Simultaneous Search in the Labor and Marriage Markets with Endogenous Schooling Decisions*

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Abstract

Labor market decisions are not taken in isolation when individuals are engaged in stable relationships. There now exist a number of estimated models of household search able to address and estimate the impact of these decision processes. However, in these cases a number of simplifying assumptions have been made that limited the usefulness of the models for policy evaluation purposes, notably the lack of intrahousehold behavior and of the process that led to the formation of the household. Our analysis, instead, develops and estimates a model designed to determine the joint equilibrium distribution of schooling levels, labor market outcomes, and marriage market statuses. The model is estimated using the Method of Simulated Moments (MSM) using labor market information from the *Current Population Survey* (CPS) and marriage market information from the *American Community Survey* (ACS).

We plan to use the estimates of the model to perform several comparative statics exercises in order to: (i) separate the impact of the labor market from the impact of the marriage market in determining lifetime returns to schooling; (ii) explore the impact of eliminating gender differences in the wage offers distribution on marriage rates, assortative mating patterns, and schooling investments; (iii) assess the importance of marital status in determining labor market outcomes. Finally, we plan to use the parameter estimates to perform a series of policy experiments comparing a labor income tax system based on individual taxation with a system based on joint taxation.

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1 Introduction

Labor market decisions are not taken in isolation when individuals are engaged in stable relationships. There now exist a number of estimated models of household search (Dey and Flinn (2008), Gemici (2011), Flabbi and Mabli (2012)) that are able to address and estimate the impact of these decision processes. However, in these cases a number of simplifying assumptions have been made that limited the usefulness of the models for policy evaluation purposes, notably the lack of intrahousehold behavior and of the process that led to the formation of the household. Only in Gemici (2011) is the focus of the analysis intrahousehold behavior (the other two papers assume a household utility function): primarily in terms of how they impact the geographical location decisions of the household. She also introduces endogenous marriage choice, although there are no equilibrium conditions imposed on the marriage market.

Our analysis utilizes a different methodological framework and is designed to determine the joint equilibrium distribution of schooling levels, labor market outcomes, and marriage market statuses. A number of simplifying assumptions are made which enable us to estimate the model using cross-sectional wage distributions, unemployment durations and transitions across marriage market statuses taken from readily available and nationally representative data sources.

We assume individuals begin adult life by making a schooling decision. After schooling is completed, individuals enter the marriage market and the labor market. Each market is characterized by frictions and by match-specific shocks. Household interaction is assumed to be non-cooperative. Each spouse decides if accepting or rejecting a job offer and if keeping or quitting the current job. The spouse who is receiving the offer is the first-mover, while the other spouse acts as a follower. This timing solve the equilibrium multiplicity that may arise in the dual searchers setting we are analyzing.

The model is estimated using the Method of Simulated Moments (MSM) using labor market information from the *Current Population Survey* (CPS) and marriage market information from the *American Community Survey* (ACS) under the assumption that a monthly CPS sample is a point sample from the steady state distribution. With no on-the-job search in the labor market and no on-the-marriage search in the marriage market, identifying the transition rate parameters associated with the labor and marriage markets is reasonably straightforward, as are the wage offer distributions under the assumption that they are log normal. The identification of the distribution of marriage match values and the distribution of schooling costs is more problematic, and it is assumed that these distributions are known up to one parameter.

Using the estimates of the model, we perform several comparative statics exercises to determine the following. First, we separate the impact of the labor market from the impact of the marriage market in determining lifetime returns to schooling. Second, we explore the impact of eliminating gender differences in the wage offers distribution on marriage rates, assortative mating patterns, and schooling investments. Finally, we assess how important is the marital status in determining labor market outcomes.

As a last contribution, we use the parameter estimates to perform a series of policy experiments comparing a labor income tax system based on individual taxation with a system based on joint taxation. Specifically, we set a tax revenue objective, we impose progressive taxation and we obtain the tax schedule necessary to satisfy the objective under the two regimes. We then compare the joint equilibrium distribution of schooling levels, labor market outcomes, and marriage market statuses under the two regimes and their associate lifetime welfare levels.

2 Model

2.1 Environment

Individuals begin adult life by making a schooling decision, which involves a comparison of the values of entering the labor and marriage markets with schooling type $s \in \{L, H\}$, denoting respectively a low and high schooling level. The benefit of acquiring schooling is the access to a schooling-specific labor market which is completely segregated from the labor market of the other schooling level. The access to a schooling-specific labor market also has an impact on marriage market opportunities. The cost of acquiring the high schooling level is heterogeneous in the population and it is gender-specific. We denote gender with $g \in \{f, m\}$ and the cost of schooling with $q \sim Q(q|g)$.

