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Family Welfare and the Cost of Unemployment

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Abstract: This paper calculates the welfare cost to families of an unemployment shock. Using U.S. data, we find that, overall, an average annualized expected dollar equivalent welfare loss of $1,156 when the unemployment rate rises by one percentage point. The welfare loss is greater for married families than for single families and increases with education. We then estimate that a loss in purchasing power of 1.8 percent generates the same amount of welfare loss as a one-percentage-point rise in the unemployment rate. Additionally, the shock to purchasing power that a family is willing to endure to avoid a one percentage point increase in the aggregate unemployment rate rises with income. The results in this paper inform policymakers about the distributional implications of decisions likely to affect labor markets.

JEL classification: I30, E52, J22, D19

Key words: family welfare, joint labor supply, microsimulation dual mandate, monetary policy

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Family Welfare and the Cost of Unemployment

1. Introduction and Background

The purpose of this paper is to evaluate the welfare cost of a shock to unemployment for families with different characteristics. We apply the microsimulation methodology to estimate parameters of a labor supply model within the context of a family utility framework for married couple households, and within the context of a unitary utility framework for single households. Estimated parameters from the utility model will be used to simulate the expected welfare loss from a rise in the aggregate unemployment rate, accounting for the negative income shocks and changes in non-market time, with the recognition that each person's probability of unemployment is impacted differently by a softening of the labor market.[1]

Others have explored the costs of unemployment almost exclusively through a macroeconomic lens. Okun's Law (Okun 1962) is often used to describe the loss in output that is generated from an additional one-percentage point rise in the unemployment rate. Gordon, Nordhaus, and Poole (1973) detail the deficiencies of Okun's Law (alone) for measuring the welfare effects of a rise in the unemployment rate because the relationship does not account for the value of non-market activity. And rather than explore the cost of a specific shock to unemployment, some focus more on the welfare costs of economic *volatility* (e.g. Lucas 1991; Krusell and Smith 1999).

An exception to the macroeconomic approach to measuring the welfare costs of unemployment is found in Hurd (1980). Hurd uses estimated individual labor supply elasticities (or, rather, the slope of the labor supply function) to calculate the payment required to make a

[1] Non-market time is a combination of time spend on leisure, household production and other activities outside paid labor.

person indifferent between working the desired hours at a prevailing wage rate, or being forced to work fewer hours than desired because of unemployment. This payment is interpreted as the cost of unemployment. Our methodology employs a similar, but more complete, strategy in that we estimate the welfare loss of deviating from desired hours, but we estimate utility function parameters in order to calculate actual loss in welfare (i.e., utility) as opposed to just loss in income that would come from unemployment. Among other things, this allows us to account for any potential welfare gain from an increase in non-market activity that comes with non-employment. The methodology also allows a comparison of welfare loss across families of different characteristics irrespective of the actual utility *level* of those families (either independently or relative to one another).

DiTella, MacCulloch, and Oswald (2001) also offer an estimate of the utility-constant cost of unemployment and provide a segue to the second part of the analysis in this paper. They assess the relative importance of high unemployment vs. high inflation in explaining variations in demographic-neutral aggregate levels of satisfaction across countries and time. They find that unemployment reduces overall satisfaction more than inflation. They motivate their analysis by stating that, "... reducing inflation is often costly, in terms of extra unemployment...," (DiTella, MacCulloch, and Oswald 2001, 335). This trade-off is also acknowledged by Gordon, Nordhaus, and Poole (1973) as a motivation for undertaking their assessment of the welfare cost of higher unemployment. However, they note that their assessment will not take account of, "...the benefits associated with the lower inflation rate made possible by higher unemployment," (p. 135).[2] De

[2] In spite of this implied negative relationship between unemployment and inflation, Berentsen, Menzio, and Wright (2011) identify a positive relationship between unemployment and inflation in very low frequency data (the long run).

Neve et al. (2017) also find a significant positive relationship between changes in macroeconomic conditions and individuals' assessments of well-being with the added revelation that negative shocks have a more dramatic effect on well-being than positive shocks.[3]

The potential trade-off between unemployment and inflation suggested by these papers is of particular interest to U.S. Federal Reserve monetary policy makers whose actions are guided by what is know as the "Dual Mandate" of full employment and stable prices, which is spelled out in Section 2A of the Federal Reserve Act:

> “The Board of Governors of the Federal Reserve System and the Federal Open Market Committee shall maintain long run growth of the monetary and credit aggregates commensurate with the economy’s long run potential to increase production, so as to promote effectively the goals of maximum employment, stable prices, and moderate long-term interest rates.”[4]

While we do not model inflation in this paper, the second part of the analysis estimates the size of an unanticipated and exogenous shock to purchasing power that would generate the same welfare loss as a one percentage-point shock to unemployment. Since the only consumption price in the model is the numeraire price of consumption, we simulate a loss in purchasing power by adjusting the value of the other components of the model that enter in real dollars -- wages and non-labor income. We are then able to say something about how the individual family views the trade off between rising unemployment and decline in purchasing power.

Several papers explore the distributional implications of monetary policy. Bernanke (2015), Nakajima (2015), and Amaral (2017) consider the relationship between monetary policy and income/wealth inequality. Carpenter and Rodgers III (2004) find that monetary policy affects labor market outcomes differently across demographic groups. The analysis in this paper finds differential welfare implications for changing labor market environments by education and

[3] A related literature is concerned with macroeconomic *levels* and subjective well-being. For example, see Proto and Rustichini (2013) and Stevenson and Wolfers (2013).
[4] See http://www.federalreserve.gov/aboutthefed/fract.htm.

marital status. In considering the welfare costs of unemployment and loss in purchasing power, we do not suggest that the FOMC thinks of unemployment or inflation as policy levers, but, rather, that these are economic outcomes that can be influenced by policy choices. If this were not the case, then the Dual Mandate would be meaningless.

We find that the annualized expected welfare loss generated by a one-percentage point shock to the unemployment rate is equivalent to $1,156, on average across all families. And even though the probability of job loss is less for those with higher education, their potential income loss is greater, making the expected welfare loss for those with higher education greater than for those with less education. In addition, married families' expected loss is greater than that of single families (both in levels and as a share of total annual income). This higher expected loss for married families translates into a higher equivalent unanticipated loss in purchasing power for married families than for single families; married families are willing to tolerate greater loss to purchasing power to avoid unemployment than single families are.

2. Methodology

Microsimulation is a popular methodology often applied to assess the impact of a specific policy on welfare (for example, see Fiorio 2008; Blundell et al. 2000; Bahl et al. 1993; Blundell 1992; Gustman 1983). Here, rather than evaluate a specific policy, we simulate the impact of the economic consequences of any policy that is expected to negatively affect the labor market. The main advantage to the theoretical framework we employ for this exercise is that it is constructed from a standard joint (unitary for singles) family utility model. For married couples, labor supply is jointly estimated. The utility function does not include unemployment as a direct input in the optimization problem. However, changes in unemployment and purchasing power can be brought to bear on the welfare outcome by simulating the impact these environmental changes have on behavior and family utility.[5]

2.1. Family Utility Framework

The model described in this section nests the more simple case of single households. Empirically, the single family version of the model implies constraining hours and wages of the second household member to zero, as well as constraining all utility parameters concerning the second member to be zero.

Family labor supply decisions are modeled 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 clear-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 for modeling intra-familial 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 Moreau and Bargain 2005). 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.

Within the framework of the neoclassical family labor supply model, a family maximizes a utility function that represents household welfare. Assuming, for simplicity, that there are only two working members of the household (husband and wife), the family chooses levels of non-

[5] While economists often consider economic conditions (such as unemployment or inflation) as an outcome of economic processes (see Hall 1981, 432), they are certainly exogenous to an individual family's decision making process.

market time (e.g., leisure, household production) for each member and a joint consumption level in order to solve the following problem:

$$\max_{(L_1,L_2,C)} U = U(L_1, L_2, C)$$

$$subject\ to\ C = w_1 h_1 + w_2 h_2 + Y\ . \tag{1}$$

Define T as total time available for an individual; $L_1 = T - h_1$ will be referred to as the husband's non-market time, and $L_2 = T - h_2$ will be referred to as the wife's non-market time; 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 and w_2 are the husband's and wife's after-tax market wage, respectively; and *Y* is non-labor income. L_1 and L_2 correspond to *all uses of non-market time*, including home production activities.[6] In addition, the model does not distinguish between unemployment and non-participation; both states are included in the non-employment status. The implications of this are discussed later in section 2.3.

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 non-labor income of the family:

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

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

[6] 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). We do include the number and age of children as determinants of labor supply decisions since the presence of children may affect the comparative advantage between husbands and wives in non-market work.

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

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

where U_1 and U_2 are the family's marginal utility of the husband's and wife's non-market time, respectively, and U_3 is the family's marginal utility of consumption. It is this equation that gives us the change in family welfare that will result from a shock to unemployment or a shock to prices. It is clear from equation (3) 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 non-market time and income.

2.2. Estimation of Utility Function Parameters and Labor Supply Elasticities

Simulating the impact on family welfare of higher unemployment and an unanticipated shock to purchasing power requires the estimation of labor supply elasticities of each family member with respect to changes in their own and each other's (in the case of married-couple families) wages, elasticities with respect to non-labor 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 related to estimating 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; most of these issues, including the potential for endogeneity of wages and non-labor income, are addressed in detail in Appendix A. 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. We also illustrate that the estimated labor supply elasticities fall well within the range of the existing literature, which contains significant variation in modeling assumptions.

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 (3), a specific functional form of utility must be specified. Following others (e.g., Hotchkiss, Moore, and Rios-Avila 2012; Hotchkiss, Kassis, and Moore 1997; Heim 2009; Ransom 1987), we estimate a quadratic form of the utility function:

$$U(Z) = \alpha(Z) - (1/2)Z'\mathrm{B}Z \,, \tag{4}$$

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 being a flexible functional form in the sense that it can be thought of as a second order approximation to an arbitrary utility function (and when the second order conditions with respect to non-market time comply with $U_{11} < 0, U_{22} < 0$ & $U_{11} * U_{22} > U_{12}^2$ it is well-behaved). 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:

$$\frac{\partial U}{\partial h_1} = \Omega_1 h_1 + \Omega_2 h_2 + \Omega_3 = 0 \tag{5}$$

$$\frac{\partial U}{\partial h_2} = \Omega_2 h_1 + \Omega_4 h_2 + \Omega_5 = 0 \tag{6}$$

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. Details of this derivation are reported in Appendix B.

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

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

$$\tilde{h}_2 = \begin{cases} h_2^* + e_2 & if\ h_2^* + e_2 > 0 \\ 0 & otherwise \end{cases}, \tag{7}$$

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, with working hours censored at zero, where we have four kinds of families: those where both husband and wife work, those where only one of the spouses works (two cases), and those where neither of them work. (Of course, for singles, this simplifies to two cases -- the individual working or not working.) 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; Eissa, Kleven, and Kreiner 2008), however, extensive margin hours adjustments appear to be unimportant for men (for example, see Heim 2009; Blundell et al. 1988). Considering the simulation of possible unemployment for both men and women, allowing for husbands with zero hours of work is important, so they will be included in the analysis.

Allowing for the presence of non-workers raises one empirical issue identified by Keane (2011) that must be addressed: market wages are not observed for individuals 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) using regressors observable for both working and non-working individuals.[7] The resulting parameter estimates are then used to predict wages for non-working 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:

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

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

$$* \left[\frac{1}{\sigma_2} \varphi \left(\frac{\tilde{h}_2 - h_2^*}{\sigma_2} \right) \left\{ 1 - \Phi \left(\frac{\sigma_2 h_1^* - \rho \sigma_1 (\tilde{h}_2 - h_2^*)}{\sigma_2 \sigma_1 \sqrt{1 - \rho^2}} \right) \right\} \right]^{(H=0,W=1)} * \Psi \left(\frac{-h_1^*}{\sigma_1}, \frac{-h_2^*}{\sigma_2}, \rho \right)^{(H=0,W=0)} , \qquad (8)$$

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. For singles, this likelihood function reduces to the univariate case. 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.

