Household Search or Individual Search: Does It Matter?*

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Abstract

Most labor market search models focus on individuals, ignoring the fact that decisions are often made at the household level. We fill this gap by developing and estimating a household search model with on-the-job search and labor supply. We build on previous work (Dey and Flinn (2008) and Guler, Guvenen and Violante (2011)) to propose a novel identification strategy for the risk aversion parameters and a specification test. We find that ignoring the household as unit of decision-making has relevant empirical consequences. In estimation, the individual search specification implies gender wage offer differentials twice as large as the household search specification. In the application, the individual search specification generates lower lifetime wage inequality for women than men while the household specification implies exactly the opposite. When we use our household model to simulate the effects of various labor policies on lifetime inequality, we find implications frequently different from those resulting from individual search models.
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1 Introduction

Search models of the labor market are widespread and influential.[1] However, they usually ignore the fact that labor market decisions are frequently 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 (2012) [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.

While the theoretical importance of the household as the unit of decision-making is starting to be accepted and understood, the empirical relevance of this feature remains much less studied and investigated. DF is the only published paper in the literature estimating a household search model to assess an empirical issue (the importance of employer-provided health insurance). Gemici (2011) is an interesting recent contribution developing and estimating a model of household migration with frictions. García Pérez and Rendon (2012) is a preliminary work looking at household search to evaluate the Unemployment Benefits system. Given the large body of empirical literature using estimations of search models to answer policy questions,[3] empirical relevance has become an important and pressing issue: Does the estimation and calibration of search models of the labor market that ignore the presence of the household imply 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?

This paper proposes an answer to these questions by developing an extended version of the model considered by DF and GGV and by estimating its structural parameters on the 2001-2003 panel of the *Survey of Income and Program Participation* (SIPP). The main extensions we introduce are on-the-job search and labor supply decisions (both the extensive and intensive margins.) The inclusion of labor supply decisions is rare in the search literature[4] but it is very important in our context. The labor supply margin is a margin of great action for women in the labor market and therefore for spousal interactions with respect to labor market outcomes.

We evaluate the importance of considering that decisions are taken at the household level in two ways. First, we show if and how the estimated structural parameters are affected. We do this by estimating with the same data both the individual search and the household search model. In evaluating differences between structural parameters, we also perform a specification test of

[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] For example, Eckstein and Wolpin (1995) study returns to schooling; Ahn, Arcidiacono and Wessels (2011) and Flinn (2006) evaluate the employment and welfare impact of minimum wage legislation; Dey and Flinn (2005) the impact of employer-provided health insurance; Flabbi (2010a) the effect of affirmative action legislation; and Cahuc, Postel-Vinay and Robin (2006) the impact of workers' bargaining power.

[4] Neither DF nor GVV allow for labor supply decisions. Blau (1991); Gørgens (2002); Bloemen (2008) and Flabbi and Moro (2012) are among the rare examples estimating a search model of the labor market in the presence of a labor supply margin. Bowlus (1997) only allows for a participation decision.

the individual search specification against the household search specification. Second, we choose a relevant empirical application and we show how policy experiment results change when assuming the household search model behavior and estimates instead of the individual search model behavior and estimates. Since we estimate within an equilibrium model framework, we are able to perform the experiments assessing equilibrium effects and welfare implications.

The empirical application focuses on the estimation and computation of lifetime inequality, i.e. a measure of inequality able to describe agents' entire labor market dynamic. The contribution of this application is twofold. First, we provide measures of lifetime inequality and not simply of cross-sectional inequality. Second, and for the first time, we provide measures of lifetime inequality at the household level and not simply at the individual level.[5]

There is a large empirical literature on income inequality focusing on dispersion in cross-sectional distributions of individual wages and earnings.[6] This approach has two main shortcomings. First, measures of inequality based on cross-sectional distributions, while informative, only describe a given moment in time for an individual labor market career. Second, measures of individual earnings and wages cannot take into account the fact that most individuals live in households that pool resources and make labor market decisions jointly. By developing and estimating a household search model which takes into account both optimal mobility and household level decisions, we are able to propose a solution to both concerns. However, we have to limit the comparison between the individual and the household search models to wages and earnings and we cannot extend it to utility. For such an extension, we would need utility assigned to individuals also in the household search model which is something we cannot provide with our assumption of a unitary model of 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 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.

We find that ignoring the household as the unit of decision-making in standard search models of the labor market has relevant empirical consequences. In estimation, the individual search model specification implies gender wage offer differentials at the mean twice as large as the household search model specification. The individual search model also significantly under-estimates the value of non-labor time for women with children. In the application, the individual search specification generates lower lifetime inequality for women than for men while the household specification implies exactly the opposite. A series of experiments evaluated by their impact on inequality measures show that the policy implications based on household search and on individual search parameter estimates can be quite different. Both the estimation and the application results indicate that the impact of considering that decisions are taken at the household level is asymmetric by gender, with female variables being more sensitive than male variables.

Our results compare well with those obtained by GGV and DF, the two papers in the literature closest to our contribution: we obtain estimates comparable with DF and we can account for all the theoretical predictions of GGV. Both papers are concerned with modeling the simultaneous dual-search process of spouses in the labor market and both share our assumption of household interaction through a unitary model with perfect income pooling. GGV provides a systematic theoretical treatment of a simpler version of our estimated model. They do not include on-the-job

[5]The small but growing literature estimating lifetime inequality measures has so far focused only on individual-level inequality. See Flinn (2002); Bowlus and Robin (2004); and Flabbi and Leonardi (2010).

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

search, labor supply, gender heterogeneity or presence of children. Moreover, their main objective is theoretical and their quantitative exercise does not provide a complete identification and estimation strategy. DF share our focus on identification and estimation and use the same data source.[7] However, their focus is on studying a specific policy: provision of health insurance. As a result, they develop a slightly different identification strategy and they are less interested in matching labor supply patterns (they do not include labor supply decisions), asymmetries by gender and the impact of children. We think that allowing for both an intensive and extensive margin of labor supply is important to give a complete picture of the channels generating differences between the household search and the individual search model. We suspect they are also the source of the main differences between our estimates and DF's estimates. Finally, neither DF nor GGV share our application and therefore our estimation of household lifetime inequality in wages and earnings is a novel contribution to the literature.

The plan of the paper is as follows. In Section 2, we develop the model of household search. In Section 3, we discuss the data source and present some descriptive statistics. In Section 4, we discuss identification and estimation of the model. In Section 5, we present and interpret the estimates of the model's parameters. In Section 6, we present the lifetime inequality application. In Section 7 we discuss in some detail limitations and future work. A concluding discussion is provided in Section 8.

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 for understanding the intuition behind them. The extended version is the version of the model that will be estimated. It adds heterogeneity between spouses and includes additional features relevant for fitting the data and providing 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.[8] We also assume no flow cost of search and no recall of past offer.

[7] Both our paper and DF use SIPP panel data but on different years: DF use 1996 while we use 2001.

[8] This is a common assumption in the search literature that can be justified by risk neutrality or by market completeness. A handful of estimated search model allowing for savings decisions exist (Rendon (2006); Lentz (2009); and Lise (2011)) but they are faced with very difficult dynamic programming problems that force them to introduce restrictive assumptions. The complication derive from the difficulty of establishing global concavity of the value functions when savings are added to the job search model (Acemoglu and Shimer (1999); Lentz and Tranaes (2005)). Therefore, even if removing this assumption could be promising in our context because saving decisions can be potentially very different if they are taken at the individual or at the household level, we leave this extension to future research. García Pérez and Rendon (2012) are working in this area but the paper is still a work in progress and no results are yet available for distribution.

Value functions The stationary assumption allows us 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 $V(w)$ will then be the corresponding discounted instantaneous utility, as stated in the following:

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

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

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

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

Equilibrium Given this characterization, the optimal decision rule is straightforward to obtain: the value of employment is continuous and monotonically increasing with 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 to 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 as the individual search model but adds the household, extending the single-agent decision problem to a joint-search problem of two agents looking for jobs. Households are composed of two agents sharing and maximizing a common utility function and pooling income (that is, we assume a unitary model of the household).[9] Each member of the household belongs to a different type and there are a total of

[9] The unitary model assumption is a strong one and it is an assumption we will also keep in our extended version of the model. We provide a detailed discussion of the advantages and limitations of this assumption in Section 7.

two types in the economy. Consistent 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 the constraint that the two types share the same structural parameters.[10] Wives' parameters are denoted by the subscript $_W$ and individuals belonging to the set of wives are indexed by j. Husbands' parameters are denoted by the subscript $_M$ and individuals belonging to the set of husbands are indexed by i.

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 job offers shocks to the unemployed spouse, leading to a value function denoted by $T(w_i, 0)$ and 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 job offers shocks to both spouses, leading to a value function denoted by U and defined by:

$$(\rho + 2\lambda) U = u(Y) + \lambda \begin{bmatrix} \int \max\{U, T(w, 0)\} dF(w) + \\ \int \max\{U, T(0, w)\} dF(w) \end{bmatrix} \tag{7}$$

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 labor market state 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 rules 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 to take into account this potential interdependence:

$$w_W^*(0) \quad : \quad T(0, w_W^*(0)) = U \tag{8}$$

$$w_W^*(w_i) \quad : \quad \max\{V(w_i, w_W^*(w_i)), T(0, w_W^*(w_i))\} = T(w_i, 0) \tag{9}$$

Both reservation values exist and are unique because in both equations the LHS is monotonically 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.

[10]This is the symmetric case extensively studied by GGV.

The implication of equation (8) is standard: a 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:

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

The implication of equation (9) is more subtle. In a household where one spouse is working and the other spouse is looking for a job, receiving a job offer may lead to three 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 decide that it is optimal for the husband to quit his current job in order to look for a better one ($T(0, w_j)$.) 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 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 receives 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 partition the set of wage offers to the wife conditioning on the husband being employed at a given wage w_i as:

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

The sets of wage offers to the husbands conditional 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:

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

We can now propose the following:

Definition 2 *Given*

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

a 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 Comparison of Individual Search and Household Search Models

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 a 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 is proved and discussed by DF and GGV and it can be summarized in our notation as follows:

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

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

a household search model equilibrium is equivalent to the equilibrium generated in an individual search model characterized by:

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

As a result:

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

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 the flow value of income they are actually receiving when making decisions about future income streams is irrelevant. Therefore the decision of one spouse does not depend on the wage of the other spouse.[11] If this is 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 saying that the household behaves as if the two spouses were optimally maximizing their individual income streams.

Concave Utility Function Assuming a concave utility function:

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

[11] In a model without search frictions, Mazzocco (2007) establishes more general conditions for this equivalence. The conditions are an intuitive generalization of the argument made here: they require each spouse Engel curves to be linear with the same slope. As a result, and just as in the linear case, the additional income provided by the other spouse does not change the equilibrium allocations.

introduces 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) is qualitatively different from the reservation wage from equation (14). 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. First, an increase in nonlabor income increases the flow utility while searching therefore decreasing the marginal *cost* of search. 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.

In the household search model environment, the concave utility function is:

$$u(c_{ij}) = u(Y + w_i + w_j), \, u''(c) < 0 \tag{17}$$

The equilibrium follows the definition given in Definition 2 and it is now qualitatively different from the individual search case. The argument 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 unlike in the linear case, endogenous quits may occur. We state the result in the following proposition:

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

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

a household search model equilibrium is different from the equilibrium generated in an individual search model characterized by:

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

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:*

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

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. Given that the labor market status of one spouse has an impact on the reservation wage of the other spouse then endogenous quitting may occur. Start with a household where both spouses are unemployed and searching. Suppose the husband receives a wage offer $w_i > w_M^*(0)$ then the household will accept it, changing its state to a household composed of a husband working at 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 that the wife accepts the offer and the husband quits his current job. The symmetry in the environment faced by the two spouses - i.e. the fact the two spouses' labor markets are characterized by the same structural parameters - guarantees that for some values in the support of the wage offers this is always the case.[12] When symmetry is removed, as in the extended model we will estimate, endogenous quitting may or may not occur depending on parameters.

2.2 Extended Version

2.2.1 Household Search Model

Environment We add a series of extensions to the environment in order to guarantee a rich set of interaction channels between the two spouses' labor market states and to obtain a better fit of the data. All the extensions listed in this section will be used in estimating the model. For concision, we present the extensions only in the context of the household search model while we describe the individual search case in Appendix A.1.

First, we allow for exogenous job termination. Exogenous terminations follow a Poisson process with parameter η_A, where recall that $A = M, W$ denotes parameters pertaining to men and women.

Second, we introduce on-the-job search. Job offers while employed follow a Poisson process with parameter γ_A. Both features are standard in the search literature and are necessary to fit job-to-job and job-to-unemployment transitions.

Third, we add a feature less common in the search literature: labor supply.[13] We use a sample of households composed of husbands and wives: as a result we have a relatively large number of women present in the final estimation sample. Since women tend to have a larger variance in labor supply than men, we think it is crucial to explicitly have in the model a labor supply decision, both on the extensive and on the intensive margin. We introduce the intensive margin of labor supply by assuming that job offers arrive as a pair of wage and hour requirements[14] (w, h). Their joint distribution is denoted by $F_A(w, h)$. We introduce the extensive margin by assuming

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

[13] 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 (2012) 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.

[14] 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). Wage-hours packages are embedded in a labor market search framework by Gorgens (2002). Other examples of empirical search model featuring job offers including not only a wage but an additional job characteristics are: DF and Aizawa and Fang (2013) adding health insurance; Flabbi and Moro (2012) adding job flexibility; and Meghir, Narita and Robin (2014) adding formality status.

that individuals have to pay a search cost in terms of time investment s if they want to receive job offers. The search cost is time invariant and individual-specific, with a distribution in the population denoted by $S_A(s)$.

To summarize, individuals can be in three different states. If they do not pay the search cost, they will stay out of the labor force and they will not receive any shocks. If they pay the search cost, they will switch to the unemployment state and they will be subject to job offer shocks. If they accept a job at wage w and hour requirement h, they will receive a flow income wh and they will be subject to additional job offer shocks and to exogenous termination shocks.

The instantaneous utility functions are defined at the household level, they depend on the idiosyncratic components and they are conditional on the time invariant household-specific heterogeneity (y_{ij}, s_i, s_j). We denote them as follows:

$$u(c_{ij}, l_i, l_j; y_{ij}, s_i, s_j) \tag{18}$$

where:

$$\begin{aligned} c_{ij} &= w_i h_i + w_j h_j + y_{ij} \\ l_i &= 1 - h_i - s_i \\ l_j &= 1 - h_j - s_j \end{aligned}$$

Value Functions Each spouse can occupy one of three different labor market states (employment, unemployment, no-participation). As a result, there are nine different value functions for each time invariant household-specific heterogeneity vector (y_{ij}, s_i, s_j). The notation for the nine value functions, together with the notation for the flow utility and the shocks affecting the state, is reported in the following matrix. For convenience, we drop the conditioning on the vector (y_{ij}, s_i, s_j).

Value Function	Flow Utility	Shocks
$V[w_i, h_i, w_j, h_j]$	$u(w_i h_i + w_j h_j + y_{ij}, 1 - h_i, 1 - h_j)$	$\gamma_M, \eta_M, \gamma_W, \eta_W$
$T[s_i, w_j, h_j]$	$u(w_j h_j + y_{ij}, 1 - s_i, 1 - h_j)$	$\lambda_M, \gamma_W, \eta_W$
$T[w_i, h_i, s_j]$	$u(w_i h_i + y_{ij}, 1 - h_i, 1 - s_j)$	$\gamma_M, \eta_M, \lambda_W$
$Q[w_j, h_j]$	$u(w_j h_j + y_{ij}, 1, 1 - h_j)$	γ_W, η_W
$Q[w_i, h_i]$	$u(w_i h_i + y_{ij}, 1 - h_i, 1)$	γ_M, η_M
$U[s_i, s_j]$	$u(y_{ij}, 1 - s_i, 1 - s_j)$	λ_M, λ_W
$R[s_i]$	$u(y_{ij}, 1 - s_i, 1)$	λ_M
$R[s_j]$	$u(y_{ij}, 1, 1 - s_j)$	λ_W
Z	$u(y_{ij}, 1, 1)$	$-$

The value function V denotes the case when both spouses are employed; T and Q the cases when one spouse is employed and the other is, respectively, unemployed or out of the labor force; U the case where both spouses are unemployed; R the case where one is unemployed and the other out of the labor force; and finally Z denotes the case when both spouses are out of the labor force.

