Household Search or Individual Search: Does It Matter? Evidence from Lifetime Inequality Estimates.*

Preliminary and Incomplete

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Abstract

We develop and estimate an household search model to evaluate if ignoring that labor market decisions are taken at the household level - as usually done in search models of the labor market - has relevant empirical consequences. We evaluate the impact of this potential mispecification error by comparing parameters estimates under different specifications, by running a specification test, and by generating simulation to compute cross-sectional and lifetime inequality measures. We build on previous literature (Dey and Flinn (2008) and Guler, Guvenen and Violante (2011)) to propose a novel identification strategy of the risk aversion parameters. We find that ignoring the household as the actual unit of decision-making leads to estimate gender differentials in average wage offers two and a half times larger and to erroneously conclude that women experience higher inequality in wages and earnings than men.

Keywords: Household Search; Inequality; Structural Estimation
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1 Introduction

Search Models of the labor market are widespread and influential.[1] However, they almost always ignore that labor market decisions are taken at the household level and not at the individual level.[2]

Recent works have started to realize the importance of this omission. Dey and Flinn (2008) [DF] and Guler, Guvenen and Violante (2011) [GGV] develop a unitary model of the household where both spouses search for work. They show that the household search model generates different equilibrium decisions than the individual search model, unless agents are risk neutral. Albrecht, Anderson and Vroman (2010) and Compte and Jehiel (2010) provide theoretical results in a related and more general framework: search by committee. They also conclude that the unique symmetric equilibrium obtained under search by committee is different from the equilibrium obtained in the corresponding individual search problem.

If the theoretical importance of the household as unit of decision-making starts to be accepted and understood, the empirical relevance of this feature is much less studied and investigated. DF is the only paper in the literature estimating an household search model to assess an empirical issue (the importance of employer-provided health insurance). Given the large body of empirical literature using calibrations or estimations of search model to answer policy questions, empirical relevance has become an important and pressing issue: Do the estimation and calibration of search models of the labor market that ignore the presence of the household implies a relevant and significant mispecification error? Would the estimates be very different and the policy implications be significantly affected if the mispecification error were to be removed?

The focus of this paper is an attempt to answer these questions by evaluating the empirical relevance of ignoring the household when estimating search models of the labor market. After developing an extended version of the model considered by DF and GGV, we estimate the model on the 2001-2003 panel of the *Survey of Income and Program Participation* (SIPP). The estimated model allows for on-the-job search and for labor supply decisions. The inclusion of the intensive margin of the labor supply in the model is rare in the search literature[3] but we believe it is important to better describe the behavior of spouses within the household, in particular women.

We evaluate the importance of considering that decisions are taken at the household level in three ways. First, we show if and how the estimated structural parameters are affected. Second, we perform a specification test to evaluate if the fact that decisions are taken at the household level has a significant impact on the optimal decision rules. Finally, we choose a relevant empirical application

[1] For a survey of the theoretical literature, see Rogerson, Shimer and Wright (2005). For a survey of the empirical literature, see Eckstein and van den Berg (2007). A very popular framework used as reference point for most of the macro literature is Pissarides (2000).

[2] For example, all the works mentioned in the exhaustive surveys cited in footnote 1 assume individual (single-agent) search.

[3] Exceptions are Blau (1991); Bloemen (2008) and Flabbi and Moro (2010).

to show how results are affected by assuming household search.

The empirical application we choose is the study of lifetime inequality. The contribution of this application is twofold. First, we provide measure of lifetime, as opposed to simply cross-sectional, inequality. Second, and for the first time, we provide these measures at the household level and not simply at the individual level. There is a large empirical literature on income inequality focusing on dispersion in cross-sectional distributions of individual wages and earnings.[4] A typical analysis compares levels of inequality in a certain year or month conditional on a set of economic and demographic characteristics such as schooling attainment, labor market experience, age, gender, or race. This approach has two main shortcomings. First, measures of inequality based on cross-sectional distributions, while informative, can differ markedly from lifetime measures of inequality. Second, focusing on individual earnings and wages often ignores that most individuals live in households that pool resources.

Empirical works that focus on mechanisms insuring individuals against risk have traditionally attempted to address both concerns. They focus on consumption and household-level variables and study how different types of shocks may impact the individual position in the inequality distribution.[5] However, they do not allow for wage and employment mobility as a result of optimal individual behavior.

Authors estimating search model of the labor market to provide lifetime inequality measures[6] can solve this problem because they explicitly model employment decisions. However, they maintain the standard assumptions of search models of the labor market and therefore ignore that labor market decision may be taken at the household level.

For these reasons, we think the approach we use in this paper - developing and estimating an household search model able to take into account both optimal mobility and household level decisions - will generate an interesting application. By estimating the model, we are able to compute lifetime inequality measures that we can compare with cross-sectional measures. By looking at household search, we are able to compare individual-level inequality with household-level inequality. All these comparisons can be done in an equilibrium context since we are able to identify and estimate the structural parameters of the model. Our dual-search model also includes labor supply, a feature frequently ignored in the search literature that allows for a better fit of female labor market outcomes and a richer interaction within the household.

We estimate the parameters of the model using the method of simulated moments in conjunction with data from the 2001-2003 panels of the Survey of

[4] For surveys see Levy and Murnane (1992) and Katz and Autor (1999).

[5] Early and influential contributions are: Shaw (1989) and Blundell and Preston (1998). Recently, the macro literature is also addressing similar concerns looking at the difference between income and consumption inequality, for example Krueger and Perri (2006) and Heathcote, Storesletten and Violante (2008).

[6] Flinn (2002) is the first contribution in this literature. Flabbi and Leonardi (2010) is the most recent. Bowlus and Robin (2004), while not estimating a search model, are similarly concern with optimal mobility and develop an innovative non-stationary model of job mobility which shares some important features with search models.

Income and Program Participation (SIPP). The SIPP is the appropriate data set for this analysis since it collects monthly information on labor market activity and links detailed spousal labor market information across time.

As a result of our analysis, we conclude that ignoring the household in standard search models of the labor market has relevant empirical consequences. In estimation, the individual search specification implies gender wage offers differentials more than twice as large than the household search specification. In the application, the impact of the mispecification error is so large that not only it implies larger gender differentials in inequality but it actually masks the true ranking in inequality between men and women. Some counterfactual experiments quantitatively evaluate the sources of the differences between the household search and the individual search model results.

The plan of the paper is as follows. In Section 2 we develop the model of household search. Section 3 includes a discussion of the data source and presents some descriptive statistics. In Section 4 we discuss identification and estimation of the model. Section 5 contains and interprets the estimates of model parameters. In Section 6 we use our parameter estimates to simulate lifetime inequality and to perform counterfactual experiments. A brief conclusion is provided in Section 7.

2 Model

We discuss two versions of the model: a simple version and an extended version. The simple version states the main equilibrium results and propositions and offers a better environment to understand the intuition behind them. The extended version is the version of the model that will be estimated. It adds heterogeneity between the spouses and includes additional features relevant to fit the data and to provide richer counterfactual experiments.

2.1 Simple Version

2.1.1 Individual Search Model

Environment The simplest possible environment for a search model of the labor market in continuous time is characterized by four elements: a single-agent decision problem, a rate of arrival of job offers obeying a Poisson process (λ), an exogenous distribution of wage offers ($F(w)$), an instantaneous utility function $(u(c))$, and a discount rate (ρ). We additionally assume that consumption is the sum of non-labor and labor income ($c = Y + w$) and that there is no saving or borrowing. We also assume no flow cost of search and no recall of past offer.

Value functions The stationary assumption allows to write the model recursively using value functions for each state in which the individual agent may be. If the agent is employed, the job lasts forever and therefore she will receive no shock. The value of being employed at a given wage will then simply be the corresponding discounted instantaneous utility:

$$\rho V(w) = u(Y + w) \tag{1}$$

When the agent is unemployed, she will receive shocks (the job offers). Therefore the value of unemployment will be the sum of the instantaneous utility while unemployed and the option value of changing labor market state:

$$(\rho + \lambda) U = u(Y) + \lambda \int \max\{U, V(w)\} dF(w) \tag{2}$$

The option value is the expected value of searching: an agent receiving a job offer decides if accepting the job offer or not by comparing the value of the current state with the value of being employed at the job (maximizes over $\{U, V(w)\}$).

Equilibrium Given this characterization, the optimal decision rule is straightforward to obtain: the value of employment is continuous monotone increasing in the wage while the value of unemployment does not depend on a specific wage. Therefore there exists a wage (the reservation wage) at which the agent is indifferent between the two states. We denote it by w^*:

$$w^* : V(w^*) = U \tag{3}$$

Her optimal decision rule will simply be to accept any job offer carrying a wage higher than the reservation wage and reject otherwise. This optimal decision rule is incorporated in the value function as follows:

$$\rho U = u(Y) + \lambda \int_{w^*} [V(w) - U] dF(w) \tag{4}$$

We can now propose the following:

Definition 1 *Given*

$$\{\lambda, \rho, u(Y + w), F(w)\}, u \text{ continuous}$$

*an **individual search model equilibrium** is a set of values*

$$V(w), U$$

that solves equations (1) and (4).

2.1.2 Household Search Model

Environment The household search model maintains the same general structure of the individual search model but adds the household, extending the single-agent decision problem to a joint-search problem of two agents looking for job. Households are composed of two agents sharing and maximizing a common utility function and pooling income (unitary model of the household). Each member of the household belongs to a different type and there are a total of two types in the economy. Conforming with the data we will use in estimation (married couples), we call individuals belonging to one type *wives* and to the other type *husbands*. The types are relevant because all the individuals belonging to the same type share the same structural parameters while this may not be true across types. In estimation, all the structural parameters with the exception of the discount rate are allowed to be type-specific but in discussing the theoretical model we impose that the two types share the same structural parameters.[7] Wives' parameters are denoted by the subscript $_W$ and individuals belonging to the set of wives are indexed by i. Husbands' parameters are denoted by the subscript $_M$ and individuals belonging to the set of husbands are indexed by j.

Value Functions The value functions are defined at the household level. When both household members are employed, the household receives value $V(w_i, w_j)$ defined by:

$$\rho V(w_i, w_j) = u(Y + w_i + w_j) \tag{5}$$

When one of the two member is unemployed (say, the wife), the household is subject to one job offers shock receiving value $T(w_i, 0)$ defined by:

$$(\rho + \lambda) T(w_i, 0) = u(Y + w_i) + \lambda \int \max\{T(w_i, 0), V(w_i, w), T(0, w)\} dF(w) \tag{6}$$

When both members are unemployed, the household is subject to two job offers shocks receiving value U defined by:

$$(\rho + 2\lambda) U = u(Y) + \lambda \left[\begin{array}{c} \int \max\{U, T(w, 0)\} dF(w) + \\ \int \max\{U, T(0, w)\} dF(w) \end{array} \right] \tag{7}$$

All the equations are straightforward generalizations of the corresponding equations in the individual search model with the exception of equation (6). Equation (6) shows the added margin implied by household search. Since the reservation wage of one spouse potentially depends on the reservation wage of the other spouse, it is possible that a wage that was acceptable to, say, the husband when the wife was unemployed becomes not acceptable when the wife is employed. As a result, equation (6) shows that the household is not maximizing simply over the current state (husband employed, wife unemployed,) and the usual alternative (wife employed, husband employed) but also over a state in which the wife accepts the job offer and the husband decides to quit his job.

Equilibrium The optimal decision rule are characterized by reservation wages but, by the argument just made, the reservation wage of one spouse may depend on the labor market status of the other spouse. We use the following notation

[7] This is the symmetric case extensively sitdued by GGV.

to take into account this potential interdependence:

$$
\begin{aligned}
w_W^*(0) &: \quad T(0, w_W^*(0)) = U & (8)\\
w_W^*(w_i) &: \quad \max\{V(w_i, w_W^*(w_i)), T(0, w_W^*(w_i))\} = T(w_i, 0) & (9)
\end{aligned}
$$

Both reservation values exist and are unique because in both equations the LHS is monotone increasing in w_i while the RHS is constant with respect to w_i. The reservation wages of the husband $w_M^*(0)$ and $w_M^*(w_j)$ are analogously defined.