Obtaining reasonable estimates of labor supply elasticities is essential in order to obtain believable estimates of the change in utility through the simulation exercise described below. Issues, well known to the literature, related to the estimation of labor supply elasticities and the implications of those issues to the problem at hand are addressed in detail in Appendix A.

[7] For purposes of identification, the Heckman selection equation uses non-labor income, number of children in the household, and spouse education (for married households) as exclusion restriction variables.

With the expectation of heterogeneity in preferences across families, particularly of different age, education, and income levels (see Keane and Wasi 2016; and Deaton 2018), we estimate different sets of parameters for families based on husband education level for married couples, and head of the household education for single families. In addition, we estimate different sets of parameters for male and female singles. In other words, we estimate five sets of parameters for married families (full sample; and husband's education is less than high school, high school, some college, and college plus) and 10 sets of parameters for singles (full sample for men and women separately; then for each education level separately for men and women).[8]

2.3. Expected Welfare Loss from a Shock to Aggregate Unemployment

We simulate the impact of a rise in the unemployment rate as an exogenous shock to the stochastic errors in equation (7). If, for example, an employed husband loses his job, then $e_1 = -h_1^*$. This also implies that the estimated welfare impact of unemployment is, by construction, zero if neither of the spouses is working.

The probability of each family member being hit by job loss is a function of his or her demographic characteristics (gender, race, age, and education), as well as time and location (details provided below). If the marginal effect on the probability that the husband loses his job when the aggregate unemployment rate rises by one-percentage point is p_1 and the marginal effect on the wife's probability of losing her job is p_2, then the expected change (loss) in family welfare (dV from equation 3) due to a positive probability of job loss is given by:

[8] There are many other dimensions across which utility function parameters could vary. We expect that differences across marital status and education/income would be most pronounced, however additional heterogeneity (across age, race, and number of children) is allowed for through the a_1 and a_2 found in equation B1; estimates of their components are reported in Appendix E, Tables E1 and E2.

$$Exp\{dV|_{p_{1>0},p_{2>0}}\} = (1-p_1)(1-p_2)dV[dh_1^* = 0, dh_2^* = 0, dC^* = 0]$$

$$+ p_1(1-p_2)dV[dh_1^* = -h_1^*, dh_2^* = 0, dC^* = -w_1h_1^* + \tau_1 wba_1]$$

$$+ (1-p_1)p_2 dV[dh_1^* = 0, dh_2^* = -h_2^*, dC^* = -w_2h_2^* + \tau_2 wba_2]$$

$$+ p_1p_2 dV[dh_1^* = -h_1^*, dh_2^* = -h_2^*, dC^* = -w_1h_1^* - w_2h_2^* + \tau_1 wba_1 + \tau_2 wba_2] \quad (9)$$

The first term on the right hand side of equation (9) is the expected change in utility if neither the husband nor the wife loses their jobs. The second term is the expected change in utility from only the husband losing his job. The third term is the expected change in utility from only the wife only losing her job. And the last term in this expression is the expected change in utility of both losing their jobs. For singles, this expected utility reduces to just two terms corresponding to the increased probability that the individual becomes non-employed and one minus that probability.

The change in aggregate unemployment is assumed to be strictly an exogenous shock and does not play a role in the optimal hours decision of the family members. And, except for being related through characteristics a husband and wife might have in common (such as age, race, state of residence, etc.), the marginal effects of job loss for husband and wife, in married-couple households, are otherwise independent of each other. [9]

When a family member loses his/her job, the family loses his and/or her earnings, but that earnings loss may be offset somewhat by receipt of Unemployment Insurance. Details of how we estimate the weekly benefit allowance (*wba*), eligibility, and expected take-up rate (τ) are provided in Appendix C.[10] The fact that take-up rates are below 100 percent reflects the choice

[9] Additionally, market wages are assumed to be sticky (e.g., see Kahn 1997), therefore assumed to not be a function of unemployment in this static framework.

[10] For simplicity, we assume that all other sources of non-labor income are not affected by the shock of unemployment.

of some individuals who lose their jobs to exit the labor force, rather than remain unemployed.

The family may also be able to offset earnings loss through previous savings. However, based on our own calculations using the Survey of Consumer Finances (SCF) (available upon request), it is unclear how the presence of savings would differentially impact the estimations of expected welfare loss across families from a rise in the unemployment rate. For example, in 2016 48.9% of households had zero liquid savings and, among those with savings, only 27.9% had $6,000 or less in savings. Additionally, there is no consistent variation across income deciles in households' average total liquid savings as a share of the average total income (or average earnings). So, even though wealthier households are more likely to save (i.e., more likely to spend less than they earn at any point in time, as also seen in the SCF), the ability of a typical family to replace lost earnings with savings (and maintain their usual level of consumption) does not appear to be significantly different than that of low-income families.[11]

The marginal impact of a change in the unemployment rate on the probability of job loss is obtained by estimating the probability of non-employment as a function of the aggregate unemployment rate.[12] Each person is assigned to one of 64 specific demographic groups (based on two gender, two race, four age, and four education classifications). The impact of a rise in the state/year aggregate unemployment rate on the probability of non-employment for a member of that group is determined by 64 separate time-series probit estimations using observations from

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[11] Whereas higher-income families are more likely to have any savings at all to be able to help smooth consumption, Aaronson et al. (2018) suggest that lower-income families rely on credit to help smooth consumption in the event of a job loss. Of course, the longer term consequences of depleting savings or exhausting credit in the event of job loss is beyond the scope of this paper.
[12] Details of the estimation procedure and a sample of estimated marginal effects are provided in Appendix D. An increase in non-employment (either from unemployment or out of the labor force) will necessarily reflect job loss.

the March supplement of the Current Population Survey from the time period 2003-2013 with year and state fixed-effects.[13] We choose a 10-year period to average the marginal effects across the most recent business cycle prior to the years of analysis. For example, the smallest marginal effect of a one-percentage point increase in the aggregate unemployment rate was estimated to be a 0.056 percentage point decline in employment for white women, between 35 and 44 years old, with at least a college degree. Therefore, p_2 for a woman with these characteristics is set equal to 0.00056. The largest marginal impact was estimated to be a 2.4 percentage point employment decline for white men, between the ages of 18 and 34, with less than a high school degree. Therefore, p_1 for a man with this set of characteristics is set equal to 0.024. Given a set of estimated utility function parameters, and estimated probabilities of job loss, then, the family-specific impact on expected utility of a one-percentage point rise in the unemployment rate is given by equation (9).

The model does not explicitly depend on the labor market environment (i.e., what the prevailing aggregate unemployment rate is) at the time of optimization. The model specification assumes that whatever non-employment exists is optimal (or, within a random error term of optimal). This means that if some of the observed non-employment is technically unemployment, it's by choice – the person's market/offered wage is less than his/her reservation wage. This optimization can be thought of as taking place in the aggregate at the natural rate of unemployment. We estimate utility function parameters using data from 2015-2016, a period of time which most sources consider the economy to be at or near the natural rate of unemployment (for example, see Federal Reserve Bank of Philadelphia 2017). Therefore, this time period

[13] This procedure is similar to that employed by Gramlich (1974) in his assessment of the distributional consequences of unemployment.

provides an environment in which we can interpret observed non-employment behavior as near optimal.

3. Data

The Current Population Survey (CPS) is administered by the U.S. Bureau of Labor Statistics each month to roughly 60,000 households.[14] The survey has a limited 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 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 2015 and 2016 in order to construct the samples for which the family labor supply model is estimated. We combine as many months as possible across two years in order to construct a data set as large as possible to meet the demands of the challenging estimation problem. Detailed non-labor income is obtained by matching each family to their March supplement survey, which is the month in which this information is collected. Households that couldn't be matched to the March data are excluded from the analysis.

We restrict the sample further for two reasons. The first is for structural reasons to make the observations conform better to the theoretical model. These restrictions involve including only households with members between 18-64 years of age and excluding households with unmarried same- or opposite sex adults/partners or children older than 18 years old. It is unclear

[14] We obtained the CPS data set from IPUMS. See Flood et al. (2015).

in these households how to assign the "husband" and "wife" labels and potential additional adult labor supply is not accounted for in the model. We also exclude households in which the main activity of both members is being a student, being retired, or self-employment. We expect that those younger than 18, older than 64, students and retired individuals have additional constraints on their optimization problem not considered here. In addition, 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.

Because the simultaneous estimation of nonlinear labor supply functions is challenging, we also "trim" the data in various ways to eliminate outliers that cause difficulties in the estimation process. Less than five percent of the sample is eliminated based on the following restrictions: non-positive after-tax weekly household income, negative non-labor income, after-tax hourly wages greater than \$600 or less than \$0.50, or an estimated marginal tax rate 75 percent or higher or lower than -60 percent.

Information on the detailed sources of non-labor income, number of children, and earnings available from the CPS is used to calculate the marginal tax rate on earnings (wages) and the total tax liability (in any year of interest) using the National Bureau of Economic Research (NBER) TaxSim tax calculator. The calculator is more complete than we have information for from the CPS, so we made assumptions for the missing values as recommended by TaxSim managers. For example, there is no information in the CPS that would allow one to calculate itemized deductions (mortgage payments, charitable contributions, etc.), so values of zero are entered for the missing information. Although unlikely to affect tax rates, this will likely over-estimate taxes paid for higher income individuals, since they would likely receive a higher deduction through itemization.[15]

Appendix E contains the means for the full sample and for each sub-sample based on education, for married and single families (respectively). We have a total of 20,163 married families and 15,485 single families in our sample. Among married families, about 88 percent of husbands and nearly 70 percent of wives are working (with both percentages increasing in husband's education). Husbands work more hours (43) and earn a higher after-tax hourly wage ($21.33 after tax) than their wives, who work about 37 hours and earn $16.16 after tax. Husbands are slightly older than wives, at 45 vs. 43 years of age. Wives are slightly more educated than their husbands. The families have roughly $347 per week in (virtual) non-labor income. Virtual non-labor income is what the non-labor income for the family would be if the portion of the non-linear constraint they are on were extended to the vertical axis. The average federal (state) marginal tax rate across families is 20 percent (4 percent).

Women comprise 56 percent of the single persons sample. On average, women have slightly more education; are slightly younger than the men; work fewer hours (39 vs. 42 for single men); have about the same non-labor (virtual) income; have a greater number of children; and earn lower wages. The majority of singles have never been married (46 percent of women and 54 percent of men).

[15] http:// www.nber.org/~ taxsim/; see also Feenberg and Coutts (1993). In addition to the detailed income source information from the CPS data, we also include information on property tax, CPS imputed capital gains and capital losses. All married households are classified as if they were declaring taxes jointly and the main earner is identified as that with the highest total earned income. The tax simulation was implemented using the Stata taxsim interface.

4. Results

4.1. Utility Function Parameter Estimates and Labor Supply Elasticities

Maximum likelihood estimates of the utility function parameters for both married and single families are presented in Appendix F, along with the average labor supply elasticity and marginal utility estimates for married and single families. For purposes of placing the estimated elasticities in context of the literature, Figure 1 illustrates the intensive margin elasticities along with others' estimates of these elasticities. Note that own wage elasticities are averaged across workers and non-workers. It is well known that varying assumptions can produce a wide array of labor supply elasticities (see Mroz 1987); our estimates generally fall within the range of those found in the literature.