It is instructive to write down the expressions for the value functions in these six different cases in order to show the potential interaction channels between spouses' labor market states.

The value of a household where both spouses are working $V[w_i, h_i, w_j, h_j]$ is characterized by:

$$(\rho + \gamma_M + \eta_M + \gamma_W + \eta_W)V[w_i, h_i, w_j, h_j] = u(w_i h_i + w_j h_j + y_{ij}, 1 - h_i, 1 - h_j) \tag{19}$$
$$+\gamma_M \int \max\{V[w_i, h_i, w_j, h_j], V[w', h', w_j, h_j], T[w', h', s_j,], Q[w', h']\} dF_M(w', h')$$
$$+\eta_M \max\{T[s_i, w_j, h_j], Q[w_j, h_j], U[s_i, s_j], R[s_i], R[s_j], Z\}$$
$$+\gamma_W \int \max\{V[w_i, h_i, w_j, h_j], V[w_i, h_i, w', h'], T[s_i, w', h'], Q[w', h']\} dF_W(w', h')$$
$$+\eta_W \max\{T[w_i, h_i, s_j], Q[w_i, h_i], U[s_i, s_j], R[s_i], R[s_j], Z\}$$

A household where both spouses work enjoys flow utility u which is a function of both labor and nonlabor income and leisure and has continuation value characterized by four shocks: a job offer shock or a termination shock to the wife or to the husband. If a job offer arrives (as in rows 2 and 4 of equation (19)), the household may accept it. If the household accepts the new job offer, the spouse that is not receiving the offer may quit the current job and search or quit and leave the labor force. If a job termination shock arrives (as in rows 3 and 5 of equation (19)), the household may react by keeping the spouse still employed in the job or not and by searching for a new job or not.

As in the simple case, a shock to one spouse may induce a change in labor state for the spouse receiving the shock but also for the spouse not receiving the shock. For example, in row 2 of equation (19) we see how a job offer to the husband, if accepted, may lead the wife to quit the current job in order to search for a new one or to quit the labor force altogether. The difference with respect to the simple case is that the range of channels of this spousal interaction is much richer since now individuals may choose their labor supply and may search on the job.

The value of a household where one spouse is working and the other is searching (say, respectively, the husband and the wife) $T[w_i, h_i, s_j]$ is characterized by:

$$(\rho + \gamma_M + \eta_M + \lambda_W)T[w_i, h_i, s_j] = u(w_i h_i + y_{ij}, 1 - h_i, 1 - s_j) \tag{20}$$
$$+\gamma_M \int \max\{T[w_i, h_i, s_j], T[w', h', s_j], Q[w', h']\} dF_M(w', h')$$
$$+\eta_M \max\{U[s_i, s_j], R[s_i], R[s_j], Z\}$$
$$+\lambda_W \int \max\{T[w_i, h_i, s_j], V[w_i, h_i, w', h'], T[s_i, w', h'], Q[w', h']\} dF_W(w', h')$$

A household where the husband works and the wife searches enjoys flow utility and it may be hit by three shocks: a job offer to the wife or to the husband, or a termination shock to the husband's job. If the husband receives an on the job offer, the household may accept it and the wife may react by stopping searching. If the wife receives a job offer, the household may accept it and the husband may keep his current job, quit and search, or quit and leave the labor force.

The value of a household where one spouse is working and the other is out of the labor force (say, respectively, the husband and the wife) $Q[w_i, h_i]$ is characterized by:

$$(\rho + \gamma_M + \eta_M)Q[w_i, h_i] = u(w_i h_i + y_{ij}, 1 - h_i, 1) \tag{21}$$
$$+\gamma_M \int \max\{Q[w_i, h_i], Q[w', h'], T[w', h', s_j]\} dF_M(w', h')$$
$$+\eta_M \max\{U[s_i, s_j], R[s_i], R[s_j], Z\}$$

When the husband works and the wife is out of the labor force, only two shocks may occur: an offer on the job and a job termination shock. If an offer on the job is accepted, the wife may remain out of the labor force or decide to enter the market. If the only job in the family is lost, both household members may decide to search for a new job, only of the two may decide to do so, or they may both decide to quit the labor force.

The value of a household where both spouses are out of work but they are both searching is characterized by:

$$\begin{aligned} (\rho + \lambda_M + \lambda_W) U[s_i, s_j] &= u(y_{ij}, 1 - s_i, 1 - s_j) \\ + \lambda_M \int \max \{U[s_i, s_j], T[w', h', s_j], Q[w', h']\} \, dF_M(w', h') \\ + \lambda_W \int \max \{U[s_i, s_j], T[s_i, w', h'], Q[w', h']\} \, dF_W(w', h') \end{aligned} \tag{22}$$

Flow utility includes only nonlabor income and leisure. The household may receive offers to the husband or the wife: if either of them accepts an offer, the other spouse may continue search or quit the labor force.

The value of a household where both spouses are out of work but only one of the two is searching (say, the husband) is characterized by:

$$\begin{aligned} (\rho + \lambda_M) R[s_i] &= u(y_{ij}, 1 - s_i, 1) \\ + \lambda_M \int \max \{R[s_i], T[w', h', s_j], Q[w', h']\} \, dF_M(w', h') \end{aligned} \tag{23}$$

As before, flow utility includes only nonlabor income and leisure. The household may receive a job offer to the husband that decides if accepting it or not. In case of acceptance, the wife may stay out of the labor force or search.

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.

Households have three types of decisions to make: accept or reject a job offer while employed; accept or reject a job offer when unemployed; participate in the labor market or not. As we have seen in the value functions above, which choices are available to the household depends on the labor market status of each of the two spouses.[15] Based on the choices and the value functions, utility reservation values can be derived in the same way as reservation wage values were derived in the simple version of the model: by finding the instantaneous utility values such that the household is indifferent between the relevant alternatives. The equations defining the reservation utility values

[15] To be precise, in the value functions we are listing all the possible options available to each spouse-labor market state combinations. Under some conditions, mainly on the utility functions, some of these options may be ruled out in equilibrium. It is beyond the scope of this paper to present conditions under which these options are available. A more general discussion, albeit in the simple version of the model and within the class of HARA (Hyperbolic Absolute Risk Aversion) utility functions, is presented in GGV.

are notationally heavy and are not reported.[16] The optimal decision rules based on the utility reservation values are also the same as in the simple version of the model: the household is choosing the set of actions generating utility above the relevant threshold. We are now ready to give the following:

Definition 5 *Given*

$$\{\lambda_A, \gamma_A, \eta_A, \rho, u(c,l,l), F_A(w,h)\}_{A=M,W}, \ u \text{ continuous}$$

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

$$\{V, T, Q, U, R\}$$

that solves equations (19)-(23).

Notice that this definition is given under the understanding that the max operator present in equations (19)-(23) is solved following the optimal decision rules based on the reservation value property described above.[17]

The previous definition is valid for the set of households characterized by a vector (y_{ij}, s_i, s_j) guaranteeing that at least one spouse participates in the labor force. If both spouses are out of the labor force, we are in the presence of an absorbing state because the household cannot receive any shock that will lead to a change of labor market state of either spouse. The corresponding value function Z is defined by the following equation:

$$\rho Z(y_{ij}, s_i, s_j) = u\left(y_{ij}, 1, 1; y_{ij}, s_i, s_j\right) \tag{24}$$

The optimal behavior of a set of households characterized by a vector (y_{ij}, s_i, s_j) such that both spouses are out of the labor force is fully described by the following ex-ante decision. Neither spouse will participate in the labor market if and only if:

$$\max\left\{R\left[s_i; y_{ij}, s_i, s_j\right], R\left[s_j; y_{ij}, s_i, s_j\right]\right\} < Z\left(y_{ij}, s_i, s_j\right) \tag{25}$$

This optimal decision concludes the definition of the equilibrium in the extended version of the model. In the next section of the paper - Section 2.2.2 - we discuss additional detail of the equilibrium while comparing the individual search and household search model specifications. In particular, we show and discuss some optimal policy rules derived from the extended version of the model by tracing reservation wage policies at given hours requirements. We discuss them in a less general form than the one presented in this section because we want to show the model we are using in estimation. In the estimated model - presented in detail in Section 4 - we specialize three features: (i) we assume a specific functional form for the utility function (see equation (26)); (ii) we discretize the intensive margin of the labor supply in part-time and full-time, and (iii) we assume a specific value for the time cost of search.

[16] For a version of these reservation values in a similar model but without the extensive margin of the labor supply, see Flabbi and Mabli (2012).

[17] Writing the optimal decision rules in the value functions is notationally heavy and it is not reported here. For a version of the value functions including the optimal decision rules but without the extensive margin of the labor supply, see Flabbi and Mabli (2012).

2.2.2 Individual Search and Household Search Models Comparison

The extensions to the model do not qualitatively change the results with respect to the comparison between the individual and household search models: all the main arguments of the previous section carry through because we are only adding options without introducing major changes in behavior.

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.

Figures 1, 2, and 3 report examples of optimal policy rules. The reported reservation values are obtained from simulation at the estimated parameters (see Section 4.2). As a result, the specification is less general that the one presented in the model so far. In particular, and as we explain in detail in Section 4.1, we assume a specific functional form for the wage offer distributions, we reduce labor supply to three discrete options (full-time, part-time and no participation) and we add additional heterogeneity in the preference parameters depending on the presence of young children in the household.[18]

We start with Figure 1 where we report the reservation wage of a wife who is currently unemployed, receives a full-time job offer and is married to a 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 gender-specific parameters of the household search environment.

The main results from Figure 1 are the following. First, we clearly see the strong dependence of the wife's reservation wage on the husband's wage. At the minimum acceptable wage, the reservation wage for the wife is less than \$3 per hour, but as the husband's wage increases, the wife's reservation value increases until about \$6 per hour. This pattern is in contrast with the reservation wage in the individual search case, which is constant at a value of little more than \$4 per hour. Second, the two reservation wage schedules cross. As a result, there is a range of husband wages such that the wife's reservation wage in the household search model is lower than the wife's reservation wage in the corresponding individual search model. We will show that this effect is important for explaining some the gender wage offer gaps 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 \$12 per hour) the slope is steeper. This is the range where the husband would prefer to quit his job when the wife accepts a high enough full-time job offer. As a result, the wife's reservation wage is very sensitive to the husband wage. After that threshold, the husband will remain employed no matter what the offer to the wife.

In Figure 2, we focus on the area where the endogenous dynamic occurs. We partition the

[18] The optimal policy rules reported in the figures are for households with low search costs; children younger than 18 present; and nonlabor income level equal to the median value. All the wages are full-time wages.

surface mapped by the husband's wages and the wife's wage offers in three areas. At the bottom, wage offers to the wife are too low: she rejects them and the husband keeps working in his current job. In the middle triangle (the area included within the two reservation value curves), wage offers are acceptable to the wife but they are not high enough to induce any change in the husband's labor market state. Finally, in the top area, wage offers to the wife are high enough not only to induce her to work but also to induce the husband to quit his current job in order to go back to unemployment and search for a better job.

In Figure 3 we show the dependence of the wife's reservation wages on risk aversion, reiterating the message of Propositions 3 and 4. We show the wife's reservation wage schedule for different values of risk aversion, bounded between the two cases most commonly used in the applied literature: the linear case (coefficient of relative risk aversion = 0) and the logarithmic case (coefficient of relative risk aversion = 1). For values moving from 1 toward 0, the reservation wage schedule is changing from a positive sloped curve to a flat line. Therefore the reservation wage of the wife is becoming less and less sensitive to the husband's wage, converging to the behavior implied by linear utility and equivalent to the individual search model. The wife's reservation wage schedule is defined over the range of acceptable jobs to the husband which is decreasing as the risk aversion coefficient decreases: this is why the curves start from different points.

Finally, in Figure 4 we show the sensitivity of the wife's reservation wage schedule to household nonlabor income. High nonlabor income denotes the highest value we use in estimation (equal to 17.6 dollars an hour.) Low nonlabor income denotes the lowest positive value we use in estimation (equal to 0.4 dollars an hour.) As expected, a higher value of nonlabor income induces both spouses to be pickier when faced with wage offers. The reservation wage schedule for the wife with high nonlabor income is always above the one for the wife with low nonlabor income, denoting that for each husband's wage she will need a higher wage offer in order to accept the job. We also observe that the high nonlabor income curve starts at a higher husband's wage level, denoting that the husband has a higher reservation wage coming out of unemployment.

2.2.3 Empirical Implications

The specification of the model, even in the extended version, is tractable enough to attain identification and estimation of its structural parameters, given a dataset of standard labor market variables for paired spouses. We will discuss identification and estimation issues in more detail in Section 4.1. In this section, we point out two relevant empirical implications of the model.

A first implication derives from Proposition 3: under linearity in preferences there is *no* misspecification 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 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 difficult and is rarely attempted within the context of a search model.[19] Proposition 4, though, shows that the presence of risk aversion is exactly what makes the

[19]As mentioned, the only previously estimates household search model is DF. However, their identification of 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.

However, it is important to point out that this identification hinges on our unitary model assumption. If we were to remove it then correlations between the two spouses' labor market decisions would arise even with linear utility. Assume for example that household interaction takes the form of bargaining between spouses. Then, even with linear preference, the optimal decision rule of one spouse would depend on the outside option of the other spouse which is in general a function of labor market status.[20] The same argument applies to the specification test: it is a test of individual search vs household search only under the assumption that individual preferences are aggregated through the unitary model framework.[21]

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 and in linking detailed spousal labor market information across time. The second characteristic 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 SIPP panel, we form point-in-time samples spaced three months apart for 24

risk aversion parameters is different because their data has an additional source of identification: the provision of employer-provided health insurance. GGV do not attempt to identify the risk aversion parameter and perform their calibrations fixing the relative risk aversion parameter at various values.

[20]See Del Boca and Flinn (2014) for a detailed discussion of the general issue and for an example showing dependence on spouse's outside options in a static framework with Nash bargaining and sub-game perfect equilibria. Mazzocco (2007), in a dynamic framework but without search frictions, shows that also the full commitment assumption embedded in the unitary model is important. Without full commitment, the equivalence between the household search and the individual search model holds under utility functions formulations more general than the linear case.

[21]Both arguments clarify the restrictions imposed by the unitary framework assumption. As we argue in more detail in Section 7, since the main objective of the paper is estimating the extent to which estimates and inference obtained from an individual search model differ from those obtained from a household search model, comparability between the two specifications and tractability is our first priority. While other frameworks may deliver comparability and tractability, the unitary framework does so in a particularly straightforward manner.

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 for remaining in the sample, then both spouses are excluded from the sample. After imposing all selection criteria our sample consists of 5,024 individuals for a total of 2,512 married couples.

We select married couples in which each spouse is aged between 25 and 49 (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).[22] 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. This is clearly a major limitation of our behavioral model but empirically the loss of information is limited since we require couples to be married only for our relative short period of observation (2 years). Additionally, neither spouse must participate in the armed services throughout the sample period.

Since we are modeling both the extensive and intensive margin of the labor supply, we do not have to impose any sample selection criteria concerning labor market participation. However, we exclude couples 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 does not supply hours worked per week 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.

Hours worked are also important to characterize the intensive margin of the labor supply. To simplify the computational problem implied by the solution and estimation of the model, we recode hours worked per week into part-time and full-time categories.[23] As a result, our intensive margin of the labor supply is reduced to a distribution with two support points. 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.

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.

[22] 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.

[23] See Section 4.1 for additional detail on why we add this aggregation.

3.2 Descriptive Statistics

Descriptive statistics of the estimation sample are reported in Tables 1 and 2. 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 column reports 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 (88.9% compared with 49.2% for women) and earn on average higher wages than women. The gender gap in full-time jobs is about 23.5%, almost equal to the gender wage gap at the median reported by the Bureau of Labor Statistics. 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 both the female and male sample.[24] As a result, the gender gap in earnings is larger than the gender gap in wages, reaching a value of about 35%.