The implication of equation (8) is standard: an household where both spouses are unemployed accepts a job offer to one of the two partners if the wage is higher than the corresponding reservation wage ($w_M^*(0)$ for the husband and $w_W^*(0)$ for the wife). Incorporating the optimal decision rule in the value function (7) leads to:

$$
\rho U = u(Y) + \lambda \left[\begin{array}{c} \int_{w_M^*(0)} [T(w, 0) - U]\, dF(w) + \\ \int_{w_W^*(0)} [T(0, w) - U]\, dF(w) \end{array} \right] \tag{10}
$$

The implication of equation (9) is more subtle. In an household where one spouse is working and the other spouse is looking for a job, receiving a job offer may lead to three and not simply two possible outcomes. Start with a couple where the wife is looking for job and the husband is working at a job paying a wage w_i. First, the household may decide to reject the offer and remain in the current state ($T(w_i, 0)$.) Second, the household may choose to accept the offer to the wife ($V(w_i, w_j)$.) Third, the household may choose to accept the offer to the wife and at the same time choose it is better off if the husband goes back to unemployment to search for a better job ($T(0, w_j)$.) This third option leads to the *endogenous* termination of the job relation and it is a relevant equilibrium channel which is not at work in the individual search framework. The intuition for this last possibility is straightforward. When the household had accepted the job offer to the husband, the wife was not working and therefore the outside option for the household was having both spouses in the unemployment state. When the wife is receiving an offer, the outside option is different and a decision that was optimal in the first case may not be optimal in the latter case. To deal with this possibility, we introduce the following notation:

$$
\begin{aligned}
\Gamma_E(w_i) &\equiv \{w_j : V(w_i, w_j) \geq T(w_i, 0), V(w_i, w_j) \geq T(0, w_j)\} & (11)\\
\Gamma_U(w_i) &\equiv \{w_j : T(0, w_j) > T(w_i, 0), T(0, w_j) > V(w_i, w_j)\}
\end{aligned}
$$

The sets of wage offers to the husbands conditioning on the wife being employed ($\Gamma_E(w_j)$ and $\Gamma_U(w_j)$) are analogously defined. Incorporating this optimal decision rule in the value function (6) leads to:

$$
\rho T(w_i, 0) = u(Y + w_i) + \lambda \left[\begin{array}{c} \int_{w \in \Gamma_E(w_i)} [V(w_i, w) - T(w_i, 0)]\, dF(w) + \\ \int_{w \in \Gamma_U(w_i)} [T(0, w) - T(w_i, 0)]\, dF(w) \end{array} \right] \tag{12}
$$

We can now propose the following:

Definition 2 *Given*

$$\{\lambda, \rho, u(Y + w_i + w_j), F(w_i), F(w_j)\}, u \text{ continuous}$$

an ***household search model equilibrium*** *is a set of values*

$$V(w, w), T(w, 0), T(0, w), U$$

that solves equations (5), (10) and (12).

2.1.3 Individual Search and Household Search Models Comparison

To make additional progress in characterizing the differences between the individual search equilibrium and the household search equilibrium we need to specify properties of the sets defined in (11). As shown in DF and GGV, the characterization crucially depends on the assumptions of the utility function.

Linear Utility Function Under linear utility:

$$u(c) = Y + w \tag{13}$$

agents are risk neutral and therefore the individual search model reverts to the standard partial equilibrium search model. Rewriting equation (4) we obtain the final equilibrium condition as:

$$w^* = \frac{\lambda}{\rho} \int_{w^*} [w - w^*] \, dF(w) \tag{14}$$

This condition characterizes the reservation wage as function of the primitive parameters. It is independent from nonlabor income because nonlabor income is received in any labor market state.

The linear utility function in the household search model is:

$$u(c_{ij}) = Y + w_i + w_j \tag{15}$$

We want to ask how the household search equilibrium compares to an environment with the same structural parameters but where each spouse is behaving as in an individual search model. The result, already pointed out by DF and GGV is summarized in the following Proposition.

Proposition 3 ***Equivalence of individual and household search under risk neutrality***

Given

$$u \text{ linear and } \{\lambda, \rho, u(Y + w_i + w_j), F(w_i), F(w_j)\}$$

an household search model equilibrium is equivalent to an equilibrium where the agents belonging to their respective type a generate an individual search model equilibrium given

$$u \text{ linear and } \{\lambda, \rho, u(Y + w_a), F(w_a)\}, \quad a = i, j$$

as a result:

$$w_A^*(w_{-a}) = w_A^*(0) = w^*, \qquad A = M, W; a = i, j$$

The result is equivalent to Proposition 1 in GGV and to Section 3.1 in DF. It is derived as follows. If the household utility is linear then the marginal utility of income is constant. If it is constant and individuals are maximizing income then it is irrelevant the flow value of income they are actually receiving when making decisions about future income streams. Therefore the decision of one spouse does not depend on the wage of the other spouse. If this the case then the set $\Gamma_U(w_i)$ is empty and the set $\Gamma_E(w_i)$ is the entire support of w_j which is equivalent to say that the household behaves as if the two spouses were optimally maximizing their individual income streams.

This result is quite powerful in terms of the objective of this paper. First, it states that there is the possibility of no mispecification error in assuming an individual search model when estimating search models of the labor market even if decisions are actually taken at the household level. Second, it allows us to develop a specification test for the individual search model. Third, it provides a strategy to identify risk aversion parameters. The last two implications arise from the comparison of the linear utility case with the concave utility case and they are discussed in the next section.

Concave Utility Function Assuming a concave utility function:

$$u(c) = u(Y + w), u''(c) < 0$$

removes risk neutrality and imposes risk aversion. By rewriting equation (4) we obtain the following equilibrium condition for the individual search case:

$$u(Y + w^*) = u(Y) + \frac{\lambda}{\rho}\int_{w^*} [u(Y + w) - u(Y + w^*)]\, dF(w) \tag{16}$$

The reservation wage resulting from equation (16) does not seem qualitatively different from the reservation wage from equation (14) but it actually is. The difference becomes clear when we perform a simple comparative static exercise: what is the impact of an increase of non-labor income Y on the reservation wage w^*? Studying this impact makes explicit the role of risk aversion in determining optimal equilibrium behavior. We know from equation (14) that the reservation wage is not affected by non-labor income in the linear case. In the concave case it must be since the flow value of income has an impact on the marginal value of additional flows of income. What is less obvious is that the effect of the current flow value of income on the reservation is ambiguous.

An increase of nonlabor income has two impacts on the reservation wage. First, it increases the flow utility while searching therefore decreasing the marginal *cost* of search. As a result, the searcher becomes pickier increasing her reservation wage. Second, it decreases the option value of waiting for a better job therefore decreasing the marginal expected *gains* of search because the marginal benefit of a higher wage offer is now smaller. As a result, the searcher becomes less picky decreasing her reservation wage. Both results depends on the concavity of the utility functions which implies decreasing marginal utility. The net effect is therefore ambiguous.

Analytically, the result can be proved by implicitly differentiating equation (16). After collecting terms, we obtain the following expression:

$$\frac{dw^*}{dY}=\frac{\rho\left[u'\left(Y\right)-u'\left(Y+w^*\right)\right]+\lambda\int_{w^*}\left[u'\left(Y+w\right)-u'\left(Y+w^*\right)\right]dF\left(w\right)}{\left[\rho+\lambda\widetilde{F}\left(w^*\right)\right]u'\left(Y+w^*\right)} \tag{17}$$

The denominator is always positive. The first term of the numerator $\left[u'\left(Y\right)-u'\left(Y+w^*\right)\right]$ captures the decrease in the marginal cost of search; it is positive since u' is decreasing and therefore contributes to a positive impact of Y on w^*. The second term of the numerator $\left[\int_{w^*}\left[u'\left(Y+w\right)-u'\left(Y+w^*\right)\right]f\left(w\right)dw\right]$ captures the decrease in the marginal expected benefit of search; it is negative since u' is decreasing and the integrral is over $w>w^*$. Therefore it generates a negative impact of Y on w^*, proving the result.

The concave utility function in the household search model is:

$$u\left(c_{ij}\right)=u\left(Y+w_i+w_j\right),u''\left(c\right)<0 \tag{18}$$

The equilibrium follows the definition given in Definition 2 and it is now qualitatively different from the individual search case. The reason is straightforward and follows the discussion of the impact of nonlabor income on the reservation wage in the individual search case. Just as nonlabor income affects the marginal cost and the marginal expected benefit of search, the wage of one spouse affects the marginal cost and the marginal expected benefit of search of the other spouse, leading to a dependence between the reservation wages of the two partners. Nonlabor income and the spouse's wage are not equivalent, though, because nonlabor income is permanent and the spouse's wage is transitory since it depends on receiving a job offer shock. As a result, and differently from the linear case, endogenous quits may occur. We state the result in the following:

Proposition 4 ***Nonequivalence of individual and household search under risk aversion***

Given

$$u \textit{ concave and } \left\{\lambda,\rho,u\left(Y+w_i+w_j\right),F\left(w_i\right),F\left(w_j\right)\right\}$$

an household search model equilibrium is different from an equilibrium where the agents belonging to their respective type a generate an individual search model equilibrium given

$$u \textit{ concave and } \left\{\lambda,\rho,u\left(Y+w_a\right),F\left(w_a\right)\right\},\qquad a=i,j$$

as a result:

1. *The reservation wages under individual and household search are different. For* $A = M, W; a = i, j$ *it holds:*

$$\begin{aligned} w_A^*(0) &\neq w^* \\ w_A^*(w_{-a}) &\neq w^* \text{ for at least some } w_{-a}, \end{aligned}$$

2. *In the household search equilibrium the reservation wage of one spouse depends on the wage and labor market status of the other spouse. For* $A = M, W; a = i, j$ *it holds:*

$$\begin{aligned} w_A^*(w_{-a}) &\neq w_A^*(0), \quad A = M, W; a = i, j \\ w_A^*(w_{-a}) &\neq w_A^*\left(w'_{-a}\right), w_{-a} \neq w'_{-a}, \quad A = M, W; a = i, j \end{aligned}$$

3. *Endogenous quits are possible. For* $A = M, W; a = i, j$ *it holds:*

$$\text{It exists a set of } w_a > w_A^*(0) \text{ such that } \Gamma_U(w_a) \text{ is nonempty}$$

The proposition is equivalent to Proposition 2 and 3 in GGV and to Section 3.3 in DF. The reason for the result is that the additional flow of income generated by the spouses' job has the same effect on household utility as the increase in nonlabor income had on individual utility in the individual search case: it decreases the marginal cost of search and it decreases the expected marginal benefit of search. As a result, it does now matter if we are looking at a single-searcher problem or at a dual-searcher problem.

Given that the labor markets status of one spouse has an impact on the reservation wage of the other spouse then endogenous quit may occur. Start with an household where both spouses are unemployed and searching. Suppose the husband receives a wage offers $w_i > w_M^*(0)$ then the household will accept it, changing its state to an household composed by an husband working at a wage w_i and a wife searching for a job. If the wife receives an offer $w_j > w_W^*(w_i)$ and $T(0, w_j) > V(w_i, w_j)$ then the optimal behavior of the household mandates to the wife acceptance of the offer and to the husband quit of the current job. The symmetry in the environment faced by the two spouses - i.e. the fact the two spouses labor market are characterized by the same structural parameters - guarantees that for some values in the support of the wage offers this is always the case.[8] When symmetry is removed, as in the extended model we will estimate, endogenous quits may or may not occur depending on parameters.

We conclude this section by pointing out two empirical implications of Propositions 3 and 4. First, they clarify that in the linear case the labor market status of one spouse does not depend on the labor market status of the other spouse while in the concave case it does. If in the data we observe dependence between the labor market status of the two spouses then we can use that information to learn about the concavity of the utility function. Second, if we specialize the concave utility function to a parametric form that nests the linear case then we can test for linear utility. A test for linear utility is relevant because it is equivalent to a specification test for the individual search model.

[8] See Proposition 2 in GVV. They label this situation the "breadwinner" cycle.

2.2 Extended Version

2.2.1 Individual Search Model

Environment We add the following features to the environment discussed in the simplified version. First, we allow for exogenous termination of jobs. Exogenous terminations follow a Poisson process with parameter η. Second, we introduce on-the-job search. Job offers while employed follow a Poisson process with parameter γ. Both features are standard in the search literature and are necessary to fit job-to-job and job-to-unemployment transitions.

The third feature we add to the environment is less common in the literature[9] and it is motivated by our objective to fit household behavior. We will use a sample of households composed by husbands and wives, both participating in the labor market. As a result we have a relative large number of women in the sample and women tend to have a larger variance in labor supply than men, in particular at lower than full-time levels. We have therefore decided to introduce a labor supply decision in the model, albeit limited to the intensive margin. Adding an extensive margin is interesting and would fit more data features but it greatly complicates the computation problem during estimation. Moreover, we think that the comparison of individual search and household search is still very informative even if it is limited to labor market participants. We introduce the intensive margin of labor supply by assuming that job offers arrive as a pair of wage and hours requirement[10] (w, h). Their joint distribution is denoted by $F(w, h)$. Consumption is then defined as $c = Y + wh$, leisure as $l = 1 - h$ and the utility function as $u(c, l)$. To make the notation in the rest of the paper less cumbersome we define the function $v(w, h) \equiv u(Y + wh, 1 - h)$.

Value Functions The value of being employed at given wage and hours requirement is equal to the sum of the flow utility of consumption and leisure allowed by the job, the option value of receiving a better wage offer, and the value of becoming unemployed if the job gets exogenously terminated:

$$\begin{aligned} V[v(w,h)] = {} & (\rho+\gamma+\eta)^{-1}\{v(w,h) \\ & +\gamma \iint \max\{V[v(w,h)], V[v(w',h')]\}\, dF(w',h') \\ & +\eta U\} \end{aligned} \tag{19}$$

The value of being unemployed is equal to the sum of the flow utility of consumption and leisure when unemployed, and the option value of receiving

[9] Blau (1991) is the only example of an estimated search model including this feature, i.e. the joint offer of wage-hours pairs. Flabbi and Moro (2010) estimate a search model allowing for the choice between part-time and full-time work but the choice is contingent to a wage offer and it is bargained with the employer.