After the irrevocable schooling decision is made, schooling is acquired. After schooling is completed[1], individuals enter the marriage market and the labor market. Each market is characterized by frictions and by match-specific shocks. In the labor market, we denote the Poisson rate of arrival of job offers with $\lambda(g, s)$. A job offer is fully characterized by a wage $w \sim F(w|g, s)$. If a job is accepted and a match realized, it is terminated by an exogenous shock $\eta(g, s)$. A job-match may also be endogenously terminated as a result of changes in the marital status or a as a result of changes in the labor market status of the other spouse. There is no on-the-job search.

Marriage markets are also characterized by frictions and offers arrive following Poisson processes. Any member of one gender, no matter the education group, may meet a marry a member of the other gender, no matter the education group. However, the probability of meeting between and within schooling groups are allowed to be different and to be governed by a CRS matching function $\Gamma[S(g, s), S(g', s')]$ where $S(g, s)$ denotes the measure of single of gender g and schooling level s in the economy and the superscript $'$ denotes the other spouse variables. As a result, the Poisson arrival rate of a marriage opportunity to an individual of gender g and schooling s with an individual of the opposite gender[2] and

[1] The timing implies that we ignore any time cost involved in the acquisition of schooling and any marriage market or labor market activities happening during the schooling completion process.

[2] Driven by data availability, we impose that marriage only happens between individuals of opposite sex.

schooling $s\prime$ is:

$$\lambda_M\left(g,s,s'\right)=\frac{\Gamma\left[S\left(g,s\right),S\left(g',s'\right)\right]}{S\left(g,s\right)} \tag{1}$$

A marriage offer is characterized by the gender, education level and labor market status of each of the two spouses and by a match-specific utility of marriage denoted by $\theta \sim G(\theta)$. One individual of each gender is necessary to create a married couple. Only single individuals are allowed to meet in the marriage market. Marriages can be terminated only by an exogenous process with a schooling-specific Poisson rate $\eta_M(s)$.

Each single individual of gender g and educational level s has a utility function given by:

$$u(l,c|g,s)=\alpha(g)\ln(l)+(1-\alpha(g))\ln(c) \tag{2}$$

where:

$$\begin{aligned} c &= wh(g,s)+y \\ T &= l+h(g,s) \end{aligned}$$

Consumption c is equal to the sum of labor income $wh(g,s)$ and nonlabor income y. Time T is allocated between leisure l and work but there is not intensive margin decision on labor supply: $h(g,s)$ is the gender and school-specific amount of hours required by each job contract and individuals cannot choose it. An unemployed agent set $l=T$, where T is the upper bound on time available for leisure and work.

Each married individual of gender g and educational level s married with an individual of gender g' and educational level s' has utility function given by:

$$u(l,c,\theta|g,s,s')=\alpha(g)\ln(l)+(1-\alpha(g))\ln(c)+\theta \tag{3}$$

where:

$$\begin{aligned} c &= wh(g,s)+w'h\left(g',s'\right)+y+y' \\ T &= l+h(g,s) \end{aligned}$$

Consumption c is a public good and it is equal to the sum of both spouses labor and nonlabor incomes. θ is another public good and results by the utility of staying together. Time T is allocated between the private good, leisure l and work, under the constraint mention above that $h(g,s)$ is not a choice variable but a job requirement.

Household interaction is assumed to be non-cooperative. Each spouse decides if accepting or rejecting a job offer and if keeping or quitting the current job. The spouse who is receiving the offer is the first-mover, while the other spouse acts as a follower. This timing solve the equilibrium multiplicity that may arise in the dual searchers setting we are analyzing. It may be justified by assuming that the spouse receiving the offer may restrain to inform the other agent about the job offer unless it is optimal to do so.[3]

The model is in continuous time, agents live forever and they face a common discount rate ρ.

2.2 Value Functions

The value function for an agent of gender g and schooling s, employed at wage w and married to an agent with schooling s' employed at wage w' and enjoying a marriage flow value of θ is:

$$\begin{gathered}\left[\rho+\eta\left(g,s\right)+\eta\left(g',s'\right)+\eta_M\left(s\right)\right]V\left(w,w',\theta|g,s,s'\right)=u(l,c,\theta|g,s,s') \\ +\eta\left(g,s\right)V\left(0,w_R\left(w',0|g',s',s\right),\theta|g,s,s'\right) \\ +\eta\left(g',s'\right)\max\left\{V\left(w,0,\theta|g,s,s'\right),V\left(0,0,\theta|g,s,s'\right)\right\} \\ +\eta_M\left(s\right)\max\left\{V\left(w|g,s\right),V\left(0|g,s\right)\right\}\end{gathered} \tag{4}$$