[Figure 1 about here]

Note that married women's own wage elasticities are higher than married men's elasticities, indicating that women's labor supply is more responsive to changes in their own wages. In addition, married women are more responsive to changes in their own wages than are single women, who average an own-wage elasticity very close to that of single men. The estimated negative cross-wage elasticities (among married families) indicate that husbands and wives view their non-market time as substitutes, which is consistent with the existing literature. Cross wage elasticities for husbands and wives correspond to families in which both members are working. Both men and women present the expected negative income elasticity. The bottom line from these estimates is that the simulation will be based on behavior reflected through labor supply elasticities consistent with those estimated by others, using different data, empirical models, and for different purposes. Appendix G provides a sensitivity analysis (discussed below) showing that our results are robust to variations in labor supply elasticities.

4.2. Expected Welfare Loss From a Shock to Unemployment

By dividing the calculated expected loss in welfare from a one-percentage point rise in the unemployment rate (in *utils*) by the family's marginal utility of income/consumption (U_3), we get a dollar value of that expected welfare loss. Table 1 reports the annualized dollar value for the expected welfare loss from a positive shock to unemployment for families of different types and education levels (the loss as a share of total household income is also reported).

[Table 1 about here]

Workers at higher education levels earn higher wages, putting upward pressure on the expected welfare loss from losing their job. For example, the average annual income for families with at least a college degree is roughly twice as large as families with less than a high school degree (i.e., roughly $87,000 vs. $42,000). Therefore, families with higher education (higher earnings) have much more to lose if they are hit by job loss.

However, a higher education level also means a lower probability of job loss, putting downward pressure on the expected welfare loss from rising unemployment. For example, a one percentage point rise in the unemployment rate increases the probability of job loss for someone with less than a college degree by 1.23 percentage points, whereas the marginal effect on someone with a college degree is only 0.54 percent points. Based on the results in Table 1, we see that, since the expected welfare loss increases with education, the impact of the potential of losing higher wages dominates the lower job loss probability. To better visualize the differences across families, the estimates in Table 1 are plotted for both married and single families in Figure 2 (panel a). The largest difference in estimates across both married and single families is that between the most and least educated, illustrating that the loss of income is likely dominating the higher probability of employment loss.[16]

[Figure 2 about here]

The average annualized expected welfare loss for the whole sample is $1,156. This estimate of expected welfare loss is much lower than that found in Hurd (1980), who estimates an individual welfare loss per unemployment spell of about $7,000 (in 2012 dollars). One reason Hurd's estimate is so much higher than ours is that we are estimating the *expected* welfare loss from losing a job, rather than the actual cost of a specific job loss. In addition, his model does not allow for any positive utility gained from additional non-market time that results from unemployment, nor the potential mitigating effects of unemployment insurance.[17]

There is a significant difference between single and married families (in both levels and as a percent of annual family income) -- the average expected welfare loss overall is $1,944 among married families, whereas the average annualized expected loss is only $131 among singles. To get some idea of where this sizable difference might be coming from, we decompose the change in welfare into each of its components: differences in non-employment probabilities, change in hours for each family member, change in total consumption, and changes in the marginal utilities (since we are moving families to a different point on their indifference curve). The results of this decomposition are found in Table 2. Note that the decomposition is performed for the average married and average single families, whereas the welfare losses reported in Table

[16] The very imprecise estimate of the welfare loss among college educated singles could likely be deriving from the estimated negative wage elasticity. Based on the literature, this is more likely to be found among high-earning workers, suggesting that the income effect from a wage change on hours dominates the substitution effect.
[17] To put this figure into perspective, a recent survey finds that 63 percent of Americans report they do not have enough savings to face an unexpected expense of $500 to $1,000 (Picchi 2016; also see Trubey 2016).

1 reflect the average loss across families (while the total loss estimates differ slightly, the relative comparison is the same).

[Table 2 about here]

There are four possible employment outcomes for married families and two possible employment outcomes for single families when the unemployment rate increases. The lowest probability of job loss occurs for women in the average married family, followed by the average single women, men in the average married family, and then the average single man. Regardless of family type, preferences behave has expected. When someone becomes non-employed (i.e., an increase non-market time and a decrease in income), the marginal value of their non-market time (U_1 and U_2) declines and the marginal value of consumption/income (U_3) increases. However, one remarkable difference between married families and single families is that whenever the husband loses his job, the family's marginal utility of his non-market time (U_1) declines so much it becomes negative -- there is a tremendous loss in welfare from the husband not working. In fact the average married family would pay to get the husband back into the workforce.

Note that concluding that the welfare *loss* from a one percentage point rise in the unemployment rate is greater for married families than for single families, and is greater for the more educated, does not say anything about the welfare *levels* of different family types or education levels.[18] Additionally, the losses estimated here from a rise in the unemployment rate

[18] In addition, welfare costs of a rise in the unemployment rate discussed here do not take into account the potential long term consequences of job loss on the mental and physical health of those impacted and/or their children or on lifetime wealth (for example, see Golberstein, Gonzales, and Meara 2016; Sullivan and Wachter 2009; Mathers and Schofield 1998; Krueger, Mitman, and Perri 2016; Gathmann et al. 2018). Nor does our estimate of the expected welfare cost of rising unemployment take into account any fear that families or individuals might have of losing their job (as DiTella, MacCulloch, and Oswald 2001 claim their survey of happiness does).

do not imply that an analogous decline in unemployment would generate a symmetric gain in welfare for families. In fact, De Neve et al. (2017) find that subjective well-being is more sensitive to negative economic conditions than to positive economic conditions. Further, the model in this paper is not well-suited to assess employment gains since it is predicated on the assumption of full employment.

4.3. Equivalent Welfare loss from an Unanticipated Loss in Purchasing Power

In order to illustrate how we simulate the loss in purchasing power needed to generate the same expected welfare loss of a one percentage point rise in the unemployment rate, the total derivatives in the indirect utility function from equation (3) $(dh_1^*, dh_2^*, and\ dC^*)$ are expanded and the terms are rearranged to isolate those reflecting changes in wages and non-labor income $(dw_1, dw_2, and\ dY)$:

$$dV = \left\{-U_1 \frac{\partial h_1}{\partial w_1} - U_2 \frac{\partial h_2}{\partial w_1} + U_3 \left[w_1 \frac{\partial h_1}{\partial w_1} + h_1 + w_2 \frac{\partial h_2}{\partial w_1}\right]\right\} dw_1$$

$$+ \left\{-U_1 \frac{\partial h_1}{\partial w_2} - U_2 \frac{\partial h_2}{\partial w_2} + U_3 \left[w_1 \frac{\partial h_1}{\partial w_2} + h_2 + w_2 \frac{\partial h_2}{\partial w_2}\right]\right\} dw_2$$

$$+ \left\{-U_1 \frac{\partial h_1}{\partial Y} - U_2 \frac{\partial h_2}{\partial Y} + U_3 \left[w_1 \frac{\partial h_1}{\partial Y} + 1 + w_2 \frac{\partial h_2}{\partial Y}\right]\right\} dY. \quad (10)$$

The only consumption price in our model is that of the numeraire price of consumption. Therefore, we can reflect a loss in purchasing power by changing the other components that enter the model in real dollars. Equation (10) shows how family welfare is affected by changes in wages and non-labor income, directly, and also through each person's labor supply elasticities. Of course, there are no cross-elasticities that enter the calculation in a single family's change in utility.

If prices increase by i, one dollar of income would only be able to buy $1/(1 + i)$ of any particular composite good. This implies that the value, or purchasing power, of wages and non-labor income declines by $-[i/(1+i)]$. Given that we are considering a one-time, unanticipated change in the level of prices, we assume that nominal wages are sticky over the same time period, thus there are no adjustments on wages or non-labor income over the horizon of analysis (e.g., see Kahn 1997), hence there is a decline in purchasing power by the same percent as the price increase.

Calculating the equivalent welfare cost from an unanticipated loss in purchasing power, then, amounts to finding the value of *i* that equates equation (9) and equation (10):

$$Exp\{dV|_{p_1>0, p_2>0}\} = \left\{-U_1 \frac{\partial h_1}{\partial w_1} - U_2 \frac{\partial h_2}{\partial w_1} + U_3 \left[w_1 \frac{\partial h_1}{\partial w_1} + h_1 + w_2 \frac{\partial h_2}{\partial w_1}\right]\right\}\left(-\frac{i}{1+i} * w_1\right)$$
$$+\left\{-U_1 \frac{\partial h_1}{\partial w_2} - U_2 \frac{\partial h_2}{\partial w_2} + U_3 \left[w_1 \frac{\partial h_1}{\partial w_2} + h_2 + w_2 \frac{\partial h_2}{\partial w_2}\right]\right\}\left(-\frac{i}{1+i} * w_2\right)$$
$$+\left\{-U_1 \frac{\partial h_1}{\partial Y} - U_2 \frac{\partial h_2}{\partial Y} + U_3 \left[w_1 \frac{\partial h_1}{\partial Y} + 1 + w_2 \frac{\partial h_2}{\partial Y}\right]\right\}\left(-\frac{i}{1+i} * Y\right). \quad (11)$$

In other words, *i* is the percent increase in the consumption price level that generates, for each family, the same expected change in utility as a one-percentage point rise in the aggregate unemployment rate. This one-time price level change will be able to tell us something about how the individual family views the trade-off between a rise in unemployment and a loss in purchasing power.

Table 3 presents the equivalent loss in purchasing power by marital status and education. For the full sample, the average equivalent loss in purchasing power is 1.82 percent (with a median of 0.83 percent). The results in Table 3 are also illustrated in Figure 2, (panel b). The unanticipated loss in purchasing power is much lower among single families at 0.30 percent (0.21 percent at the median). Since a one-percentage point rise in the unemployment rate is not as costly to them, singles, if given a choice, would not willingly endure as large a loss in purchasing power in order to avoid a rise in unemployment. If we interpret this valuation of an unanticipated loss in purchasing power as reflective of a short-term reaction to unanticipated inflation, this result is consistent with Burdett et al. (2016) who find that singles are much more likely to hold cash than non-singles, which loses value more quickly with inflation than other assets; they conclude that, "...inflation is a tax on being single" (p. 352).[19] Although they address the cost of inflation, and we simulate the cost from a loss in purchasing power, the lower estimated cost from a loss in purchasing power among singles is consistent with the conclusions of (Burdett et al. 2016), who find that inflation (which can be thought of as a loss in purchasing power *if* it affects prices and not wages) is more costly for singles because, "...being single is cash intensive" (p. 337); also see (Dong, Sun, and Wright 2015). In addition, Burdett et al. find that among the non-married, inflation is likely to be most costly to those who are widowed; we find the same, as illustrated in Table 3.

[Table 3 about here]

Another potential comparison for these results is the work by DiTella, MacCulloch, and Oswald (2001). Their analysis across countries and time finds that, "a 1-percentage-point increase in the unemployment rate equals the loss brought about by an extra 1.66 percentage points of inflation" (p. 339). Again, their analysis is quite different from the one presented here -- they estimate life satisfaction as a function of unemployment and inflation across many countries and time. And, although they do not provide the nuances seen here across demographics, their estimated inflation generated loss of happiness (or, welfare) equivalent to 1pp rise in the

[19] Note that inflation can be thought of as a loss in purchasing power *if* it affects prices and wages do not adjust (also see Aruoba, Davis, and Wright 2016; Dong, Sun, and Wright 2015). Other research (Alm, Whittington, and Fletcher 2002) has identified a tax on singles (relative to others with similar economic and demographic characteristics) through the structure of the U.S. tax system, however it is unclear how inflation or losses in purchasing power would make that worse.

unemployment rate is within the range of the equivalent loss in purchasing power presented in Table 3.

Appendix G contains the results from a sensitivity analysis for the equivalent loss in purchasing power presented in Table 3. For the full sample of married families, the alternate loss in purchasing power, using alternative elasticities found in the literature, range from a low of 2.69 to a high of 3.95 percent. For single men and women, there is no measurable difference in the estimates using alternative labor supply elasticities. The estimates presented here for the expected welfare cost of unemployment and its equivalent shock to purchasing power are clearly not being driven by differences found between our labor supply elasticities and those in the rest of the literature.