[10] This characterization is consistent with the usual assumption in implicit contract theory where firms post job package offers. See for example, Abowd and Card (1987); Hwang, Mortensen and Reed (1998).

an acceptable job offer:

$$U = (\rho+\lambda)^{-1}\left\{v(0,0) + \lambda \iint \max\{U, V[v(w,h)]\}\, dF(w,h)\right\} \tag{20}$$

Equilibrium The optimal decision rule retains the reservation value property of the simplified version of the model but the critical value is now defined on the utility value. The reason, as discussed extensively in Blau (1991) and Hwang, Mortensen and Reed (1998), is that the mapping between the characteristics of a job offer and its utility value is not one-to-one: when both wage and hours enter the utility function, different combinations of job packages (w,h) generate the same level of utility.

Agents have two decisions to make: accept or reject a job offer while employed and accept or reject a job offer when unemployed. The reservation utility value while employed at a given job (w,h) is simply the instantaneous utility value of the current job. The reservation utility value while unemployed is defined in the same way as the reservation wage in the simplified model (equation (3)):

$$v^* : U = V[v^*] \tag{21}$$

Incorporating both decision rules in the value functions leads to the following value of employment at a job (w,h):

$$\rho V[v(w,h)] = v(w,h) + \gamma \iint_{\{(w',h'):v(w',h')>v(w,h)\}} \{V[v(w',h')] - V[v(w,h)]\}\, dF(w',h') + \eta\{U - V[v(w,h)]\} \tag{22}$$

and to the following value of unemployment:

$$\rho U = (\rho+\lambda)^{-1}\left\{v(0,0) + \lambda \iint_{\{(w,h):v(w,h)>v^*\}} \{V[v(w,h)] - U\}\, dF(w,h)\right\} \tag{23}$$

As a result, we obtain the following:

Definition 5 *Given*

$$\{\lambda, \gamma, \eta, \rho, u(c,l), F(w,h)\}, u \text{ continuous}$$

*an **individual search model equilibrium** is a set of values*

$$V[v(w,h)], U$$

that solves equations (22) and (23).

2.2.2 Household Search Model

Environment The extended household search model incorporates the features of the extended individual search model. It also removes the symmetry between the two spouses imposed in the simplified version. Agents belongs to two types - *husbands* and *wives* - and an household is composed by one member for each type. In estimation, all the structural parameters of the model will be allowed to be type-specific with the exception of the discount rate. We follow the notation of the simplified model by denoting with the subscripts $_W$ and $_M$ respectively the wives' parameters and the husbands' parameters and with the index j and i respectively individuals belonging to the set of wives and to the set of husbands.

Value Functions When both household members are employed, the household receives a value equal to the sum of the flow utility of consumption and leisure allowed by both jobs, the option value both spouses have of receiving a better wage offer, and the value of becoming unemployed if any of the two job relations gets exogenously terminated:

$$\begin{aligned} V\left[v\left(w_i,h_i,w_j,h_j\right)\right] = \left(\rho+\gamma_M+\gamma_W+\eta_M+\eta_W\right)^{-1}\{v\left(w_i,h_i,w_j,h_j\right) \\ +\gamma_M \iint \max\left\{V\left[v\left(w_i,h_i,w_j,h_j\right)\right], V\left[v\left(w_i',h_i',w_j,h_j\right)\right]\right\} dF_M\left(w_i',h_i'\right) \\ +\eta_M T\left[v\left(0,0,w_j,h_j\right)\right] \\ +\gamma_W \iint \max\left\{V\left[v\left(w_i,h_i,w_j,h_j\right)\right], V\left[v\left(w_i,h_i,w_j',h_j'\right)\right]\right\} dF_W\left(w_j',h_j'\right) \\ +\eta_W T\left[v\left(w_i,h_i,0,0\right)\right]\} \end{aligned} \tag{24}$$

When only one of the two members is employed (for example, the husband), the household receives a value equal to:

$$\begin{aligned} T\left[v\left(w_i,h_i,0,0\right)\right] = \left(\rho+\gamma_M+\lambda_W+\eta_M\right)^{-1}\{v\left(w_i,h_i,0,0\right) \\ +\gamma_M \iint \max\left\{T\left[v\left(w_i,h_i,0,0\right)\right], T\left[v\left(w_i',h_i',0,0\right)\right]\right\} dF_M\left(w_i',h_i'\right) \\ +\eta_M U \\ +\lambda_W \iint \max\left\{T\left[v\left(w_i,h_i,0,0\right)\right], V\left[v\left(w_i,h_i,w_j',h_j'\right)\right], T\left[v\left(0,0,w_j',h_j'\right)\right]\right\} dF_W\left(w_j',h_j'\right)\} \end{aligned} \tag{25}$$

As in the simplified version of the model, an offer to the wife may generate the endogenous quit of the husband from his current job (last term of equation (25)).

When both spouses are unemployed, the household receives a value equal to:

$$\begin{aligned} U &= (\rho + \lambda_M + \lambda_W)^{-1} \{ v(0,0,0,0) \\ &\quad + \lambda_M \iint \max \{ U, T[v(w_i, h_i, 0, 0)] \} \, dF_M(w_i, h_i) \\ &\quad + \lambda_W \iint \max \{ U, T[v(0,0,w_j,h_j)] \} \, dF_W(w_j, h_j) \} \end{aligned} \tag{26}$$

Equilibrium The equilibrium is an extension of the equilibrium definitions previously discussed. The reservation values are defined over utility values, as in the individual search extended version of the model. The household, though, has more decisions to make because the optimal decision of one spouse depends upon the labor market status of the other spouse.

When both household members are employed, the household has to decide if accepting or rejecting on-the-job job offers. The reservation value is the current utility value because the household is comparing in both cases the value of both spouses being employed.

When only one of the two members is employed (for example, the husband), the household has two qualitatively different decisions to make. First, it has to decide if accepting or rejecting on-the-job job offers to the husband. The reservation value is the current utility value because the household is comparing in both cases the value of having the husband working and the wife searching. Second, it has to decide if accepting or rejecting job offers to the wife. If the offer is accepted the optimal policy for the husband can be both staying on the job or quitting, just as in the simplified version of the model. The reservation utility value is therefore defined as:

$$v_W^*(w_i, h_i) : \max \{ V[v_W^*(w_i, h_i)], T[v_W^*(w_i, h_i)] \} = T[v(w_i, h_i, 0, 0)] \tag{27}$$

Notice that in $T[v_W^*(w_i, h_i)]$ is the wife who is working while in $T[v(w_i, h_i, 0, 0)]$ is the husband who is working. Since we remove the symmetry assumption imposed in the simplified version (and by GGV), the combinations of (w_j, h_j) and (w_i, h_i) that guarantee the same value of T are in general different. As in the simplified version, it is convenient to define the following sets:

$$\begin{aligned} \Gamma_E(w_i, h_i) &\equiv \left\{ \begin{array}{c} (w_j, h_j) : V[v(w_i, h_i, w_j, h_j)] \geq T[v(w_i, h_i, 0, 0)], \\ V[v(w_i, h_i, w_j, h_j)] \geq T[v(0, 0, w_j, h_j)] \end{array} \right\} \\ \Gamma_U(w_i, h_i) &\equiv \left\{ \begin{array}{c} (w_j, h_j) : T[v(0, 0, w_j, h_j)] > T[v(w_i, h_i, 0, 0)], \\ T[v(0, 0, w_j, h_j)] > V[v(w_i, h_i, w_j, h_j)] \end{array} \right\} \end{aligned} \tag{28}$$

The sets of wage offers to the husbands conditioning on the wife being employed ($\Gamma_E(w_j, h_j)$ and $\Gamma_U(w_j, h_j)$) are analogously defined.

When both spouses are unemployed, the household has to decide if accepting or rejecting job offers to the wife or to the husband. The reservation utility value is defined as:

$$v_W^*(0,0) : T[v_W^*(0,0)] = U$$

for the wife and analogously for the husband.

By incorporating the optimal decision rules in equations (24), (25), and (26), we obtain the equilibrium value for both spouses working:

$$\rho V\left[v\left(w_i,h_i,w_j,h_j\right)\right]=v\left(w_i,h_i,w_j,h_j\right) \tag{29}$$
$$+\gamma_M \iint_{\left\{\left(w_i',h_i'\right):v\left(w_i',h_i',w_j,h_j\right)>v\left(w_i,h_i,w_j,h_j\right)\right\}} \left\{\begin{array}{c} V\left[v\left(w_i',h_i',w_j,h_j\right)\right] \\ -V\left[v\left(w_i,h_i,w_j,h_j\right)\right]\end{array}\right\} dF_M\left(w_i',h_i'\right)$$
$$+\eta_M\left\{T\left[v\left(0,0,w_j,h_j\right)\right]-V\left[v\left(w_i,h_i,w_j,h_j\right)\right]\right\}$$
$$+\gamma_W \iint_{\left\{\left(w_j',h_j'\right):v\left(w_i,h_i,w_j',h_j'\right)>v\left(w_i,h_i,w_j,h_j\right)\right\}} \left\{\begin{array}{c} V\left[v\left(w_i,h_i,w_j',h_j'\right)\right] \\ -V\left[v\left(w_i,h_i,w_j,h_j\right)\right]\end{array}\right\} dF_W\left(w_j',h_j'\right)$$
$$+\eta_W\left\{T\left[v\left(w_i,h_i,0,0\right)\right]-V\left[v\left(w_i,h_i,w_j,h_j\right)\right]\right\}$$

for one spouse working and the other searching:

$$\rho T\left[v\left(w_i,h_i,0,0\right)\right]=v\left(w_i,h_i,0,0\right) \tag{30}$$
$$+\gamma_M \iint_{\left\{\left(w_i',h_i'\right):v\left(w_i',h_i',0,0\right)>v\left(w_i,h_i,0,0\right)\right\}} \left\{T\left[v\left(w_i',h_i',0,0\right)\right]-T\left[v\left(w_i,h_i,0,0\right)\right]\right\} dF_M\left(w_i',h_i'\right)$$
$$+\eta_M\left\{U-T\left[v\left(w_i,h_i,0,0\right)\right]\right\}$$
$$+\lambda_W\left\{\begin{array}{l} \iint_{\left(w_j',h_j'\right)\in\Gamma_E\left(w_i,h_i\right)} \left\{V\left[v\left(w_i,h_i,w_j',h_j'\right)\right]-T\left[v\left(w_i,h_i,0,0\right)\right]\right\} dF_W\left(w_j',h_j'\right) \\ +\iint_{\left(w_j',h_j'\right)\in\Gamma_U\left(w_i,h_i\right)} \left\{T\left[v\left(0,0,w_j',h_j'\right)\right]-T\left[v\left(w_i,h_i,0,0\right)\right]\right\} dF_W\left(w_j',h_j'\right)\end{array}\right\}$$

and for both spouses searching:

$$\rho U=v\left(0,0,0,0\right) \tag{31}$$
$$+\lambda_M \iint_{\left\{\left(w_i,h_i\right):v\left(w_i,h_i,0,0\right)>v_M^*\left(0,0\right)\right\}} \left\{V\left[v\left(w_i,h_i,0,0\right)-U\right]\right\} dF_M\left(w_i,h_i\right)$$
$$+\lambda_W \iint_{\left\{\left(w_j,h_j\right):v\left(0,0,w_j,h_j\right)>v_M^*\left(0,0\right)\right\}} \left\{V\left[v\left(0,0,w_j,h_j\right)\right]-U\right\} dF_W\left(w_j,h_j\right)$$

We can now propose the following definition.

Definition 6 *Given*

$$\left\{\lambda_{M,W},\gamma_{M,W},\eta_{M,W},\rho,u\left(c,l_i,l_j\right),F_M\left(w_i,h_i\right),F_W\left(w_j,h_j\right)\right\}, u \text{ continuous}$$

*an **household search model equilibrium** is a set of values*

$$V\left[v\left(w_i,h_i,w_j,h_j\right)\right], T\left[v\left(w_i,h_i,0,0\right)\right], T\left[v\left(0,0,w_j,h_j\right)\right], U$$

that solves equations (29), (30) and (31).

2.2.3 Individual Search and Household Search Models Comparison

The extensions added to the model do not qualitatively change the main results with respect to the comparison between the individual and household search models.

First, as stated in Proposition 3, if agents are risk neutral then the household search model equilibrium is equivalent to the individual search model equilibrium. The proof of the result in the simplified version of the model is based on the fact that the marginal utility of income is constant and therefore the actual flow value of income is irrelevant when maximizing future income streams. This basic fact does not change if we add exogenous job termination, on-the-job search and labor supply.

Second, as stated in Proposition 4, if agents are risk averse then the household search model equilibrium is different from the individual search model equilibrium because the optimal decision rule concerning the labor market status of one spouse is potentially affected by the labor market status of the other spouse. Since the result is implied by the concavity of the utility functions, it carries through when we add job termination, on-the-job search and labor supply. Adding these extensions simply add choices and options but it does not change the fact that concavity of the utility function makes the optimal decision rule of one spouse dependent on the labor market status of the other spouse.

