(0.0346)	(0.0598)
b33								
_cons	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	(0.0000)	(0.2544)	(0.1347)	(0.0000)	(0.0000)	(0.9784)	(0.0069)	(0.0043)
drho								
_cons	0.1827	0.1940	0.0259	0.2174	0.1594	0.1767	0.0148	0.2030
	(0.0000)	(0.0000)	(0.4333)	(0.0000)	(0.0000)	(0.0000)	(0.6347)	(0.0000)
s1								
_cons	22.7595	21.7384	24.8746	22.5914	23.3363	22.4803	24.8770	22.8681
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
s2								
_cons	24.5969	29.3450	15.9513	19.0752	25.4780	30.3543	16.0057	21.2581
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Statistics	-3.2456	-2.2784	-7.1910	-4.8746	-3.5641	0.6911	-5.1872	-10.8927
ll	(0.0001)	(0.0475)	(0.0001)	(0.0010)	(0.0000)	(0.5472)	(0.0021)	(0.0000)
N	-3.9655	0.3099	-12.7665	-8.2684	-4.5014	0.6149	-16.3253	-7.9051

Notes: P-values below parameter estimate. Husband and wife have similar wages means they are within 0.2 log points of one another; the husband's wage being greater (less than) the wife's wage means that his wage is more (less) than 0.2 log points of his wife's wage.

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

The quadratic functional form as presented in equation (5) in the text can also be written in the following form:

$$U(Z) = a_1(L_1) + a_2(L_2) + a_3(C) - \frac{1}{2}b_{11}(L_1)^2 - \frac{1}{2}b_{22}(L_2)^2 - \frac{1}{2}b_{33}(C)^2 - b_{12}L_1L_2 - b_{13}L_1C - b_{23}L_2C \quad (B1)$$

Where  $L_1 = T - h_1$ ;  $L_2 = T - h_2$ ; and,  $C = w_1h_1 + w_2h_2 + Y$

This becomes an unconstrained utility maximization problem which depends on the working hours  $h_1$  and  $h_2$ , assuming that  $Y$  (non-labor income) is exogenous. The corresponding first order conditions become:

$$\frac{\partial u}{\partial h_1} = a_1^* + a_3^*w_1 - b_{11}h_1 - b_{33}w_1(w_1h_1 + w_2h_2 + Y) - b_{12}h_2 + b_{13}(2w_1h_1 + w_2h_2 + Y) + b_{23}w_1h_2 = 0 \quad (B2)$$

$$\frac{\partial u}{\partial h_2} = a_2^* + a_3^*w_2 - b_{22}h_2 - b_{33}w_2(w_1h_1 + w_2h_2 + Y) - b_{12}h_1 + b_{23}(w_1h_1 + 2w_2h_2 + Y) + b_{13}w_2h_1 = 0 \quad (B3)$$

There is no need to specify a time endowment ( $T$ ) in order to estimate the labor supply functions because  $a_1^*$ ,  $a_2^*$ , and  $a_3^*$  are re-parameterized functions of  $T$  and  $Y$ . 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,

$$a_1^* = X_1\Gamma_1 \quad \text{and} \quad a_2^* = X_2\Gamma_2$$

where  $X_1$  and  $X_2$  are vectors of individual and family characteristics and  $\Gamma_1$  and  $\Gamma_2$  are parameters to be estimated.

Using equations (B2) and (B3), we can solve the system obtaining the values of  $h_1$  and  $h_2$  that maximize the utility function, in the following way:

$$\Omega_1h_1^* + \Omega_2h_2^* + \Omega_3 = 0 \quad (B4)$$

$$\Omega_2h_1^* + \Omega_4h_2^* + \Omega_5 = 0 \quad (B5)$$

Where:



$$\Omega_1 = 2b_{13}w_1 - b_{11} - b_{33}w_1^2; \quad (\text{B6})$$

$$\Omega_2 = b_{23}w_1 + b_{33}w_1w_2 - b_{12} + b_{13}w_2; \quad (\text{B7})$$

$$\Omega_3 = a^*_1 + a^*_3w_1 + (b_{33}w_1 + b_{13})Y; \quad (\text{B8})$$

$$\Omega_4 = 2b_{23}w_2 - b_{22} - b_{33}w_2^2; \text{ and} \quad (\text{B9})$$

$$\Omega_5 = a^*_2 + a^*_3w_2 + (b_{33}w_2 + b_{23})Y. \quad (\text{B10})$$

From equations (B4) and (B5), the solutions for  $h_1^*$  and  $h_2^*$  become:

$$h_1^* = \frac{\Omega_3\Omega_4 - \Omega_2\Omega_5}{\Omega_2^2 - \Omega_1\Omega_4} \quad (\text{B11})$$

$$h_2^* = \frac{\Omega_1\Omega_5 - \Omega_2\Omega_3}{\Omega_2^2 - \Omega_1\Omega_4} \quad (\text{B12})$$

Observed hours ( $\tilde{h}$ ), however, can differ from optimum hours due to stochastic errors, such that:

$$\tilde{h}_1 = \begin{cases} h_1^* + e_1 & \text{if } h_1^* + e_1 > 0 \\ 0 & \text{otherwise} \end{cases} \quad (\text{B13})$$

$$\tilde{h}_2 = \begin{cases} h_2^* + e_2 & \text{if } h_2^* + e_2 > 0 \\ 0 & \text{otherwise} \end{cases}, \quad (\text{B14})$$

where we assume that  $(e_1, e_2)$  follows a bivariate normal distribution with mean 0 and covariance  $\Sigma$ . This model can be considered a simultaneous Tobit model, where both variables are censored from below.

In order to calculate the new optimal hours (post-recession, see equation 4 in the text), we require expressions for the partial derivatives of the labor supply equations (equations B11 and B12) with respect to  $w_1$ ,  $w_2$ , and  $Y$ . These functions are differentiated accordingly, with the help of Mathematica® (Wolfram Research, version 8). Since we specify a censored error distribution through estimation of a bivariate Tobit, the derivatives and hour predictions are adjusted following Muthen (1990), and then evaluated for each family. Only the averaged elasticity values are presented.

For the case of single headed households, the corresponding quadratic utility form can be simplified to:

$$U(Z) = a_1(L_1) + a_3(C) - \frac{1}{2}b_{11}(L_1)^2 - \frac{1}{2}b_{33}(C)^2 - b_{13}L_1C \quad (\text{B15})$$

Where  $L_1 = T - h_1$ ; and,  $C = w_1 * h_1 + Y$

In this case, the first order condition corresponding to the single household case becomes:

$$\frac{\partial u}{\partial h_1} = a_1^* + a_3^*w_1 - b_{11}h_1 - b_{33}w_1(w_1h_1 + Y) + b_{13}(2w_1h_1 + Y) = 0 \quad (\text{B16})$$

In this case, the optimal hour supply can be directly obtain from solving equation (B16):

$$h_1^* = \frac{a_1^* + a_3^*w_1 - b_{33}w_1Y + b_{13}Y}{b_{11} + b_{33}w_1^2 - 2b_{13}w_1} \quad (\text{B17})$$

Finally, since observed hours ( $\tilde{h}$ ) can differ from optimum hours due to stochastic errors, the corresponding model becomes:

$$\tilde{h}_1 = \begin{cases} h_1^* + e_1 & \text{if } h_1^* + e_1 > 0 \\ 0 & \text{otherwise} \end{cases} \quad (\text{B18})$$

Which can be estimated as a non-linear tobit model, that are censored from below.