Family Welfare and the Great Recession

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Abstract
The analysis in this paper provides estimates of family welfare losses generated by wage and non-labor income declines experienced across the Great Recession and by labor market constraints existing post-recession. Welfare losses are greater as families (both married and single) move up the income distribution. Total welfare losses are estimated to amount to roughly $191 billion.

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I. Introduction and Background

Analyses of the impact of the Great Recession on families have taken many forms. Morgan et al. (2012) find little evidence that the Great Recession affected fertility rates, cohabitation, or divorce, although they do find an increase in the proportion of young adults living with their parents. A more dramatic assessment can be found in Warner (2010: 2):

> "The poor are getting poorer, and the rich, despite stock-market setbacks, are still comparatively rich. The most devastating losses in household wealth over the past two years have been suffered by the middle class. And families are fraying at the seams."

There is no question that economic statistics, such as net family wealth (Lerman 2012), foregone consumption (Lansing 2011), underemployment (Sum and Khatiwada 2010), and long-term unemployment (Kroft, et al 2013) paint of picture of families worse off after the recession than before. The purpose of this paper is to quantify the overall welfare impact of the Great Recession experienced by families across the income distribution. A particular focus will be on the implications for welfare of the decline on real wages and non-labor income, and the constrained optimization implied by the notion of underemployment.

The microsimulation methodology employed by Hotchkiss, Moore, and Rios-Avila (2012) will be used to estimate parameters of a joint labor supply model within the context of a family utility framework for couple households, while a similar extension will be applied to single headed households.[1] For the purposes of the question posed here, the estimated parameters from the family utility model will be used to simulate the impact on family welfare of varying labor market conditions. The goal of the analysis will be to provide a quantitative value

[1] Microsimulation is a popular methodology for assessing the impact of tax policy changes (for example, see Fiorio 2008, Blundell et al. 2000, and Blundell 1992).

of welfare against which to compare the cost of policies under consideration to alleviate suboptimal labor market outcomes. In this paper, a family's welfare is measured directly as the dollar equivalent utility the family experiences under alternative labor market scenarios. This paper does not to derive an optimal policy (monetary or otherwise) that would return families to their pre-recession, or even unconstrained post-recession, utility levels, but, rather, the goal of this analysis is to quantify the welfare loss in order to be able to evaluate the benefit of a corrective policy, if one is proposed.

II. Methodology

A. Family Utility Framework

Family labor supply decisions are modeled here in a neoclassical joint utility framework. This model can be thought of as a reduced-form specification of family decision making. The model yields a clean-cut expression of family welfare that allows for cross wage effects on each member's labor supply decision. 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 Apps and Rees, 2009, McElroy, 1990). However there is evidence that the choice of structure for household decision making has very little implication for conclusions in microsimulation 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).

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 working 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:[2]

$$\max_{(L_1,L_2,C)} U = U(L_1, L_2, C)$$
$$subject\ to\ C = w_1 h_1 + w_2 h_2 + Y\ . \qquad (1)$$

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 after-tax market wage; w_2 is the wife's market wage; and *Y* is unearned 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.[3]

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 unearned income of the family:

$$V(w_1, w_2, Y) = U\{[T - h_1^*(w_1, w_2, Y)], [T - h_2^*(w_1, w_2, Y)],$$
$$[w_1 h_1^*(w_1, w_2, Y) + w_2 h_2^*(w_1, w_2, Y) + Y]\}\ , \qquad (2)$$

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 derives from changes in optimal hours of work and consumption (also see Apps and Rees, 2009: 263):

[2] This strategy is adapted to expand the analysis and include single headed households. Empirically, this implies setting hours and wages of the second member equal to zero, as well as constraining all utility parameters concerning the second member to be zero.

[3] 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.

$$dV = -U_1 dh_1^* - U_2 dh_2^* + U_3 dC^* , \tag{3}$$

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. 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 home income.

B. Simulating the Welfare Impact of Suboptimal Outcomes

When assessing welfare at suboptimal outcomes, equation (3) can no longer be interpreted as a change in indirect utility, but, rather, interpreted as a change in direct utility. One statistic often pointed to in support of the contention of suboptimal outcomes during the Great Recession is the stubbornly elevated share of the workforce that is part-time for economic reasons (i.e., have a part-time job, but would like to work full-time). We would consider these individuals to be underemployed from a utility maximizing perspective.

Generally, we will identify someone as underemployed in this analysis if the person is observed working fewer hours post-recession than his/her predicted optimum, based on pre-recession preferences and post-recession wages and non-labor income. Figure 1 illustrates the type of comparison that will be possible from the empirical analysis. The indifference curve U_{2007}^* corresponds to this person's pre-recession optimum level of hours of work/leisure and consumption. Post-recession, if real wages and non-labor income are lower (e.g. due to uncompensated higher inflation), this person would be forced to a new optimum, U_{2011}^*, at fewer hours of work and lower consumption. If this person is further constrained in hours of work (e.g., part-time for economic reasons, or, in the extreme, unemployed), he/she ends up on the indifference curve $\widetilde{U}_{2011}$, at even fewer hours of work and lower consumption.

[Figure 1 here]

When labor markets are tight, we assume that individuals are able to choose their optimal hours of work without constraint. Or, at least there are enough wage/hours combinations of job offers that one can get close to their optimum hours for a given wage. In a weak labor market, the number of wage/hours combinations is likely significantly reduced, constraining the hours options available at a given wage. The welfare impact of this scenario is illustrated in Figure 1 as a movement from U_{2011}^{*} (unconstrained hours optimization) to $\widetilde{U}_{2011}$(with constrained hours). Empirically, in the framework of the proposed methodology, the family welfare changes described above can be calculated as:[4]

$$U_{2011}^{*} - U_{2007}^{*} = -\overline{U}_1 \times dh_1^{*} - \overline{U}_2 \times dh_2^{*} + \overline{U}_3 \times [dC^{*}] \quad (4)$$

and

$$\widetilde{U}_{2011} - U_{2011}^{*} = -\widetilde{U}_1 \times d\tilde{h}_1 - \widetilde{U}_2 \times d\tilde{h}_2 + \widetilde{U}_3 \times \left[d\tilde{C}\right] \quad (5)$$

The actual calculations made for calculating these changes in family welfare are found in Appendix A. Note that the change in hours (dh_i^{*} and $d\tilde{h}_i$) take into account changes on the extensive and intensive margin of the hours worked, averaged across the population.

The actual impact on utility will depend on the relative value a family places on leisure and income. At low values of marginal utility of income or low wages, it is possible for utility to increase for small decrease in hours of work. However, as hours of work decline further, the marginal utility of leisure declines while the marginal utility of income increases, possibly reducing overall family welfare. This makes the relationship between hours of work and family welfare nonlinear. The dollar value of this change in family welfare is obtained by simply dividing the change in utility by the marginal utility of income (U_3).

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[4] Since utility is decreasing in hours of work, hours enter negatively on the right hand side of the equation.

Utility function parameters are estimated separately for married and single families at different points on the income distribution, allowing preferences regarding trade-offs between leisure and consumption to vary by family income level, besides other correlating characteristics.[5]

C. Estimation Issues

Calculation of the average post-recession optimal labor supply (h^*_{2011} in Figure 1) depends on the estimation of labor supply elasticities of the husband and wife with respect to changes in their own and each other's wages and changes, elasticities respect to unearned family income, as well as the changes in the probability of employment (extensive margin elasticities) (i.e., the probability of being at an interior solution on the budget constraint). 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. While the focus of this paper is on the simulation exercise itself, the simulation does require labor supply elasticities and it is therefore worthwhile to address some of the empirical issues. The goal here is to produce reasonable labor supply elasticities that are consistent with the literature. Toward that end, the methodology adopted takes as 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. 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., Hotchkiss et al. 2012, Heim, 2009, Hotchkiss et al., 1997, and Ransom, 1987), we estimate a

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[5] As shown in Hotchkiss, et al (2012), wage elasticities and marginal utilities vary considerably across household income.