We illustrate the features of the extended version of the model by drawing the reservation wages schedules in a series of Figures. We start with Figure 1 that we label the benchmark model because it is computed at the parameters estimates in our favourite specification (see Table 2, Columns 3 and 4). We report the reservation wage of a wife who is currently unemployed, receives a full-time job offer and is married to an husband working full-time. We compare this reservation wage schedule with the reservation wage the wife would be facing if she was a single-searcher in an individual search environment characterized by the same parameters of the household search environment. First, we clearly see the strong dependence of the wife's reservation wage on the husband wage: at the minimum acceptable wage, the reservation wage for the wife is less than 2$/h. As the husband's wage increases, the wife's reservation value rapidily increases till about 6$/h. After that, it keeps increasing but at a lower rate reaching a reservation wage of about 8$/h when the husband is making about 24$/h. This pattern contrasts with the reservation wage in the individual search which is constant at a value a little higher than 2$/h. Second, it is interesting to see that the two reservation wage schedules cross, so that there is a range of husband wages generating a wife's reservation wage in the household search model lower than the wife's reservation wage in the corresponding individual search model. We will show that this effect is able to explain a significant portion of the gender wage gap in our sample. Third, the change in slope in the wife's reservation wage schedule shows the importance of allowing for endogenous quitting. When the husband is earning a relatively low wage (less than about 6$/h), he would prefer to quit his job when the wife accepts a full-time job offer. As a result, the wife's reservation wage is very sensitive to the husband wage. After the 6$/h threshold, the husband will remain employed even if the wife accepts a job offer: his wage is high enough that it is not optimal to go back to unemployment to receive job offers at an higher rate than in employment. As a result, the wife's reservation wage is less and less sensitive to the husband wage.

Figure 2 reiterates the message of Propositions 3 and 4 about the impact of risk aversion. We show the wife's reservation wage schedule for different values of risk aversion, bounded between the two case most commonly used in the applied literature: the linear case (coefficient of relative risk aversion (rra) = 0) and the logarithmic case (coefficient of relative risk aversion (rra) = 1). We can clearly see that for rra values moving from 1 toward 0, the reservation wage schedule is changing from a positive sloped curve to a flat line and therefore the reservation wage of the wife is becoming less and less sensitive to the husband's wage. The husband's wage at which the wife's reservation wage schedule changes slope is decreasing as the risk aversion coefficient decreases: this is consistent with the amount of endogenous quitting decreasing as we get closer to risk neutrality.

Figure 3 shows the endogenous quitting behavior in more detail (notice the change of scale in the Figure). Figure 3 reports the same wife's reservation wage schedule reported in 1 but also husband's reservation wage schedule computed at the wife's reservation wage. We will prove that the crossing of this curve with the 45 degree line splits the husband wages support in two regions: the region up to the wage corresponding to the crossing is such that all the wages belong to $\Gamma_U(w_j, FT)$, i.e. the endogenous quitting region. The region above the crossing threshold is such that all the wages belong to $\Gamma_E(w_j, FT)$, i.e. the region where the husband remains employed at the current job no matter what the wife will do. To see the result, first focus on the set of husband wages smaller than the wage corresponding to the intersection between the 45 degree line and the husband reservation wage. Denote with w_i an husband's wage in this region and suppose the wife accepts a wage exactly at her corresponding reservation value, i.e. $w_W^*(w_i)$. The curve we denote as "Husband's w* at wife's w*" pins down the husband reservation wage when the wife is employed at $w_W^*(w_i)$, i.e. $w_M^*(w_W^*(w_i))$. By using the 45 degree line to project this reservation wage on the x-axis, we can see that $w_M^*(w_W^*(w_i)) > w_i$ and therefore the husband will quit is current job working full-time at w_i when the wife accepts a job offer paying at least the reservation wage. Now focus on the set of husband wages larger than the wage corresponding to the intersection between the 45 degree line and the husband reservation wage. In this region $w_M^*(w_W^*(w_i)) < w_i$ and therefore the husband will never quit his current job due to the wife accepting a job offer. Finally, notice that the wife's reservation wage schedule changes slope exactly where the husband reservation wage curve is crossing the 45 degree line, i.e. when the husband behavior changes from quitting the current job to keeping the current job as a result of the wife's accepting the job offer. This results confirms the discussion we provided commenting on Figure 1 where we imputed the change in the slope of the wife's reservation wage schedule to the endogenous quitting behavior of the husband.

Figure 4 shows the impact of introducing labor supply and heterogenous nonlabor income in the household search model. We compare two levels of labor supply (part-time and full-time)[11] and two levels of nonlabor income ($Y = 0.44\$/h$ and $Y = 19.50\$/h$).[12] First, both factors have a signficant impact on the reservation wages schedule. Consider a woman in an household with low nonlabor income and an husband's wage equal to 10$/h. Her reservation wage is a little more than 6$/h when offered a full-time job but it is more than 8$/h when offered a part-time job. Fixing labor supply at full-time, her reservation wage ranges from a little more than 6$/h if her household's nonlabor income is low to about twice as much if nonlabor income is high. Second, nonlabor income and labor supply have interesting interaction effects. At low values of nonlabor income, the part-time reservation wage is higher than the full-time reservation wage at any values of the husband's wage; the opposite is true at high values of nonlabor income. The reason is once again the curvature of the utility function. At low values of nonlabor income, individuals value consumption relatively more than leisure and therefore they will be more willing to accept a full-time job. At high level of nonlabor income, instead, the marginal benefits of additional consumption are lowered and leisure time becomes relatively more valuable making a part-time job more attractive. The rich impact of nonlabor income and labor supply points out that ignoring these sources of heterogeneity, as done by previous empirical works in the area, may lead to very different estimation results and may dramatically change the inference. Finally, another remark on endogeous quitting. Both nonlabor income and labor supply have an impact on the amount of endogenous quitting or, more formally, on the measure of the sets $\Gamma_U(w_j, h_j)$ and $\Gamma_E(w_j, h_j)$. Under our parametrizations, part-time and nonlabor income decrease the amount of endogenous quitting. Their combined effect leads to a case where there is no endogeous quitting, i.e. the reservation wage schedule is a straight line. This is the case for the second reservation wage schedule from the top where nonlabor income is high and the wife is offered a part time job.

2.2.4 Empirical Implications

The specification of the model, even in the extended version, it is tractable enough to obtain identification and estimation of its structural parameters given the appropriate dataset. We will discuss the issue in more detail in the identification section. In this section we just want to point out two relevant empirical implications of the model.

A first straightforward implication derives from Proposition 3: under linearity in preferences there is *no* mispecification error in assuming individual search behavior *even if decisions are actually taken at the household level.* In other words, the parameter estimates obtained from a given set of data using

[11] They correspond to the labor supply regimes we will use in estimation: part-time is defined as working less than 35 hours per week and full-time as working more than 35 hours per week.

[12] The first value corresponds to the average nonlabor income of households with nonlabor income higher than 0 but lower than the median. The second value corresponds to the average nonlabor income of households with nonlabor income higher than the median. They are two of the nonlabor income values at which we estimate the model.

the individual search specification or the household search specification will be exactly the same if the utility function is linear. This is due to the equivalence of the two equilibria under the two specifications and it is the implication often used to justify the estimation of individual search models. In our context, we can use this implication to run a specification test. If we estimate the model under concave preferences that nest the linear case, then a test for the linear utility specification is equivalent to a test for the individual search specification.

A second more subtle empirical implication derives from Proposition 4. The identification of risk aversion parameters is notoriously non-trivial and is rarely attempted within the context of a search model.[13] Proposition 4, though, shows that the presence of risk aversion is exactly what makes the equilibrium of the household search model different from the equilibrium of the individual search model. Therefore, all the dependence of the labor market decisions of one spouse on the labor market status of the other spouse must come from the curvature of the utility function. As a result, we can use the correlation between the labor market decisions of the two spouses to identify the risk aversion parameters.

3 Data

We use data from the 2001-2003 panel of the *Survey of Income and Program Participation* (SIPP) to estimate the model. The main objective of the SIPP is to provide accurate and comprehensive information about the principal determinants of the income of individual households in the United States. The SIPP collects monthly information regarding individual's labor market activity including earnings, average hours worked, and whether the individual changed jobs within an employment spell. The main advantage of using the SIPP is the ease in creating labor market histories for all individuals in the sample as well as in linking detailed spousal labor market information across time. The second characteristics is clearly a fundamental requirement in our empirical application and it is not available at this level of precision in other commonly used panel data for the US. The main disadvantage is the relatively short time span over which the panel data are available. However, our model has enough structure to be able to identify and precisely estimate the main structural parameters even if the time dimension of the panel is short.

3.1 Sample Restrictions

Although the target sample size for each SIPP panel is quite large, the size of our sample is reduced by several restrictions. As we describe in the econometrics section, we use point-in-time samples from the panel instead of the detailed individual-level event histories to estimate the model. Specifically, for each

[13] As mentioned, the only previoulsy estimates household search model is Dey and Flinn (2008). However, their identification of the risk aversion parameters is different because their data has an additional source of identification: the provision of employer-provided health insurance.

SIPP panel, we form point-in-time samples spaced three months apart for 24 months. We use wage and hours data from several of these eight point-in-time samples. For convenience we will refer to these times as times $t_1, t_2, .., t_8$.

In each of the selection criteria we describe, if at least one spouse fails to satisfy the criteria to remain in the sample, then both spouses are excluded from the sample. After imposing all selection criteria our sample consists of 3,984 individuals for a total of $1,992$ married couples.

We select married couples in which each spouse is aged between 25 and 50 (inclusive) at the beginning of the panel. Although this selection criteria excludes married couples in which the age of one spouse is outside this range and the age of the other spouse is within this range, we feel that it is better to be more restrictive due to differences in labor market outcomes for younger workers (aged 18 to 24 inclusive) and for older workers (aged 50 to 65 inclusive).[14] We only consider married couples in which each spouse is "present" in the household throughout the panel, meaning that we exclude any couples that are separated or not living together at any point in the panel. We do this because we do not model marriage formation and dissolution. Additionally, neither spouse must participate in the armed services throughout the sample period.

When using event history data, it is typical to observe a sequence of responses in which the individual is unemployed for several periods, then transitions to being out of the labor force (OLF), then re-enters the unemployed state, and finally obtains a job. We choose to include spouses in the sample who answer that they are OLF at some point in the panel, but have an employment spell or unemployment spell at other points in the sample. We exclude spouses if either spouse is OLF for the entire panel period or if either spouse transitions between OLF and unemployment, but does not work in the panel period. Finally, we exclude spouses if either spouse has a "broken" labor market history, such as being in the sample at the beginning and the end of the panel, but absent in between.

Hours and earnings information must also be observable at every point in the panel for any employed individual. Couples in which at least one individual supplies wage information, but does not supply how many hours per week he or she works are excluded from the sample. In most surveys that provide disaggregate labor market information, one usually observes a greater proportion of employed individuals reporting hourly wages rather than weekly, monthly, or annual earnings when the average age of the respondents is younger. Because older workers are less likely to be paid at an hourly rate, we are forced to impute hourly wage rates for individuals who report weekly earnings and weekly hours worked. Thus, it is essential that we have hours of labor supplied for each employed individual.

We recode hours worked per week into part-time and full-time categories, that is our intensive margin of the labor supply is reduced to a distribution with

[14] The labor market outcomes of younger workers are typically characterized by high turnover rates between jobs and between employment and unemployment, and are affected by human capital investment decisions. The labor market outcomes of older workers are typically characterized by end-of-career decisions made well before individuals reach retirement age.

two support points. We impose this assumption to simplify the computational problem implied by the solution and estimation of the model. We denote with p the probability of receiving a part-time offer. Individuals are coded as working part-time if they work less than 35 hours per week and full-time if they work at least 35 hours per week. We label the two resulting labor supply regimes with h_i^{pt} and h_i^{ft}. Their specific values in the simulation are calculated from the average hours worked in each hours category in the sample unconditional on gender. They are normalized for a time endowment available for work and leisure equal to 80 hours per week.

Empirical wage distributions are used extensively in the estimation procedure. The only adjustment we impose on the raw wage data is excluding couples in which there exist at least one spouse whose wage lies in the top 0.75 percent or the bottom 0.75 percent of the wage distribution conditional on gender. All wages are adjusted for inflation to the 2001 CPI.

3.2 Descriptive Statistics

Descriptive statistics of the estimation sample are reported in Tables 1 and 2. Since we separately estimate the model for couples with and without children younger than 18 years, we present the descriptive statistics conditioning on the presence of children. We add this control in estimation to partially take into account the systematic difference in labor market behavior induced by the presence of children. A better solution would have been to directly model fertility decisions but this is clearly a not trivial extension to the model. Moreover, the short time dimension of the data does not provide a lot of information about this process.[15]

Table 1 contains descriptive statistics of the cross-sectional features of the data. We compute them at the beginning of the observation period (beginning of 2001) and then three months apart for the following 24 months. The values of the statistics are very stable across time and in Table 1 we just report values for the first point-in-time sample. The first and fifth columns report unconditional moments while the other columns report moments conditional on the other spouse's labor market status.