4.4. Unanticipated Loss in Purchasing Power vs. Unemployment Shock Trade-off

There is a rich literature that estimates the cost of inflation in terms of how much consumption one would be willing to give up to lower inflation (typically, by 10 percentage points). Estimates range between 0.5 percent and 10 percent (see Lagos, Rocheteau, and Wright, Forthcoming, for a review of estimates from the literature). The larger the estimate, the more consumption one would be willing to give up to reduce inflation. There is a large literature assessing the distributional effects of inflation (see Amaral for a review) suggesting that since inflation is not as costly to wealthy individuals, they would not be willing to give up as much consumption to avoid inflation. Or, inversely, they would be willing to endure greater inflation to avoid higher unemployment (potential loss to consumption).

Using results presented above, Figure 3 illustrates the shock to purchasing power that is equivalent to the welfare loss from a rise in unemployment, that welfare loss as a share of income (roughly, loss in consumption), and the ratio of the two across the income distribution.

The loss in purchasing power equivalent to the welfare lost from a one percentage-point rise in the unemployment rate (panel a) increases with income in the lower half of the income distribution, then basically flattens out. The expected welfare loss from an increase in unemployment, as a percent of income (panel b), also rises in the lower half of the income distribution, but then declines as income continues to rise.

[Figure 3 about here]

The ratio of the two (panel c) tells us how much loss in purchasing power a family would be willing to endure to avoid a one percentage point rise in unemployment. The ratio is increasing in income, indicating that higher income families are willing to endure a greater unanticipated loss in purchasing power to avoid a rise in unemployment; lower income families are not willing to endure as much loss in purchasing power to avoid the same thing.[20] This result is consistent with results from the literature summarized by Amaral (2017) -- lower income families are more cash dependent, and thus are hurt more from an unanticipated increase in inflation; higher income families are more likely to be borrowers, thus benefiting from an unanticipated increase in inflation; and families in the top quartiles rely more on earnings as an income source, thus making the potential loss of earnings through a rise in the unemployment rate more painful. While our consideration of an unanticipated loss in purchasing power is not the same thing as a rise in inflation, the short-term effect of a shock might be argued to have similar welfare implications.

[20] This comparison is made separately for married and single families in Appendix H. In spite of the dramatically different annualized dollar amount of expected loss from a one percentage point rise in the unemployment rate, and hence tolerance for unanticipated loss in purchasing power, the ratio of the two across the income distribution is similar across family types.

5. Conclusions and Policy Implications

Awareness of the personal or family welfare cost of a shock to unemployment and how that cost varies across families is of interest due to the distributional implications of policy that might affect the labor market. We find, on average, that the expected loss to family welfare of a one-percentage point rise in the aggregate unemployment rate is equivalent to an annualized dollar amount of $1,156. We also find a considerable amount of heterogeneity across families, which means that aggregate averages yield very different answers than looking more closely at population sub-groups. For example, the expected welfare cost of a shock to unemployment is much higher among married (vs. single) families and increases for both in education and income levels.

We also find that an unanticipated loss in purchasing power of about 1.8%, on average for all families, produces a welfare loss equivalent to that generated by a one percentage point shock to unemployment and is much lower for single families than for married families. On average singles would only be willing to trade a loss in purchasing power of roughly one-third of a percent to avoid a one percentage point rise in the unemployment rate, whereas married families would tolerate a loss in purchasing power of up to three percent to avoid the same degree of unemployment rate shock.

Additionally, we find that higher income families are willing to endure a greater unanticipated loss in purchasing power to avoid a rise in unemployment than lower income families. This conclusion holds for both married and single families, suggesting that, regardless of family structure and overall dollar equivalent value of the expected loss from a rise in the unemployment rate, the willingness to endure an unanticipated loss in purchasing power to avoid higher unemployment varies consistently across the income distribution.

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Table 1 Average welfare loss of a negative shock to employment by family type and education.

	Married Families	Single Families
All education types	$1,944 [$1,735-$2,197] 2.85%	$131 [$122-$141] 0.29%
Less than high school	$818 [$587-$1,230] 1.90%	$7 [$0-$57] 0.03%
High school	$1,501 [$1,244-$2,001] 2.47%	$94 [$78-$119] 0.25%
Some college	$1,769 [$1,488-$2,169] 2.55%	$184 [$158-$211] 0.46%
College or more	$2,970 [$2,382-$3,824] 3.30%	$1,039 [$349-$4,165] 2.04%
Single family type		
married, spouse-not-present		$153 [$128-$173] 0.32%
separated		$125 [$106-$140] 0.31%
divorced		$128 [$116-$138] 0.26%
widowed		$75 [$60-$87] 0.16%
never married		$139 [$125-$149] 0.32%

Note: Education refers to single head of household or husband education for married families. Full sample estimates are used to report results for the full sample and the education specific estimates are used to report results by education group. 95 percent confidence intervals are in brackets; they were obtained through bootstrapping with 199 repetitions. Percents reflect average across families of the welfare loss as share of total family income.

Table 2 Decomposition of the weekly welfare loss for the average married and average single family from a one percentage point increase in the aggregate unemployment rate.

	Average Married Family					Average Single Man			Average Single Woman		
	No job loss	Both husband and wife lose job	Husband loses job	Wife loses job	TOTAL	Single man does not lose job	Single man loses job	TOTAL	Single women does not lose job	Single women loses job	TOTAL
p	98.20%	0.01%	1.08%	0.72%		98.84%	1.16%		99.22%	0.78%	
dh_1^*	0	-37.80	-37.80	0		0	-34.06		--	--	
dh_2^*	0	-25.92	0	-25.92		--	--		0	-30.44	
dC^*	0	-967.63	-633.43	-334.20		0	-481.68		0	-384.00	
U_1	5.602	-14.96	-14.14	4.78		132.51	86.02		--	--	
U_2	4.221	0.56	3.59	1.19		--	--		67.57	39.72	
U_3	0.297	0.39	0.37	0.31		8.50	10.75		4.95	6.14	
$Exp\{dV\}$	0	-926.32	-769.93	-73.72	-8.92	0	-2,248.22	-26.08	0	-1,148.68	-8.96
$ equivalent	0	-$3,120	-$2,593	-$248	-$30	$0	-$209	-$3	$0	-$187	-$2
Annualized					-$1,562			-$160			-$94

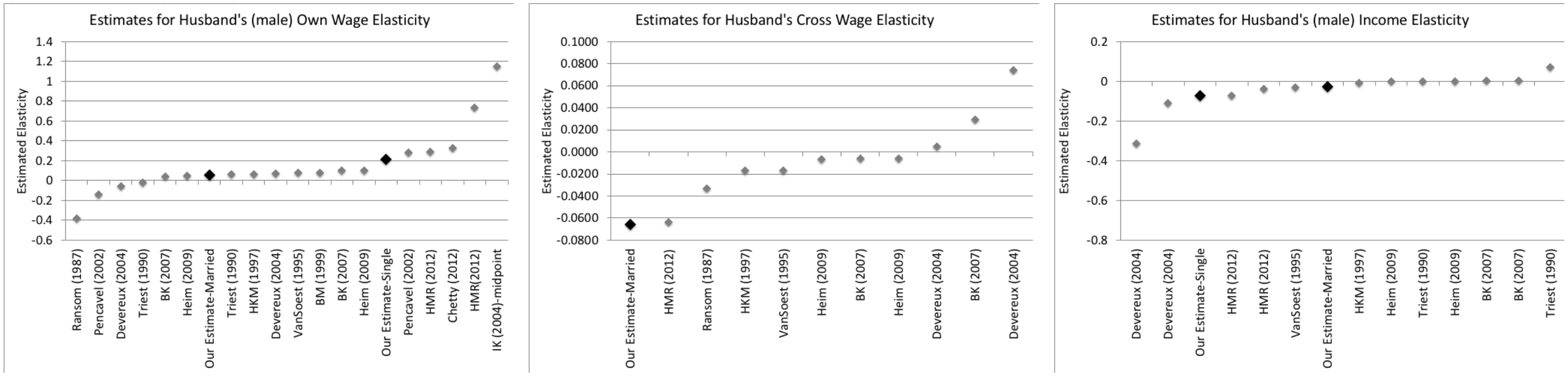
Note: Subscript "1" refers either to the husband, or single man; "2" refers to wife or single women. Notation corresponds to equations (3) and (9). $U_{1/2/3}$ correspond to the marginal utilities of the husband's/single man's non-market time, wife's/single woman's non-market time, and consumption, respectively. As an illustration of how the estimates in the table are used to construct $Exp\{dV\}$, consider the case of the average single man: $Exp\{dV\} = p_{jobloss}\{-U_1 dh_1^* + U_3 dC^*\} + p_{nojobloss}\{-U_1 * 0 + U_3 * 0\} = 0.9884\{-132.51 * 0 + 8.5 * 0\} + 0.0116\{-86.02 * (-34.06) + 10.75 * (-481.68)\} = -26.08$, where p is the probability of each outcome. This value is then divided by the marginal utility of consumption (U_3), under no job loss to get the weekly dollar equivalent of lost welfare.

Table 3 Average loss in purchasing power equivalent to the welfare loss from a rise in the unemployment rate by one percentage point, estimated by family type and education.

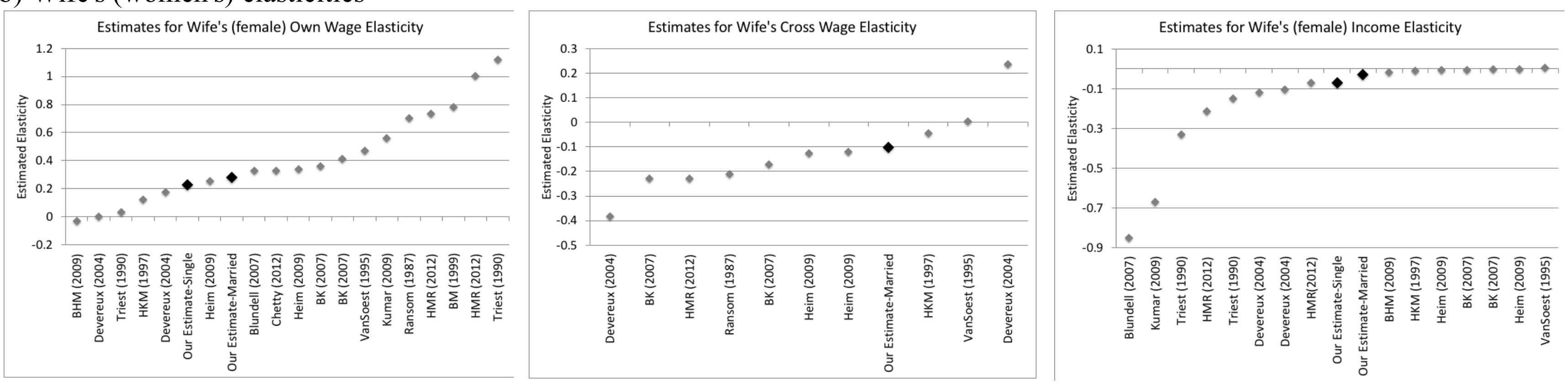
	Married Families	Single Families
All education types	2.98% [2.66%-3.44%]	0.30% [0.27%-0.33%]
Less than high school	2.58% [1.29%-4.05%]	0.11% [0%-0.39%]
High school	2.49% [2.01%-3.37%]	0.23% [0.17%-0.31%]
Some college	2.57% [2.14%-3.54%]	0.50% [0.41%-0.6%]
College or more	3.19% [2.54%-4.21%]	2.28% [0.76%-34.15%]
Single Family Types		
married, spouse-not-present		0.34% [0.29%-0.39%]
separated		0.30% [0.25%-0.35%]
divorced		0.28% [0.25%-0.3%]
widowed		0.18% [0.15%-0.2%]
never married		0.33% [0.29%-0.37%]

Note: Education refers to single head of household or husband education for married families. Full sample estimates are used to report results for the full sample and the education specific estimates are used to report results by education group. 95 percent confidence intervals are in brackets; they were obtained through bootstrapping with 199 repetitions.