quadratic form of the utility function:[6]

$$U(Z) = \alpha(Z) - (1/2)Z'\mathrm{B}Z \ , \tag{6}$$

where *Z* is a vector with elements $Z_1 = T - h_1$, $Z_2 = T - h_2$, and $Z_3 = w_1 h_1 + w_2 h_2 + Y$; α 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 wife's labor supply functions. Obtaining the first order conditions of this unconstrained maximization problem results in a system of equations linear in h:[7]

$$\frac{\partial U}{\partial h_1} = \Omega_1 h_1 + \Omega_2 h_2 + \Omega_3 = 0 \tag{7}$$

$$\frac{\partial U}{\partial h_2} = \Omega_2 h_1 + \Omega_4 h_2 + \Omega_5 = 0 \tag{8}$$

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:

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

$$\tilde{h}_2 = \begin{cases} h_2^* + e_2 & if\ h_2^* + e_2 > 0 \\ 0 & otherwise \end{cases} , \tag{9}$$

[6] In the extension to single household families, the strategy is adapted to be function of only one member labor supply and consumption. Details on this model are presented in Appendix B.
[7] The components of and solution for desired hours are found in Appendix B.

where we assume that (e_1, e_2) follows a bivariate Normal distribution with mean 0 and covariance matrix $\sum$. This model can be thought of as a simultaneous Tobit model, where we have four kinds of families: those where both husband and wife 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 Heim, 2009 and Eissa et al., 2004), however, extensive margin hours adjustments appear to be unimportant for men (for example, see Heim, 2009, Blundell et al., 1988). Considering the simulation of suboptimal labor market outcomes that we plan to conduct allowing for non-working husbands may be important, so we opt to include them in the analysis.

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. 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:

$$L = \prod_{i=1}^{N} \left[\left(\frac{1}{\sigma_1 \sigma_2} \right) \psi \left(\frac{\tilde{h}_1 - h_1^*}{\sigma_1}, \frac{\tilde{h}_2 - h_2^*}{\sigma_2}, \rho \right) \right]^{(H=1,W=1)}$$

$$* \left[\frac{1}{\sigma_1} \varphi \left(\frac{\tilde{h}_1 - h_1^*}{\sigma_1} \right) \left\{ 1 - \Phi \left(\frac{\sigma_1 h_2^* - \rho \sigma_2 (\tilde{h}_1 - h_1^*)}{\sigma_2 \sigma_1 \sqrt{1 - \rho^2}} \right) \right\} \right]^{(H=1,W=0)}$$

$$* \left[\frac{1}{\sigma_2}\varphi\left(\frac{\tilde{h}_2 - h_2^*}{\sigma_2}\right)\left\{1 - \Phi\left(\frac{\sigma_2 h_1^* - \rho\sigma_1\left(\tilde{h}_2 - h_2^*\right)}{\sigma_2\sigma_1\sqrt{1-\rho^2}}\right)\right\}\right]^{(H=0,W=1)}$$

$$* \Psi\left(\frac{-h_1^*}{\sigma_1}, \frac{-h_2^*}{\sigma_2}, \rho\right)^{(H=0,W=0)} \quad (10)$$

Where φ and Φ correspond to the probability density and cumulative distribution functions of a univariate normal, and ψ and Ψ 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), σ_i (i=1,2) represents the standard deviations of (e_1, e_2) and ρ is the correlation between the stochastic errors.

The stochastic errors accounted for in equation (9) represent errors in optimization -- observed hours do not exactly reflect desired hours.[8] Keane (2010) points out that there may exist 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, we cannot restrict the sample to workers paid weekly or hourly, since the American Community Survey (ACS) does not provide information on hourly or weekly wages. Instead, we construct the person's hourly wage using information about weeks worked per year 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.

[8] These errors, however, are not expected to reflect suboptimal outcomes that might be observed because of labor market constraints (as we might expect exist post-recession).

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 highly non-linear nature of the labor supply functions. 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, Hernstein and Murray, 1994). In addition, we abstract from the progressivity of the tax structure by using gross wages and estimating utility function parameters separately for families at different points in the income distribution. This amounts to "linearizing" the budget constraint (see Hall 1970), which is valid if preferences are strictly convex.[9] This means that family members would make the same hours choice facing this linearized budget constraint that they would have made facing the nonlinear budget constraint. If this assumption is binding, Keane points out that labor supply elasticities will be biased in a negative direction.

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.

[9] 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.

Toward that end, we include an indicator for race that could affect observed wage through employer discrimination, but, *ceteris paribus* (e.g., education), should not affect taste for work.

Further, the issue of the presence of fixed costs of working is raised by Apps and Rees (2009). We only marginally control for fixed costs 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).

III. Data

The American Community Survey (ACS) is a national random survey collected by the U.S. Census every year since 2000. The survey is sent to approximately 250,000 households every month. The ACS was designed to replace the decennial Census long form, and to be able to provide reliable demographic, housing, social, and economic data, for states and local areas, annually. From 2005, the ACS collects information for approximately 1% of the population, containing approximately 1.2 million household records.

A. *Sample Creation*

For the analysis in this paper, we use data from the 2007 American Community Survey (ACS) to estimate the pre-recession family utility function parameters used in the microsimulation, and data from 2011 to obtain a picture on labor market supply post-recession.[10] In order to estimate the joint household labor supply, the sample is restricted as follows:

- Husband and wife present,
- Husband and wife age between 24 and 64 years old,

[10] The reference period of relevant labor market variables (Income from wages and hours of work) corresponds to the past 12 months. As such, data collected in 2007 (2011) could reflect labor market experience anywhere between January 2006 (2010) and November 2007 (2011).

- Households with members other than parents and children are excluded, and
- Households where the age of the oldest child living in the household is 30 yrs or younger.

In order to broaden the applicability of the analysis, households with single house holders are also included in the sample (single household). The selection criteria for this sample are similar to above described, with the exception that the head of the household is single or not currently living with a spouse.

In addition, to reduce the noise from outliers in the sample, households with hourly wages at the top 0.5 percent and bottom 0.5 percent are excluded from the data, as well as households with zero total income. This leaves us with a total of 416,345 (384,456) married households and 243,792 (253,948) single households with single households for the 2007 (2011) sample.

B. Simulation of the Great Recession

Ideally, we would like to observe the same families pre- and post-recession in order to observe how the recession affected wages, unearned income, hours worked, and unemployment. In the absence of such data, the next best alternative is to construct a synthetic panel for 2007 and 2011, creating household groups based on detailed family characteristics that would not likely be affected by the recession itself. The household groups or "cells" are defined using all possible combinations on the following characteristics:

- 9 Census Divisions
- Dummy for living in the Metro Area
- If both husband and wife are present in the household. (married or single household)
- Age combination of husband and wife (or single householder), using 5yr brackets (25-29, 30-34, 35-39,…,60-64)
- Number of children between 0 to 5yrs old (0, 1, or 2 or more)
- Number of children 6yrs to 17yrs old (0, 1, 2, 3 or more)
- If there is any child 18yr or older living in the household
- Combinations of educational levels of Husband and Wife (Less than middle school, less than HS, High school, Some college, College, Grad school) (education level of single household)
- Race of the married couple: 0 White couple, 1 Non-white couple, 2 Mix couple (white

or non-white for single household).
- Hispanic: If either the husband or wife is Hispanic.

Based on these characteristics, initially 183,000 household groups can be identified. For each identified cell with information available in 2007 and 2011, corresponding averages of selected variables (hours of work, employment rate, non-labor income) in 2011 are calculated and assigned to the 2007 households. In cases where families in 2007 cannot be matched with similar 2011 families, based on the most detailed characteristics, rather than dropping the information of the "unmatched" family groups, we re-define the criteria for family groups using less restrictive information (e.g., excluding the “Hispanic” characterization, using dummies for presence of children in the household, combining certain education groups, etc). The least restrictive criteria identify 2,002 unique family groups. In turn, average cell information from 2011 is assigned to the previously unpaired 2007 households groups based on the less restrictive grouping (e.g. an unmatched "Hispanic" family in 2007 would receive information from 2011 families regardless of their "Hispanic" designation).

Table 1 presents information on the rate of cell matching for households in 2007. From a total of 416,345 married households in 2007, 343,480 (82.5 percent) were paired using the most restrictive criteria. Only 107 households remain in groups that could not be matched even with the least restrictive cells. For single households, just over 99 percent of the sample was matched in the first round, with negligible number of observations being matched in later rounds.