Gender differentials are in line with the literature and the aggregate evidence: men are much more likely to work full-time (91.6% compared with 55.8% for women in household with children) and earn on average higher wages than women. The gender gap in full-time jobs is about 23%, almost equal to the gender wage gap at the median reported by the Bureau of Labor Statistics. The gender gaps are not significantly reduced on the sample without young children, pointing out the well known persistence of the phenomenon. There is indication of a full-time premium in accepted wages: average hourly wages are higher in full-time jobs than in part-time jobs on all the samples. As a result, the gender

[15]We use 18 years as cut-off point because it usually denotes the age when children leave home therefore significantly changing the child-care requirements on the household. We have experimented with different cut-off points without experiencing qualitative changes in the results.

gap in earnings is larger than the gender gap in wages, reaching 40% overall on the sample of couples with young children.

We describe cross-sectional inequality at the individual level by reporting coefficient of variations (CV) computed on hourly wages and weekly earnings. Hourly wages inequality is quite similar between men and women while overall inequality in weekly earnings is slightly higher for women. This is mainly due to the higher proportion of women working part-time and point out to the importance of labor supply decisions in determining gender differentials in the labor market.

But the most relevant result emerging from the descriptive statistics is that the labor market status of one spouse varies with the labor market status of the other spouse. For example, in the sample with children, 26.5% of women are employed part-time overall but only 11.3% of the women married to an unemployed husband are employed part-time. Not only the labor market status but also the average wage varies with the labor market status of the husband. Women's average wages decrease from 15.13 dollars an hour, to 14.94 dollars an hour, to 13.08 dollars an hour if, respectively, the husband works full-time, works part-time or is unemployed. Wage variation is also sensitive to the husband's labor market status: the coefficient of variation is decreasing as we move from the husband working full-time, to working part-time, to unemployment. Husbands are less sensitive than wives to the spouse's labor market status but there are still non-negligible effects: the full-time employment rate decreases from 91.2% on the sample of men married to women working full-time to 87.8% on the sample married to unemployed women. The variation in average wages is more modest (average wages are 18.37 dollars an hour in the first sample and 18.74 dollars an hour in the second) but the variation in wage dispersion is very sensitive to the wife's labor market status (the coefficient of variation in hourly wages is much smaller of the wife is working than if the wife is unemployed). The sample of couples without young children confirms the sensitivity of one's labor market status to the spouse's labor market status. In some cases the differences are larger than in the sample of couples with young children: for example, full-time employment range from 77.9% on women married to men employed full-time to 43.8% on women married to unemployed men. Notice, however, that if the sensitivity is similar the impact of the other spouse's labor market status may be different: on the sample of couples without young children we see women working more frequently full-time if the husband does the same while the opposite is true on the sample with young children.

Table 2 contains descriptive statistics of the labor market dynamics information contained in the data. We summarize the information reporting transition probabilities between the labor market state at the beginning of the period and the labor market state three months later. Again, we present the evidence conditioning and not conditioning on the other spouse's labor market status. There is persistence across labor market states, in particular on full-time employment: for example, 90% of women and 96% of men employed full-time are still employed full-time three months later. However, transition across labor market states are not rare, in particular for men: 45% of men who are unemployed at the beginning of the period are employed three months later. This proportion is much lower on the female sample: only 15% of unemployed women are employed three months later.

The evidence conditioning on the spouse's labor market status confirms the sensitivity observed in Table 1. For example, in the sample with children an employed women married to an unemployed husband is much more likely to become unemployed (a frequency of 14.3% as opposed to about 4% if the husband is employed) and a woman working part-time is much more likely to do so three months later if also the husband is employed part-time. Males transitions are also sensitive to their wives labor market status: if they work part-time, they are 20 percentage points more likely to do so three months later if the wife works part-time than if the wife is unemployed. Qualitatively similar results are found in the sample without young children. However, a larger number of transitions are not observed due to the smaller sample size: for example, we observe zero transitions from part-time employment to unemployment on both the males and females samples.

In conclusion, both Table 1 and Table 2 show the sensitivity of one spouse labor market status to the other's spouse labor market status. Explaining this sensitivity is one of the motivation of our paper since it constitutes evidence that cannot be generated by an individual search model. In fact, an individual search model with random matching should generate no correlation at all between the spouses' labor market states. It is also an empirical feature crucial to our identification strategy and that we will fully exploit in the estimation procedure.

4 Estimation and Identification

4.1 Identification

We discuss the identification conditioning on the data set we just described and on the functional form assumptions we will use in estimation. The identification discussion can be more general but, given the contribution of the paper, we think it is better to discuss the identification within the framework actually used in the application.

We make three functional form assumptions. First, we need to assume a utility function that allows for risk aversion. We assume a Constant Relative Risk Aversion formulation (CRRA). The instantaneous utility for household i, j is:

$$u\left(c_{ij}, l_i, l_j; \delta, \boldsymbol{\beta}, \boldsymbol{\alpha}\right) = \quad (32)$$
$$\left(1 - \alpha_M - \alpha_W\right) \frac{c_{ij}^{\delta} - 1}{\delta} + \alpha_M \frac{l_i^{\beta_M} - 1}{\beta_M} + \alpha_W \frac{l_j^{\beta_W} - 1}{\beta_W}$$

We choose a CRRA specification because it nests the two main utility function specifications used in the applied micro literature: linear and log utility. It is also a utility function frequently used in the macro literature, even if GGV obtain their theoretical results for a larger class of utility functions. However, in their calibration exercise, GGV end up using a CRRA specification.

Second, to simplify the computation problem we reduce the intensive margin labor supply decision to a choice between part-time work and full-time work. The probability of receiving a part-time job offer is denoted by p. The indexes $_{PT}$ and $_{FT}$ will be used to denote parameters referring to part-time and full-time jobs. Individuals are coded as working part-time if they work less than 35 hours per week and full-time if they work at least 35 hours per week. In the simulations, hours worked per week are normalized for a time endowment available for work and leisure equal to 80 hours per week.

Finally, due to the well-known non-identification result of Flinn and Heckman (1982), we need to assume a *recoverable* wage offers distribution[16] if we want to estimate the entire wage offer distribution and not simply fit the accepted wage distribution. Following the most common assumption in the recent literature, we will assume a lognormal distribution.[17] The wage offers distribution is allowed to be specific to the agent's types and to the hours requirement. The density for agents of type $I \in \{W, M\}$ and hours requirement $H \in \{PT, FT\}$ is:

$$f\left(w; \mu_I^H, \sigma_I^H\right) = \frac{1}{\sigma_I^H w} \phi[\frac{\ln(w) - \mu_I^H}{\sigma_I^H}],\ w > 0 \tag{33}$$

where ϕ denotes the standard normal density.

Conditioning on these functional form assumptions, the set of parameters to be identified is denoted by the following set:

$$\theta = \left\{ \begin{array}{c} \lambda_{W,M}, \gamma_{W,M}, \eta_{W,M}^{PT}, \eta_{W,M}^{FT} \\ \\ \mu_{W,M}^{PT}, \sigma_{W,M}^{PT}, \mu_{W,M}^{FT}, \sigma_{W,M}^{FT}, p_{W,M} \\ \\ \alpha_{W,M}, \delta, \beta_{W,M} \end{array} \right\} \tag{34}$$

where the first row pertains to the mobility parameters, the second one to the wage offer distributions parameters and the third one to the utility parameters. The discount rate parameter ρ is not included in θ because it will not be estimated but fixed to 5% a year.

As quite clear from the discussion of the theoretical model, the mapping from the structural parameters to the data is too complicated to be solved analytically and therefore an analytical proof of identification cannot be provided. However, we can build on previous work on the identification of search model and point out where our model differs and what additional information we use to identify parameters specific to our model. It is useful to discuss the identification of

[16] A distribution is *recoverable* from it truncation if knowledge of the point of truncation and of the truncated distribution are enough to uniquely determine it.

[17] See Flabbi and Moro (2012), van der Klaauw and A. van Vuuren (2010), Yamaguchi (2010), Dey and Flinn (2008). The lognormal is frequently chosen because, on top of recoverability, it offers a very good fit of the accepted wage distribution.

the three groups of parameters (mobility parameters, wage offer distributions parameters and utility parameters) separately because they *mainly* use three different sources of information. Mainly does not mean exclusively since all the parameters have an impact on all the observed outcomes through the reservation wages and the optimal decision rules but the structure of the model is strong enough to make some parameters much more sensitive to some specific observed outcomes than others.

The mobility parameters are mainly identified by the steady state proportion of workers in each labor market states and by the transitions probabilities between labor market states.[18] To see this, recall that in our model the transition probability between two states (i.e. the hazard rate out of a given labor market states and into another) is equal to the (exogenous) shock probability times the (endogenous) probability that the transition is optimal for the agent. The are four exogenous shocks in our model corresponding to the four mobility parameters: arrival rate while employed or unemployed and termination rates while working full-time or part-time. The probability that the transition is optimal clearly depends on all the other parameters in the model but Flinn and Heckman (1982) shows that once the wage offers distribution is assumed to belong to a *recoverable* distribution, information on accepted wages and transitions probabilities (or, alternatively, durations) is enough to identify the mobility parameters. The intuition is that the endogenous acceptance probability is identified from accepted wage information leaving to the transitions probability enough information to identify the mobility parameters. Transitions from unemployment to employment part-time or full-time identify the arrival rates $\lambda_{W,M}$. Job-to-job transitions identify the arrival rates while employed $\gamma_{W,M}$. Finally, transitions from employment part-time or employment full-time to unemployment identify the terminations rates, respectively, $\eta_{W,M}^{PT}$ and $\eta_{W,M}^{FT}$.

The wage offers distribution parameters are mainly identified from the accepted wages information. The model implies that the accepted wages are truncations of the wage offer distributions. If the wage offers distributions can be recovered from their truncation then accepted wage information is enough to identify the wage offers parameters. The recoverability condition we impose by assuming a lognormal distribution exactly defines this property and secures identification. Without imposing this assumption the probability mass below the reservation wage (i.e. the truncation point) cannot be recovered and therefore no counterfactual exercise or policy experiment can be run. What we add in our model is the labor supply margin. We discretize the decision by allowing individuals to choose between working part-time and full-time. Since we observe accepted wage distributions for individuals working part-time and full-time, we can replicate the same identification strategy separately on the two labor supply regimes and allow all the parameters to be part-time and full-time specific.

Finally, we have to identify the utility parameters. The weight on leisure

[18] Alternatively, and more conventionally, the duration information can be used in place of the transitions probabilities. Transition probabilities and durations contain the same information: we discuss transitions probabilities here because these are the moments we will use in estimation.

($\alpha_{W,M}$) represents the preference of consumption with respect to leisure and it is therefore identified by the labor supply decisions. More interestingly, the risk aversion parameters on consumption δ and the utility coefficient on leisure $\beta_{W,M}$ are identified by the sensitivity of one spouse labor market status to the other's spouse labor market status. As stated in Proposition 4 the presence of risk aversion is what makes the equilibrium of the household search model different from the equilibrium of the individual search model, i.e. what creates the correlation between the two spouses labor market decisions. The fact that one spouse reservation wage depends on the other spouse labor market status *only if* the utility function is nonlinear implies that if the transitions probabilities and the accepted wages we observe in the data are sensitive to the spouse's labor market states then we can secure identification of the δ and $\beta_{W,M}$ parameters. The descriptive statistics we have already presented amply support the presence of this sensitivity.

4.2 Estimation

We use the method of simulated moments to estimate the parameters of the model. We choose this estimation method for two reasons. First, we cannot use a maximum likelihood estimator because the model may generate simultaneous changes in the labor market states of both spouses in an household (the endogenous job termination case). Second, we prefer to use continuos time as opposed to discrete time (which can generate a likelihood able to deal with simultaneity) to avoid the inherently arbitrary choices of the length and boundaries of the time interval to apply on the data. Morever, a discrete time interval may lead to multiple equilibria issues in a dual-searcher model as our extended household search model. We follow DF by building our moments from point-in-time samples extracted from the longitudinal data.

The estimation procedure works by first selecting the T moments with which to estimate the K parameters of the model, where $T \geq K$. We calculate these moments in our original sample and reserve them for use in the criterion function to be defined below. Next we write a procedure that generates the simulated moments given a set of parameter estimates. Each time the simulation is run, the value functions are solved using fixed point methods. Next, we randomly assign each couple an initial labor supply configuration. We simulate a total of R labor market histories, where each labor market history denotes a sequence of transitions between labor market states for a pair of spouses.

To simulate one labor market history (call it the r^{th} history) for one pair of spouses, we draw a vector of pseudo-random draws (from a pseudo-random number generator) denoted by ψ_r, where the dimension of ψ_r is $L \times 1$. Then the event history associated with the r^{th} replication when using parameter vector θ is

$$\Im_r(\theta) = J(\psi_r, \theta) \tag{35}$$

We choose a time $t_{ss} >> 0$ far enough into each household's history so that the household's initial state does not affect the likelihood of the household occupying any one state at time t_{ss}. We evaluate a household's labor market state and the wage of any employed spouse at time t_{ss}. From this simulated data, we can calculate a set of moments identical to the selected set of sample moments. In this fashion, the event history of all R households in the simulation, $\Im = (\Im_1(\theta), \Im_2(\theta), ...\Im_R(\theta))'$, is "mapped" into a simulated data set from which the simulated moments are then calculated.