Figure 1 Comparison of intensive margin elasticity estimates with the literature.
(a) Husband's (men's) elasticities



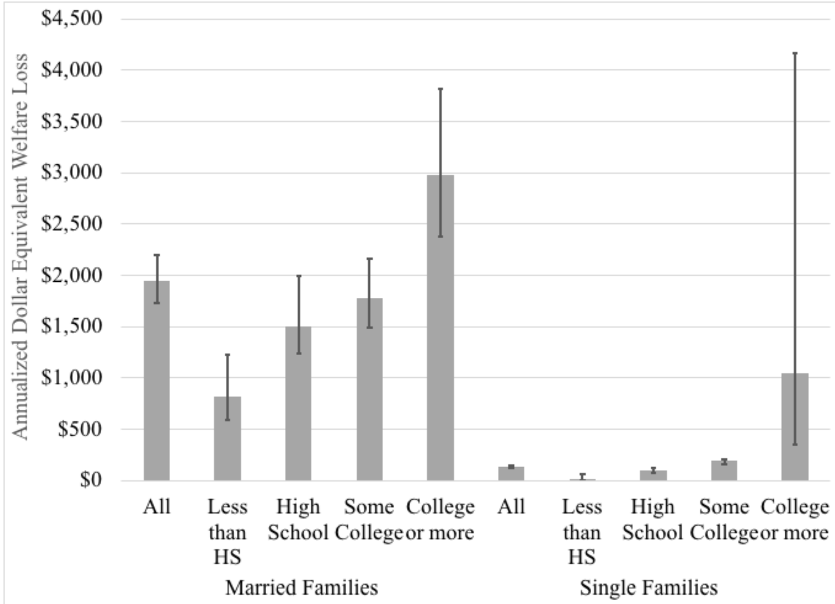
(b) Wife's (women's) elasticities



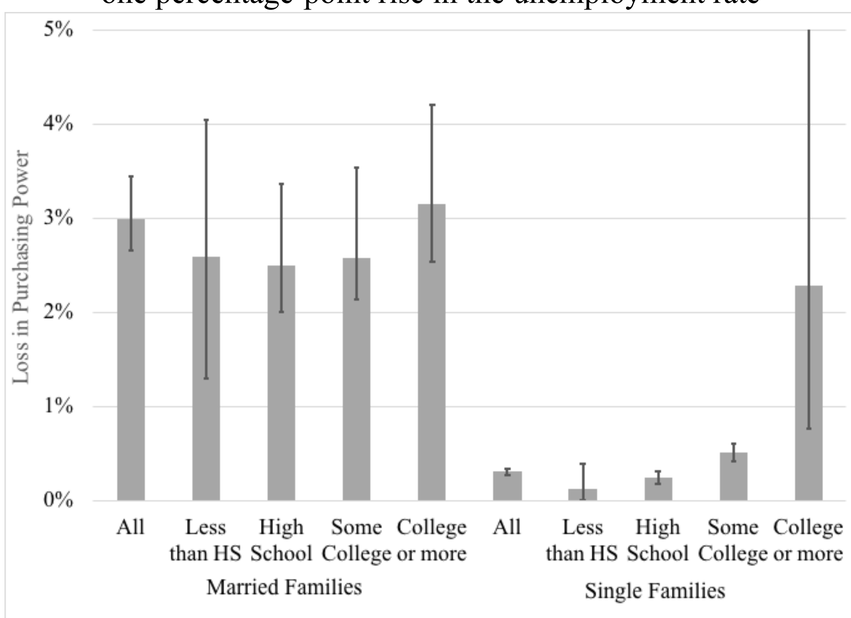
Notes: Sources of literature estimates are (Devereux 2004; Hotchkiss, Moore, and Rios-Avila 2012; Hotchkiss, Kassis, and Moore 1997; Heim 2009; Blau and Kahn 2007; Triest 1990; Pencavel 2002; Ransom 1987; Blundell and Macurdy 1999; Kumar 2009; Bishop, Heim, and Mihaly 2009; Imai and Keane May2004; Chetty 2012; van Soest 1995). Also see Keane (2011) and McClelland and Mok (2012) Many fewer sources provide estimates for participation elasticities, but ours fall within the literature bounds (available upon request).

Figure 2 Graphical representation of the annualized welfare loss and equivalent loss in purchasing power arising from a one percentage point rise in the aggregate unemployment rate.

(a) Annualized dollar equivalent welfare loss by family type



(b) Loss in purchasing power equivalent to welfare loss from a one percentage-point rise in the unemployment rate



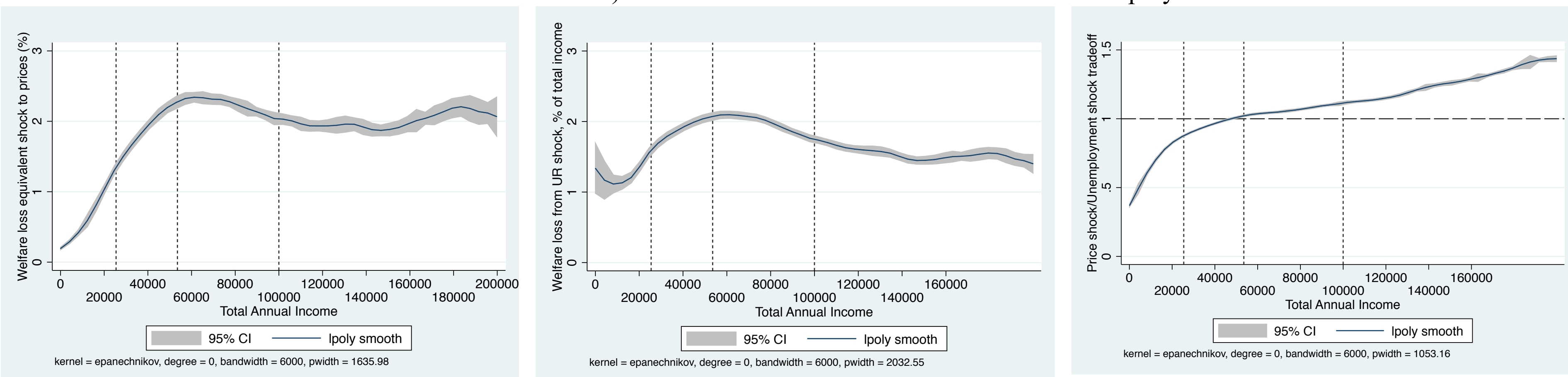
Note: See notes to Table 1.

Figure 3 Comparing welfare losses from a price shock vs. an unemployment shock across the income distribution, full sample averages.

(a) Welfare loss from equivalent loss in purchasing power

(b) Welfare loss from 1pp increase in the aggregate unemployment rate (% of total income)

(c) Ratio of welfare loss from loss in purchasing power vs. welfare loss from unemployment shock



Note: Percent of the sample noted by dashed lines at maximum household income for those in the bottom 20%, the sample median, and the min household income for those in the top 20%. Comparable 2015 median household incomes reported for the U.S. by the Census Bureau can be found here: https://goo.gl/XkzVMR.

Supplemental Online Appendices for

Cost of Policy Choices: A Microsimulation Analysis of the Impact on Family Welfare of Unemployment and Price Changes

Appendix A: Estimation Issues -- obtaining reasonable labor supply elasticities

The simulations detailed in Section 2 are only possible to the extent to which we are able to obtain realistic estimates of labor supply elasticities through which the change in family welfare is calculated. This appendix discusses a number of issues well-known to the literature related to the estimation of those labor supply elasticities and the implications of those issues to the problem at hand. Many of the caveats, warnings, solutions, and implications related to this specific model were first detailed in Hotchkiss et al (2012).

First of all, the stochastic errors accounted for in equation (7) represent errors in optimization -- observed hours do not exactly reflect desired hours. Keane (2011) 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, restricting the sample to hourly workers reduces the sample size too much. Instead, we construct the person's hourly wage using information about weekly earnings and usual weekly hours. 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 (2011) 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 and Herrnstein and Murray 1994). In addition, we abstract from the progressivity of the tax structure by using net wages and "linearizing" the budget constraint (see Hall 1973), which is valid if preferences are strictly convex. 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. It should also be pointed out that assuming a linear budget constraint is for empirical simplification only. The ultimate test of the generated bias is if the model produces labor supply elasticities in line with existing literature. The accomplishment of this goal is illustrated in Figure 1.

This assumption of strictly convex preferences can be tested by analyzing the second order conditions of the maximization problem, which are akin to the internal consistency conditions established by (Amemiya 1974, 1006). Using the nomenclature presented in equations 5 and 6, the conditions imply that $\Omega_1 < 0$; $\Omega_4 < 0$ and $\Omega_1\Omega_4 > \Omega_2 * \Omega_2$, which are found to be true for all the models estimated here. If this assumption is binding, Keane points out that labor supply elasticities will be biased in a negative direction. Aaronson and French (2009) illustrate only a very slight downward bias when progressivity of the tax system is not taken into account.

An additional concern Keane (2011) 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* (e.g., controlling for 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).

As is seen in Figure 1 of the paper, the simplifications that we've made because of the complexity of the model do not harm our goal of obtaining reasonable labor supply elasticities with which to perform the simulations in this paper.

Appendix B: First order conditions of utility maximization problem and labor supply equations.

The quadratic functional form as presented in equation (4) 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 $L_1 = T - h_1; L_2 = T - h_2; and, C = w_1h_1 + w_2h_2 + Y$

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:

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

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

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:

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

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

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

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

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

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

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

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

$$h_1^* = \frac{\Omega_3\Omega_4 - \Omega_2\Omega_5}{\Omega_2^2 - \Omega_1\Omega_4} \quad \text{and} \quad h_2^* = \frac{\Omega_1\Omega_5 - \Omega_2\Omega_3}{\Omega_2^2 - \Omega_1\Omega_4} \ . \tag{B11}$$

These derivatives are obtained with the help of Mathematica® (version 8 2010). We calculate expected hours conditional on being positive according to Muthen (1990).

Appendix C: Unemployment Insurance eligibility, take-up, and benefit amounts.

Expected weekly benefit allowance from UI is simulated using published eligibility and benefit rules published by the Employment and Training Administration (http://www.unemploymentinsurance.doleta.gov/unemploy/statelaws.asp#Statelaw). See Chetty 2008), Cullen and Gruber (2000), and Edwards (2015) for other applications of this simulation procedure. The simulation requires us to know details of the recipient's earnings history that are not available from the cross-section used for analysis here. Consequently, we assume that current weekly earnings reflect the earnings history for the person losing their job and use that amount to estimate base period and quarterly earnings used to calculate benefits and eligibility. It's not clear whether using current earnings will over- or under-estimate eligibility and benefits.

It is well known that only a fraction of those eligible for UI actually "take-up" the benefit (Blank and Card 1991; Currie 2006). Take-up rates are estimated to be anywhere between 40-55 percent (Anderson and Meyer 1997) and 80 percent (Ebenstein and Stange 2010, using aggregate state level data), and varies over time (Michaelides and Mueser 2012) and across the business cycle (Fuller, Ravikumar, and Zhang 2012; Kettemann 2014). Take-up rates have also been shown to vary by demographics (Michaelides and Mueser 2012) and by benefit amount, tax rates, and expected duration (Anderson and Meyer 1997). We make use of the take-up rate of 55 percent estimated by Anderson and Meyer since it is estimated based on individual level data and we also vary the take-up rate based on their estimated benefit amount (WBA) elasticity of 0.0225. Along the distribution of estimated WBAs (separately for men and women), we set the take-up rate at 0.55 for the median WBA (WBA_m), then use the following formula for eligible recipient *i* as his/her simulated WBA_i differs from the median value:

$\tau_i = 0.55 + 0.0225 * \left[\frac{WBA_i - WBA_m}{WBA_i}\right]$. τ_i is restricted to fall between zero and one.