[Table 1 here]

While the creation of the synthetic panel could also be used to estimate the changes on real wages caused by the recession, the information from the ACS does not match the overall trend of wages reported by the Bureau of Labor Statistics. In other words, while the estimation of wage per hour provides a good approximation maintaining the cross section variation, it is less consistent regarding time variation. In this case, the changes on real wages are estimated using information from the Current Population Survey (CPS), specifically that corresponding to the Monthly Outgoing Rotation Group (MORG) for the years 2006-07 and 2010-2010. Based on the same synthetic panel principle, cells are defined based on sex, education level, and five years age groups, as this are the principal factors that characterize wage profiles and wage growths. For each cell, average real wage growth is estimated, and assigned to each individual in the ACS 2007 sample.

Figure 2 illustrates how the cell averages, for 2007 families alone, compare to the actual data. This gives us some idea about how accurate using cell averages for actual data will be.[11] Figure 2 compares the distribution of actual hours worked in the previous year to the cell average hours worked, for couples and single households. The densities are estimated using household weights. We see that cell averages do a better job reflecting actual hours for husbands than for wives, but are equally good adjusting hours for single men and women. The cell averages clearly smooth through much of the clumping typically observed on integer values, but appear to replicate the actual distribution fairly well.

[Figure 2 here]

Table 2 provides initial summary statistics comparing the probability of working, hours, and wages for husbands in wives, comparing 2007 and 2011 family cell means. On average, the probability of the husband and wives to have worked at all during the previous year is just under two percent lower in 2011 than in 2007, for singles the probability falls by just under three percent. With respect to hours of work, husbands worked about 34 fewer hours per year in 2011

[11] The Cell averages could be thought as a nonlinear prediction of the number of hours worked, non-labor income, and employment rates, based on family characteristics.

than in 2007, while wives increased their hours worked by about 39 hours.[12] Once we consider the reduction in employment, however, husbands' labor supply is reduced by about 68 hours, while wives' labor supply is one hour lower. Among singles, their labor supply is reduced in 78 hours. In addition, non-labor income falls 13 percent in married households and nine percent in single households; wages fell in real terms by about one percent for both couples and singles.[13]

[Table 2 here]

Figures 3, 4 and 5 provide an overview of how the labor supply changed between 2007 and 2011 (on average) across income deciles, based on pre-recession cell-average household income.[14] While the data indicate the effect of the recession was fairly consistent across the middle income groups, there is some heterogeneity on the impact of the recession for high and low income households. The figures show that employment of both husbands and wives uniformly declined from 2007 to 2011, except in the very lowest quintile. Regarding hours of work, Figure 4 shows that husbands across most of the income groups seem to have been affected in a similar way, working fewer hours on average in 2011 than in 2007, except for the poorest households. A similar pattern is observed in Figure 5, for singles. Wives, on the other hand, consistently increased their hours of work between 2007 and 2011 across all income groups, especially in the low-income households.

[Figures 3, 4, and 5 here]

[12] The total number of hours worked last year is calculated using the declared "usual number of hours worked per week," and multiplied by the number of weeks worked last year. In the absence of wages per hour, this variable is estimated as the result of total salaried wage income earned last year, divided by estimated total number of hours worked last year.

[13] It's of interest to note that stagnating aggregate real wages have been noted in several places (e.g., Mishel and Shierholz 2013), disaggregated wages, for example by education level, have actually shown a real decline, suggesting that any increases (or non-declines) in the aggregate are the result of shifting demographics, such as increasing educational attainment.

[14] These data (and the rest of the analysis) exclude households in the bottom three percent of the income distribution.

IV. Results

A. Utility Function Parameter Estimates and Labor Supply Elasticities

Utility function parameters are estimated separately for two types of households, married households, where both husband and wife are present, and for single households, where the householder is single or the spouse is not present. In order to take into consideration the heterogeneity across income groups (Hotchkiss et al 2012), the models are estimated across income deciles within each type of households.[15]

Theoretically, labor is supplied to the extent that the marginal utility of leisure is equal to the market wage, suggesting that, within a family, if husbands are paid more than wives, $U_1 > U_2$. In addition, lower estimates of the marginal utilities of leisure would be consistent with greater values of labor supply, ceteris paribus. As the additional utility gained from an additional dollar of income increases at a decreasing rate, we would expect U_3 (marginal utility of consumption) to be smaller for higher income families. Figure 6 illustrates the estimated marginal utilities of leisure and income for families across income deciles, for married households and for single headed households. These figures shows that the estimations of marginal utilities of leisure and consumption replicate the theoretical expectations.

[Figure 6 here]

Figure 7 present average wage and income elasticities for husbands (Panel a), wives (Panel b), and singles (Panel c). Own wage elasticities for husbands and wives are averages across working and non-working spouses. Cross wage elasticities for husbands and wives

[15] This strategy was preferred instead of using a single income classification for both single and married households, as there was a larger concentration of single households within the low income groups, with a similarly large concentration of married households in upper income groups.

correspond to families in which both members are working. Recall that linearizing the budget constraint (and denominator bias in the measurement of wages) can bias labor supply elasticities in a negative direction (Keane, 2010). While this could explain the estimation of negative own wage hours elasticities for husbands in the lower end of the income distribution, these are not inconsistent with estimates reported by Kaiser et al (1992) for Germany; and Ransom (1987), MaCurdy et al. (1990), and Pecanvel (2002) using U.S. data.[16]

[Figure 7 here]

Among all families, wives' own wages elasticities are much higher than husbands' elasticities, indicating that wives' labor supply is more responsive to changes in their own wages. These estimates for wives' own labor supply elasticities are mostly within the range reported in the literature using U.S. data.[17] The estimated negative cross-wage elasticities across all income levels indicate that husbands and wives view their leisure time as substitutes; this is consistent with cross-elasticities estimated by in Hotchkiss et al. (2012), Heim (2009), Ransom (1987). Both husbands and wives present the expected low and negative income elasticity, although wives are slightly more responsive to changes in non-labor income than their husbands.

With respect to single headed households, on average, the householders present a positive own wage elasticity, decreasing monotonically with income, as would be expected. The estimated income elasticity is also negative, as expected.

[16] Similar to Ransom (1987), while the uncompensated wage elasticity is negative albeit small, the corresponding compensated own wage elasticity for husbands is positive and around 0.2.

[17] 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. Also see Killingsworth (1983:107) and Hotchkiss et al. (2012).

B. Estimated Welfare Impact

Figure 8 presents the loss in welfare experienced by families moving from their optimal hours and consumption combination pre-recession to their predicted optimal combination post-recession, and finally to the actual outcome post-recession.[18] These results take into account both the change in hours and consumption experienced on the intensive margin (on the budget constraint), as well as taking into account the change in probability of being employed in the two time periods. The results for the lowest quintile indicate that after the recession, both single and married families have marginally improved their welfare. Two factors explain this. On the one hand, the utility loss from lower consumption that resulted from lower wages and fewer hours of work was partially compensated by a small increase in non-labor income among these households. On the other hand, the marginal utility of leisure is large enough among first decile families that the utility gain from more leisure (fewer hours) helped to compensated for the utility loss from lower consumption. Both married and single families experienced increasing dollar-equivalent welfare losses with family income.

[Figure 7 here]

What is of particular interest in Figure 7 is that the greatest share of total welfare loss across deciles derived from the wage and non-labor income changes from pre- to post-recession (the dashed line). Families only suffered relatively minor additional loss in welfare from constraints in the labor market (the difference between the dashed and solid lines).

The loss in welfare from the pre- to post-recession optimal hours/consumption combinations can be traced to the losses of real values in wages and non-labor income

[18] Appendix A details the calculations and formulas used to calculate the change in family welfare between 2007 and 2011.

experienced by the average family in each decile, which are displayed in Table 3; these declines were larger among higher income families.

[Table 3 here]

V. Conclusions and Policy Recommendations

This analysis in this paper illustrates that for any given family the dollar equivalent welfare loss across the Great Recession could have been significant, and that it varied greatly across family income deciles. In fact, some of the lowest income families are estimated to have experienced a modest welfare gain across the recession, resulting primarily from smaller declines in wages than experienced by families at the upper end of the income distribution, and from an average increase in non-labor income.