We construct the column vector of T simulated moments $Q(\theta)$, where θ is the parameter vector, and choose a set of parameter values to minimize the simulated method of moments criterion function $(Q(\theta) - q_s)' W^{-1} (Q(\theta) - q_s)$, where q_s is a column vector of the T corresponding sample moments and W^{-1} is a symmetric, positive definite weighting matrix that is TxT, the derivation of which we will discuss below. We define the simulated method of moments estimator as the parameter vector $\hat{\theta}_{SMM}$, where

$$\hat{\theta}_{SMM} = \arg\min_{\theta} (Q(\theta) - q_s)' W^{-1} (Q(\theta) - q_s) \tag{36}$$

The function is minimized using the Nelder-Mead Simplex Algorithm.

The matrix W^{-1} weights the different moments in $Q(\theta)$ and q_s according to their sample variability. We calculate a matrix W by bootstrapping N_{boot} samples from the original sample of data and calculating the T sample moments for each bootstrapped sample, yielding an $N_{boot}xT$ matrix of sample moments. To form W, we replace the diagonal of an identity matrix with the sample variances of the sample moments among the bootstrapped samples. The inverse of W produces the desired weighting matrix. Thus, the estimation procedure places a greater importance on matching the sample moments with the lowest variance.[19]

We choose the moments to match in the estimation procedure by mirroring the identification strategy. We allow all the parameters to be gender specific and therefore we compute the individual moments separately on husband and wives. The first group of moments pertains to the steady state transitions probabilities between labor market states and to the proportion of workers in each labor market states. This is the information that mainly identifies the mobility parameters. We have three possible labor market states and we compute transitions between labor market states one period and two periods apart. As a result, we obtain a total of 21 moments for each gender.

The second groups of moments pertains to the accepted wage distribution and mainly identifies the wage offers distributions parameters. We compute mean, standard deviation, skewness and wage growth on the accepted wage distribution for each gender and for each labor supply regime. We also introduce skewness to better capture that female wage distributions are frequently char-

[19] The weighting matrix also serves as a way to scale each of the moments so that they approximately possess the same magnitude. For example, since proportions are between 0 and 1 they will have very small variances that are close to 0. The means of sample wages will have variances which are also small, yet which are generally more than three orders of magnitude larger than the sample variance of a proportion. Taking the inverse of these variances compensates for the differences in scale among the moments.

acterized by a high probability mass right above the reservation wage. From the accepted wage information, we obtain a total of 14 moments for each gender.

The third groups of moments are the cross-moments, i.e. the moments representing correlations in the labor market status of the two spouses. The presence and degree of this correlation are captured by the following moments. The contemporaneous and over-time correlations between the two spouses' accepted wages, conditioning on the labor supply regime. The mean and standard deviation of one spouse's wage given the other spouse's labor market status. And finally, the transition probabilities across labor market states conditional on the labor market status of the spouse. As a result, we obtain a total of 51 cross-moments.

To summarize, the estimation procedure is using 121 moments to estimate 23 parameters. We build each moment by forming interaction variables between variables of interest (e.g. wages of female part-time workers) and dummy variables rapresenting labor market status (e.g. a variable equal to 1 when the individual is a female part-time worker and equal to 0 otherwise). These procedure effectively creates unconditional moments. Unconditional moments are preferable to conditional moments since they exist for all proportions of agents' labor market status in the simulation generated using different sets of parameter vectors, whereas the conditional moment may be undefined when simulating the model using certain parameter vectors.[20]

5 Estimation results

5.1 Results

Table 2 reports the parameter estimates for both the Individual search and the Household search model. The estimates are run separately on the sample of households with children likely to be living at home (younger than 18 years old) and on the sample of household without children likely to be living at home. We want to estimate conditioning on the presence of children because children have an impact on all household decisions, including labor market decisions. It is also well-known that the impact of children is asymmetric by gender and it is therefore important to condition on their presence if we want to make any comparison by gender.

[20] Not surprisingly, we found when using conditional moments that the simulated moments were very unstable and could vary dramatically across iterations of the algorithm since they were based only on the group that actually contributed the information. In some iteration of the simplex algorithm, a vertex of the simplex might consist of a parameter vector which produces 100 female part-time workers. The next iteration might simulate the model using a different parameter vector that produces only 3 female part-time workers. Defined on such a small subsample, the conditional moment is capable of changing dramatically across iterations. Using the unconditional moments, instead, improves the stability of changes in the moments across iterations of the estimation algorithm since the moment is defined over the whole sample. It also enables the moment to be defined when the proportion of the sample in the simulation contributing information (e.g. female part-time workers) is equal to or close to zero.

The parameters estimates are different between men and women on all the sample and specifications. Conditioning on gender, the estimates are also different depending on the model specification. This is a first indication that estimating under the assumption that decision are taken at the individual level and not at the household level has important empirical consequences. The main differences are in the mobility parameters and in the wage offers parameters. The utility parameters are more stable across specifications but some important difference remains. The weight on leisure is estimated to be similar across specification while the relative risk aversion coefficient (one minus the estimated parameters in our specification) on leisure is estimated to be higher for wives than husbands in the household search model but lower for wives than husbands in the individual search model.

To better judge how sensitive are the mobility and wage offers parameters estimates to the model specification, we report in Table 3 some statistics implied by the structural estimates. The most interesting result is that the individual search model overestimates the gender differential in the wage offers distribution. The parameters imply that the average wage offers differentials between husbands and wives is estimated to be two and a half times larger under the individual search specification than under the household search specification (19.1% instead of 7.3%). This is found when estimating the model on the sample with children: the results on the sample without children are even more dramatic (15.5% instead of 2.2%). This implication is interesting because it suggests that some of the gender wage differential we observe in the data (i.e. the accepted wages differential) may be due to optimal behavior of women in a stable relationship with an husband.

The differentials in average durations are less sensitive to the model specification but when moving from the individual to the household search specification we still estimate the following: (1) a substantial increase in the gender differential in the frequency of offers while employed and (2) a substantial decrease in the differential in the termination rate while unemployment. These results are mainly driven by the fact that the individual search model overestimates the wives' mobility rates.

The explanation for both results resides in the interaction between spouses in the household. We know that in the household search model with risk aversion the reservation wage of the wife depends on the husband labor market status. If husbands have on average a relative high wage and the expected gains from search effect dominates the lowest cost of search effect then wives' reservation wages in the household search models are lower than in the individual search model implying more mobility. For given transitions probabilities observed in the data, the individual search model may explain this mobility only by increasing the exogenous mobility rates. The household search model, instead, may capture some of this mobility by adjusting the wives' reservation wages. By a similar argument, the individual search model will fit the negative gender wage differential for women with a negative differential in the average wage offer distribution of a similar magnitude. The houshold model, instead, may partially reduce the differential because it has another channel to lower the wives reservation wage: the relative high wage of husbands.

5.2 Fit of the Model

TO BE COMPLETED

5.3 Specification Test

TO BE COMPLETED

6 Inequality

Thanks to the estimation of the model structural parameters, we can simulate labor market careers for households and individuals. This labor market careers can then be used to compute inequality measures both cross-sectional and overtime. We call *lifetime inequality* the inequality that summarize the entire labor market careers of given agents. We give a formal definition below.

6.1 Simulations Procedure

The simulation procedure works as follows. We start by fixing the parameter vector: the parameter vector is set at the point estimates of the estimated model when computing the *benchmark* inequality measures and at a proper combination of the point estimates when computing the *counterfactual* inequality measures. Each household begins in the state in which both spouses are unemployed. Two random numbers are generated to determine the length of time until each spouse receives a job offer. Another random draw decides whether the job offer is a part-time or full-time job. The wage associated with each spouse's job offer is generated using another random number draw and the exogenous wage distribution, where the wage distribution is conditional on the part-time or full-time status of the job offer from the previous step. The length of time until a spouse first receives an acceptable offer is recorded as the duration spent in this first state. Other random numbers are used to determine (1) when job offers continue to arrive for the employed spouse and the unemployed spouse, (2) the wages associated with these job offers and the part-time or full-time status of the offer, and (3) the amount of time until each spouse is exogenously dismissed from his or her job (which depends on the part-time or full-time status of the job). The duration a household spends in each labor market state is recorded, along with the wages and hours associated with labor market states in which at least one spouse is employed. This process is repeated until the labor market history (the sum of the durations spent in all states) reaches 480 months (40 years).

Lifetime values are created for each household in the sample by integrating over discounted values of being in each labor market state over the full length of the labor market career. For example, the lifetime utility measure for the household i,j is defined as:

$$LU_{ij} = \sum_{s=1}^{S} \exp\left(-\rho t_s\right) \int_{t_{s-1}}^{t_s} u\left(c_{ij}, l_i, l_j; \delta, \boldsymbol{\beta}, \boldsymbol{\alpha}\right) \exp\left(-\rho v\right) dv \tag{37}$$

where s denotes a spell in which the labor market status of both partners is unchanged.

6.2 Simulations Results

Table 4 and 5 illustrate the results of the simulations by reporting the coefficient of variation for cross-sectional and lifetime inequality computed on wages, earnings and utility. The top panel reports results on the benchmark models, i.e. the model generated by the point estimates reported in Table 2. The bottom panel reports results on the counterfactual experiments. We run two experiments with the objective of decomposing the sources of differences in inequality between the individual search and the household search model. These differences have two main sources: the *different parameter estimates* and the *different behavior* that the two models imply. To judge the impact of the first, we simulate a model without household interaction behavior (i.e. the individual search model) but using the household search parameter estimates. To judge the impact of the second, we simulate a model with household interaction behavior (i.e. the household search model) but using the individual search parameter estimates.

The top panel of Table 4 reports that the model specification has a large impact on cross-sectional inequality: under the individual search specification, women experience higher inequality than men on earnings while under the household search specification the opposite is true. Utility inequality remains higher for women but under the household search specification the differential is greatly reduced. Lifetime inequality is more stable across specifications but we still observe the switch on ranking in earnings and a reduction of the gender differential in lifetime utility when moving from the individual to the household search specification. All the household inequality measures indicate that inequality across individuals is higher than inequality across households.

Overall, these results show that the empirical impact of ignoring that labor market decisions are taken at the household level is large. The impact is so large that not only it implies larger gender differentials in inequality (a result similar to what we had found on the gender wage offers differential) but it may actually mask the true ranking in inequality between men and women.

The bottom panel shows that most of the difference in the two specifications is due to biased estimates. The inequalities values generated by the household search model using individual search estimates (columns 3 and 4, bottom panel) are very similar to those obtained using the same parameters estimates but the individual search behavior (columns 1 and 2, top panel). This means that differences in behavior are important because of the impact they have on the estimates and not because of the different equilibrium they generate at same parameters. All these results are essentially confirmed in Table 5 which reports the same exercise of Table 4 but using the no-children households sample.

7 Conclusions

In this paper, we develop and estimate an household search model to evaluate if ignoring that labor market decisions are taken at the household level - as usually done in search models of the labor market - has relevant empirical consequences. We judge the empirical relevance by comparing parameters estimates under different specifications, by running a specification test, and by generating simulation to compute cross-sectional and lifetime inequality measures. We build on previous literature (Dey and Flinn (2008) and Guler, Guvenen and Violante (2011)) to reiterate that risk aversion is necessary to generate meaningful interactions between spouses within a unitary model of the household. We exploit this result to propose an identification strategy of the risk aversion parameters.

We find that ignoring the household as crucial unit of decision-making has relevant empirical consequences, particularly on gender differentials. Ignoring the household leads to estimate gender differentials in average wage offers for full-time jobs two and a half times larger and to erroneously conclude that women experience higher inequality in wages and earnings than men. Lifetime inequality is more stable across specifications but we still observe a reduction of the gender differential in lifetime utility. Counterfactual experiments show that the main source of the differences in inequality measures between the individual search and the household search specification is the bias in the individual search estimates. This means that differences in behavior are important because of the impact they have on the estimates and not because of the different equilibrium they generate at same parameters. All the results are robust to estimating the model on samples of households with or without children. These preliminary results show that in many applications it may be costly to ignore that labor market search decisions are taken at the household level.

The main limitation of our work is the very restrictive unitary model assumption we use to capture households' behavior. Without other estimates in the literature, it is difficult to judge if our results constitute a lower bound or an upper bound of the impact of the mispecification error of ignoring the household as the genuine unit of decision-making about labor market choices. More complex household interactions may definitely exacerbate the problem. At the same time, household interactions that give to each spouse a larger share of their own labor income may actually reduce the problem.

References

[1] Albrecht, J. A. Anderson and S. Vroman (2010) "Search by Committe", *Journal of Economic Theory*, July 2010.

[2] Blau, D. (1991) "Search for Nonwage Job Characteristics: a Test for Reservation Wage Hypothesis", *Journal of Labor Economics*, 9(2): 186-205.

[3] Bloemen, H. (2008), "Job Search, Hours Restrictions, and Desired Hours of Work", *Journal of Labor Economics*, 26(1): 137-179.

[4] Blundell, R., and I. Preston (1998), "Consumption inequality and income uncertainty", *Quarterly Journal of Economics,* 113, 603-640.

[5] Bowlus, Audra J. and Jean-Marc Robin (2004), "Twenty Years of Rising Inequality in US Lifetime Labor Values", *Review of Economic Studies,* 71(3), 709-743.