We also report a measure of wage dispersion common in the inequality literature, the coefficient of variation (CV), because in one of the empirical application we will perform wages and earnings inequality comparisons. Inequality in wages is higher for men than for women, a result commonly found in the literature,[25] while inequality in earnings is higher for women. Wages are relatively more compressed among individuals working full-time than part-time.

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. This type of sorting can be generated by our household search model while it clearly cannot by an individual search model. For example, 20.5% of women are employed part-time overall but only 12.2% of them are when married to an unemployed husband. Not only the labor market status but also the average wage varies with the labor market status of the husband. Average hourly wages for women working full-time decrease from 15.38 dollars an hour, to 14.09 dollars an hour, to 11.43 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, ranging from 0.547 if the husband is out of the labor force to 0.427 if the husband is unemployed. Husbands are less sensitive than wives to their spouse's labor market status but there are still non-negligible effects: the full-time employment rate decreases from 88.8% on the sample of men married to women working full-time to 77.4% on the sample married to unemployed women. The variation in average wages is more modest (average wages are 18.70 dollars an hour in the first sample and 18.80 dollars an hour in the second) but the variation in wage dispersion and earnings remains quite sensitive to the wife's labor market status.

Table 2 contains descriptive statistics of the labor market dynamics information contained in the data. We summarize the information by 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, 91% of women and 95.7% of men employed full-time are still employed full-time three

[24] This is also a common results in the literature (Altonji and Paxson (1988)). Blank (1990) estimates large wage penalties for working part-time using Current Population Survey data but suggests that selection into part-time is significant and that the estimates are not very robust. Blau (1991) and Flabbi and Moro (2012) control for some of this selection adding a search model structure (as we do in this paper) and they also find a full-time premium.

[25] See for example Figure 4 in the survey by Katz and Autor (1999), Figure 3 in Autor, Katz, and Kearney (2008) or Table 1 in Dey and Flinn (2008).

months later. However, transitions across labor market states are not rare, in particular for men: 57.2% of men who are unemployed at the beginning of the period are employed three months later. This proportion is lower on the female sample: about 34% of unemployed women are employed three months later. Persistence in non-participation is a particularly important feature of the wives' sample, reaching almost 95%.

The evidence conditioning on the spouse's labor market status confirms the dependence observed in Table 1. For example, an employed women married to an unemployed husband is twice more likely to become unemployed than an employed women married to an employed husband. Husbands transitions are also sensitive to their wives labor market status: if they are unemployed, they transit to full-time employment in about 60% of the cases if the wife is employed and in about 17% of the cases if the wife is unemployed.

In conclusion, both Table 1 and Table 2 show the dependence of one spouse's labor market status on the other spouse's labor market status. Our proposed model, unlike individual search models, provides channels able to generated this dependence and allows for the full use of this empirical feature in the identification and estimation strategy.

4 Identification and Estimation Procedure

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 five main 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:

$$u\left(c_{ij}, l_i, l_j; \delta, \beta, \alpha\right) = \\ \left(1-\alpha_M-\alpha_W\right)\frac{c_{ij}^{\delta}-1}{\delta}+\alpha_M\frac{l_i^{\beta_M}-1}{\beta_M}+\alpha_W\frac{l_j^{\beta_W}-1}{\beta_W} \tag{26}$$

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.[26]

Second, to simplify the computational problem we discretize the choice set of the intensive margin of the labor supply to part-time work and full-time work. The probability of receiving a part-time job offer is a primitive parameter in the econometric model and it is denoted by p. The indexes $_{PT}$ and $_{FT}$ will be used to denote parameters referring to part-time and full-time jobs. Notice that we allow all the relevant job offers parameters to depend on the full-time or part-time regime.[27] As mentioned in Section 3.1, 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 and

[26] GGV obtain their theoretical results for a larger class of utility functions but their calibration exercise is performed using a CRRA specification.

[27] They include the wage offers distribution parameters and the exogenous job termination rate parameters

estimation procedures 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.

Third, we need to make a distributional assumption on the heterogeneity in search costs. Search costs play a fundamental role in the extensive margin decision of the labor supply. Given our data, we cannot separately identify market tightness leading to a certain rate of job offers from search effort. The only information we have is that a proportion of the population is out of the labor force or transit in and out of the labor force. This “threshold crossing”behavior can identify only one parameter. A frequent approach in similar situations is assuming a one parameter continuous distribution such as a negative exponential. However, in our case the search cost has an impact every time a shock is received by the other spouse in the household, generating in principle a infinite number of optimal decision rule for each search cost and making this approach unfeasible. The choice we have made is to use the one piece of information we have to identify the proportion of the population who has a high cost of search without attempting identification and estimation of the magnitude of the search costs.[28] We denote the proportion of individuals with *low cost* of search with the parameter ζ_A. Since we measure search costs in terms of time required to receive offers, we anchor the magnitude of these costs to the magnitude we observe in the intensive margin of the labor supply. We define individuals with *high cost* of search as those requiring a time investment equal to working full-time to elicit an arrival rate of offers equal to λ_A. We define individuals with *low cost* of search as those requiring a time investment equal to working part-time to elicit an arrival rate of offers equal to λ_A.

Fourth, we allow for the presence of children to play a role, albeit a very limited one, in the estimation procedure. The presence of children has a systematic relation with labor market outcomes and the proper way to treat it in the behavioral model would be to endogenize the fertility decision. However, the determinants of fertility decisions are not straightforward to model theoretically and they are not investigated in detail in the data at our disposal.[29] Moreover, a genuine endogenous fertility decision would make the comparison between the household search model and the individual search model more difficult. In the individual search specification, decisions are assumed to be taken at the individual level instead that at the household level: If this assumption is a strong restriction when referring to labor market decisions, it becomes really untenable when referring to fertility decision. Our pragmatic but admittedly arbitrary solution has been to use the presence of children in a certain age range to affect a specific utility parameter: the weight on leisure α_M and α_W. The weight on leisure is a good candidate to incorporate differences in the behavior generated by the presence of children because leisure in our parametrization is really time left when not working. This is exactly the time that can acquire more or less value if children are present. Since we do not

[28] In principle, the household search specification provides some information to identify the magnitude of the search cost. Assume for example that only high cost individuals will ever transit to non-participation. Then, if we see that, say, wives transit to non-participation only when husband receive very high wage offers, we could conclude that the search cost differential between high-cost and low-cost types is not very big. The opposite would be true if we observe these transitions for low wage values. We have attempted some estimation runs where we use this information to estimate at least the ratio between high cost and low cost of search. However, the transitions are few and the empirical identification very weak. Moreover, and more importantly in terms of the objectives of the paper, we can not replicate the same identification strategy on the individual search model because in that model non-participation of a given individual is an absorbing state. It is very clear that in the individual search model only the proportion of high cost individual can be identified and therefore these are the only results we are going to present in the paper.

[29] Erosa, Fuster and Restuccia (2002) and (2010) are among the few examples of models allowing for fertility decisions in a fully developed labor market search environment. However, their models do not allow for dual-search in the labor market.

model the fertility decision, the presence of children is assumed to be a time invariant household-specific heterogeneity component as the vector (y_{ij}, s_i, s_j). We have experimented with different age ranges in creating the dummy for presence of children and the one generating the better fit was 0 to 18 years old.[30] It also make sense in terms of our model because children older than 18 tend to leave the household and therefore tend to have a very different impact on the time of their parents. The parametrization we propose is particularly extreme in terms of being parsimonious: we assume impact on only one parameter for each gender. We have also experimented with an assumption at the other extreme: a parametrization generating an impact on all parameters.[31] While we think the current specification is more meaningful because better linked to the theoretical model, they are clearly both arbitrary. However, they create an informative bound and we can anticipate that the main results of the paper are not sensitive to the assumption. The indexes $_{YC}$ and $_{NC}$ will be used to denote parameters referring to household respectively with or without children younger than 18 years old.

Finally, due to the well-known non-identification result of Flinn and Heckman (1982), we need to assume a *recoverable* wage offers distribution[32] 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.[33] 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 $A \in \{W, M\}$ and hours requirement $H \in \{PT, FT\}$ is:

$$f\left(w; \mu_A^H, \sigma_A^H\right) = \frac{1}{\sigma_A^H w}\phi\left[\frac{\ln(w) - \mu_A^H}{\sigma_A^H}\right],\ w > 0 \tag{27}$$

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 where $A \in \{W, M\}$:

$$\theta = \left\{ \begin{array}{c} \lambda_A, \gamma_A, \eta_A^{PT}, \eta_A^{FT}, \zeta_A \\ \\ \mu_A^{PT}, \sigma_A^{PT}, \mu_A^{FT}, \sigma_A^{FT}, p_A \\ \\ \alpha_A^{YC}, \alpha_A^{NC}, \delta, \beta_A \end{array} \right\} \tag{28}$$

where the first row pertains to the mobility and cost of search 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

[30] We have experimented with cutoffs at 12 and 6 years old. Estimation results do not change much when using different cutoffs. The parameter most affected by the presence of children is the weight on leisure for women α_W. In the benchmark specification, see Table 3, the point estimate is 0.2334. For cutoffs at 12 and 6, the point estimate is, respectively, 0.2589 and 0.2595. All the other parameters are less sensitive than this.

[31] Results in a model formulation without the extensive margin of the labor supply are reported in Flabbi and Mabli (2012).

[32] 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.

[33] 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.

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 by groups of parameters (mobility search cost 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.[34] 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, $\eta^{PT}_{W,M}$ and $\eta^{FT}_{W,M}$.

The cost of search parameter may in principle impact some transitions but since it is time invariant, its main contribution is to push individuals above or below the threshold for participation. Therefore, the steady state proportion of non- participants mainly identifies the proportion of high-cost-of-search individuals ζ_A.

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 assures 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.

This by now standard identification argument is usually made without allowing for labor supply decisions. We allow for both the extensive and intensive margin of labor supply decisions but in a parametrization where we discretize the intensive margin 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. The parameters governing the extensive margin of the labor supply are essentially

[34] 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.

the cost of search parameters and their identification has been discussed above.

Finally, we have to identify the utility parameters. The weight on leisure ($\alpha_{W,M}$) represents the preference for 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 dependence of one spouse's labor market status to the other spouse's labor market status. As stated in Proposition 4 the presence of risk aversion is what creates the correlation between the two spouses labor market decisions. The fact that one spouse's 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. As shown by the descriptive statistics, this is exactly what happens in our data and we exploit this data feature for identification and estimation.

However, it is important to recall that, as we discussed in Section 2.2.3, this last identification result is valid *conditioning on* our unitary model assumption. Under different household interaction assumptions, correlations between the two spouses' labor market decisions would arise even in the case of linear utility. A prominent example is a model of cooperation within the household, for example household bargaining, where each spouse labor market status has an impact on his or her outside option and as a result has an impact on the other spouse labor market decision. It is also worth noticing that this alternative source of household interaction (the impact of outside options) is not easy to distinguish from our model's source of household interaction (the curvature of the utility function). The main reason is that outside options may generate ambiguous impacts of one spouse labor market status on the other spouse's optimal decision rules just as risk aversion does.[35] Assume a standard bargaining model with linear utility where divorce is the outside option and consider the impact of the husband's wage on the wife's optimal decisions. On one side, a higher husband's wage allows the wife to be pickier when faced with wage offers since the husband's wage provides resources during the search process. On the other side, the wife's gain from waiting for a better wage offer is lowered by a higher husband's wage because his stronger outside option will secure a higher share of the wage that will eventually be accepted. This second channel has the opposite impact on the wife's optimal decision rule leading her to be less picky when faced with wage offers. This conclusion may potentially change if we introduce household production. In this case, a higher husband's wage generates a higher opportunity cost for his contribution to household production and may actually induce him to distribute a higher share of resources to the wife in order to maintain her time investment in household production.

While this discussion does not clarify general identification condition for household interaction models, it does emphasize how our assumption of a very specific interaction model, despite being very restrictive, is also extremely hard to remove. If the empirical features available to us are sufficient to attain identification *once* our household behavior model is assumed, they are not enough to discriminate between different modes of household behavior, even if we were limiting ourselves to a very standard set of household behaviors such as the bargaining model with linear utility briefly described above.

[35] Recall that in our setting the wage of one spouse affects both the marginal cost and the marginal expected benefit of search of the other spouse, leading not only to a dependence between the reservation wages of the two partners but also to an ambiguous direction of this dependence.

4.2 Estimation Procedure

We use the method of simulated moments (MSM) to estimate the parameters of the model. We choose this estimation method as opposed to the more efficient simulated maximum likelihood estimator because our household search model in continuous time generates *simultaneous* changes in the labor market states of both spouses in a given household (due to endogenous job terminations). While a pragmatic definition of simultaneity could be imposed on the data, it would necessarily be arbitrary and may potentially open the door to multiple equilibria issues.[36] We prefer the alternative proposed by DF: extracting moments from point-in-time samples that focus on steady states aggregated moments and transitions probabilities instead that on individual labor market histories. Of course, individual labor market histories are still at the center of the analysis because both the sample and simulated moments are computed based on individual-level data and the simulations themselves generate individual labor market histories.

Specifically, the estimation procedure works as follows. First, we select 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 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

$$\Im_r(\theta) = J(\psi_r, \theta) \tag{29}$$

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 $(Q(\theta) - q)' W^{-1} (Q(\theta) - q)$, where q is a column vector of the T corresponding sample moments and W^{-1} is a symmetric, positive definite weighting matrix that is TxT. We define the simulated method of moments estimator as the parameter vector $\hat{\theta}_{MSM}$, where

$$\hat{\theta}_{MSM} = \arg\min_{\theta} (Q(\theta) - q)' W^{-1} (Q(\theta) - q) \tag{30}$$

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

We construct W so that the matrix W^{-1} weights the different moments in $Q(\theta)$ and q according to their sample variability. We calculate the matrix W by bootstrapping N_{boot} samples from

[36] Choosing when two events occur simultaneously in the data would be similar to choosing the length and boundaries of the time interval to apply on the data when specifying the model in discrete time. It is an arbitrary choice and, more importantly, may generate multiple changes of state in the same time interval and multiple equilibria.

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.[37]

We choose the moments to match in the estimation procedure by mirroring the identification strategy. The complete list of moments, including their predicted and sample values, are reported in the Appendix, Table 7. We allow all the parameters to be gender-specific and therefore we compute the individual moments separately on husband and wives. The moments are also computed separately on households with or without children younger than 18 years old in order to estimate the parameters sensitive to the presence of children in the household.

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 four possible labor market states and we compute transitions between them one period (3 months) and three periods (1 year) apart. To the transitions, we add the proportions in each labor market state in the first period. As a result, we obtain a total of 36 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 introduce skewness to better capture that female wage distributions are frequently characterized by a high probability mass right above the reservation wage. Wage growth is computed one and three periods apart. As a result, 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 over-time correlations are computed one period apart. 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. These transitions are contemporaneous and one period apart. As a result, we obtain a total of 72 cross-moments.

To summarize, the estimation procedure is using 172 moments for households with and without children in order to estimate 27 parameters.[38] We have chosen to fit a relatively large set of moments to avoid making arbitrary decisions about which moments to fit and which moments to ignore. Once decided for identification purposes that some features of the data should be targeted, the number of moments in our household search moments becomes immediately quite large if we want to treat the two spouses symmetrically and we want to account for transitions over all the labor market states, including full-time and part-time. For example, if we want to fit transitions probabilities over 2 time periods given the spouse's labor market status, we have to generate at

[37] 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. On the other hand, means of sample wages will have variances which 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. There are also a few transitions we have chosen to match that occurs very rarely leading to extremely small variances: we rescale the weight of these moments to be in the same scale of the (weighted) average wages.

[38] The list of parameters is reported in equation (28).

least 18 moments. Similarly, if we introduce a moment to fit the wives labor market behavior, we have to do the same for the husbands labor market behavior, doubling the number of moments to fit.