On average, across all deciles, married families suffered a welfare loss equivalent to roughly $3,000 and single families suffered a welfare loss equivalent to about $1,200. In 2007, there were approximately 56 million married couple households and about 19 million single households (Kreider and Elliott 2009). This means the total welfare loss accruing to families in the U.S. from the recession amounts to roughly $191 billion. Of course, this estimate does not take into account losses incurred by families in 2008 and 2009, or any losses experienced from labor market transitions. To put this into perspective, roughly $494 billion was spend by the American Recovery and Reinvestment Act of 2009 (Congressional Budget Office, http://www.cbo.gov/publication/42682). The estimated family welfare loss might have been much higher without this fiscal stimulus.

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Figure 1. Indifference curve reflecting different pre- and post-recession scenarios

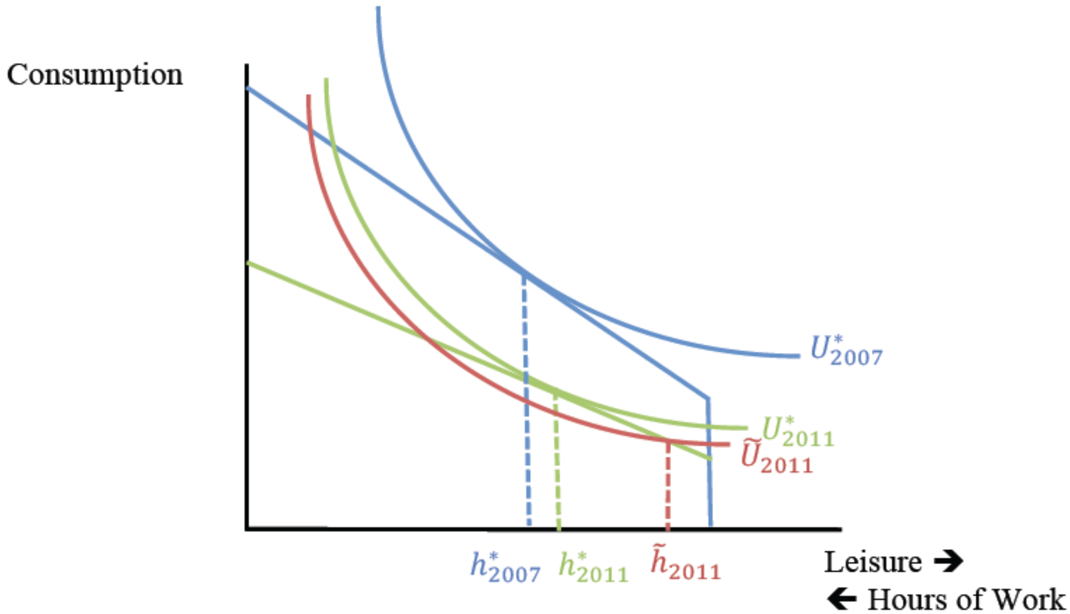


Figure 2. Distribution of hours worked last year in family cell averages and in the actual data, 2007 families.

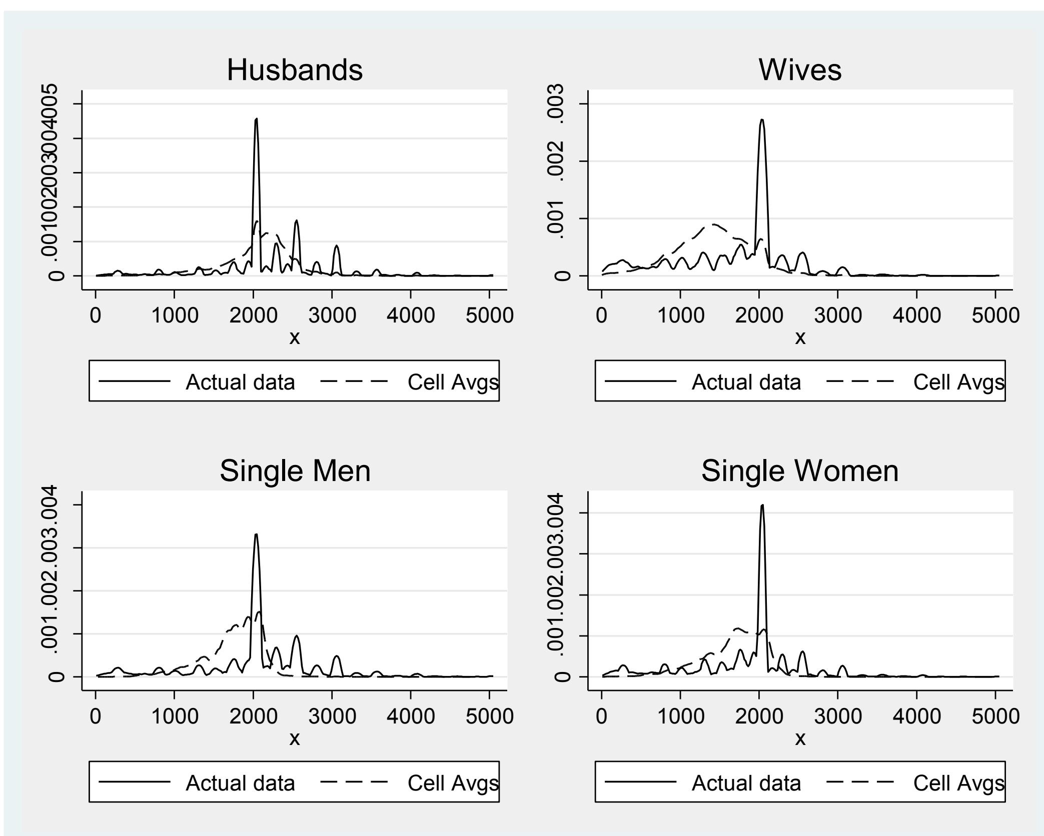


Figure 3. Share of people who worked during the last year, 2007 and 2011 married family cell averages by income decile.