The value function is conditioning on gender of the agent, schooling of the agent and schooling of the spouse and it is function of wage of the agent (a wage of zero denotes unemployment), wage of the spouse and marriage match-value. Given the state, three shocks may hit the agent: an exogenous termination of her job at a rate $\eta\left(g,s\right)$; an exogenous termination of her spouse's job at a rate $\eta\left(g',s'\right)$; and exogenous termination of the marriage at a rate $\eta_M\left(s\right)$. Notice that each spouse reacts optimally to a shock to the other spouse's labor market status, following the household interaction process described above. We denote the optimal reaction (quitting or not quitting the current job) with the function w_R. For example $w_R\left(w',0,\theta|g',s',s\right)$ in equation (4) assumes either value w' if the spouse keeps the current job after the agent has been exogenously terminated or value 0 if the spouse quits the current job as a result of the agent's change in labor market status. The agent also reacts optimally to exogenous divorce, deciding if staying in the current job or quitting to look for a better job offer. Notice we have introduced the notation for value functions of single agents: they are just a function of the agent's labor market state.

The value function for an agent of gender g and schooling s, unemployed and married to an agent with schooling s', working at job w' and enjoying a marriage flow value of θ is:

$$\begin{gathered}\left[\rho+\lambda\left(g,s\right)+\eta\left(g',s'\right)+\eta_M\right]V\left(0,w',\theta|g,s,s'\right)=u(T,c,\theta|g,s,s') \\ +\lambda\left(g,s\right)\int\max\left\{V\left(w,w_R\left(w',w,\theta|g',s',s\right),\theta|g,s,s'\right),V\left(0,w',\theta|g,s,s'\right)\right\}dF\left(w|g,s\right) \\ +\eta\left(g',s'\right)V\left(0,0,\theta|g,s,s'\right) \\ +\eta_M\left(s\right)V\left(0|g,s\right)\end{gathered} \tag{5}$$

[3] When two single employed agent meet and decide to marry, it is not clear who should be considered and who should be considered the follower conditioning on the criteria just described. In this case, we randomize assuring a 50% chance to each gender.

Given the state, three shocks may hit the agent: a job offer at a rate $\lambda(g,s)$, an exogenous termination of her spouse's job at a rate $\eta(g',s')$, and an exogenous termination of the marriage at a rate $\eta_M(s)$. When the spouse's job is terminated, no endogenous reaction follows since agents are not allowed to divorce as a result of a change in labor market status. When the agent receives a job offer, she will decide if accepting or rejecting the job by maximizing over the alternative value functions, anticipating the spouse's optimal reaction. As before we denote the spouse optimal reaction with w_R. If the marriage is terminated, no additional actions is available.

The value function for an agent of gender g and schooling s, employed at wage w and married to an agent with schooling s', searching for a job, and enjoying a marriage flow value of θ is:

$$\begin{aligned}\left[\rho+\eta(g,s)+\lambda\left(g',s'\right)+\eta_M\right]V\left(w,0,\theta|g,s,s'\right) &= u(l,c,\theta|g,s,s') \\ &+\eta(g,s)V\left(0,0,\theta|g,s,s'\right) \\ +\lambda\left(g',s'\right)\int_{\mathcal{A}'(w|g,s,s')} & V\left(w_R\left(w,w',\theta|g,s,s'\right),w',\theta|g,s,s'\right)dF\left(w'|g',s'\right) \\ &+\eta_M(s)\max\left\{V(w|g,s),V(0|g,s)\right\}\end{aligned} \tag{6}$$

where:

$$\mathcal{A}'\left(w|g,s,s'\right)=\left\{w:V\left(w,w_R\left(w,w',\theta|g,s,s'\right),\theta|g,s,s'\right)>V\left(0,w,\theta|g',s',s\right)\right\}$$

Given the state, three shocks may hit the agent: an exogenous job termination at a rate $\eta(g,s)$, a job offer to her spouse at a rate $\lambda(g',s')$, and exogenous termination of the marriage at a rate $\eta_M(s)$. When the job is terminated, no endogenous reaction follows since agents are not allowed to divorce as a result of a change in labor market status. When the spouse receives a job offer, she will decide if accepting or rejecting the job. If he accepts, the current agent will react optimally as denoted by the reaction function w_R. But not all the job offers are acceptable to the spouse and in general the acceptance region depends on the agent's labor market state and type. We denote with $\mathcal{A}'(w)$ the support of the job offers distribution which is acceptable to the spouse given the agent's job (w,h). If the marriage is terminated, the agent decides if staying in the current job or quitting to look for a better job offer.