We build each moment by forming interaction variables between variables of interest (e.g. wages of female part-time workers) and dummy variables representing 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. Using unconditional moments improves the stability of changes in the moments across iterations of the estimation algorithm since the moment is defined over the whole sample. They also enable the moment to be defined when the proportion of the sample in the simulation contributing information (e.g. male part-time workers) is equal to or close to zero.

We have just given the complete list of moments we use when estimating the household search model. When estimating the individual search model we ideally want to use exactly the same information since we are interested in comparing the two specifications. However, there are moments that the individual search model cannot match appropriately. A first, and most important, set of moments that cannot be matched are the cross-moments: the individual search model predicts no correlation between spouses moments since the household is not included as unit of decision-making in the behavioral model. While this is straightforward, it adds an identification issue. Identification of the utility parameters is weaker than in the household search model since it cannot exploit the correlated choices of the spouses and it therefore relies heavily on the nonlinearities generated by the functional form assumptions of the model. Still, we know from Dey and Flinn (2008) that this procedure may lead to reasonably precise estimates when imposing a structure and using an information set very similar to ours. A second set of moments that cannot be matched are the transitions in and out of non-participation. In the household search model these transitions are generated by changes in labor market status of the spouse but in the individual search model non-participation is an absorbing state: once an individual is out of the labor market, there are no shocks that can bring her back. The decision is an ex-ante decision based on the time invariant search cost. As a result, the individual search model can only match the steady state proportions of non-participants, moments that will map directly in the proportion of high-cost-of-search individuals. With the exclusion of these two sets of moments that we cannot match, all the other moments matched in the individual search estimation procedure are exactly the same as the ones used in the household search estimation procedure.

5 Estimation Results

5.1 Results

We report the estimation results in Tables 3 and 4. Table 3 reports the structural parameter estimates and Table 4 some relevant predicted values. The first two columns pertain to the separate estimation of the individual search model on the sample of men and women; the last two columns pertain to the joint estimation of the household search model on the sample of couples, where couples are composed exactly by the same individuals used in the estimation of the individual search model.

The structural parameter estimates confirm and reinforce DF's result: parameter estimates obtained by estimating on the same sample an individual search model and a household search model are systematically different. This is a first indication that estimating under the assumption that decisions are taken at the household level and not at the individual level has important empirical consequences.

With respect to the mobility parameters, the main differences concern the arrival rates of offers: the individual search model underestimates them for both men and women. Wage offers parameters are also sensitive to the specification: the main differences are concentrated on the women sample. Table 4 shows that the average wage offer for women is estimated to be about 21% lower in the individual search specification than in the household search specification.

The structural parameter estimates also confirm the systematic differences by gender found in the literature. As the individual search model estimated by Flabbi (2010a) on CPS data and by Bowlus (1997) on NLSY data, the individual search model we estimate on SIPP data shows that there are differences by gender in all the structural parameters of the model, with the stronger differences concentrated on the wage offers distribution. As reported in Table 3 and 4, women are more likely to receive part-time job offers and when they receive full-time offers the wage offers are on average lower than those received by men. The wage offers differential we estimate in the individual search specification is about 25%, a value very similar to the 26% estimated by Flabbi (2010a) on CPS data and to the 17% estimated by Bowlus (1997) NLSY data. But under the household search specification the wage offer differentials is reduced in half, reaching a value of about 13%. We consider this the most relevant difference between the household search estimates and the individual search estimates since it suggests that some of the gender wage differential in accepted wages we observe in the data (frequently labelled as the *gender wage gap*) may be due to the optimal behavior of women making decisions at the household level. The mechanism works as follows. Assume for a moment that the mobility parameters are the same for men and women. Then the individual search model can fit lower accepted wages for women only with lower wage offers to women. The household search model, instead, may explain part of the gap through additional channels as, for example, a decrease in the wives' reservation wages implied by the husbands' labor market status.

The additional spouses' interaction channels included in our household search model provide a different explanation for the observed gender wage gap from those usually proposed in the empirical labor search literature. Usual explanations account for the gender gap using differentials in productivity (Bowlus (1997)), the presence of discrimination (Flabbi (2010a)), different preferences or different occupational choices (Flabbi and Moro (2012)).[39] Our results suggest that another factor should be considered, namely that the gender gap in accepted wages may be much larger than the gender gap in wage offers as a result of joint labor market decisions taken at the household level. Notice that this result is obtained by taking into account many of the other factors listed in the literature as possible determinants of gender gaps: for example, we allow for gender-specific preferences, productivity and labor supply decisions.[40] The mechanism we suggest is not new, it has been present in the literature since at least the influential *Treatise* by Becker (Becker (1981)). However, it has been notoriously difficult to quantify and it has never been before identified and estimated within a search model of the labor market. In particular, if many selection issues are taken into account in the empirical literature within this field, they are not usually embedded in models able to generate equilibrium unemployment as in the search model we use here. Thanks to this, our model can make a clear distinction between wage offers and accepted wages providing an

[39]In the main text, we are just referring to contributions within the empirical labor search but the empirical literature in general is also using similar ingredients. For broader surveys and more complete references, see Fang and Moro (2011) and Altonji and Blank (1999).

[40]However, we do not include the possibility of discrimination or gender-specific job amenities.

estimate of the gender gap in wage offers, arguably a better measure of the differential treatment received by men and women in the labor market.

With respect to labor supply estimates, the rate of part-time offers received by men is estimated to be similar under the two specifications while the rate of part-time offers received by women is estimated to be higher under the household search specification. What is relevant for the other component of labor supply, the participation decision, is the proportion of individuals with low cost of search, denoted by the parameter ζ. This parameter is fit exactly by the proportion of labor market participant in the individual search specification while it is estimated as any other parameter in the household search specification. We notice a very similar estimates on the male sample but a slightly lower estimate on the female sample. The second finding indicates that some women decide to participate in the labor market even if they have high cost of search when taking decisions at the household level.

The main difference in the point estimates of the utility parameters concerns the weight on leisure α. In both specifications, it is estimated to be higher for women than men and to be higher for couples with children younger than 18 than without. Since leisure is the residual time while not working, it may well include some childcare time and both results are in line with this. However, the value assigned to leisure by women is strongly underestimated in the individual search model, confirming a stronger sensitivity of the female parameters to the specification of a model able to take into account household-level decisions.

The coefficient of relative risk aversion, defined in our parametrization as $(1-\delta)$, is estimated to be a little lower than one in all the estimation runs. The coefficients estimated on the individual search specification are slightly smaller than the common coefficient estimated on the household search specification. Our estimated value for the households is higher than the one estimated by DF (about 0.5), lower than the preferred value in GGV (about 2)[41] and in general lower but comparable with values found in the micro literature (Chetty (2006)). Our parametrization nests the linear case since the utility function becomes linear in consumption when $\delta = 1$. A specification test for linearity in the household search model is strongly rejected.[42] By Propositions 3 and 4, this result also implies rejection of the individual search model specification with respect to the household search model specification but only conditioning on the unitary model assumption.

5.2 Fit of the Model

We first judge the fit of the model by looking at the moments we explicitly target in the estimation procedure. The sample and estimated moments are reported in the Appendix, Table 7. We have chosen to fit a relatively large set of moments with a relatively parsimonious specification so it should not be too surprising that we fit some data features better than others. The household search model does a very good job in fitting the first and second moments of the accepted wage distribution for both men and women. The third moments are fitted less well but they are definitely in the same order of magnitude. We predict well wage growth if the individual does not switch from full-time time to part-time over the observation period. The ability to fit well both male and female wage distributions is an improvement with respect to previous literature[43] and we think it

[41]Recall, though, that GGV do not estimate the relative risk aversion coefficient. They simply say that, in their calibration exercise, when they fix the relative risk aversion coefficient at about 2 "the data are closest to the model" than when they fix it at values between 0 and 8.

[42]The null for the specification test is $\delta = 1$. The P-value we obtain is smaller than 0.0001.

[43]Both Flabbi (2010a) and Bowlus (1997) obtain a better fit of the male wage distribution than the female wage distribution. Also the fit of the household search model estimated by DF generates a worse fit for the cross-sectional

is related both to our taking into account household decisions and to our more careful treatment of labor supply. The model fits well steady state proportions and transitions with the exception of those involving non-participation of husbands. In terms of the spouses' cross-moments, we obtain a good fit of average wages of one spouse as a function of the other spouse labor market status but we do not fit well wage correlations between spouses.

To give a more concise idea of how the model match the most relevant data moments, we report in Table 5 some of the same descriptive statistics we reported in Table 1 and Table 2. Table 1 and 2 compute the descriptive statistics on the data sample while Table 5 computes the same statistics on the simulated sample where the simulations are run at the point estimates reported in Table 3. Notice that most of these moments are not explicitly targeted by the minimization procedure because they are conditional moments as opposed to the unconditional moments used in the procedure. We first focus on the moments not conditioning on the spouse's labor market status. The labor market status proportions, the labor market status transitions, average earnings, and earnings dispersion are predicted reasonably well by both the individual search and the household search model. The only exception is the proportion of men in non-participation: while this value is fit exactly by construction in the individual search model, it is significantly underestimated by the household search model.

When we condition on the spouse's labor market status, the individual search model obviously generates a poor fit because it cannot account for the variation in the descriptive statistics over the different spouse's labor market states. The household search model, instead, exhibits variation along this dimension and qualitatively matches the variation in the data in most cases. The exception is again about combinations involving husbands in non-participation. The magnitude of the variation is almost always lower in the simulated data than in the sample data.

The following examples are particularly interesting. The data report that the average weekly earnings for men married to an unemployed are lower than the average male earnings on the overall sample. We match this fact in the simulations but we underestimate the difference by about 17 dollars a week. We observe a similar ranking for wives. Again, we match the ranking but we underestimate the difference, this time by about 10 dollars per week. Another interesting example is found in the transitions rate. Women working full-time are very likely to keep working full-time after three months if the husband is also working full-time. If the husband is working part-time, they are very likely to transit to part-time. We match this behavior very well in our simulated data. Finally, if we look at steady-state proportions in labor market states, we observe that men married to unemployed women are less likely to work full time than men married to employed women. We match this assortative mating variation well in our simulation. If we look at women, we match the variation over part-time and full-time but not the variation over unemployment and non-participation. As we mention at the beginning, we have very few husband in non-participation in our simulated data and therefore all the moments computed conditioning on this labor market state are very noisy.

6 Empirical Application

In section 5 we evaluate the importance of considering the fact that decisions are taken at the household level by comparing the estimated structural parameters obtained under the household search model and under the individual search model. In this section we focus on a relevant empirical

moments of wives.

application and we show how policy measures and experiments change when assuming a different search behavior.

The estimation of the model structural parameters allows us to simulate labor market careers for households and individuals. These labor market careers can then be used to compute lifetime measures of labor market dynamics. The empirical application we propose focuses on computing *lifetime inequality* measures on wages and earnings. Computing lifetime inequality at the household level provides a possible solution to the two main shortcomings of usual cross-sectional inequality measures computed on individual wages and earnings. The first shortcoming is that cross-sectional measures are only representative of the *current* position of the individual in the wage or earnings distribution. The second is that individual-level measures cannot take into account that households' members pool resources and make joint labor market decisions.

Empirical works focusing on mechanisms that insure 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 individual positions in the inequality distribution.[44] However, they do not allow for wage and employment mobility as a result of optimal individual behavior. The few works estimating search models of the labor market to provide lifetime inequality measures[45] can solve this problem because they explicitly model employment decisions. However, they maintain the usual individual search assumption ignoring the possibility that decisions may be taken at the household level. Therefore they cannot address the second problem mentioned above, namely that households' members pool resources and make joint decisions.

By developing and estimating a household search model able to take into account both optimal mobility and household level decisions, we are able to propose a solution to both shortcomings. By computing lifetime inequality measures we are able to go beyond cross-sectional measures. By looking at household search, we are able to compare individual-level inequality with household-level inequality.

6.1 Simulation Procedure

The simulations procedure works as follows. We start by fixing the parameter vector: the 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 policy experiments inequality measures. We assign an initial state to each household and we then use pseudo-random number generators to shock the households. Households react to shocks following the optimal decision rules described in Section 2.2. 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.

Lifetime measures are created for each household or individual in the sample by integrating over discounted values of being in each labor market state over the full length of the labor market career.

[44] 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).

[45] 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.

For example, the lifetime earnings measure for household i, j is defined as:

$$\Xi_{ij} = \sum_{d=1}^{D} \exp(-\rho t_d) \int_{t_{d-1}}^{t_d} (w_i h_i + w_j h_j) \exp(-\rho v)\, dv \tag{31}$$

where d denotes a spell in which the labor market status of both partners is unchanged. When building this lifetime index for individuals or wages we simply change appropriately the argument of the integral and the length of the spells. Our lifetime inequality comparisons will be based on computing inequality measures on indexes defined as Ξ_{ij}.

6.2 Simulation Results

Table 6 illustrates the results of the simulations by reporting the coefficient of variation for cross-sectional and lifetime inequality measures computed on wages and earnings. The top panel reports results on the benchmark models, i.e. the models generated by the point estimates reported in Table 3. The bottom panel reports results on a series of policy experiments that have the objective of evaluating the impact of relevant features of the labor market structure on the inequality measures.

6.2.1 Benchmark

We first focus on the benchmark model under the household search model specification (Table 6, top panel, last three columns). The results show that cross-sectional measures can be substantially different from lifetime measures. Cross-sectional measures report higher level of inequality than lifetime measures. If we look at between-household inequality, the coefficient of variation of earnings decrease from about 0.46 in the cross-section to about 0.27 in the lifetime. This is a result of the optimal household behavior in response to shocks in an environment where mobility is high enough that households are not locked in the same labor market state over very long periods of time.

Second, the results on between-individuals inequality show substantial differences between the household search specification and the individual search specification. For example, the coefficient of variation on male wages decrease from about 0.57 in the individual search specification to about 0.46 in the household search specification. When looking at lifetime measures the difference are even larger. We see a decrease in the index for men when moving to the household specification but an increase for women leading to an inversion of the ranking between husbands and wives. If the individual search model estimates a slightly higher lifetime inequality for men, on the contrary the household search model estimates a much lower lifetime inequality for men than women. We think this is a result of the different way in which the household search model is able to take into account transitions to non-participation. As we mentioned in Section 2.2, only the household search model can generate transitions of one spouse in and out of the labor market as a result of the other spouse's labor market state. This dynamic is much more important for women than men and may lead women to have a greater variety of labor market trajectories and therefore more dispersion in lifetime measures.

In conclusion, we think that the benchmark results comparing lifetime and cross-sectional measures confirm the point put forward by Flinn (2002) and also found by Bowlus and Robin (2004) and Flabbi and Leonardi (2010): cross-sectional measures of inequality based on wages or earnings are not enough to draw conclusive inference about lifetime variables.

We also think that the benchmark results comparing the individual search and the household search model confirm what we have seen on the implied values reported in Table 4. The impact of taking into account that decisions are taken at the household level is asymmetric by gender, with female variables being more sensitive than male variables. Contrary to what we have seen on the implied gender gap in wage offers, this different sensitivity may lead to an increase in the gender gap as we can observe in the lifetime inequality measures on both wages and earnings. The gap not only increases but also changes sign since the individual specification generates lower lifetime inequality for women than men while the household specification implies exactly the opposite.

6.2.2 Experiments

We perform four policy experiments to estimate the impact of relevant features of the labor market structure on household inequality. We simulate the impact of changes in search frictions and job termination rates; the impact of an increase and a decrease in the proportion of part-time offers; and the impact of an increase in the dispersion of wages offers. Results are reported in the bottom panels of Table 6. In each experiment, we change a specific subset of parameters by 50% leaving the remaining parameters at the benchmark values. All the simulations at post-policy intervention values are based on the new equilibrium implied by the new post-policy parameters.