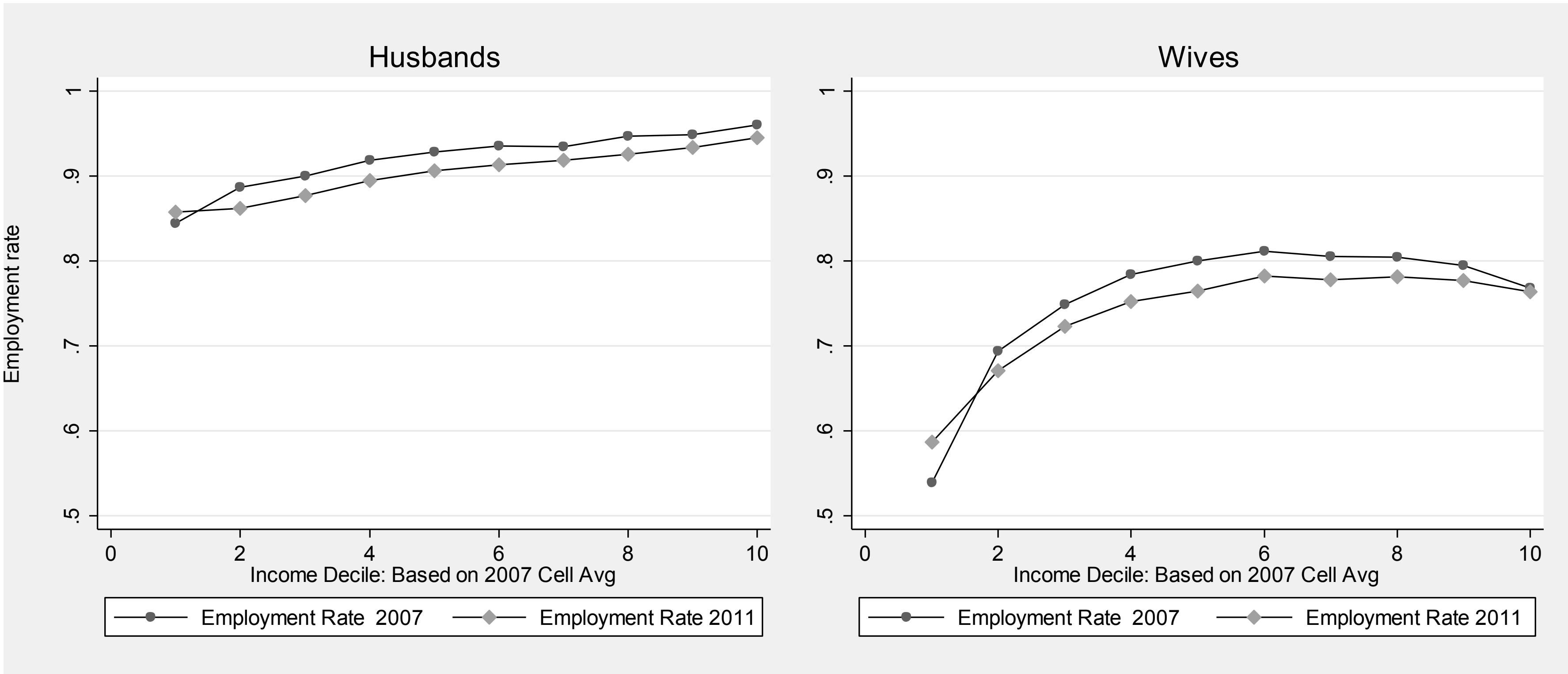
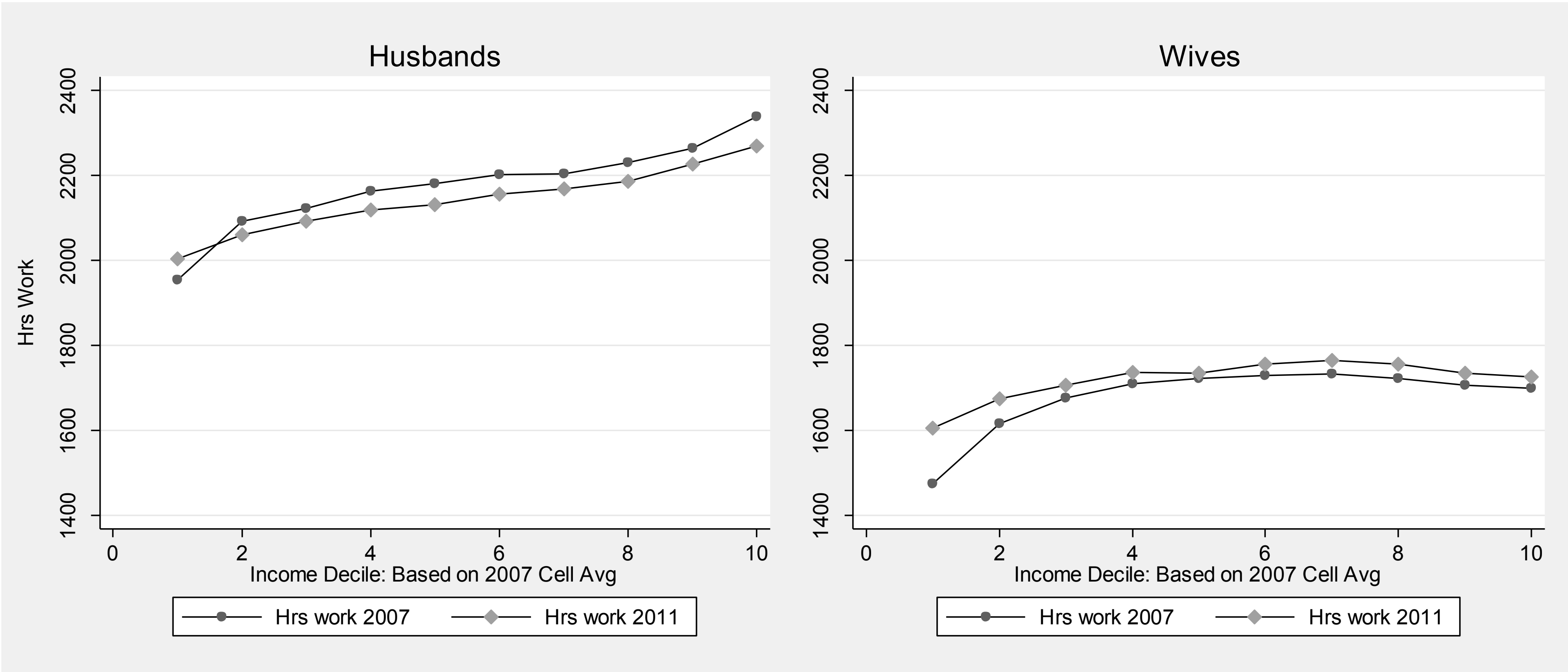
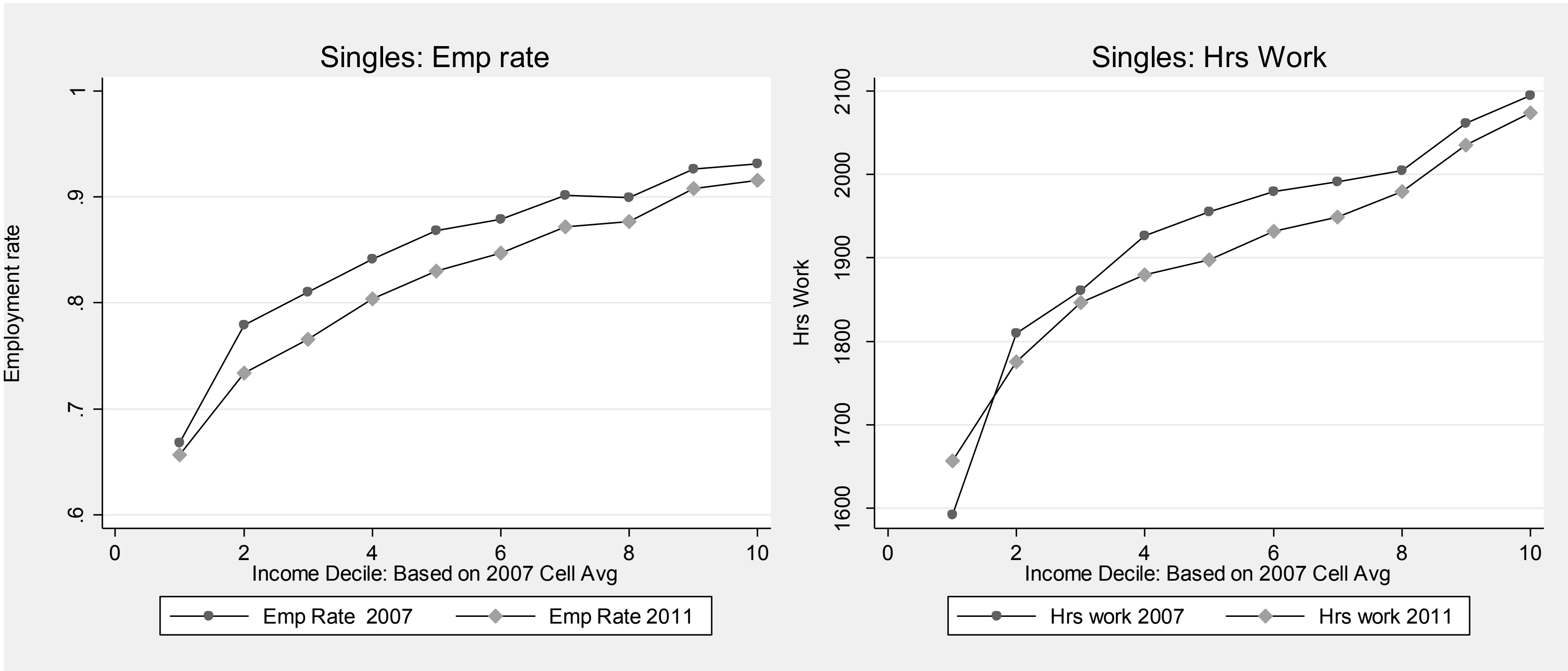


Figure 4. Total hours of work last year, workers only, 2007 and 2011 married family cell averages by income decile.



Note: Information is restricted to people with positive number of hours worked last year.