Appendix D: Estimating the marginal effect of a rise in the aggregate unemployment rate on the probability of non-employment.

This appendix contains details of the estimating procedure used to generate the marginal impact of a rise in the state/year aggregate unemployment rate (UR_{sy}) on the probability of non-employment for each of the 64 separate demographic groups. The following equation is estimated separately via maximum likelihood probit for individuals (*i*) in each gender (*g*), race (*r*), age (*a*), and education (*e*) group in state, *s* in year *y*:

$$Prob[nonemployed = 1]_{igraesy} = \alpha_0 + \alpha_1 UR_{sy} + s_i + y_i + \varepsilon_{igraes} \,, \qquad (1)$$

where s_i and y_i are the state and year, respectively in which individual *i* is observed and ε_{graes} is distributed as a standard normal random variable. Table D1 contains just a sample of parameter estimates and marginal effects obtained for just a few of the demographic groups. The full set of results is available upon request.

Table D1. Sample of results from probit estimation relating the probability of non-employment to the state level unemployment rate.

Estimated Parameter Coefficients						Demographic Group			
State Unempl Rate		Constant Term		Obs.	Marginal Effect	Sex	Race	Age	Ed
Estimate	St. Err.	Estimate	St. Err.						
0.0628***	(0.00327)	-0.772***	(0.0241)	35,767	0.0237	1	1	1	1
0.00190	(0.00321)	-0.790***	(0.0232)	48,562	0.00056	2	1	2	4
0.0568***	(0.00502)	-0.701***	(0.0374)	15,750	0.0216	1	2	1	2
0.0319***	(0.00335)	-0.749***	(0.0246)	38,802	0.0111	2	1	3	2
0.0235***	(0.00625)	-0.621***	(0.0455)	10,421	0.00844	2	2	2	2

Notes: Sex=1 if male, 2 if female; Race=1 if white; 2 if non-white; Age groups are 1 for 18-34, 2 for 35-44, 3 for 45-54, and 4 for 55-64; Education groups are 1 for less than high school, 2 for high school, 3 for some college, and 4 for college and above. Marginal effect reflects the impact on the probability of nonemployment from a one percentage point change in the unemployment rate. ***, **, * => statistically significant at the 99, 95, and 90 percent confidence level.

Appendix E: Sample means and labor supply elasticity parameters

Table E1 Sample means for married families, combined 2015-16 CPS observations.

	Full Sample	Husband Less Than High School	Husband High School	Husband Some College	Husband College and Above
Number of Married Families	20,163	1,502	5,401	5,233	8,027
Husband Average Characteristics					
Husband working = 1	88.10%	76.70%	84.50%	86.60%	93.60%
Husband gross wage (w1), incl. imputed	$28.90	$16.26	$21.94	$25.16	$38.38
Husband after-tax wage	$21.33	$13.45	$17.15	$18.99	$27.13
Husband hours (h1), if working	42.9	41.1	42.2	42.7	43.8
Husband age	44.5	44.2	45.2	44.8	43.8
Husband Non White = 1	25.5%	57.5%	26.3%	22.2%	21.1%
Husband Less than High School = 1	7.4%				
Husband High School = 1	26.8%				
Husband Some College = 1	26.0%				
Husband College and Above = 1	39.8%				
Wife Average Characteristics					
Wife working = 1	69.70%	49.10%	68.10%	72.90%	72.60%
Wife wage (w2), incl. imputed	$21.98	$11.08	$17.46	$21.09	$27.63
Wife after-tax wage	$16.16	$9.06	$13.53	$15.85	$19.46
Wife hours (h2), if working	37.2	36.2	37.3	37.2	37.2
Wife age	42.6	41.8	43.2	43.0	42.0
Wife Non White = 1	26.0%	56.3%	26.4%	22.0%	22.5%
Wife Less than High School = 1	6.0%	46.7%	6.0%	2.6%	0.5%
Wife High School = 1	23.0%	29.1%	49.0%	19.5%	6.6%
Wife Some College = 1	27.4%	18.4%	27.8%	46.1%	16.5%
Wife College and Above = 1	43.7%	5.8%	17.2%	31.8%	76.4%
Family Average Characteristics					
Weekly net non-labor (virtual) inc. (Y)	347.13	248.12	291.53	344.15	405.01
Number of children less 0-5	0.38	0.41	0.31	0.34	0.44
Number of children less 6-12	0.46	0.61	0.44	0.42	0.47
Number of children less 13-18	0.31	0.40	0.31	0.30	0.30
Federal marginal tax rate	19.55	12.35	16.54	18.84	23.38

State marginal tax rate	4.27	2.98	3.99	4.33	4.65

Table E2 Sample means for single families, combined 2015-16 CPS observations.

	Full Sample	Less Than High School	High School	Some College	College and Above
Number of Single Men	6,877	644	2,138	1,998	2,097
Working = 1	81.60%	56.10%	76.30%	83.20%	93.30%
Gross wage (w1), incl. imputed	$22.73	$10.70	$17.20	$21.42	$33.29
After-tax wage	$17.41	$9.10	$13.84	$16.62	$24.34
Hours (h1), if working	41.7	40.0	41.0	41.3	43.1
Age	44.7	48.1	45.2	45.1	42.8
Non White = 1	29.8%	48.6%	30.7%	27.0%	25.6%
Less than High School = 1	9.4%				
High School = 1	31.1%				
Some College = 1	29.1%				
College and Above = 1	30.5%				
Single Status					
married, spouse absent	3.8%	3.9%	3.2%	2.7%	5.3%
separated	6.0%	11.3%	6.7%	5.8%	4.0%
divorced	33.8%	34.0%	34.9%	40.1%	26.6%
widowed	2.9%	5.4%	3.3%	2.6%	2.0%
never married	53.5%	45.3%	51.9%	48.8%	62.2%
Weekly net non-labor (virtual) income (Y)	$195.51	$152.56	$170.68	$195.04	$234.46
Number of children less 0-5	0.02	0.02	0.02	0.02	0.01
Number of children less 6-12	0.05	0.04	0.04	0.05	0.05
Number of children less 13-18	0.06	0.05	0.06	0.07	0.07
Federal marginal tax rate	14.80	4.76	11.74	15.07	20.76
State marginal tax rate	3.51	1.87	3.12	3.63	4.30
Number of Single Women	8,608	763	2,061	2,810	2,974
Working = 1	78.50%	47.70%	67.80%	79.40%	92.90%
Gross wage (w1), incl. imputed	$19.92	$8.62	$12.68	$18.04	$29.63
After-tax wage	$15.90	$8.24	$11.11	$14.92	$22.11
Hours (h1), if working	38.8	35.3	36.8	38.3	40.7
Age	44.5	45.7	44.5	45.1	43.7
Non White = 1	36.5%	59.4%	43.9%	35.2%	26.7%

Less than High School = 1	8.9%				
High School = 1	23.9%				
Some College = 1	32.6%				
College and Above = 1	34.5%				
Single Status					
married, spouse absent	3.5%	4.2%	4.0%	2.8%	3.6%
separated	6.8%	12.7%	8.1%	6.8%	4.4%
divorced	36.9%	26.6%	34.9%	43.1%	35.1%
widowed	7.1%	11.4%	9.1%	6.9%	4.8%
never married	45.7%	45.1%	44.0%	40.4%	52.0%
Weekly net non-labor (virtual) income (Y)	$196.36	$169.91	$173.13	$185.53	$229.49
Number of children less 0-5	0.13	0.23	0.20	0.13	0.07
Number of children less 6-12	0.24	0.32	0.26	0.28	0.16
Number of children less 13-18	0.21	0.28	0.23	0.24	0.16
Federal marginal tax rate	10.08	-4.72	3.43	9.85	18.71
single women with children	4.04	-12.51	-2.94	5.68	16.29
single women without children	12.95	0.19	7.16	12.21	19.46
State marginal tax rate	2.99	0.57	2.10	3.07	4.14
single women with children	2.46	0.30	1.54	2.70	4.02
single women without children	3.24	0.74	2.43	3.28	4.18

Appendix F: Maximum likelihood estimation results, labor supply elasticities, and estimated marginal utilities.

Table F1 Maximum likelihood parameter estimates for married families.

	Full Sample	Husband Less Than High School	Husband High School	Husband Some College	Husband College or More
a1: Husband					
Age	2.122*	2.013*	1.991*	2.675*	2.033*
	(0.120)	(0.550)	(0.251)	(0.245)	(0.178)
Age^2	-0.0278*	-0.0290*	-0.0277*	-0.0341*	-0.0255*
	(0.00135)	(0.00629)	(0.00284)	(0.00275)	(0.00199)
Black	-2.356*	3.015+	-3.472*	-3.977*	-1.785*
	(0.332)	(1.428)	(0.726)	(0.710)	(0.445)
Education (excluded=Less than High School)					
High School	5.245*				
	(0.574)				
Some College	7.107*				
	(0.586)				
College	11.89*				
	(0.605)				
nkids 0-5	-0.169	1.980^	-0.296	0.0281	-0.535^
	(0.243)	(1.098)	(0.588)	(0.516)	(0.303)
nkids 6-12	0.0112	1.310	-0.0943	-0.453	-0.312
	(0.202)	(0.853)	(0.450)	(0.428)	(0.270)
nkids 13-18	1.041*	2.257+	0.626	0.381	0.924*
	(0.243)	(1.025)	(0.532)	(0.514)	(0.325)
Constant	-7.440*	-13.04	0.668	-14.02*	6.614^
	(2.579)	(11.62)	(5.218)	(5.148)	(3.805)
a2: Wife					
Age	0.462*	0.00951	0.485*	0.921*	0.325*
	(0.0503)	(0.111)	(0.123)	(0.164)	(0.0566)
Age^2	-0.00631*	-0.000618	-0.00668*	-0.0119*	-0.00434*
	(0.000627)	(0.00131)	(0.00150)	(0.00200)	(0.000716)
Black	-0.806*	0.215	-1.454*	0.0779	-0.712*
	(0.120)	(0.313)	(0.353)	(0.334)	(0.130)
Education (excluded=Less than High School)					
High School	2.430*	0.497	3.821*	2.753*	0.871
	(0.277)	(0.351)	(0.779)	(0.984)	(0.550)

	Full Sample	Husband Less Than High School	Husband High School	Husband Some College	Husband College or More
Some College	3.098*	0.742^	5.090*	4.296*	0.862
	(0.311)	(0.427)	(0.931)	(1.061)	(0.540)
College	3.883*	-1.507+	5.991*	6.539*	1.461*
	(0.357)	(0.721)	(1.081)	(1.288)	(0.558)
nkids 0-5	-1.511*	-0.0800	-1.857*	-2.318*	-0.970*
	(0.135)	(0.262)	(0.348)	(0.390)	(0.148)
nkids 6-12	-0.727*	-0.130	-0.793*	-0.846*	-0.551*
	(0.0855)	(0.198)	(0.216)	(0.233)	(0.0969)
nkids 13-18	-0.0676	0.835*	0.285	-0.310	-0.212*
	(0.0803)	(0.256)	(0.226)	(0.250)	(0.0803)
Constant	-7.282*	-7.423*	-11.43*	-14.30*	-3.239*
	(0.945)	(2.765)	(2.672)	(3.106)	(1.071)
a3	0.524*	1.408*	0.852*	0.623*	0.286*
	(0.0308)	(0.254)	(0.0920)	(0.0699)	(0.0274)
b12	0.0298*	0.00427	-0.0469^	0.0401	0.0399+
	(0.00918)	(0.0265)	(0.0265)	(0.0254)	(0.0160)
b13	-0.00264*	-0.00331^	-0.00383*	-0.00159*	-0.00238*
	(0.000202)	(0.00174)	(0.000587)	(0.000449)	(0.000212)
b22	0.231*	0.139*	0.332*	0.389*	0.126*
	(0.0166)	(0.0256)	(0.0431)	(0.0500)	(0.0178)
b23	-0.000207+	0.000822	-0.000531	-0.000185	-0.000109^
	(0.0000882)	(0.000778)	(0.000354)	(0.000276)	(0.0000650)
b33	0.0000792*	0.000500*	0.000143*	0.000108*	0.0000338*
	(0.00000670)	(0.000127)	(0.0000233)	(0.0000168)	(0.00000505)
drho	0.0219^	0.124*	0.0825*	0.00210	-0.0281
	(0.0117)	(0.0470)	(0.0230)	(0.0228)	(0.0183)
s1	17.94*	22.52*	19.58*	19.16*	15.10*
	(0.0993)	(0.505)	(0.216)	(0.211)	(0.126)
s2	23.94*	27.69*	24.29*	22.63*	23.61*
	(0.156)	(0.822)	(0.311)	(0.281)	(0.237)
N	20163	1502	5401	5233	8027
LL	-149921.9	-9517.4	-39636.0	-39446.3	-60673.0

Notes: Standard errors are in brackets. *, +, ^ => significant at the 99, 95, and 90 percent confidence levels, respectively.