The first experiment concerns all the exogenous mobility parameters. We increase both the arrival rates λ_A and γ_A and the termination rates η_A^{PT} and η_A^{FT} to assess if a more "dynamic" labor market - i.e. a market with less search frictions and more terminations - increases or decreases inequality. Since the optimal reservation rules change and since we can build indexes taking into account both cross-sectional and duration components the result of the exercise is theoretically ambiguous and therefore it can only be assessed by counterfactual experiments at given parameters. We find very limited impact on cross-sectional measures under both specification and a strong effect on lifetime measures but only under the household search specification. Under the household search model, lifetime inequality increases at the household level and at the individual level for men but not for women. Again we find a strong asymmetry by gender implied by differences in labor market trajectory. For women, a more dynamic labor market implies that a marginal increase in cross-sectional wage inequality is more than compensated by mobility over labor market states that are able to smooth out differences over a lifetime horizon.

The second set of policy experiments looks at the impact of part-time (second and third experiment). The introduction of a labor supply margin in a search model is unusual but we claimed in Section 2.2 that it is justified to better match the labor market behavior of women. Women tend to work fewer hours than men and value job flexibility more.[46] The possibility of working part-time is still one of the most important institutional arrangement able to provide this flexibility. While previous works have tried to determine the presence of a "part-time penalty" at mean wages,[47] we can evaluate here the impact of the presence of part-time on overall inequality. The first experiment shows the impact of an increase in part-time offers as described by a 50% increase in the parameters p_A. Results shows very minimal changes in the inequality indexes despite a substantial increase in the rate of arrival of part-time offers, in particular for women. The same is true when we decrease the probability of receiving part-time offers by 50%, as we do in the third experiment.

The last policy experiment we implement tries to mimic a demand-driven increase in the dispersion of wage offers distributions. Such a policy could be interpreted as a very stylized version of the "skill-biased technological change" viewed by many scholars as an important source of the significant

[46] See for example, Altonji and Paxson (1988) and Flabbi and Moro (2012).

[47] For example, Blank (1990) estimates large wage penalties for working part-time using Current Population Survey data.

increase in inequality in the U.S. in this and in the previous decade.[48] We implement the policy by changing the wage offers distribution parameters $\mu_A^{PT}, \sigma_A^{PT}$ and $\mu_A^{FT}, \sigma_A^{FT}$ so that the coefficient of variation in full-time and part-time wage offers increases by 50% but the mean remains unchanged. The mean-preserving spread has a large impact on both cross-sectional and lifetime inequality but again the impact is quite asymmetric by gender. Under the household search specification, men experience almost a 100% increase in lifetime earnings inequality while women experience a still large but much lower increase of about 50%. Under the individual search specification, the ranking is reversed with women registering a 93% increase and men a 36% increase.

7 Limitations and Future Research

Our model assumes a specific form of household interaction. Though some recent works attempt to identify the mode of household interaction from labor market data,[49] they are still limited and difficult to extend to a dynamic setting where both spouses are allowed to simultaneously search in a labor market with frictions as in our model.

The limitation of assuming a specific form of household interaction seems therefore unavoidable in our context. However, the specific functional form we use - the unitary model - is particularly restrictive and has been criticized for generating empirical implications inconsistent with consumption and time allocation decisions. We therefore see it as the main limitation of the paper. Removing the assumption, though, is challenging and keeping it has the important advantage of making our paper directly comparable with the only two previous published papers implementing household search models: DF and GGV. Moreover, the main objective of the paper is to estimate the extent to which estimates and inference obtained from an individual search model differ from those obtained from a household search model: We think that the unitary framework is very effective in ensuring that the comparison between the household search and the individual search specification remains transparent and straightforward.

The main challenge in removing the unitary model assumption is that alternative and more general forms of household interaction make the problem intractable very quickly. For example, assuming a cooperative model, as done in the recent literature in household economics, generates equilibrium multiplicity and therefore introduces the issue of which efficient outcome to pick in equilibrium. One approach in the literature proposes an axiomatic solution, such as Nash bargaining,[50] while the other suggests the direct use of empirical information.[51] A consensus about the most appropriate method has not yet emerged in the literature (Del Boca and Flinn (2012)) and none of the two approaches has ever been implemented for a dynamic model like ours where the labor market is characterized by frictions, individuals make labor supply choices and both spouses are simultaneously searching in the labor market. These three features of our model make the choice of outside options required by the axiomatic approach very challenging and do not allow a direct implementation of the identification strategy proposed by the more data-based approach.

[48] Katz and Murphy (1992) is an influential earlier contribution; Acemoglou (2002) provides theoretical background; Eckstein and Nagypal (2004) documents skill-premia over a long time span.

[49] See for example Del Boca and Flinn (2012 and 2014) which allows for the choice between a cooperative and a non-cooperative solution; and Mazzocco (2007) which focuses on determining the presence or lack of commitment between spouses.

[50] See for example, McElroy and Horney (1981 and 1990) and more recently Jacquemet and Robin (2012) and Knowles (2013).

[51] See for example, Chiappori (1988) and more recently Bourguignon, Browning and Chiappori (2009).

A second important limitation of our analysis is the lack of endogenous household formation and dissolution. This limitation leads to two sets of issues. The first is empirical: by focusing only on individuals who are married and that remain married over our observation period, we generate sample selection bias. This is definitely a problem but its impact on the data is less severe than in other contexts because our observation period is very short (it is just one year for most of the moments we match in estimation) and our demographic group has a relatively high marriage rate.[52] Still, the proportion of individuals who are not married remains significant and we cannot take into account if we observe individuals in their first or subsequent marriages.

The second issue is theoretical: if it is well established that labor market status has an impact on the probability of marriage, it is also important to take into account that particularly large labor market shocks may lead to divorce. This is a potentially important channel of household interaction that we ignore in our model and that may lead to underestimate the differences between the household search and the individual search specifications. Developing a model with dual search in the labor market and contemporaneous endogenous household formation and dissolution is therefore desirable and it would constitute a natural extension of the current literature. However, it would need to be a model with a more general household interaction setting than the unitary framework, since in the unitary model setting the individual-level utility function necessary to make household formation and dissolution decisions is not defined. As a result, such a model would present the same challenges implied by removing the unitary model assumption with the additional data requirements and additional theoretical and computational challenges implied by adding a marriage market.

A third limitation of our paper is the lack of a joint location decision. This is certainly an empirically relevant feature that, for example, is the focus of one of GGV's calibrations and of Gemici (2011)'s estimated model. Generating such an extension would not be theoretically challenging but the structure of the data we have is not appropriate to implement it.[53] For the purpose of this paper, however, adding this feature would only strengthen the main message, i.e. that the presence of a spouse who is also a labor market searcher has important implications for the labor market decisions of the other spouse. The same is true for another related and potentially interesting feature: endogenous search intensity. For example, if the household decides to relocate as a result of an attractive job offer received by one spouse, the other spouse could start to search more intensively in the new location. Again, with our data such extension is difficult to implement since we only observe transitions and wages when a job offers is accepted. Only with additional information (such as which or at least how many job offers are received by the spouses) we would be able to separately identify search intensity from the other two components we already include in the mobility decisions: exogenous rate of offers and endogenous acceptance probability.

A fourth limitation is that in our estimation procedure we average out over individuals of different ages. If we limit the age range of the individuals included in the estimation sample, it is still a range large enough (from 25 to 49 years old) to potentially imply both some life cycle effects and some cohort effects.[54] The lack of life cycle effects is likely to have the strongest impact on the children-specific parameters since moments computed on parents without young children are

[52] *American Community Survey* data for 2001 report a marriage rate of 66% in our demographic group. It also reports a year-to-year divorce rate of about 0.75% for 2008 (the earliest year this information was collected).

[53] The appropriate data set is not easy to find. For example, PSID (used by Gemici (2011) and others in the internal migration literature) is a long panel that can track migration but it cannot measure monthly labor market transitions and therefore it cannot generate the labor market dynamics moments necessary for our estimation procedure.

[54] We do not additionally restrict the age range because we need a large enough sample size to have data variability for all or most of the household configurations over labor market states

likely to select relatively older individuals.[55] The lack of cohort effects implies that our estimated parameters and our policy experiment results may aggregate over important compositions effects. This problem may be particularly acute on the results on gender asymmetry. Our older cohort is in its forties in 2001 and therefore entered the labor market in the 1980s. Our younger cohort is in its mid- and late twenties in 2001 and therefore entered the labor market in the late 1990s. Both the gender wage gap and the participation rate gap are different when we compare early 1980s and late 1990s, mainly due to the weaker labor market position of women at the beginning of the period. As a result, the cohort effects may be more important for women than men, driving some of the gender asymmetry we estimate. However, if we look at the entire twenty year period,[56] we see that the whole 1990s have experienced remarkable stability in terms of gender differentials in the labor market. The 1980s show some convergence but at a decreasing rate and at a level which is quite low when compared to the previous decades. As a result, we think it is unlikely that the important gender asymmetries we find in the paper are driven by composition effects implied by cohort effects.[57] A crude robustness check we have run to find corroboration for this claim has been re-estimating the model excluding older individuals.[58] We find results very comparable with our original estimates with the gender gap in wage offers increasing only marginally, from 13.1% in the original sample to 13.2% in the younger sample. The structural parameters experiencing the largest changes never change more than 10% with respect to the original estimates.

A fifth limitation of our paper is the assumption of no saving or borrowing. This is a common assumption in the search literature that can be justified by risk neutrality or by market completeness. We actually test and reject risk neutrality in the paper and we provide identification and estimation of the relative risk aversion coefficients. As a result, an extension of our model allowing for saving decisions would be very interesting and it is likely to add a very active margin in the differentiation between the household search and individual search specification. However, such an extension would be challenging. The handful of estimated search models allowing for savings decisions (Rendon (2006); Lentz (2009); and Lise (2011)) are faced with very difficult dynamic programming problems that force them to introduce restrictive assumptions. The complications derive from the difficulty of establishing global concavity of the value functions when savings are added to the job search model (Acemoglu and Shimer (1999); Lentz and Tranæs (2005)). The model would become even less tractable in the presence of a dual-searchers specification. Therefore, even if removing this assumption could be very promising, we leave it for future research.

[55] The lack of a life cycle dynamic in the model leads also to the broader issue of which one is the most appropriate way to estimate lifetime inequality. We see the inequality application presented in our paper as a complementary contribution to the life cycle literature because it is able to take into account more labor market dynamics features (employment risk on top of wage risk, endogenous decisions over labor market states, the importance of labor market frictions) than those typically included in a life cycle model. On the other side, some life cycle models can take into account important non-stationarities related to labor market decisions over time such as retirement decisions or endogenous accumulation of work experience.

[56] See Eckstein and Nagypal (2004), Blau and Kahn (2006) and Flabbi (2010b). Interestingly the gender gap in the employment rate has been essentially constant over the whole twenty year period.

[57] Of course, even if the aggregate levels did not change very much the selection of women (or men) participating may have changed. Blau and Kahn (2006) suggest that some change in selectivity on unobservables may have occurred in the 1990s while evidence of change in selectivity on observables is not very strong.

[58] We have excluded all the households where at least one spouse is older than 44 which are the workers more likely to have entered the labor market in the early 1980s.

8 Conclusion

Search models of the labor market are widespread and influential but they usually ignore that labor market decisions are frequently taken at the household level. We fill this gap by developing and estimating a household search model of the labor market with on-the-job search and labor supply. Our objective is to assess the empirical relevance of ignoring the household as the unit of decision-making. We judge empirical relevance by comparing parameter estimates under different specifications and by studying a policy-relevant application using the estimated structural parameters. The application involves building lifetime inequality measures and studying their sensitivity with respect to counterfactual and policy experiments. We build on previous work (DF and GGV) to establish our main theoretical results but we contribute on the empirical side by pointing out a novel identification strategy for the risk aversion parameters and by proposing a straightforward but informative specification test.

We find that ignoring the household as a crucial unit of decision-making has relevant empirical consequences and that these consequences are quite asymmetric by gender. The point estimates obtained under the individual search specification imply a gender differential in wage offers twice as large as the one obtained using the household search model point estimates. The individual search model also significantly under-estimates the value of non-labor time for women with children and the availability of part-time work for all women. The application points out that estimates of lifetime inequality in wages and earnings can be very different under the two specification. Specifically, the individual search specification generates lower lifetime inequality in wages for women than men while the household specification implies exactly the opposite. Some policy experiments generate different implications under the two sets of point estimates. For example, the impact of a mean-preserving spread in wage offers on lifetime earnings inequality is estimated to be much larger for men than women under the household search specification but lower under the individual search specification.

Our overall conclusion is that ignoring that labor market decisions are taken at the household level may be very costly but that the costs are application-specific. The misspecifications may have a large impact on some margins (in our case, gender differentials in wage offers and in lifetime inequality) but a negligible impact on others (in our case, the exogenous labor market shocks and the impact of part-time offers).

We caution that these conclusions are obtained in a framework affected by a series of limitations. The most severe is probably our household interaction assumption: the unitary model with perfect income pooling. We have chosen to retain this assumption for model tractability and because it generates a very useful comparison with previous literature (both DF and GGV assume a unitary model of the household). For our purposes, it would be interesting to argue that the assumption represents a possible bound of the difference between the individual search model and the household search model. There is certainly a sense in which this is the case since in the individual search model each individual retains control over all her own labor income while in the unitary model there is full income pooling. Richer household interactions models generate different degrees of income sharing and, in this respect, may be considered intermediate cases between the individual search model and the household search model with a unitary household. However, it is not clear if the household search unitary model constitutes a bound with respect to the overall objective of this paper: the empirical relevance of considering that decisions are taken at the household level when studying equilibrium labor market outcomes in a search environment. Strategic household interaction may well generate a higher sensitivity of one's own labor market decisions with respect to the spouse's labor market status. However, since the theoretical implications are not clear and the empirical literature is very thin, this limitation should encourage additional empirical work in the area and our contribution should be interpreted as a first step in this direction.

A second important limitation is the lack of endogenous household formation and dissolution. This restriction generates both empirical shortcomings (it forces us to estimate on an endogenously selected sample) and theoretical limitations (we cannot assess the impact of labor market shocks on marriage status.) We think that removing this assumption and adding a richer modeling of household interaction are very promising venues for future work. A joint model of dual-search in the marriage and labor market is the necessary next step in order to fully take into account the importance of the household in determining labor market outcomes.

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Table 1: Descriptive Statistics: Cross-Sectional Components.

	Overall	By Spouse Lab. Mkt. Status:			
		FT	PT	U	NP
Males:					
Labor Market Status:					
FT	0.889	0.888	0.924	0.774	0.871
PT	0.037	0.035	0.037	0.038	0.042
U	0.020	0.023	0.012	0.113	0.013
NP	0.055	0.054	0.027	0.075	0.073
Hourly Wages					
FT					
Mean	19.70	18.70	20.21	18.80	21.14
CV	0.559	0.506	0.471	0.989	0.641
PT					
Mean	14.32	12.75	16.28	6.17	15.87
CV	0.670	0.497	0.549	0.038	0.831
Weekly Earnings					
Mean	825.5	784.3	849.3	777.1	883.0
CV	0.578	0.525	0.488	1.021	0.661
Females:					
Labor Market Status:					
FT	0.492	0.492	0.457	0.571	0.489
PT	0.205	0.213	0.202	0.122	0.102
U	0.021	0.018	0.021	0.122	0.029
NP	0.282	0.276	0.319	0.184	0.380
Hourly Wages:					
FT					
Mean	15.08	15.38	14.09	11.43	12.23
CV	0.520	0.515	0.539	0.427	0.547
PT					
Mean	12.87	12.85	13.76	10.57	13.23
CV	0.612	0.617	0.612	0.458	0.502
Weekly Earnings:					
Mean	540.9	546.9	512.9	445.9	485.3
CV	0.632	0.634	0.627	0.491	0.582
N			5,024		

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. Abbreviations: FT= employed full-time; PT= employed part-time; U= unemployed; NP= non-participant; CV= coefficient of variation.

Table 2: Descriptive Statistics: Dynamic Components.