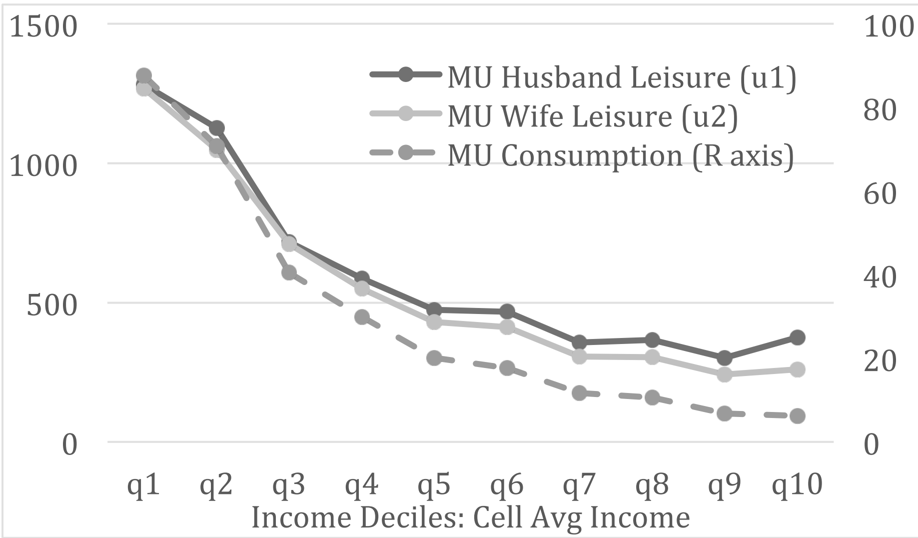
Figure 5. Total hours of work last year, workers only, 2007 and 2011 single family cell averages by income decile.



Note: Hours of work information is restricted to people with positive number of hours worked last year.

Figure 6. Estimated marginal utilities of leisure and income, by income deciles of total family income.

Panel (a): Married Households



Panel (b): Single Households

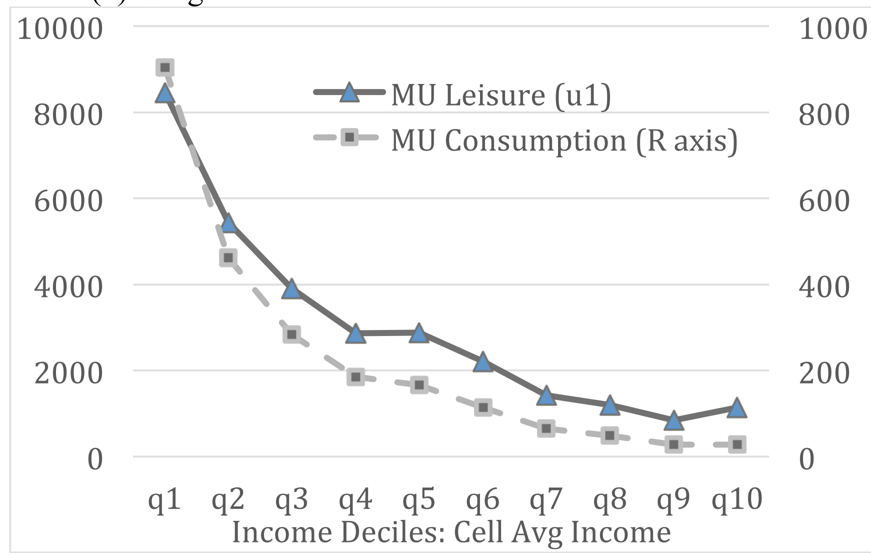
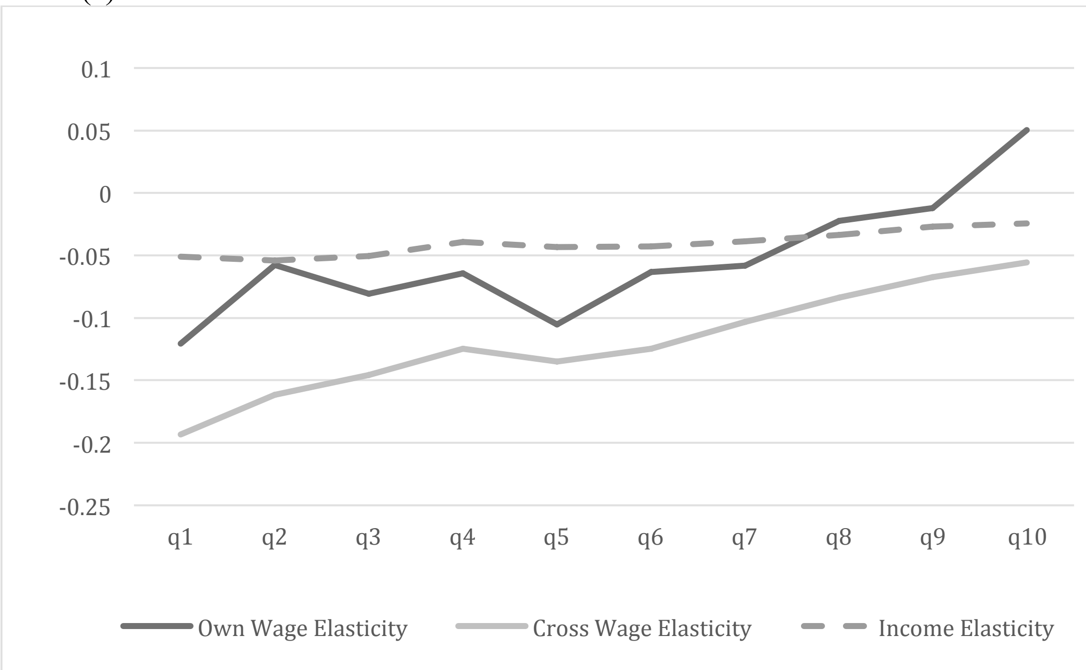


Figure 7. Own and Cross Wage Elasticities and Income Elasticities, by income decile

Panel (a): Husbands



Panel (b): Wives

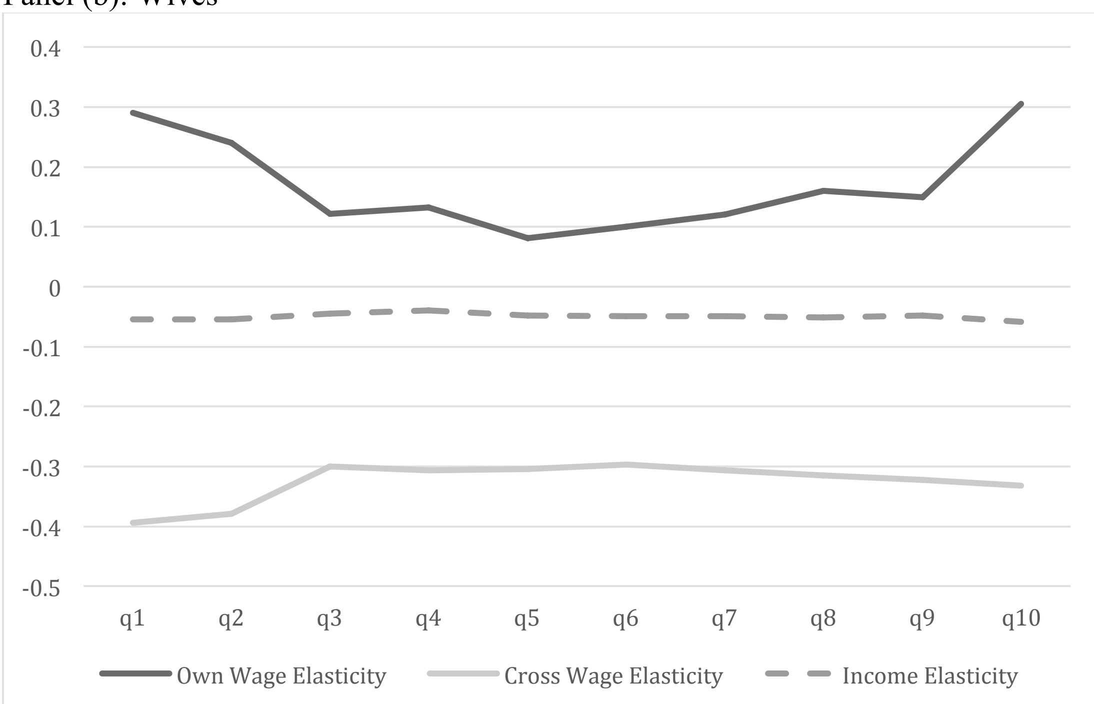


Figure 7. Own and Cross Wage Elasticities and Income Elasticities, by income decile, cont.