Table F2 Maximum likelihood parameter estimates for single families.

	Single Males					Single Females				
	Full Sample	Less Than High School	High School	Some College	College or More	Full Sample	Less Than High School	High School	Some College	College or More
Marital Status (excluded=Never married)										
Spouse absent	21.40*	94.46^	21.25+	25.72^	0.446	3.702	3.554	3.544	2.256	-0.315
	(5.966)	(57.42)	(9.477)	(15.60)	(2.096)	(3.325)	(7.159)	(6.481)	(6.106)	(2.139)
Separated	10.22+	-32.38	7.203	19.72+	7.576*	-3.184	-8.177^	0.952	-2.573	-4.610+
	(4.302)	(30.14)	(6.621)	(9.609)	(2.530)	(2.403)	(4.790)	(4.837)	(4.027)	(2.021)
Divorced	12.12*	0.444	11.92*	17.90*	0.530	4.520*	-2.038	6.888+	3.102	0.559
	(2.639)	(15.80)	(4.070)	(6.201)	(1.226)	(1.499)	(3.982)	(3.150)	(2.447)	(0.974)
Widow	10.30^	-47.58	8.498	21.21	2.719	0.686	3.945	6.625	-6.003	-9.042*
	(6.160)	(50.20)	(9.247)	(14.17)	(3.410)	(2.458)	(5.251)	(4.765)	(4.245)	(1.933)
age	1.352+	-12.11	-1.143	4.471*	1.416*	-0.510	-0.725	-2.641*	-0.424	1.227*
	(0.661)	(7.582)	(0.982)	(1.574)	(0.347)	(0.408)	(0.955)	(0.856)	(0.699)	(0.294)
agesq	-0.0336*	0.138	-0.00427	-0.0768*	-0.0202*	-0.00319	0.00507	0.0220+	-0.00582	-0.0171*
	(0.00791)	(0.0882)	(0.0115)	(0.0204)	(0.00410)	(0.00466)	(0.0109)	(0.00974)	(0.00798)	(0.00335)
Non-White	-5.070+	16.45	-3.651	-5.206	-2.065^	-3.638*	6.512+	-4.878^	-5.918*	-1.297
	(2.222)	(16.00)	(3.483)	(4.671)	(1.064)	(1.287)	(3.049)	(2.727)	(2.188)	(0.878)
Education (excluded=LTH)										
High School	15.03*					9.526*				
	(3.321)					(1.987)				
Some College	23.46*					22.23*				
	(3.830)					(2.247)				
College and Grad School	52.76*					43.59*				
	(5.938)					(3.240)				
# Children 0-5	14.91+	107.1	18.68+	-1.479	-5.527	-5.018*	-4.051	-6.390+	-6.461*	-4.150*
	(6.082)	(67.79)	(8.733)	(11.71)	(5.174)	(1.375)	(2.806)	(2.603)	(2.490)	(1.305)

	Single Males					Single Females				
	Full Sample	Less Than High School	High School	Some College	College or More	Full Sample	Less Than High School	High School	Some College	College or More
# Children 6-12	6.124	26.29	2.360	0.923	-0.0249	3.447*	-2.585	6.914*	2.212	-1.371
	(4.010)	(36.45)	(6.623)	(7.448)	(1.865)	(1.089)	(2.024)	(2.465)	(1.775)	(0.883)
# Children 13-18	12.97*	-7.111	12.63+	18.29+	-0.963	6.916*	1.791	6.267+	5.853*	-0.525
	(3.870)	(36.37)	(6.168)	(7.949)	(1.529)	(1.311)	(2.555)	(2.753)	(2.185)	(0.891)
_cons	-22.17	3.565	32.16^	-36.09	22.66*	9.548	-44.26+	30.90^	51.71*	20.40*
	[11.97]	[891.1]	[58.27]	[13.63]	[7.575]	[13.94]	[68.88]	[19.18]	[43.88]	[6.841]
a3	12.88*	53.51^	12.05*	13.16*	0.503*	7.452*	12.03*	10.15*	5.030*	0.924*
	(1.223)	(28.67)	(1.672)	(3.035)	(0.194)	(0.459)	(1.172)	(1.113)	(0.711)	(0.197)
b12	-0.122*	-0.314	-0.104*	-0.146*	-0.00649*	-0.0658*	0.0286+	-0.0561*	-0.0586*	-0.00865*
	(0.0144)	(0.220)	(0.0199)	(0.0378)	(0.00237)	(0.00607)	(0.0137)	(0.0144)	(0.0103)	(0.00228)
b22	0.00070*	0.00956+	0.000245	-0.000236	0.000049	0.00098*	0.0110*	0.00212*	0.000239	0.00015*
	(0.00018)	(0.00392)	(0.00036)	(0.00034)	(0.00003)	(0.00014)	(0.00177)	(0.00064)	(0.00014)	(0.00004)
sigma1	18.87*	19.66*	20.30*	18.74*	15.70*	19.32*	24.29*	22.46*	20.45*	14.73*
	(0.187)	(0.777)	(0.379)	(0.341)	(0.257)	(0.177)	(1.001)	(0.463)	(0.327)	(0.203)
ll	-25598.0	-1692.3	-7672.8	-7577.8	-8371.8	-31297.9	-1830.1	-6844.9	-10531.3	-11669.0
N	6877	644	2138	1998	2097	8608	763	2061	2810	2974

Notes: Standard errors are in brackets. *, +, ^ => significant at the 99, 95, and 90 percent confidence levels, respectively.

Table F3 Estimated elasticities and marginal utilities, married and single families.

	Full Sample	Husband (or single head) LT HS	Husband (or single head) HS	Husband (or single head) Some College	Husband (or single head) College+
Husband Elasticities					
Own wage elasticity	0.052	0.142	0.093	0.096	-0.003
	[0.036 to 0.058]	[0.09 to 0.157]	[0.057 to 0.104]	[0.062 to 0.108]	[-0.022 to 0.005]
Cross wage elasticity	-0.066	-0.081	-0.054	-0.055	-0.063
	[-0.07 to -0.056]	[-0.111 to -0.038]	[-0.067 to -0.035]	[-0.069 to -0.035]	[-0.071 to -0.048]
Income elasticity	-0.027	-0.034	-0.033	-0.023	-0.025
	[-0.03 to -0.022]	[-0.046 to -0.011]	[-0.04 to -0.022]	[-0.026 to -0.013]	[-0.027 to -0.018]
Participation own wage elasticity	0.009	0.071	0.023	0.018	0.000
	[0.006 to 0.01]	[0.041 to 0.076]	[0.014 to 0.025]	[0.011 to 0.021]	[-0.001 to 0]
Participation cross wage elasticity	-0.010	-0.045	-0.014	-0.011	-0.003
	[-0.011 to -0.008]	[-0.058 to -0.019]	[-0.018 to -0.008]	[-0.014 to -0.006]	[-0.003 to -0.002]
Participation income elasticity	-0.004	-0.017	-0.009	-0.005	-0.001
	[-0.005 to -0.003]	[-0.022 to -0.005]	[-0.012 to -0.005]	[-0.006 to -0.002]	[-0.002 to -0.001]
Wife Elasticities					
Own wage elasticity	0.281	0.676	0.294	0.243	0.259
	[0.27 to 0.304]	[0.638 to 0.831]	[0.277 to 0.366]	[0.225 to 0.295]	[0.239 to 0.304]
Cross wage elasticity	-0.102	-0.168	-0.081	-0.080	-0.106
	[-0.116 to -0.09]	[-0.222 to -0.118]	[-0.111 to -0.055]	[-0.107 to -0.057]	[-0.129 to -0.083]
Income elasticity	-0.029	-0.064	-0.033	-0.026	-0.027
	[-0.036 to -0.025]	[-0.088 to -0.045]	[-0.044 to -0.022]	[-0.04 to -0.016]	[-0.038 to -0.021]
Participation own wage elasticity	0.192	1.066	0.216	0.141	0.160
	[0.182 to 0.21]	[0.962 to 1.418]	[0.199 to 0.281]	[0.124 to 0.184]	[0.145 to 0.195]
Participation cross wage elasticity	-0.068	-0.239	-0.057	-0.046	-0.065
	[-0.081 to -0.058]	[-0.421 to -0.13]	[-0.086 to -0.035]	[-0.065 to -0.028]	[-0.087 to -0.048]
Participation income elasticity	-0.019	-0.090	-0.025	-0.014	-0.016

	Full Sample	Husband (or single head) LT HS	Husband (or single head) HS	Husband (or single head) Some College	Husband (or single head) College+
	[-0.026 to -0.015]	[-0.16 to -0.041]	[-0.038 to -0.013]	[-0.026 to -0.007]	[-0.026 to -0.011]
Married Families Marginal Utilities					
MU wrt husband's non-market time	5.611	11.198	8.507	7.020	2.926
	[4.452 to 6.044]	[6.034 to 11.678]	[5.459 to 9.081]	[4.696 to 7.4]	[1.765 to 3.14]
MU wrt wife's non-market time	4.226	7.709	6.620	5.714	2.081
	[3.342 to 4.571]	[4.152 to 7.933]	[4.233 to 7.036]	[3.799 to 5.994]	[1.245 to 2.22]
MU wrt income	0.297	0.928	0.534	0.405	0.119
	[0.235 to 0.32]	[0.486 to 0.953]	[0.345 to 0.572]	[0.269 to 0.424]	[0.071 to 0.127]
Single Men Elasticities and MUs					
Own wage elasticity	0.22	0.92	0.39	0.18	-0.05
	[0.18 to 0.25]	[0.82 to 1.2]	[0.31 to 0.47]	[0.14 to 0.22]	[-0.08 to -0.01]
Income elasticity	-0.072	-0.136	-0.062	-0.067	-0.023
	[-0.077 to -0.067]	[-0.197 to -0.107]	[-0.073 to -0.053]	[-0.076 to -0.059]	[-0.041 to -0.009]
Participation own wage elasticity	0.032	0.518	0.098	0.025	-0.002
	[0.026 to 0.038]	[0.265 to 0.833]	[0.066 to 0.127]	[0.019 to 0.034]	[-0.003 to 0]
Participation income elasticity	-0.010	-0.049	-0.013	-0.009	-0.001
	[-0.011 to -0.008]	[-0.09 to -0.026]	[-0.015 to -0.01]	[-0.012 to -0.007]	[-0.002 to 0]
MU wrt non-market time	132.51	355.36	115.97	137.78	4.30
	[93.7 to 227.76]		[72.51 to 547.5]	[74.61 to 442.49]	[0.13 to 16.51]
MU wrt income	8.50	49.14	9.05	8.65	0.19
	[6.04 to 14.54]		[5.64 to 44.24]	[4.65 to 27.63]	[0.01 to 0.66]
Single Women Elasticities and MUs					
Own wage elasticity	0.23	0.63	0.54	0.15	-0.01
	[0.21 to 0.26]	[0.54 to 0.74]	[0.46 to 0.6]	[0.11 to 0.18]	[-0.05 to 0.02]
Income elasticity	-0.085	-0.037	-0.095	-0.071	-0.050
	[-0.091 to -0.078]	[-0.106 to -0.016]	[-0.114 to -0.073]	[-0.092 to -0.057]	[-0.074 to -0.017]