	Overall	By Spouse Lab. Mkt. Status:			
		FT	PT	U	NP
Males:					
From FT to:					
FT	0.957	0.953	0.975	0.878	0.958
PT	0.015	0.018	0.013	0.049	0.008
U	0.011	0.013	0.004	0.024	0.013
NP	0.017	0.016	0.008	0.049	0.021
From PT to:					
FT	0.298	0.349	0.211	0.000	0.300
PT	0.649	0.628	0.789	1.000	0.567
U	0.021	0.023	0.000	0.000	0.033
NP	0.032	0.000	0.000	0.000	0.100
From U to:					
FT	0.531	0.607	0.667	0.167	0.444
PT	0.041	0.000	0.167	0.167	0.000
U	0.367	0.321	0.167	0.667	0.444
NP	0.061	0.071	0.000	0.000	0.111
From NP to:					
FT	0.161	0.119	0.214	0.000	0.212
PT	0.007	0.000	0.000	0.000	0.019
U	0.051	0.060	0.071	0.000	0.038
NP	0.781	0.821	0.714	1.000	0.731
Females:					
From FT to:					
FT	0.910	0.953	0.975	0.878	0.958
PT	0.046	0.018	0.013	0.049	0.008
U	0.015	0.013	0.004	0.024	0.013
NP	0.028	0.016	0.008	0.049	0.021
From PT to:					
FT	0.091	0.349	0.211	0.000	0.300
PT	0.823	0.628	0.789	1.000	0.567
U	0.021	0.023	0.000	0.000	0.033
NP	0.064	0.000	0.000	0.000	0.100
From U to:					
FT	0.189	0.607	0.667	0.167	0.444
PT	0.151	0.000	0.167	0.167	0.000
U	0.358	0.321	0.167	0.667	0.444
NP	0.302	0.071	0.000	0.000	0.111
From NP to:					
FT	0.023	0.119	0.214	0.000	0.212
PT	0.021	0.000	0.000	0.000	0.019
U	0.010	0.060	0.071	0.000	0.038
NP	0.946	0.821	0.714	1.000	0.731

Notes: Data are from the 2001-2003 panel of the Survey of Income and Program Participation (SIPP). The transitions are computed 3 months apart. Abbreviations: FT= employed full-time; PT= employed part-time; U= unemployed; NP= non-participant; CV= coefficient of variation.

Table 3: MSM Estimation Results: Parameter Estimates.

	Individual Search		Household Search	
	Males	Females	Males	Females
λ	0.2697	0.2401	0.3060	0.3057
	(0.0179)	(0.0120)	(0.0010)	(0.0013)
γ	0.1158	0.0840	0.1660	0.1659
	(0.0047)	(0.0048)	(0.0027)	(0.0008)
η^{PT}	0.0137	0.0141	0.0202	0.0126
	(0.0012)	(0.0006)	(0.0002)	(0.00005)
η^{FT}	0.0177	0.0275	0.0208	0.0260
	(0.0008)	(0.0012)	(0.0003)	(0.0005)
μ^{PT}	2.0187	1.9591	1.9919	2.1396
	(0.0314)	(0.0310)	(0.0090)	(0.0065)
μ^{FT}	2.0868	1.7663	2.2049	2.0638
	(0.0314)	(0.0514)	(0.0028)	(0.0021)
σ^{PT}	0.5735	0.4859	0.6712	0.4026
	(0.0206)	(0.0309)	(0.0043)	(0.0026)
σ^{FT}	0.6480	0.6632	0.5557	0.5400
	(0.0122)	(0.0146)	(0.0011)	(0.0001)
p	0.0591	0.1436	0.0521	0.1824
	(0.0040)	(0.0108)	(0.0012)	(0.0004)
α^{YC}	0.1654	0.2016	0.1541	0.3164
	(0.0091)	(0.0077)	(0.0022)	(0.0059)
α^{NC}	0.0964	0.1163	0.1060	0.2334
	(0.0043)	(0.0112)	(0.0004)	(0.0012)
δ	0.0466	0.0438	0.0257	
	(0.0053)	(0.0030)	(0.0002)	
β	0.0448	0.0527	0.0557	0.0340
	(0.0037)	(0.0036)	(0.0003)	(0.0003)
ζ	0.9455	0.7182	0.9576	0.6812
			(0.0033)	(0.0039)
N	2,512	2,512	5,024	

Notes: Data are from the 2001-2003 SIPP. Standard errors in parentheses are computed by boostrap with 30 replications.

Table 4: Estimation Results: Implied Values.

	Individual Search		Household Search	
	Males	Females	Males	Females
Implied Values:				
Wage Offers:				
$E[w]$	9.878	7.388	10.510	9.130
	(0.265)	(0.290)	(0.036)	(0.025)
$V[w]$	50.332	27.568	40.905	25.701
	(2.799)	(0.983)	(0.433)	(0.163)
$E[w\|PT]$	8.874	7.982	9.182	9.213
	(0.327)	(0.284)	(0.096)	(0.070)
$V[w\|PT]$	30.661	16.968	47.985	14.938
	(4.575)	(3.495)	(1.610)	(0.456)
$E[w\|FT]$	9.941	7.288	10.583	9.112
	(0.280)	(0.327)	(0.036)	(0.019)
$V[w\|FT]$	51.567	29.346	40.516	28.102
	(2.895)	(1.157)	(0.458)	(0.125)
Durations:				
$E[t_o\|U]$	3.707	4.165	3.268	3.271
	(0.226)	(0.187)	(0.011)	(0.014)
$E[t_o\|E]$	8.635	11.907	6.023	6.026
	(0.390)	(0.752)	(0.105)	(0.029)
$E[t_e\|PT]$	72.775	70.817	49.443	79.263
	(5.524)	(3.333)	(0.389)	(0.311)
$E[t_e\|FT]$	56.564	36.307	48.188	38.390
	(4.293)	(1.709)	(0.744)	(0.842)
Gender Differentials:				
Wage Offers:				
$E[w]$	0.252		0.131	
$V[w]$	0.452		0.372	
$E[w\|PT]$	0.101		-0.003	
$V[w\|PT]$	0.447		0.689	
$E[w\|FT]$	0.267		0.139	
$V[w\|FT]$	0.431		0.306	
Durations:				
$E[t_o\|U]$	-0.123		-0.001	
$E[t_o\|E]$	-0.379		-0.001	
$E[t_e\|PT]$	0.027		-0.603	
$E[t_e\|FT]$	0.358		0.203	

Note: w are hourly wages; PT and FT part-time and full-time; U and E unemployment and employment; t_o durations in months before job offer shock; t_e durations in months before job termination shock.

Table 5: Model Fit: Descriptive Statistics on Simulated Data.

	Individual Search	Household Search Overall	By Spouse Lab. Mkt. Status: FT	PT	U	NP
Males:						
Labor Market Status:						
FT	0.857	0.907	0.914	0.924	0.887	0.892
PT	0.030	0.024	0.023	0.022	0.021	0.029
U	0.058	0.067	0.061	0.055	0.092	0.080
NP	0.055	0.001	0.003	0.000	0.000	0.000
Transitions from FT to:						
FT	0.953	0.948	0.951	0.946	0.968	0.940
PT	0.002	0.004	0.004	0.003	0.000	0.000
U	0.045	0.048	0.045	0.049	0.032	0.050
NP	-	0.000	0.000	0.001	0.000	0.000
Weekly Earnings:						
Mean	817.4	846.0	813.8	863.1	815.0	882.8
CV	0.581	0.468	0.460	0.470	0.488	0.470
Females:						
Labor Market Status:						
FT	0.473	0.425	0.428	0.398	0.381	1.000
PT	0.180	0.191	0.194	0.168	0.154	0.000
U	0.065	0.053	0.052	0.045	0.073	0.000
NP	0.282	0.332	0.326	0.389	0.392	0.000
Transitions from FT to:						
FT	0.911	0.906	0.905	0.073	0.404	0.000
PT	0.022	0.031	0.032	0.897	0.159	0.000
U	0.067	0.062	0.062	0.030	0.433	0.000
NP	-	0.001	0.001	0.000	0.004	1.000
Weekly Earnings:						
Mean	447.9	594.1	593.8	577.6	579.8	1,371
CV	0.700	0.558	0.556	0.507	0.580	0.281

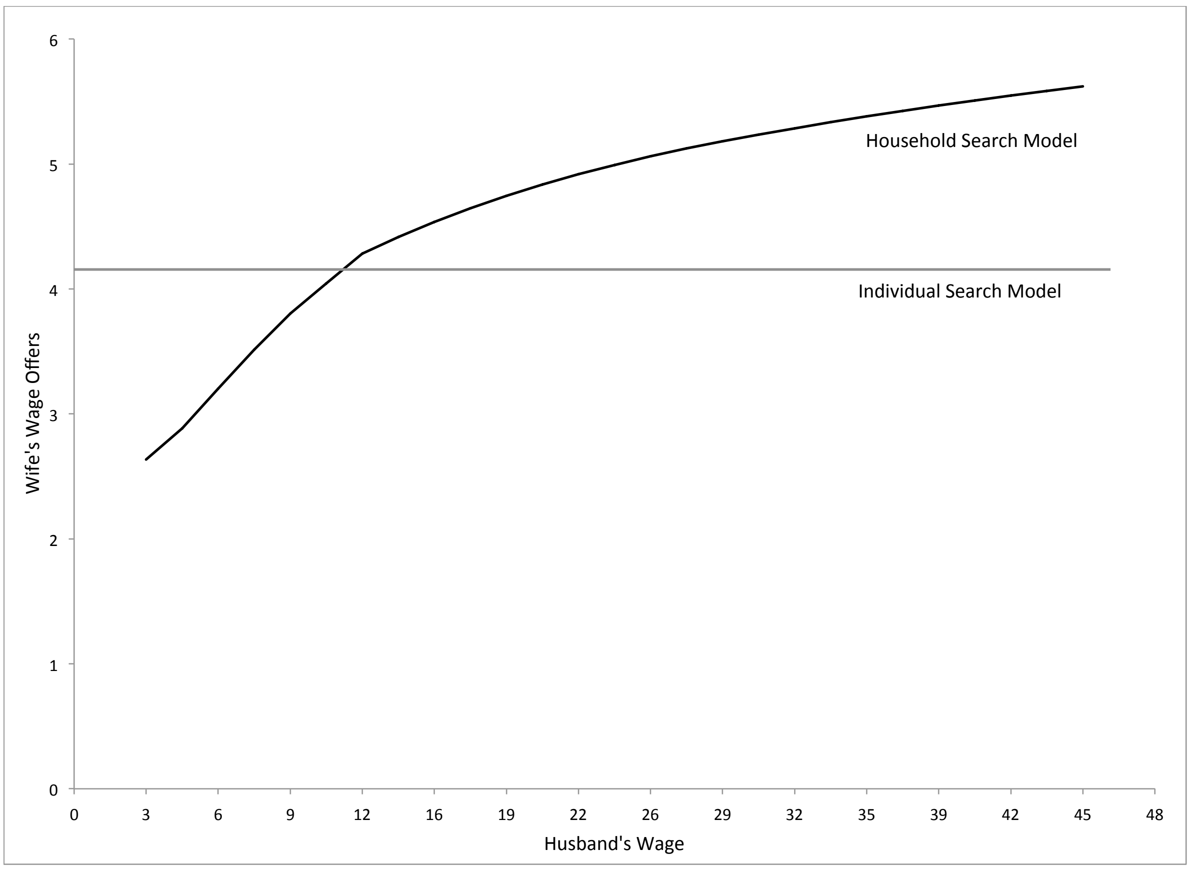
Note: Simulations at the point estimates reported in Table 3. Statistics to be compared with sample moments reported in Tables 1 and 2. Abbreviations: FT= employed full-time; PT= employed part-time; U= unemployed; NP= non-participant; CV= coefficient of variation.

Table 6: Inequality Measures and Policy Experiments.

	Individual Search		Household Search		
	Individuals		Household	Individuals	
	Males	Females		Males	Females
Benchmark:					
Cross-section:					
Wages	0.569	0.596	0.444	0.465	0.430
Earnings	0.581	0.700	0.459	0.468	0.436
Lifetime:					
Wages	0.247	0.225	0.277	0.206	0.406
Earnings	0.257	0.269	0.269	0.208	0.427
Experiments:					
1. Less Frictions More Terminations					
Cross-section:					
Wages	0.571	0.595	0.412	0.488	0.432
Earnings	0.582	0.708	0.439	0.478	0.435
Lifetime:					
Wages	0.212	0.197	0.554	0.543	0.286
Earnings	0.220	0.235	0.556	0.544	0.305
2. More Part-Time Offers					
Cross-section:					
Wages	0.571	0.566	0.448	0.468	0.428
Earnings	0.589	0.703	0.467	0.470	0.435
Lifetime:					
Wages	0.246	0.221	0.275	0.208	0.392
Earnings	0.258	0.270	0.266	0.211	0.418
3. Less Part-Time Offers					
Cross-section:					
Wages	0.574	0.617	0.457	0.462	0.455
Earnings	0.580	0.682	0.466	0.461	0.455
Lifetime:					
Wages	0.246	0.226	0.278	0.205	0.403
Earnings	0.254	0.265	0.274	0.207	0.419
4. Mean-Preserving Spread Wage Off					
Cross-section:					
Wages	0.809	0.836	0.521	0.689	0.627
Earnings	0.823	0.950	0.546	0.690	0.591
Lifetime:					
Wages	0.357	0.702	0.663	0.613	0.715
Earnings	0.370	0.735	0.662	0.614	0.723

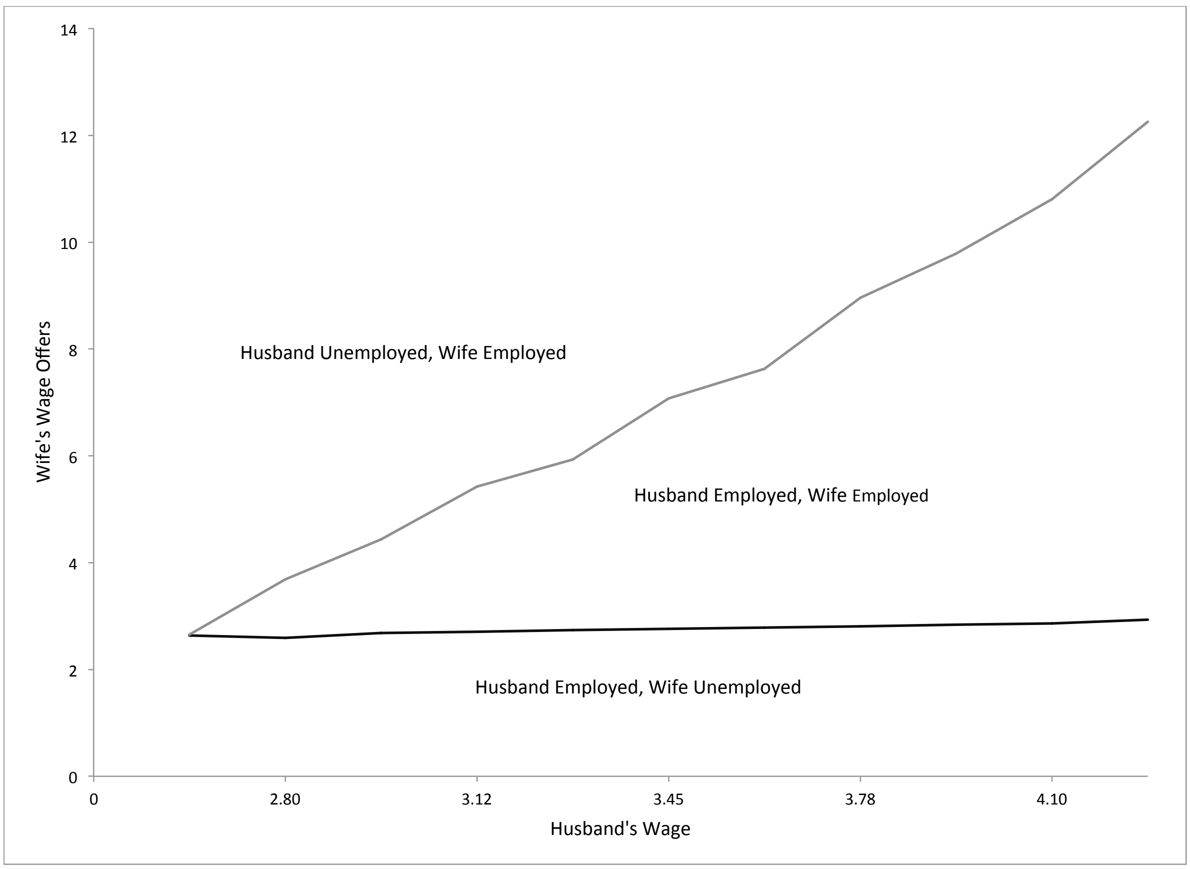
Note: The Table reports coefficients of variation. Lifetime measures are computed as in equation (31). *Benchmark* is the model at the estimated parameters. *Experiments* are defined by changing a subset of parameters by 50% leaving the other at the benchmark values. *Less Frictions More Terminations* increases $\lambda_A, \gamma_A, \eta_A^{PT}, \eta_A^{FT}$. *More (Less) Part-Time Offers* increases (decreases) p_A. *Mean Preserving Spread in Wage Offers* changes $\mu_A^{PT}, \sigma_A^{PT}, \mu_A^{FT}, \sigma_A^{FT}$ so that the Coefficient of Variation in wage offers increases but the mean is unchanged.