The value function for an unemployed agent of gender g and schooling s, married to an unemployed agent with schooling s', and enjoying a marriage flow value of θ is:

$$\begin{gathered}\left[\rho+\lambda\left(g,s\right)+\lambda\left(g',s'\right)+\eta_M\right]V\left(0,0,\theta|g,s,s'\right)=u(T,c,\theta|g,s,s') \\ +\lambda\left(g,s\right)\int\max\left\{V\left(w,0,\theta|g,s,s'\right),V\left(0,0,\theta|g,s,s'\right)\right\}dF\left(w|g,s\right) \\ +\lambda\left(g',s'\right)\int\limits_{\mathcal{A}'(0|g,s,s')}V\left(0,w',\theta|g,s,s'\right)dF\left(w'|g',s'\right) \\ +\eta_M\left(s\right)V\left(0|g,s\right)\end{gathered} \tag{7}$$

Given the state, three shocks may hit the agent: an exogenous job offer at a rate $\lambda\left(g,s\right)$, a job offer to the spouse at a rate $\lambda\left(g',s'\right)$, and exogenous termination of the marriage at a rate $\eta_M\left(s\right)$. When the agent receives the offer, she is the first mover and decides about accepting or rejecting the offer. When the spouse receives the offer, the spouse is deciding about accepting or rejecting it. In both cases, the other spouse has not action available to respond. If the marriage is terminated, the agent is back to the single unemployment state.

The value function for an unemployed single agent of gender g and schooling s is:

$$\begin{gathered}\left[\rho+\lambda\left(g,s\right)+\lambda_M\left(g,s,L\right)+\lambda_M\left(g,s,H\right)\right]V\left(0|g,s\right)=u(T,c|g,s) \\ +\lambda\left(g,s\right)\int\max\left\{V\left(w|g,s\right),V\left(0|g,s\right)\right\}dF\left(w|g,s\right) \\ +\sum_{s'\in\{L,H\}}\lambda_M\left(g,s,s'\right) \\ \left[\begin{array}{c}U\left(g',s'\right)\int\limits_{\mathcal{B}(0,0|g',s',s)}\max\left\{V\left(0,0,\theta|g,s,s'\right),V\left(0|g,s\right)\right\}dG\left(\theta\right)+ \\ E\left(g',s'\right)\int\limits_{\mathcal{C}(g',s')}\int\limits_{\mathcal{B}(w',0|g',s',s)}\max\left\{V\left(0,w_R\left(w',0,\theta|g',s',s\right),\theta|g,s,s'\right),V\left(0|g,s\right)\right\} \\ dG\left(\theta\right)dF\left(w'|g',s',w'\in\mathcal{C}\left(g',s'\right)\right)\end{array}\right]\end{gathered} \tag{8}$$

where:

$$\begin{aligned}\mathcal{B}\left(w,w'|g,s,s'\right)&\equiv\left\{\theta:V\left(w_R\left(w,w',\theta|g,s,s'\right),w_R\left(w',w,\theta|g',s',s\right),\theta|g,s,s'\right)>V\left(w|g,s\right)\right\} \\ \mathcal{C}\left(g,s\right)&\equiv\left\{w:V\left(w|g,s\right)>V\left(0|g,s\right)\right\}\end{aligned}$$

Given the state, two shocks may hit the agent: a job offer at a rate $\lambda\left(g,s\right)$ and a marriage offer at a rate $\lambda_M\left(g,s,L\right)$ if coming from a low schooling level individual or at a rate $\lambda_M\left(g,s,H\right)$ if coming from a high schooling level individual. Given the schooling level, the potential spouse can be unemployed or employed: we denote the endogenous measures of these two sets in equilibrium with $U\left(g',s'\right)$ and $E\left(g',s'\right)$. The set of employed singles is drawn only from the accepted wage distribution which has support $\mathcal{C}\left(g',s'\right)$. The set $\mathcal{B}\left(w,w'|g,s,s'\right)$ takes into account that marriage is consensual and the current agent can decide about marrying a potential spouse only if the potential spouse also agree to marry.