[6] Bowlus, Audra J. and Jean-Marc Robin (2010), "An International Comparison of Lifetime Labor Income Values and Inequality: A Bounds Approach", *Journal of the European Economic Association.*

[7] Compte, O. and Jehiel (2010) "Bargaining and Majority Rules: A Collective Search Perspective", *Journal of Political Economy,* 2010

[8] Dey, M. and C. Flinn (2008) "Household Search and Health Insurance Coverage", *Journal of Econometrics* 145: 43-63.

[9] Eckstein, Z. and G. van den Berg (2007), "Empirical labor search: A survey", *Journal of Econometrics*, 136: 531-564.

[10] Flabbi, L., and M. Leonardi (2010) "Sources of Earnings Inequality: Estimates from an On-the-Job Search Model of the U.S. Labor Market", *European Economic Review*, 54(6): 832-854, 2010.

[11] Flabbi, L., and A. Moro (2012), "The Effect of Job Flexibility on Female Labor Market Outcomes: Estimates from a Search and Bargaining Model", forthcoming, *Journal of Econometrics*, 168: 81–95.

[12] Flinn, C. (2002), "Labour Market Structure and Inequality: A Comparison of Italy and the U.S." *Review of Economic Studies,* 69, 611-645.

[13] Flinn, C. and J. Heckman (1982), "New Methods in Analyzing Structural Models of Labor Market Dynamics." *Journal of Econometrics*, 18, 115-168.

[14] Guler, Guvenen and Violante (2010), "Joint-Search Theory: New Opportunities and New Frictions", mimeo, NYU.

[15] Heathcote, J., F. Perri and G. Violante (2009), "Unequal We Stand: An Empirical Analysis of Economic Inequality in the United States", *Review of Economic Dynamics*, forthcoming.

[16] Heathcote, J., K. Storesletten and G. Violante (2008), “Insurance and opportunities: A welfare analysis of labor market risk”, *Journal of Monetary Economics*, 55: 501-525.

[17] Katz, L., and D. Autor (1999), ”Changes in the Wage Structure and Earnings Inequality.” Chapter 26 *Handbook of Labor Economics* vol.3A. Amsterdam North Holland.

[18] Krueger, D. and Fabrizio Perri (2006), “Does Income Inequality Lead to Consumption Inequality? Evidence and Theory.” *Review of Economic Studies* 73 (January): 163-93.

[19] Pissarides (2000) *Equilibrium Unemployment Theory*, Cambridge, MA: MIT Press..

[20] Richard Rogerson, Robert Shimer and Randall Wright, "Search-Theoretic Models of the Labor Market: A Survey." *Journal of Economic Literature*, 2005, 43(4), pp. 959-88.

[21] Yamaguchi, S. (2010) "Job Search, Bargaining, and Wage Dynamics", *Journal of Labor Economics*, Vol. 28, No. 3, pp. 595-631.

[22] van der Klaauw and A. van Vuuren (2010), "Job search and academic achievement", *European Economic Review*, Volume 54, Issue 2, 294–316.

Table 1: Descriptive Statistics:
Cross-Sectional Components

	Yes Children Younger than 18 $N = 3,340$				No Children Younger than 18 $N = 644$			
	Tot.	Spouse Lab Mkt Status			Tot.	Spouse Lab Mkt Status		
		Employed		Unemp.		Employed		Unemp.
		FT	PT			FT	PT	
Females								
Labor Mkt Status:								
Employed FT	0.558	0.556	0.550	0.613	0.755	0.779	0.625	0.438
Employed PT	0.265	0.275	0.217	0.113	0.168	0.159	0.313	0.188
Unemployed	0.177	0.170	0.233	0.275	0.078	0.062	0.063	0.375
Hourly Wages:								
Employed FT								
Mean	15.02	15.13	14.94	13.08	15.79	16.11	11.28	12.11
CV	0.517	0.516	0.537	0.504	0.510	0.506	0.479	0.371
Employed PT								
Mean	12.72	12.71	13.35	12.27	12.87	12.98	11.01	14.30
CV	0.605	0.608	0.605	0.501	0.555	0.578	0.432	0.385
Weekly Earnings:								
Mean	528.1	528.0	543.9	516.9	607.1	623.7	404.1	459.0
CV	0.640	0.644	0.632	0.553	0.584	0.578	0.563	0.425
Males								
Labor Mkt Status:								
Employed FT	0.916	0.912	0.950	0.878	0.901	0.930	0.852	0.720
Employed PT	0.036	0.035	0.029	0.047	0.050	0.041	0.093	0.040
Unemployed	0.048	0.053	0.020	0.074	0.050	0.029	0.056	0.240
Hourly Wages:								
Employed FT								
Mean	18.91	18.37	20.09	18.74	19.29	19.43	19.78	16.37
CV	0.509	0.490	0.471	0.616	0.490	0.507	0.384	0.513
Employed PT								
Mean	15.57	13.68	16.96	18.73	12.52	9.68	14.90	29.00
CV	0.681	0.491	0.556	0.916	0.601	0.374	0.629	0.000
Weekly Earnings:								
Mean	795.3	771.8	849.3	785.9	800.6	808.9	799.3	700.3
CV	0.526	0.508	0.484	0.634	0.520	0.536	0.441	0.502

Notes: Data are from the 2001-2003 panel of the Survey of Income and Program Participation (SIPP). The cross-sectional moments are computed from the first point-in-time sample extracted from the panel. CV stands for Coefficient of Variation.

Table 2: Descriptive Statistics:
Dynamic Components

	Yes Children Younger than 18				No Children Younger than 18			
	$N = 3,340$				$N = 644$			
	Tot.	Spouse Lab Mkt Status			Tot.	Spouse Lab Mkt Status		
		Employed		Unem.		Employed		Unem.
		FT	PT			FT	PT	
Females								
Labor Mkt Transitions:								
From Empl. FT to:								
Employed FT	0.902	0.909	0.879	0.796	0.926	0.934	0.800	0.857
Employed PT	0.050	0.048	0.091	0.061	0.037	0.031	0.200	0.000
Unemployed	0.047	0.042	0.030	0.143	0.037	0.035	0.000	0.143
From Empl. PT to:								
Employed FT	0.090	0.093	0.077	0.000	0.111	0.087	0.400	0.000
Employed PT	0.812	0.807	0.923	0.889	0.889	0.913	0.600	1.000
Unemployed	0.097	0.100	0.000	0.111	0.000	0.000	0.000	0.000
From Unemp. to:								
Employed FT	0.084	0.088	0.000	0.091	0.080	0.111	0.000	0.000
Employed PT	0.071	0.073	0.000	0.091	0.080	0.056	0.000	0.167
Unemployed	0.845	0.838	1.000	0.818	0.840	0.833	1.000	0.833
Males								
Labor Mkt Transitions:								
From Empl. FT to:								
Employed FT	0.960	0.954	0.974	0.958	0.948	0.947	0.978	0.889
Employed PT	0.016	0.019	0.012	0.012	0.017	0.018	0.022	0.000
Unemployed	0.024	0.027	0.014	0.031	0.034	0.035	0.000	0.111
From Empl. PT to:								
Employed FT	0.300	0.333	0.231	0.286	0.313	0.400	0.200	0.000
Employed PT	0.650	0.636	0.769	0.571	0.688	0.600	0.800	1.000
Unemployed	0.050	0.030	0.000	0.143	0.000	0.000	0.000	0.000
From Unemp. to:								
Employed FT	0.438	0.469	0.556	0.318	0.375	0.286	0.667	0.333
Employed PT	0.013	0.000	0.000	0.045	0.063	0.000	0.333	0.000
Unemployed	0.550	0.531	0.444	0.636	0.563	0.714	0.000	0.667

Notes: Data are from the 2001-2003 panel of the Survey of Income and Program Participation (SIPP). The transitions proportions are computed from the first point-in-time sample extracted from the panel to the point-in-time sample extracted three months later.

Table 3: Estimation Results:
Parameter Estimates

	With Children Younger Than 18				Without Children Younger Than 18			
	Individual Search		Household Search		Individual Search		Household Search	
	Males	Females	Males	Females	Males	Females	Males	Females
λ	0.3912	0.3069	0.2993	0.2356	0.3132	0.4079	0.3871	0.3112
γ	0.0911	0.0790	0.1179	0.0857	0.1033	0.0737	0.1232	0.0929
η^{pt}	0.0157	0.0083	0.0191	0.0127	0.0183	0.0097	0.0167	0.0182
η^{ft}	0.0140	0.0314	0.0149	0.0153	0.0148	0.0189	0.0175	0.0144
μ^{pt}	2.1295	2.1268	2.0361	2.1986	2.0905	2.2145	1.9434	2.0934
μ^{ft}	2.0598	1.8029	1.9369	1.9497	2.1139	1.8406	1.9031	2.0058
σ^{pt}	0.6655	0.5333	0.6871	0.4566	0.6039	0.5229	0.5709	0.5220
σ^{ft}	0.6354	0.6885	0.6637	0.4103	0.5440	0.6767	0.6606	0.3603
p	0.0600	0.0599	0.0588	0.1819	0.0563	0.0777	0.0542	0.1615
α	0.1371	0.1561	0.1248	0.2082	0.1530	0.1485	0.1324	0.1472
δ	0.0534	0.0487	0.0439		0.0527	0.0476	0.0478	
β	0.0335	0.0509	0.0547	0.0488	0.0368	0.0508	0.0471	0.0481
N	1,670	1,670	3,340		322	322	644	

Note: TO BE COMPLETED Standard Errors by Boostrap

Table 3: Estimation Results:
Implied Values

	With Children Younger Than 18				Without Children Younger Than 18			
	Individual Search		Household Search		Individual Search		Household Search	
	Males	Females	Males	Females	Males	Females	Males	Females
Wage Offers:								
$E[w]$	9.652	7.809	8.709	8.073	9.607	8.121	8.335	8.151
$V[w]$	46.762	35.563	42.285	12.985	32.292	36.299	37.413	11.681
$E[w\|PT]$	10.496	9.670	9.701	10.003	9.707	10.498	8.219	9.296
$V[w\|PT]$	61.380	30.759	56.789	23.193	41.478	34.652	26.029	27.063
$E[w\|FT]$	9.599	7.690	8.647	7.644	9.601	7.921	8.342	7.930
$V[w\|FT]$	45.830	35.869	41.378	10.715	31.743	36.438	38.066	8.719
Durations:								
$E[t_o\|U]$	2.556	3.258	3.341	4.244	3.192	2.451	2.584	3.213
$E[t_o\|E]$	10.982	12.653	8.479	11.674	9.678	13.560	8.116	10.768
$E[t_e\|PT]$	63.563	120.445	52.331	78.634	54.578	103.261	59.775	54.807
$E[t_e\|FT]$	71.259	31.850	67.295	65.498	67.492	52.993	57.072	69.242
Gender Differentials:								
Wage Offers:								
$E[w]$	0.191		0.073		0.155		0.022	
$V[w]$	0.239		0.693		-0.124		0.688	
$E[w\|PT]$	0.079		-0.031		-0.081		-0.131	
$V[w\|PT]$	0.499		0.592		0.165		-0.040	
$E[w\|FT]$	0.199		0.116		0.175		0.049	
$V[w\|FT]$	0.217		0.741		-0.148		0.771	
Durations:								
$E[t_o\|U]$	-0.275		-0.270		0.232		-0.244	
$E[t_o\|E]$	-0.152		-0.377		-0.401		-0.327	
$E[t_e\|PT]$	-0.895		-0.503		-0.892		0.083	
$E[t_e\|FT]$	0.553		0.027		0.215		-0.213	

Note: Definitions: w denotes hourly wages; PT and FT part-time and full-time; t_o durations in months before receiving a job offer shock; t_e durations in months before receiving a job termination shock.

Table 4: Inequality Measures and Counterfactual Experiments.
- With Children Younger Than 18 -

	BENCHMARKS:				
	Individual Search		Household Search		
	Male	Female	Male	Female	Household
Cross-section:					
Wages	0.518	0.617	0.552	0.350	0.431
Earnings	0.523	0.703	0.554	0.362	0.438
Utility	0.260	0.445	0.269	0.282	0.224
Lifetime:					
Wages	0.253	0.229	0.255	0.220	0.174
Earnings	0.260	0.273	0.264	0.238	0.185
Utility	0.361	0.785	0.526	0.767	0.219
	COUNTERFACTUALS:				
	Impact of Parameters		Impact of Behavior		
	Male	Female	Male	Female	Household
Cross-section:					
Wages	0.573	0.400	0.519	0.606	0.444
Earnings	0.570	0.387	0.518	0.663	0.458
Utility	0.278	0.379	0.235	0.325	0.223
Lifetime:					
Wages	0.261	0.182	0.247	0.238	0.173
Earnings	0.268	0.172	0.256	0.269	0.186
Utility	0.537	0.791	0.497	0.986	0.203

Notes: The Table reports the coefficient of variation of the corresponding variable. The counterfactual experiments are defined as follows: *Impact of Parameters* runs simulations of a model using the individual search model optimal behavior but the household search model paramters estimates; *Impact of Behavior* runs simulations of a model using the household search model optimal behavior but the individual search model parameters estimates.