Figure 1: Reservation Wage Schedules: Benchmark.



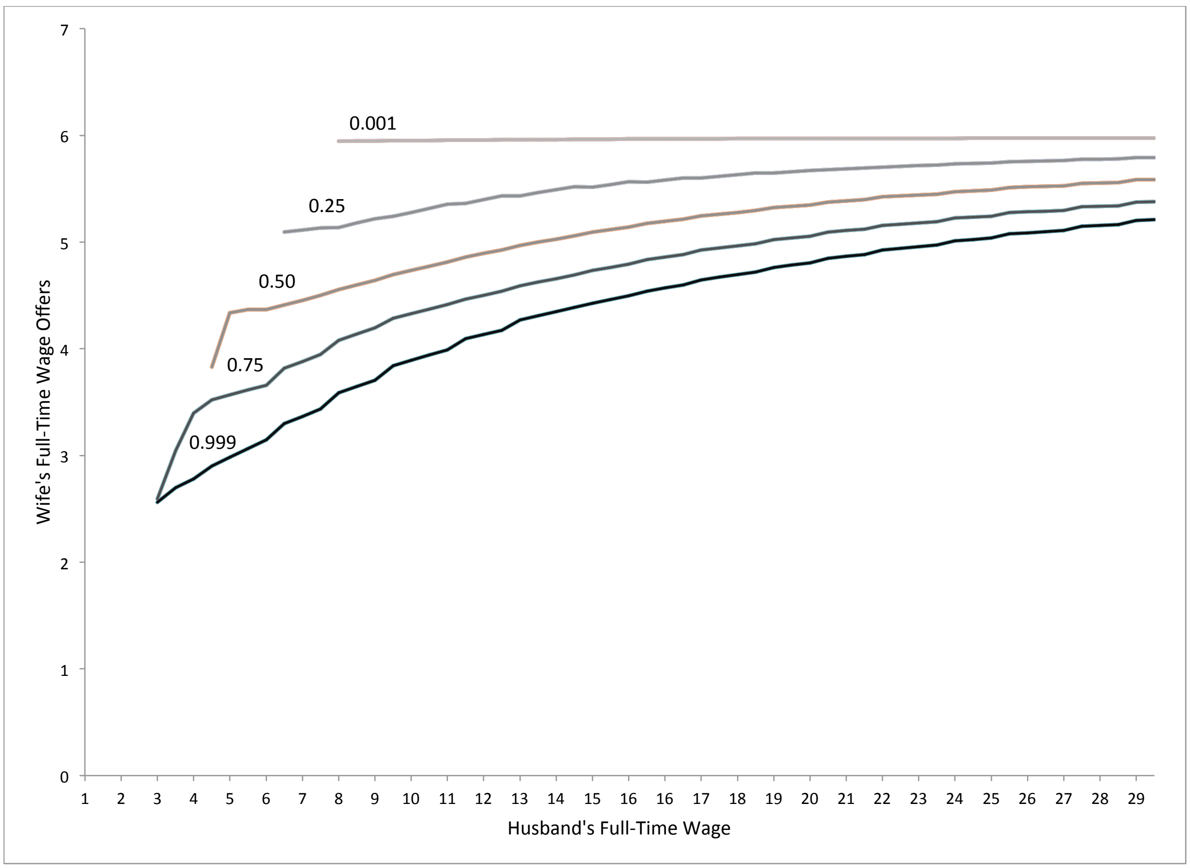
Note: Figure reports wife's reservation wage schedules out of unemployment. Simulations based on parameter estimates (see Table 3.)

Figure 2: Endogenous Quitting Region.



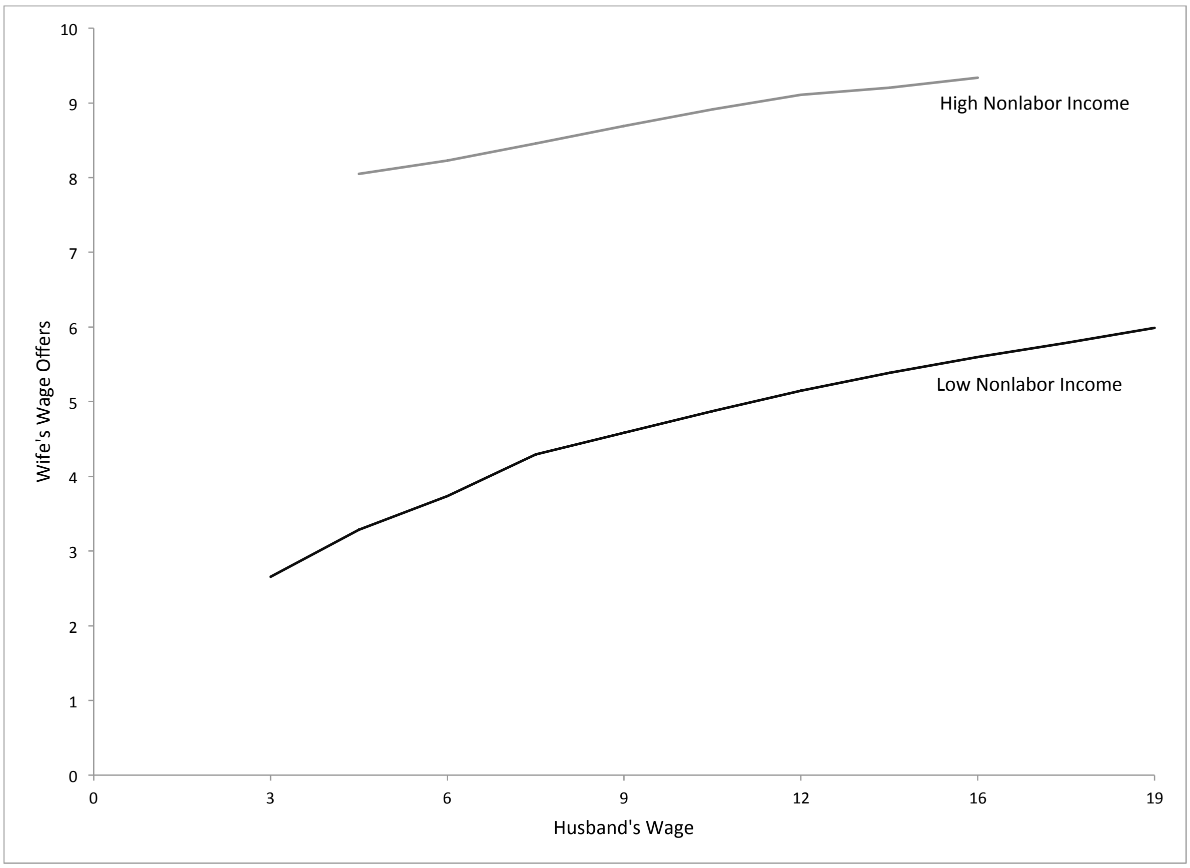
Note: Figure reports optimal household labor market states and corresponding reservation wage schedules. Simulations based on parameter estimates (see Table 3.)

Figure 3: Reservation Wage Schedules: Sensitivity to Risk Aversion.



Note: Figure reports wife's reservation wage schedules out of unemployment at different levels of relative risk aversion. Simulations based on parameter estimates (see Table 3.)

Figure 4: Reservation Wage Schedules: Sensitivity to Nonlabor Income.



Note: Figure reports wife's reservation wage schedules out of unemployment at different levels of nonlabor income. High nonlabor income denotes the highest value we use in estimation (17.6\$/h); Low the lowest positive value we use in estimation (equal to 0.4\$/h.) Simulations based on parameter estimates (see Table 3.)

A Appendix

A.1 Individual Search Model in the Extended Version

Environment The individual search model is subject to the same environment of the household search model and shares the same notation. The only difference is that decisions are taken at the individual level and not at the household level, just as we saw in the simple version of the model. Moreover, parameters are allowed to be different by gender, under the assumption that markets are fully segmented by gender. We describe here the version for male workers, the version for female workers is analogous.

The instantaneous utility functions are defined at the individual level, they depend on the idiosyncratic components and they are conditional on the time invariant individual-specific heterogeneity (y_i, s_i). We denote them as follows:

$$u\left(c_i, l_i; y_i, s_i\right) \tag{32}$$

where:

$$\begin{aligned} c_i &= w_i h_i + y_i \\ l_i &= 1 - h_i - s_i \end{aligned}$$

Value Functions Each Individual can occupy one of three different labor market states (employment, unemployment, no-participation). As a result, there are three different value functions for each time invariant individual-specific heterogeneity vector (y_i, s_i). The notation for the three value functions for males, together with the notation for the flow utility and the shocks affecting the state, are reported in the following matrix. For convenience, we drop the conditioning on the vector (y_i, s_i).

Value Function	Flow Utility	Shocks
$V\left[w_i, h_i\right]$	$u\left(w_i h_i + y_i, 1 - h_i\right)$	γ_M, η_M
$U\left[s_i\right]$	$u\left(y_i, 1 - s_i\right)$	λ_M
Z	$u\left(y_i, 1\right)$	$-$

The value function V denotes the case when the individual is employed; U the case where is unemployed; and finally Z denotes the case in which the individual is out of the labor force. Let us first focus on the labor market participants.

The value of an employed (male) individual $V\left[w_i, h_i\right]$ is characterized by:

$$\begin{aligned} (\rho + \gamma_M + \eta_M) V\left[w_i, h_i\right] = u\left(w_i h_i + y_i, 1 - h_i\right) \\ + \gamma_M \int \max\left\{V\left[w_i, h_i\right], V\left[w', h'\right]\right\} dF_M\left(w', h'\right) \\ + \eta_M U\left[s_i\right] \end{aligned} \tag{33}$$

We notice a much lower range of alternatives available to the individual when a labor market shocks hits with respect to the household search model. For example, if an on-the-job offers arrive the labor market state will always remain employment, while the wage-hours schedule may change or not if the offer is accepted or not.

The value of an unemployed is characterized by:

$$(\rho+\lambda_M)U[s_i] = u(y_i, 1-s_i) \tag{34}$$
$$+\lambda_M \int \max\{U[s_i], V[w', h']\} dF_M(w', h')$$

Equilibrium As in the household search parameterization, 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 equations defining the reservation utility values are notational heavy and are not reported but they are available (with minor notational changes) in Flabbi and Mabli (2012). The optimal decisions rules based on the utility reservation values are also the same as in the simple version of the model: the individual is choosing the set of actions generating utility above the relevant threshold. We are now ready to give the following:

Definition 6 *Given*

$$\{\lambda_M, \gamma_M, \eta_M, \rho, u(c,l), F_M(w,h)\}, \text{ } u \text{ continuous}$$

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

$$\{V, U\}$$

that solves equations (33) and (34).

Notice that this definition is given under the understanding that the max operator present in equations (33) and (34) is solved following the optimal decision rules based on the reservation value property described above.

The previous definition is valid for the set of individuals characterized by a vector (y_i, s_i) guaranteeing participation in the labor market. If the individual is out of the labor force, we are in the presence of an absorbing state because he cannot receive any shock that will lead to a change of labor market state. The value of this state is defined by the following equation:

$$\rho Z[y_i, s_i] = u(y_i, 1; y_i, s_i) \tag{35}$$

The optimal behavior of individuals characterized by a vector (y_i, s_i) such that they are out of the labor force is fully described by the following ex-ante decision. Individual i will not participate in the labor market if and only if:

$$U[s_i; y_i, s_i] < Z[y_i, s_i] \tag{36}$$

This optimal decision concludes the definition of the equilibrium in the extended version of the model for the individual search case.

A.2 Sample and Estimated Moments

In Table 7 we report sample and estimated moments used in the Metohod of Simulated Moments estimation procedure. The first three columns report the male moments and the last three columns the female moments. For each gender, the first column reports the sample moments, the second the estimated moments in the individual search specification and the third the estimated moments in the household search specification. The notes to the Table explain the abbreviations we used in the first column to label the various moments.

Table 7: Appendix: Sample and Estimated Moments

Moments	Males			Females		
	Sample	Estimated		Sample	Estimated	
		Individual Search	Household Search		Individual Search	Household Search
Individual Moments:						
With children:						
ave w1 pt 1	0.5450	0.5472	0.4956	2.7872	2.7724	2.6530
ave w1 ft 1	17.6176	17.5425	18.1270	6.7579	8.0122	6.6289
sd w1 pt 1	3.3189	3.4222	3.8411	6.0351	4.8687	5.3805
sd w1 ft 1	10.7553	10.6955	8.8744	7.6930	7.1502	7.8567
skewn w1 pt 1	9.4523	8.0528	11.1375	4.0218	3.0473	2.9077
skewn w1 ft 1	2.5467	2.2568	1.8152	2.8216	3.1243	2.5062
prop u t1	0.0196	0.0592	0.0696	0.0216	0.0639	0.0523
prop pt t1	0.0372	0.0306	0.0239	0.2149	0.1731	0.1905
prop ft t1	0.8908	0.8579	0.9065	0.4504	0.4499	0.3952
prop np t1	0.0523	0.0523	0.0000	0.3130	0.3130	0.3620
diff ave w1 ptpt t12	0.0341	0.0003	0.0000	-0.0299	0.0135	0.0145
diff ave w1 ptft t12	-0.0049	0.0240	0.0093	0.0061	0.0650	0.0837
diff ave w1 ftpt t12	0.0279	0.0023	0.0094	0.0002	0.0010	0.0005
diff ave w1 ftft t12	0.2659	0.3079	0.1989	0.0152	0.1394	0.0737
diff ave w1 ptpt t14	0.0017	0.0012	0.0001	0.0610	0.0241	0.0379
diff ave w1 ptft t14	0.0018	0.0325	0.0076	-0.0128	0.0709	0.1753
diff ave w1 ftpt t14	0.0246	-0.0329	0.0375	0.0549	-0.0163	-0.0717
diff ave w1 ftft t14	0.3582	0.4220	0.2502	0.1188	0.2124	0.1468
prop ftt2 ftt1	0.8546	0.8618	0.8587	0.4061	0.5966	0.3569
prop ptt2 ftt1	0.0131	0.0024	0.0032	0.0232	0.0140	0.0126
prop unt2 ftt1	0.0081	0.0412	0.0446	0.0060	0.0443	0.0256
prop ftt2 ptt1	0.0116	0.0050	0.0043	0.0176	0.0154	0.0145
prop ptt2 ptt1	0.0242	0.0261	0.0182	0.1772	0.2257	0.1699
prop unt2 ptt1	0.0005	0.0012	0.0014	0.0050	0.0109	0.0061
prop ftt2 unt1	0.0111	0.0341	0.0429	0.0040	0.0448	0.0222
prop ptt2 unt1	0.0005	0.0023	0.0012	0.0040	0.0095	0.0086
prop unt2 unt1	0.0065	0.0261	0.0255	0.0081	0.0387	0.0215
prop npt2 ftt1	0.0151	0.0000	0.0000	0.0151	0.0000	0.0001
prop npt2 ptt1	0.0010	0.0000	0.0000	0.0151	0.0000	0.0000
prop ftt2 npt1	0.0091	0.0000	0.0000	0.0060	0.0000	0.0000
prop ptt2 npt1	0.0005	0.0000	0.0000	0.0060	0.0000	0.0000
prop npt2 npt1	0.0403	0.0000	0.0000	0.2979	0.0000	0.3619
prop npt2 unt1	0.0015	0.0000	0.0000	0.0055	0.0000	0.0000
prop unt2 npt1	0.0025	0.0000	0.0000	0.0030	0.0000	0.0001
prop ftt4 ftt1	0.8374	0.8405	0.8324	0.3709	0.5456	0.3192
prop ptt4 ftt1	0.0242	0.0102	0.0102	0.0453	0.0449	0.0389
prop unt4 ftt1	0.0191	0.0546	0.0639	0.0101	0.0645	0.0369
prop ftt4 ptt1	0.0171	0.0112	0.0111	0.0337	0.0430	0.0416
prop ptt4 ptt1	0.0161	0.0192	0.0114	0.1535	0.1912	0.1389
prop unt4 ptt1	0.0020	0.0019	0.0014	0.0065	0.0178	0.0099
prop ftt4 unt1	0.0136	0.0547	0.0607	0.0050	0.0628	0.0331
prop ptt4 unt1	0.0015	0.0025	0.0015	0.0035	0.0154	0.0112
prop unt4 unt1	0.0020	0.0052	0.0074	0.0025	0.0147	0.0081
prop npt4 ftt1	0.0101	0.0000	0.0000	0.0242	0.0000	0.0002
prop npt4 ptt1	0.0020	0.0000	0.0000	0.0211	0.0000	0.0000
prop ftt4 npt1	0.0106	0.0000	0.0000	0.0106	0.0000	0.0000
prop ptt4 npt1	0.0030	0.0000	0.0000	0.0226	0.0000	0.0001
prop npt4 npt1	0.0367	0.0000	0.0000	0.2718	0.0000	0.3619
prop npt4 unt1	0.0025	0.0000	0.0000	0.0106	0.0000	0.0000
prop unt4 npt1	0.0020	0.0000	0.0000	0.0081	0.0000	0.0000

Notes: The table reports the sample and simulated moments used in the quadratic form in equation (30). In describing the moments in the first column we use the following abbreviation: w denotes wages; pt, ft, un, and np denotes part-time, full-time, unemployment, and non-participation; t# stand for the time period (each time period is three months apart); m and f stand for males and females.