Panel (c): Singles

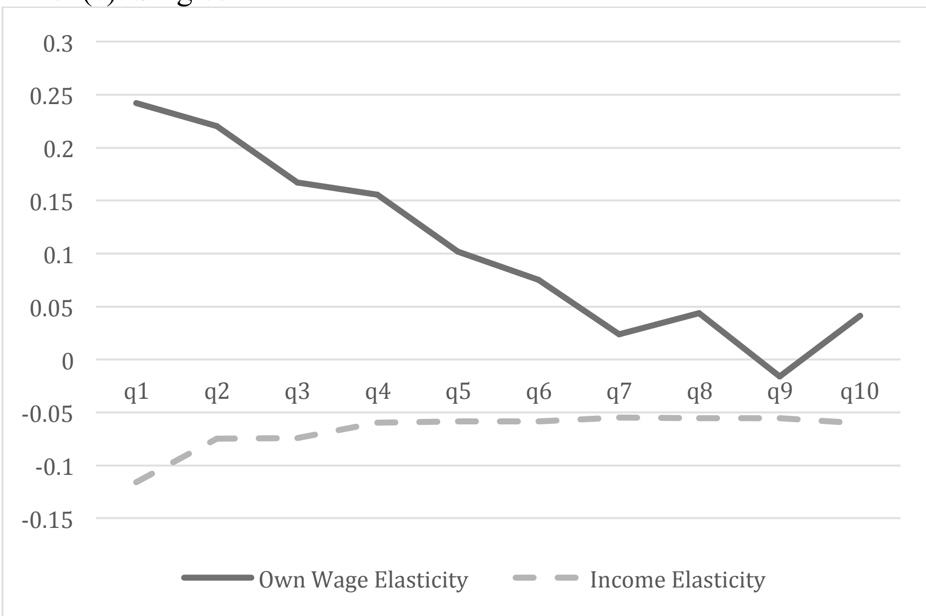
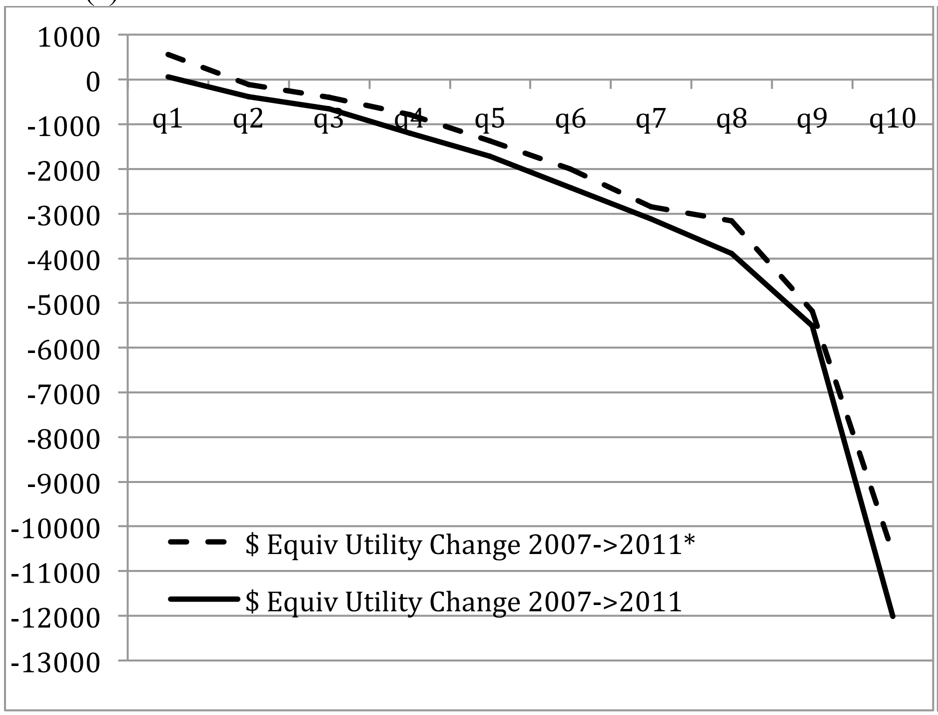


Figure 8. Simulated dollar-equivalent change in family welfare from pre-to post-recession by income deciles.

Panel (a): Married Households



Panel (b): Single Households

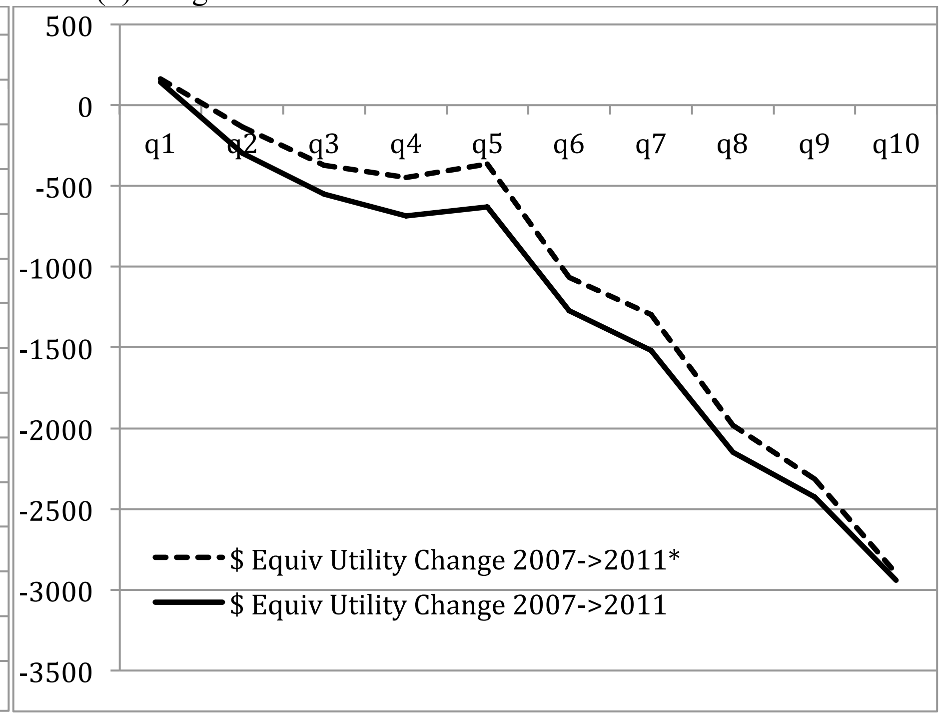


Table 1. Rates of matching 2007 family cells with 2011 families based on increasingly less restrictive criteria.

	Single Households		Married Households	
Round	#Households	Share	#Households	Share
0	239,501	99.01	343,480	82.50
1	1,701	0.44	13,032	3.13
2	2,179	0.48	31,443	7.55
3	175	0.03	3,677	0.88
4	86	0.02	620	0.15
5	0	0.00	14,358	3.45
6	87	0.02	7,309	1.76
7	36	0.00	1,435	0.34
8	15	0.00	616	0.15
9	7	0.00	268	0.06
Not match	5	0.00	107	0.03
Total number of Households	241,382	99.01	416,345	

Table 2. Summary statistics, 2007 and matched 2011 family cell means.

	2007 Cell Avg	2011 Cell Avg
Couples		
Husband working = 1	92.0%	90.3%
Average total hours worked last year if working, husband	2175.9	2141.6
Wife working = 1	75.5%	73.8%
Average total hours worked last year if working, wife	1682.0	1721.5
Husband hourly wage	$29.2	$28.8
Wife hourly wage	$19.4	$19.2
Annual Non Labor Income	$10,574.3	$9,152.4
Singles		
Working=1	85.0%	82.1%
Average total hours worked last year if working	1928.4	1903.3
Hourly Wage	$20.7	$20.5
Annual Non Labor Income	$6,762.6	$6,147.8

Notes: Non-labor income is deflated to 2007 dollars. Wages are estimated using the CPS real wage growth. Means are estimated using 2007 household weights.

Table 3. Changes in wages and family income from pre- to post-recession by deciles.