Table 5: Inequality Measures and Counterfactual Experiments.
- Without Children Younger Than 18 -

	BENCHMARKS:				
	Individual Search		Household Search		
	Male	Female	Male	Female	Household
Cross-section:					
Wages	0.442	0.604	0.245	0.168	0.158
Earnings	0.444	0.645	0.256	0.160	0.165
Utility	0.242	0.394	0.491	0.577	0.209
Lifetime:					
Wages	0.212	0.251	0.546	0.334	0.403
Earnings	0.218	0.277	0.558	0.294	0.411
Utility	0.426	0.470	0.267	0.279	0.222
	COUNTERFACTUALS:				
	Impact of Parameters		Impact of Behavior		
	Male	Female	Male	Female	Household
Cross-section:					
Wages	0.568	0.367	0.390	0.556	0.396
Earnings	0.575	0.331	0.396	0.594	0.408
Utility	0.277	0.371	0.230	0.272	0.208
Lifetime:					
Wages	0.244	0.159	0.209	0.242	0.157
Earnings	0.252	0.149	0.216	0.267	0.167
Utility	0.451	0.528	0.530	0.582	0.198

Notes: The Table reports the coefficient of variation of the corresponding variable. The counterfactual experiments are defined as follows: *Impact of Parameters* runs simulations of a model using the individual search model optimal behavior but the household search model paramters estimates; *Impact of Behavior* runs simulations of a model using the household search model optimal behavior but the individual search model parameters estimates.

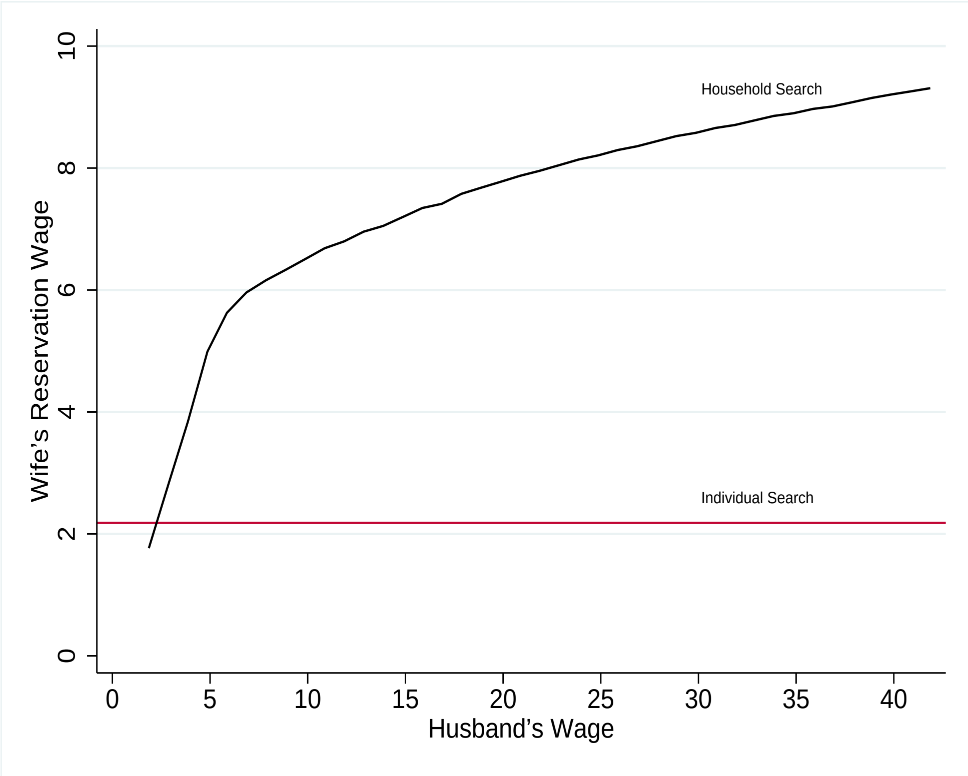

Figure 1: **Wife's Reservation Wage Out of Unemployement: Benchmark**

Note: Simulations based on parameter estimates from household search model with children (See Table 2, Columns 3 and 4). Labor supply regime: Full-time. Nonlabor Income = 0.44$/h.

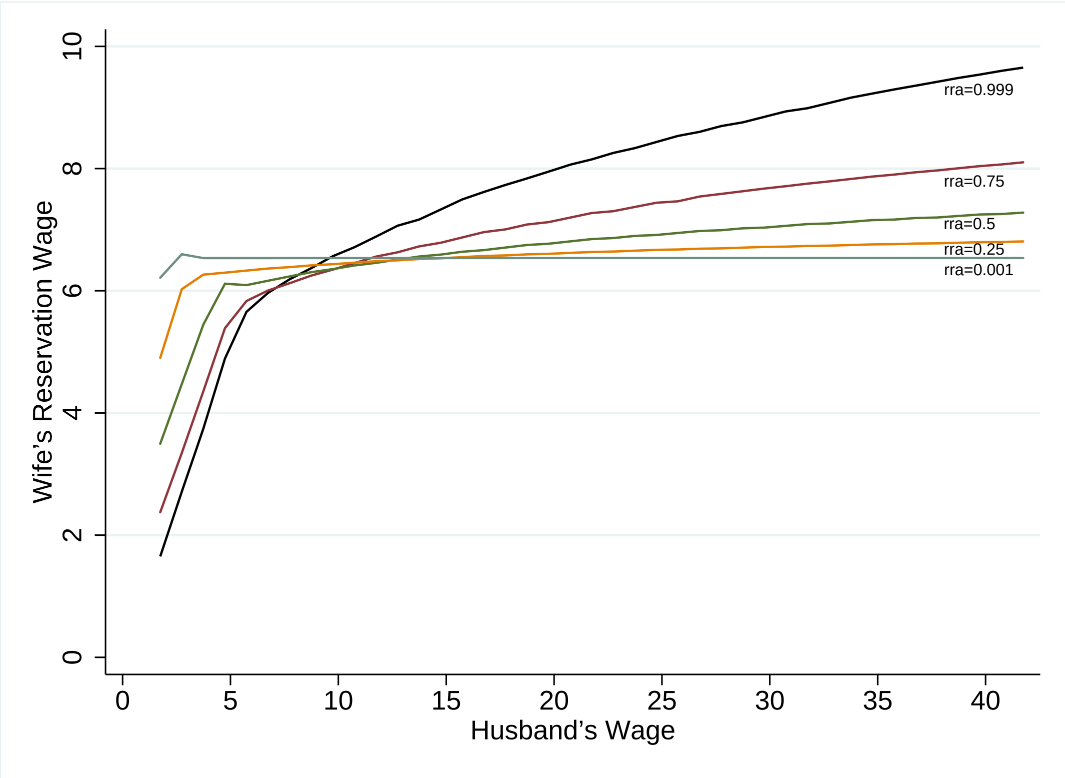

Figure 2: **Wife's Reservation Wage Out of Unemployement: Sensitivity to Risk Aversion**

Note: Simulations based on parameter estimates from household search model with children (See Table 2, Columns 3 and 4). Labor supply regime: Full-time. Nonlabor Income = 0.44$/h Relative Risk Aversion coefficient (rra=1-δ) ranges from 0.0001 to 0.999.

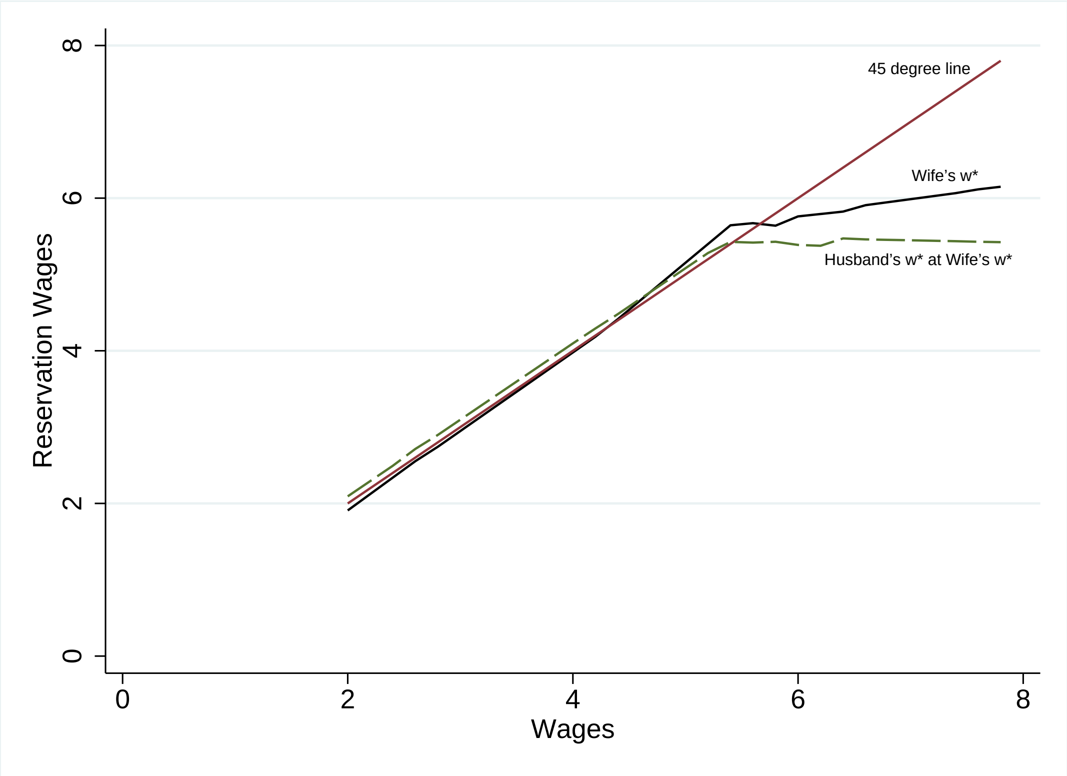

Figure 3: **Wife's Reservation Wage Out of Unemployement: Husband's Endogenous Quit**

Note: Simulations based on parameter estimates from household search model with children (See Table 2, Columns 3 and 4). Labor supply regime: Full-time. Nonlabor Income = 0.44$/h. Definitions: "Wife's w*" is the wife's reservation wage at given husband's wage on the x-axis; "Husband's w* at Wife's w*" is the husband's reservation wage corresponding to the the wife's reservation wage at given husband's wage on the x-axis.

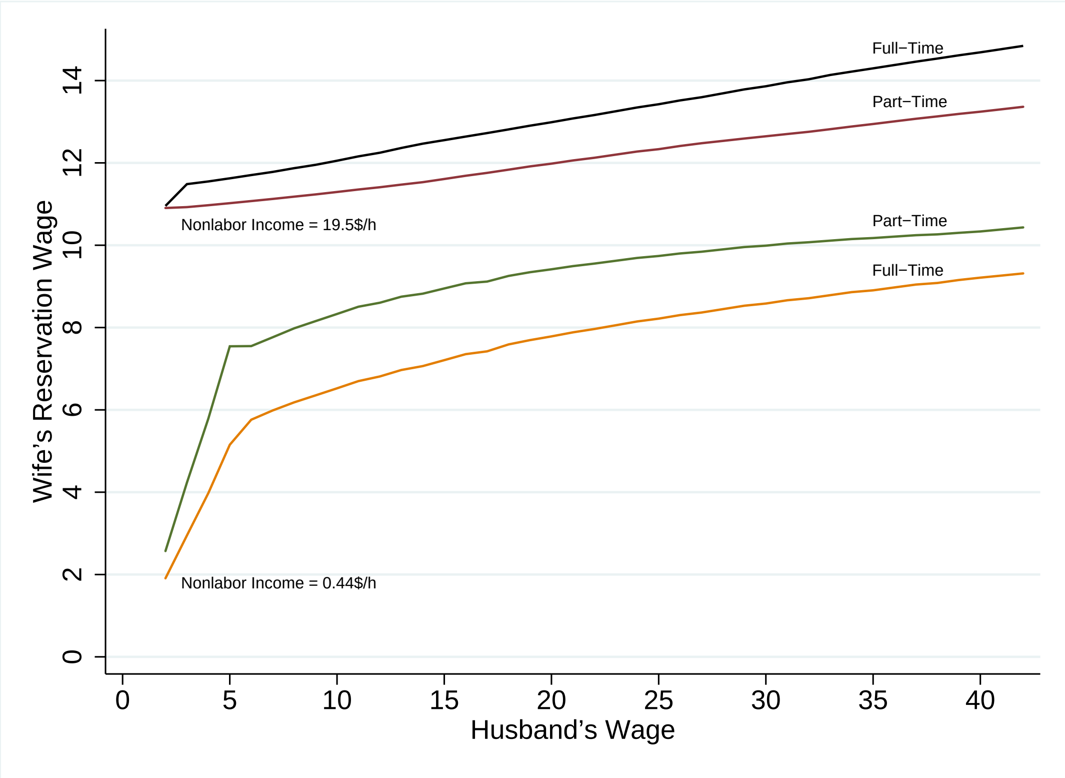

Figure 4: **Wife's Reservation Wage Out of Unemployement: Sensitivity to Labor Supply and Nonlaborincome**

Note: Simulations based on parameter estimates from household search model with children (See Table 2, Columns 3 and 4). Labor supply regime of the husband is always fixed at Full-time.