Table 8: Appendix: Sample and Estimated Moments - continued

Moments	Males			Females		
	Sample	Estimated		Sample	Estimated	
		Individual Search	Household Search		Individual Search	Household Search
Individual Moments:						
Without children:						
ave w1 pt 1	0.5011	0.5224	0.5287	2.0743	2.7603	2.7223
ave w1 ft 1	17.0607	17.6409	17.7592	9.9163	8.2629	9.8054
sd w1 pt 1	2.9407	3.1688	3.5861	4.9971	5.0944	5.5452
sd w1 ft 1	9.8974	10.3106	8.8296	7.4316	6.7137	7.9316
skewn w1 pt 1	7.8407	7.8941	8.4450	3.8782	3.2725	2.9098
skewn w1 ft 1	2.9688	2.1604	1.7025	2.5833	2.7234	2.6354
prop u t1	0.0190	0.0529	0.0558	0.0190	0.0677	0.0583
prop pt t1	0.0381	0.0300	0.0270	0.1676	0.2020	0.1913
prop ft t1	0.8800	0.8542	0.9097	0.6495	0.5665	0.5790
prop np t1	0.0629	0.0629	0.0075	0.1638	0.1638	0.2039
diff ave w1 ptpt t12	0.0010	0.0000	0.0000	-0.0396	0.0120	0.0679
diff ave w1 ptft t12	-0.0038	0.0253	0.0112	-0.0098	0.0103	-0.0096
diff ave w1 ftpt t12	-0.0050	0.0055	0.0057	0.0138	0.0102	0.1073
diff ave w1 ftft t12	-0.3657	0.1306	0.2183	0.0189	0.1413	0.0509
diff ave w1 ptpt t14	0.0079	-0.0017	0.0003	0.1124	0.0175	0.1833
diff ave w1 ptft t14	0.0457	0.0535	-0.0143	-0.0450	0.0155	-0.0566
diff ave w1 ftpt t14	0.1329	-0.0128	-0.0029	0.0359	0.0101	0.1801
diff ave w1 ftft t14	-0.2653	0.0335	0.2126	-0.1804	0.1120	0.5314
prop ftt2 ftt1	0.8362	0.8714	0.8670	0.6057	0.6154	0.0151
prop ptt2 ftt1	0.0133	0.0013	0.0038	0.0210	0.0158	0.0301
prop unt2 ftt1	0.0171	0.0389	0.0376	0.0133	0.0462	0.0113
prop ftt2 ptt1	0.0095	0.0025	0.0063	0.0229	0.0082	0.1744
prop ptt2 ptt1	0.0248	0.0295	0.0188	0.1371	0.2233	0.0056
prop unt2 ptt1	0.0019	0.0000	0.0019	0.0019	0.0101	0.0188
prop ftt2 unt1	0.0076	0.0301	0.0383	0.0038	0.0411	0.0038
prop ptt2 unt1	0.0019	0.0013	0.0006	0.0000	0.0101	0.0320
prop unt2 unt1	0.0095	0.0251	0.0169	0.0057	0.0297	0.4768
prop npt2 ftt1	0.0133	0.0000	0.0013	0.1638	0.0000	0.1713
prop npt2 ptt1	0.0019	0.0000	0.0000	0.0095	0.0000	0.0025
prop ftt2 npt1	0.0076	0.0000	0.0006	0.0057	0.0000	0.0000
prop ptt2 npt1	0.0000	0.0000	0.0000	0.0076	0.0000	0.0013
prop npt2 npt1	0.0514	0.0000	0.0063	0.0057	0.0000	0.0013
prop npt2 unt1	0.0000	0.0000	0.0000	0.1486	0.0000	0.1662
prop unt2 npt1	0.0038	0.0000	0.0006	0.0095	0.0000	0.0038
prop ftt4 ftt1	0.8095	0.8551	0.8331	0.0019	0.5674	0.0025
prop ptt4 ftt1	0.0267	0.0038	0.0082	0.0381	0.0443	0.0527
prop unt4 ftt1	0.0190	0.0527	0.0652	0.0152	0.0658	0.0370
prop ftt4 ptt1	0.0171	0.0100	0.0107	0.0457	0.0367	0.1424
prop ptt4 ptt1	0.0152	0.0213	0.0138	0.1086	0.1929	0.0094
prop unt4 ptt1	0.0019	0.0006	0.0025	0.0019	0.0120	0.0307
prop ftt4 unt1	0.0095	0.0483	0.0508	0.0038	0.0582	0.0088
prop ptt4 unt1	0.0019	0.0019	0.0013	0.0019	0.0133	0.0119
prop unt4 unt1	0.0076	0.0063	0.0031	0.0019	0.0095	0.0119
prop npt4 ftt1	0.0248	0.0000	0.0031	0.0152	0.0000	0.0056
prop npt4 ptt1	0.0038	0.0000	0.0000	0.0114	0.0000	0.0025
prop ftt4 npt1	0.0114	0.0000	0.0031	0.0133	0.0000	0.0075
prop ptt4 npt1	0.0000	0.0000	0.0000	0.0095	0.0000	0.0013
prop npt4 npt1	0.0438	0.0000	0.0044	0.1371	0.0000	0.1575
prop npt4 unt1	0.0000	0.0000	0.0006	0.0114	0.0000	0.0069
prop unt4 npt1	0.0076	0.0000	0.0000	0.0038	0.0000	0.0050

Table 9: Appendix: Sample and Estimated Moments - continued

Moments	Males			Females		
	Sample	Estimated		Sample	Estimated	
		Individual Search	Household Search		Individual Search	Household Search
Cross-moments						
With children						
ave w1 given spouse un t1	0.3346		0.9507	0.1412		0.5576
ave w1 given spouse pt t1	4.2164		3.6946	0.3520		0.1987
ave w1 given spouse ft t1	7.5077		7.1427	8.6557		8.5256
ave w1 given spouse np t1	6.1039		6.8346	0.3962		0.0000
sd w1 given spouse un t1	3.6412		4.7336	1.3713		3.2149
sd w1 given spouse pt t1	9.3437		8.8739	2.5931		1.8908
sd w1 given spouse ft t1	10.7560		10.7602	9.4920		9.3267
sd w1 given spouse np t1	11.9959		11.1407	2.5138		0.0000
			Joint			
		Sample			Estimated	
corrwages ftft t1		0.0378			-0.0227	
corrwages ptpt t1		0.0148			-0.0126	
corrwages ptft t1		-0.0073			-0.0092	
corrwages ftpt t1		0.1012			0.0317	
corrwages ftft t1t4		0.0229			-0.0315	
corrwages ptpt t1t4		0.0488			-0.0131	
corrwages ptft t1t4		-0.0192			-0.0046	
corrwages ftpt t1t4		0.0911			0.0351	
corrwages ftft t4t1		0.0371			-0.0130	
corrwages ptpt t4t1		0.0125			0.0014	
corrwages ptft t4t1		-0.0096			-0.0110	
corrwages ftpt t4t1		0.1073			0.0119	
prop mftt1 fftt1		0.3956			0.3609	
prop mptt1 fftt1		0.0166			0.0092	
prop munt1 fftt1		0.0111			0.0251	
prop mftt1 fptt1		0.2013			0.1769	
prop mptt1 fptt1		0.0070			0.0032	
prop munt1 fptt1		0.0015			0.0103	
prop mftt1 funt1		0.0161			0.0471	
prop mptt1 funt1		0.0010			0.0010	
prop munt1 funt1		0.0025			0.0043	
prop mftt4 fftt1		0.3931			0.3603	
prop mptt4 fftt1		0.0211			0.0082	
prop munt4 fftt1		0.0086			0.0266	
prop mftt4 fptt1		0.1958			0.1751	
prop mptt4 fptt1		0.0101			0.0030	
prop munt4 fptt1		0.0050			0.0124	
prop mftt4 funt1		0.0171			0.0482	
prop mptt4 funt1		0.0005			0.0007	
prop munt4 funt1		0.0015			0.0034	
prop mftt1 fftt4		0.3729			0.3586	
prop mptt1 fftt4		0.0156			0.0093	
prop munt1 fftt4		0.0091			0.0261	
prop mftt1 fptt4		0.2073			0.1762	
prop mptt1 fptt4		0.0081			0.0029	
prop munt1 fptt4		0.0030			0.0101	
prop mftt1 funt4		0.0232			0.0501	
prop mptt1 funt4		0.0020			0.0012	
prop munt1 funt4		0.0005			0.0036	
prop mnpt1 fftt1		0.0272			0.0000	
prop mnpt1 fptt1		0.0050			0.0000	
prop mftt1 fnpt1		0.2778			0.3216	
prop mptt1 fnpt1		0.0126			0.0106	
prop mnpt1 fnpt1		0.0181			0.0000	
prop mnpt1 funt1		0.0020			0.0000	
prop munt1 fnpt1		0.0045			0.0299	
prop mnpt4 fftt1		0.0277			0.0000	
prop mnpt4 fptt1		0.0040			0.0000	
prop mftt4 fnpt1		0.2728			0.3205	
prop mptt4 fnpt1		0.0131			0.0113	
prop mnpt4 fnpt1		0.0171			0.0000	
prop mnpt4 funt1		0.0025			0.0000	
prop munt4 fnpt1		0.0101			0.0302	
prop mnpt1 fftt4		0.0226			0.0000	
prop mnpt1 fptt4		0.0065			0.0000	
prop mftt1 fnpt4		0.2874			0.3217	
prop mptt1 fnpt4		0.0116			0.0106	
prop mnpt1 fnpt4		0.0216			0.0000	
prop mnpt1 funt4		0.0015			0.0000	
prop munt1 fnpt4		0.0070			0.0299	

Table 10: Appendix: Sample and Estimated Moments - continued

Moments	Males			Females		
	Sample	Estimated		Sample	Estimated	
		Individual Search	Household Search		Individual Search	Household Search
Cross-moments						
Without children:						
ave w1 given spouse un t1	0.2254		0.8217	0.1962		0.5798
ave w1 given spouse pt t1	2.9511		3.4580	0.3197		0.2923
ave w1 given spouse ft t1	11.7374		10.1341	11.0607		11.4156
ave w1 given spouse np t1	2.6479		3.8742	0.4140		0.2401
sd w1 given spouse un t1	1.8585		4.1290	1.5729		3.1221
sd w1 given spouse pt t1	7.6257		8.2112	2.0387		2.1690
sd w1 given spouse ft t1	12.0909		11.2259	9.2636		9.5023
sd w1 given spouse np t1	8.4906		9.7239	2.4121		2.8559

	Joint	
	Sample	Estimated
corrwages ftft t1	0.2993	-0.0692
corrwages ptpt t1	0.0514	0.0185
corrwages ptft t1	-0.0986	-0.0346
corrwages ftpt t1	0.0146	-0.0132
corrwages ftft t1t4	0.1878	-0.0635
corrwages ptpt t1t4	-0.0238	0.0031
corrwages ptft t1t4	-0.0412	-0.0263
corrwages ftpt t1t4	0.0430	-0.0282
corrwages ftft t4t1	0.2148	-0.0509
corrwages ptpt t4t1	-0.0402	0.0019
corrwages ptft t4t1	0.0001	-0.0239
corrwages ftpt t4t1	0.0362	-0.0372
prop mftt1 fftt1	0.5943	0.5301
prop mptt1 fftt1	0.0190	0.0125
prop munt1 fftt1	0.0114	0.0289
prop mftt1 fptt1	0.1448	0.1719
prop mptt1 fptt1	0.0095	0.0088
prop munt1 fptt1	0.0057	0.0107
prop mftt1 funt1	0.0171	0.0483
prop mptt1 funt1	0.0000	0.0019
prop munt1 funt1	0.0019	0.0082
prop mftt4 fftt1	0.5581	0.5238
prop mptt4 fftt1	0.0324	0.0113
prop munt4 fftt1	0.0190	0.0370
prop mftt4 fptt1	0.1505	0.1688
prop mptt4 fptt1	0.0057	0.0063
prop munt4 fptt1	0.0076	0.0151
prop mftt4 funt1	0.0133	0.0489
prop mptt4 funt1	0.0000	0.0006
prop munt4 funt1	0.0038	0.0088
prop mftt1 fftt4	0.5810	0.5069
prop mptt1 fftt4	0.0190	0.0125
prop munt1 fftt4	0.0152	0.0282
prop mftt1 fptt4	0.1390	0.1757
prop mptt1 fptt4	0.0095	0.0063
prop munt1 fptt4	0.0019	0.0132
prop mftt1 funt4	0.0210	0.0715
prop mptt1 funt4	0.0000	0.0031
prop munt1 funt4	0.0000	0.0031
prop mnpt1 fftt1	0.0248	0.0075
prop mnpt1 fptt1	0.0076	0.0000
prop mftt1 fnpt1	0.1238	0.1593
prop mptt1 fnpt1	0.0095	0.0038
prop mnpt1 fnpt1	0.0305	0.0000
prop mnpt1 funt1	0.0000	0.0000
prop munt1 fnpt1	0.0000	0.0082
prop mnpt4 fftt1	0.0400	0.0069
prop mnpt4 fptt1	0.0038	0.0013
prop mftt4 fnpt1	0.1257	0.1562
prop mptt4 fnpt1	0.0057	0.0050
prop mnpt4 fnpt1	0.0267	0.0000
prop mnpt4 funt1	0.0019	0.0000
prop munt4 fnpt1	0.0057	0.0100
prop mnpt1 fftt4	0.0286	0.0044
prop mnpt1 fptt4	0.0076	0.0013
prop mftt1 fnpt4	0.1390	0.1556
prop mptt1 fnpt4	0.0095	0.0050
prop mnpt1 fnpt4	0.0248	0.0006
prop mnpt1 funt4	0.0019	0.0013
prop munt1 fnpt4	0.0019	0.0113