Income Decile	Married Households			Single Households	
	Average change in husband wage (dw1)	Average change in wife wage (dw2)	Average change in family non-labor income (dY)	Average change in wage (dw1)	Average change in family non-labor income (dY)
q1	-$0.22	-$0.18	$1,040.48	-$0.17	$413.50
q2	-$0.23	-$0.16	$500.46	-$0.15	$108.90
q3	-$0.21	-$0.16	$224.59	-$0.14	-$153.20
q4	-$0.29	-$0.20	$66.99	-$0.15	-$188.00
q5	-$0.35	-$0.18	-$388.06	-$0.13	-$142.50
q6	-$0.39	-$0.20	-$887.13	-$0.24	-$651.70
q7	-$0.45	-$0.16	-$1,622.11	-$0.30	-$764.20
q8	-$0.51	-$0.19	-$1,755.05	-$0.32	-$1,397.30
q9	-$0.54	-$0.19	-$3,607.33	-$0.37	-$1,592.70
q10	-$0.44	-$0.19	-$9,204.22	-$0.21	-$2,453.50

Note: Non-labor income and wages are deflated to 2007 dollars.

Appendix A: Formulas for simulating change in family welfare under different scenarios.

In addition to changes interior to the budget constraint, we also want to take into account the changes to the probability of employment, which was significantly lower post-recession (higher unemployment). In order to do this, we make use of the probabilities of employment (p_1 and p_2) estimated as part of the extensive margin elasticities (how the probability of employment varies with wages and non-labor income). Changes in these probabilities can be estimated as:

$$dp_1 = \frac{\partial p_1}{\partial w_1} dw_1 + \frac{\partial p_1}{\partial w_2} dw_2 + \frac{\partial p_1}{\partial Y} dY \quad \text{(A1)}$$

$$dp_2 = \frac{\partial p_2}{\partial w_1} dw_1 + \frac{\partial p_2}{\partial w_2} dw_2 + \frac{\partial p_2}{\partial Y} dY \quad \text{(A2)}$$

where, $dw_1 = w_1^{2011} - w_1^{2007}$, $dw_2 = w_2^{2011} - w_2^{2007}$, and $dY = Y^{2011} - Y^{2007}$.

The predicted optimal change in hours in 2011, given 2007 utility function parameters, changes in wages and change in non-labor income are calculated as follows:

$$dh_1^* = \left(\frac{p_{1,2007} + p_{1,2011}^*}{2}\right)\left(\frac{\partial h_1}{\partial w_1} dw_1 + \frac{\partial h_1}{\partial w_2} dw_2 + \frac{\partial h_1}{\partial Y} dY\right) + dp_1\left(\frac{h_{1,2007}^* + h_{1,2011}^*}{2}\right) \quad \text{(A3)}$$

$$dh_2^* = \left(\frac{p_{2,2007} + p_{2,2011}^*}{2}\right)\left(\frac{\partial h_2}{\partial w_1} dw_1 + \frac{\partial h_2}{\partial w_2} dw_2 + \frac{\partial h_2}{\partial Y} dY\right) + dp_2\left(\frac{h_{2,2007}^* + h_{2,2011}^*}{2}\right) \quad \text{(A4)}$$

All of these changes (e.g., in probabilities of employment and hours) will be calculated for the average decile cell.

Similarly, the change on consumption will be calculated as:

$dC^* = C_{2011}^* - C_{2007}$, and

$$C_{2007} = w_{1,2007} * h_{1,2007} + w_{2,2007} * h_{2,2007} + Y_{2007}$$

$$C_{2011} = w_{1,2011} * \left(h_{1,2007} + dh_1^*\right) + w_{2,2011} * \left(h_{2,2007} + dh_2^*\right) + Y_{2011}$$

Comparisons between optimal utility-maximizing outcomes in 2007 and 2011 are then calculated as follows::

$$U_{2011}^* - U_{2007}^* = -\overline{U}_1 \times dh_1^* - \overline{U}_2 \times dh_2^* + \overline{U}_3 \times [dC^*] \quad \text{(A5)}$$

where,

$$\bar{U}_1 = -a_1^* + b_{11}\bar{h}_1^* + b_{12}\bar{h}_2^* - b_{13}\bar{C}^*, \tag{A6}$$

$$\bar{U}_2 = -a_2^* + b_{12}\bar{h}_1^* + b_{22}\bar{h}_2^* - b_{23}\bar{C}^*, \text{ and} \tag{A7}$$

$$\bar{U}_3 = a_3^* + b_{13}\bar{h}_1^* + b_{23}\bar{h}_2^* - b_{33}\bar{C}^*; \tag{A8}$$

and $\bar{h}_2^* = \left[\frac{1}{2}\left(h_{2,2007}^* + h_{2,2011}^*\right)\right]$, $\bar{h}_1^* = \left[\frac{1}{2}\left(h_{1,2007}^* + h_{1,2011}^*\right)\right]$, and $\bar{C}^* = \left[\frac{1}{2}\left(C_{2007}^* + C_{2011}^*\right)\right]$.

Note that the marginal utilities are calculated at the midpoint of hours and consumption, rather than at one point or the other.

Using the same formula, we can compare the predicted optimal utility outcome (U_{2011}^*) with the suboptimal at observed (rather than predicted optimal) hours (note that dY here is the same at the dY above, so there is no contribution of the change in on-labor income to the comparison of optimal to suboptimal welfare outcomes):

$$\tilde{U}_{2011} - U_{2011}^* = -\tilde{U}_1 \times d\tilde{h}_1 - \tilde{U}_2 \times d\tilde{h}_2 + \tilde{U}_3 \times \left[d\tilde{C}\right] \tag{A9}$$

where,

$$d\tilde{C} = w_{1,2011} * d\tilde{h}_1 + w_{2,2011} * d\tilde{h}_2;$$

$$d\tilde{h}_1 = \tilde{h}_{1,2011} - h_{1,2011}^*, \text{ and } d\tilde{h}_2 = \tilde{h}_{2,2011} - h_{2,2011}^*;$$

$$\tilde{U}_1 = -a_1^* + b_{11}\bar{h}_1 + b_{12}\bar{h}_2 - b_{13}\bar{C}; \tag{A10}$$

$$\tilde{U}_2 = -a_2^* + b_{12}\bar{h}_1 + b_{22}\bar{h}_2 - b_{23}\bar{C}; \tag{A11}$$

$$\tilde{U}_3 = a_3^* + b_{13}\bar{h}_1 + b_{23}\bar{h}_2 - b_{33}\bar{C}; \text{ and} \tag{A12}$$

$\bar{h}_2 = \left[\frac{1}{2}\left(\tilde{h}_{2,2011} + h_{2,2011}^*\right)\right]$, $\bar{h}_1 = \left[\frac{1}{2}\left(\tilde{h}_{1,2011} + h_{1,2011}^*\right)\right]$, and $\bar{C} = \left[\frac{1}{2}\left(\tilde{C}_{2011} + C_{2011}^*\right)\right]$.

Note that the marginal utilities are calculated at the average between the optimal and suboptimal hours and consumption, rather than at one point or the other. A simpler alternative would be to just use the 2011 suboptimal hours and consumption values.

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:

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

Where $L_1 = T - h_1; L_2 = T - h_2; and, C = w_1 * h_1 + w_2 * h_2 + Y$

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:

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

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

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,

$a_1^* = X_1\Gamma_1$ and $a_2^* = X_2\Gamma_2$

where X_1 and X_2 are vectors of individual and family characteristics and Γ_1 and Γ_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:

$$\Omega_1 h_1^* + \Omega_2 h_2^* + \Omega_3 = 0 \quad \text{(B4)}$$

$$\Omega_2 h_1^* + \Omega_4 h_2^* + \Omega_5 = 0 \quad \text{(B5)}$$

Where:

$$\Omega_1 = 2b_{13}w_1 - b_{11} - b_{33}w_1^2; \tag{B6}$$

$$\Omega_2 = b_{23}w_1 + b_{33}w_1w_2 - b_{12} + b_{13}w_2; \tag{B7}$$

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

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

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

From equations (A4) and (A5), the solutions for h_1^* and h_2^* become:

$$h_1^* = \frac{\Omega_3\Omega_4 - \Omega_2\Omega_5}{\Omega_2^2 - \Omega_1\Omega_4} \tag{B11}$$

$$h_2^* = \frac{\Omega_1\Omega_5 - \Omega_2\Omega_3}{\Omega_2^2 - \Omega_1\Omega_4} \tag{B12}$$

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

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

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

where we assume that (e_1, e_2) follows a bivariate normal distribution with mean 0 and covariance Σ. 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:

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

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:

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

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

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

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

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

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