	Full Sample	Husband (or single head) LT HS	Husband (or single head) HS	Husband (or single head) Some College	Husband (or single head) College+
Participation own wage elasticity	0.056	1.115	0.315	0.047	0.000
	[0.048 to 0.064]	[0.867 to 1.55]	[0.244 to 0.387]	[0.034 to 0.059]	[-0.004 to 0.004]
Participation income elasticity	-0.018	-0.039	-0.044	-0.021	-0.005
	[-0.02 to -0.016]	[-0.239 to -0.01]	[-0.056 to -0.032]	[-0.025 to -0.016]	[-0.012 to -0.001]
MU wrt non-market time	67.57	55.48	81.40	45.15	8.91
	[53.35 to 91.13]	[43.87 to 90.16]	[55.27 to 134.03]	[28.17 to 100.88]	[1.2 to 18.1]
MU wrt income	4.95	8.68	8.10	3.23	0.44
	[3.89 to 6.57]	[6.74 to 13.85]	[5.53 to 13.46]	[1.98 to 7.23]	[0.08 to 0.87]

Appendix G: Sensitivity analysis related to variation in labor supply elasticities.

This appendix presents the results of our test of the sensitivity of our estimates of the price shock equivalent of unemployment to variation in the labor supply elasticities. We consider variations in own wage and non-labor income elasticities, and cross-wage elasticities for married families. We assume that other factors remain constant for this exercise. We take the second highest and second lowest of each of the elasticities found in the literature (see Figure 1) and calculate the change in hours, and hence, change in utility, that would result based on these elasticities rather than the ones that we estimate and use to simulate the results in the paper.

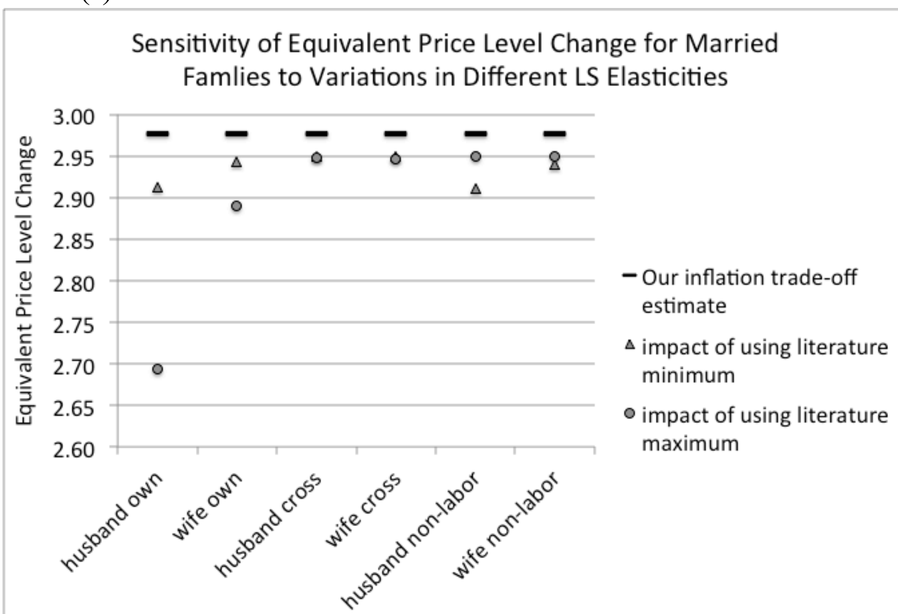
Suppose our elasticity estimate is given by $e_{h,w}$, and the alternate we want to consider is given by $e'_{h,w}$. For the same percentage change in wages ($\Delta w/w$) and the same baseline number of hours (h), we can solve for the new change in hours ($\Delta h'$) based on the ratio of the two elasticities, as follows.

The alternate elasticity is given by $e'_{h,w} = \frac{w}{h}\frac{\Delta h\prime}{\Delta w}$. Multiply the left side by $(\Delta h/\Delta h)$ and re-arrange terms to get $\Delta h' = \frac{e'_{h,w}}{e_{h,w}}\Delta h$. So we use the ratio of the alternate elasticity to our estimate multiplied by our original estimated change in hours to discern what the change of hours (hence, change in utility, etc.) would be under the alternate elasticity.

The bars in the chart below reflect the equivalent price level change estimated for the full sample of married families (panel a) and for single men and women (panel b) that result from using our own elasticity indicated along the horizontal axis. The gray triangles (gray circles) reflect the equivalent change that would result if we use the minimum (maximum) value for that elasticity indicated on the horizontal axis that is found in the literature. For the full sample of married families, the alternate price shock equivalent estimates range from a low of 3.28 percent to a high of 4.08 percent (around our estimate of 4.07 percent). For single men, there is no measurable difference in our price shock equivalent estimates using alternative labor supply elasticities. For single women, alternative price shock equivalent estimates only fall below ours to 0.23 percent (relative to our estimate of 0.27 percent).

Table G1 Alternative equivalent price level change estimates resulting from using alternative labor supply elasticities.

Panel (s): Married families



Panel (b): Singles

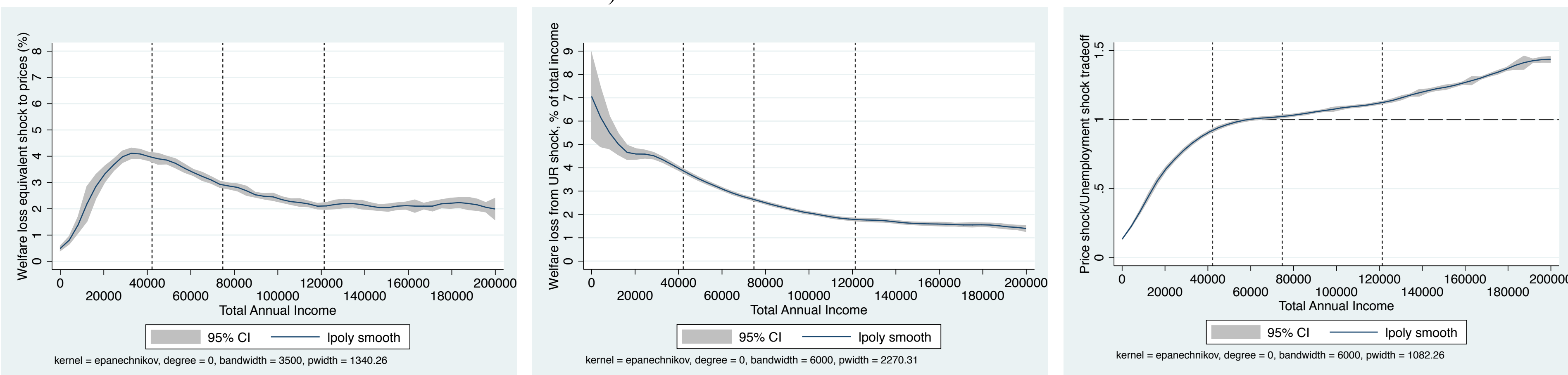
Appendix H. Welfare loss comparisons by marital status.

Figure H1. Comparing welfare losses from a price shock vs. an unemployment shock across the income distribution, married families.

(a) Welfare loss from equivalent price level change

(b) Welfare loss from 1pp increase in the aggregate unemployment rate (% of total income)

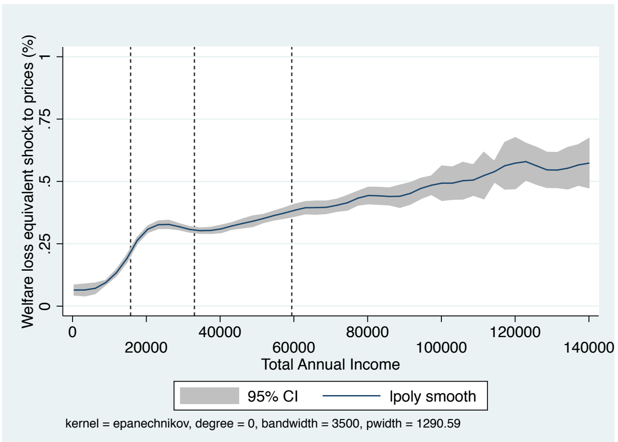
(c) Ratio of welfare loss from a price level change vs. welfare loss from unemployment shock



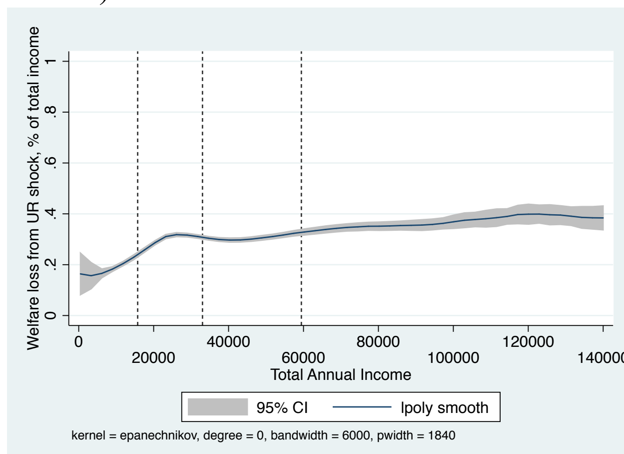
Note: Percent of the sample noted by dashed lines at maximum household income for those in the bottom 20%, the sample median, and the min household income for those in the top 20%. Comparable 2015 median household incomes reported for the U.S. by the Census Bureau can be found here: https://goo.gl/XkzVMR.

Figure H2. Comparing welfare losses from a price shock vs. an unemployment shock across the income distribution, single families.

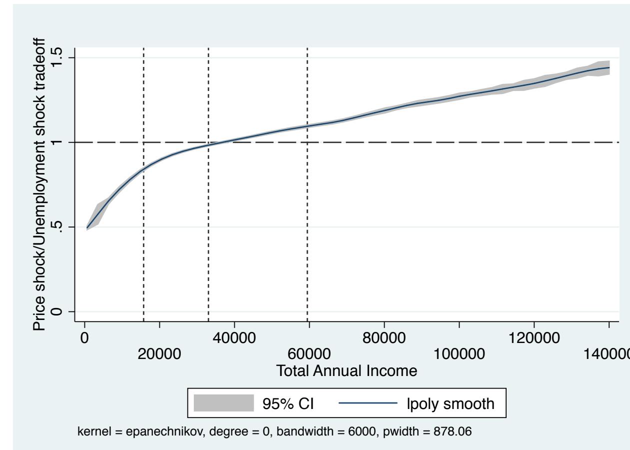
(a) Welfare loss from equivalent price level change



(b) Welfare loss from 1pp increase in the aggregate unemployment rate (% of total income)



(c) Ratio of welfare loss from a price level change vs. welfare loss from unemployment shock



Note: Percent of the sample noted by dashed lines at maximum household income for those in the bottom 20%, the sample median, and the min household income for those in the top 20%. Comparable 2015 median household incomes reported for the U.S. by the Census Bureau can be found here: https://goo.gl/XkzVMR.