The value function for a single agent of gender g and schooling s, employed at wage w is:

$$\begin{aligned}
[\rho+\eta(g,s)+\lambda_M(g,s,L)+\lambda_M(g,s,H)]\,V(w|g,s) &= u(l,c|g,s) \\
&+\eta(g,s)\,V(0|g,s) \\
&+\sum_{s'\in\{L,H\}}\lambda_M(g,s,s')
\end{aligned} \tag{9}$$

$$\left[\begin{array}{l}
U(g',s')\displaystyle\int_{\mathcal{B}(0,w|g',s',s)}\max\{V(w_R(w,0,\theta|g,s,s'),0,\theta|g,s,s'),V(w|g,s)\}\,dG(\theta)+ \\
E(g',s')\displaystyle\int_{\mathcal{C}(g',s')}\int_{\mathcal{B}(w',w|g',s',s)}\max\{V(w,w_R(w',w,\theta|g',s',s),\theta|g,s,s'),V(w|g,s)\} \\
\qquad dG(\theta)\,dF(w'|g',s',w'\in\mathcal{C}(g',s'))
\end{array}\right]$$

Given the state, two shocks may hit the agent: an exogenous job termination at a rate $\eta(g,s)$ and a marriage offer at a rate $\lambda_M(g,s,L)$ if coming from a low schooling level individual or at a rate $\lambda_M(g,s,H)$ if coming from a high schooling level individual. As before, meeting in the marriage market may be with singles of any schooling level that can be employed or unemployed. And as before, each agent reacts optimally with respect to her labor market decision when considering marriage. However, now there is the possibility that two single employed agents meet in the marriage market, generating an ambiguity about which one of the two is the leader. In the notation above we are assuming that the agent for whom we are writing the value function is the leader. In simulation and estimation, we randomize which one of the two agents is the leader when meetings of two employed singles occur.

2.3 Equilibrium

The optimal decision rules have a reservation value property. In the labor market the reservation value is defined over the wage$w$; in the marriage market over the marriage match value θ; and in the with respect to the schooling decision over the cost q.

First, we look at labor market decisions. When single, decision rules are identical to a standard single agent search model and the reservation wage above which offers are accepted is defined as:

$$w^*(g,s):V(w^*|g,s)=V(0|g,s) \tag{10}$$

When married, labor market decision rules also depend on the labor market status of the spouse, due to the nonlinearity of the utility function.[4] As a result, the reservation wage

[4]See Dey and Flinn (2008). A systematic treatment of the issue is also provided by Guler, Guvenen and Violante (2012) while Flabbi and Mabli (2012) exploit the result in estimation.

of an individual with schooling s, married to a spouse with schooling s' and labor market status characterized by w'[5], in a marriage generating a match value θ is given by:

$$\begin{gathered} w^* \left(w', \theta | g, s, s'\right) : \\ V\left(w^*, w_R\left(w', w^*, \theta | g', s', s\right), \theta | g, s\right) = V\left(0, w', \theta | g, s, s'\right) \end{gathered} \tag{11}$$

Then, we look at marriage market decisions. Again, given the assumptions on the utility function, the two markets are interdependent and the marriage market decision depends on the labor market status of both the agent and the potential spouse. The reservation match value above which the marriage is defined by:

$$\begin{gathered} \theta^* \left(w, w' | g, s, s'\right) : \\ V\left(w_R\left(w, w', \theta^* | g, s, s'\right), w_R\left(w', w, \theta^* | g', s', s\right), \theta^* | g, s\right) = V\left(w | g, s\right) \end{gathered} \tag{12}$$

Finally, we look at schooling decisions. Schooling decisions have a different timing than labor market and marriage market decisions because they are taken *before* entering the two markets. Once a schooling decision is made, it cannot be changed and the individual enters simultanously the marriage and labor market as a single unemployed agent of schooling level s. As a result, the reservation cost of acquiring the high level of schooling H is given by:

$$\begin{gathered} q^* \left(g\right) : \\ V\left(0 | g, H\right) - q^* = V\left(0 | g, L\right) \end{gathered} \tag{13}$$

where individuals with cost lower than $q^*(s)$ acquire schooling level H.

We can now propose the following:

Definition 1 *Given $g \in \{f, m\}$, $s \in \{L, H\}$, $s' \in \{L, H\}$ and:*

$$\left\{ \begin{array}{c} \lambda\left(g, s\right) \\ \eta\left(g, s\right) \\ F(w|g, s) \end{array}, \begin{array}{c} \lambda_M\left(g, s, s'\right) \\ \eta_M\left(s\right) \\ G(\theta) \end{array}, \begin{array}{c} \alpha\left(g\right) \\ \rho \\ h(g, s) \end{array}, Q(q|g) \right\}$$

*an **equilibrium** is a set of values*

$$V\left(., ., \theta | g, s, s'\right), V\left(. | g, s\right)$$

that solves equations (4)-(9) under the optimal decisions rules characterized by equations (10)-(13).

[5]Recall that $w' > 0$ defines employement and $w' = 0$ defines unemployment.

2.4 Solution Method

A closed form solution for the value function characterized in Definition 1 is not available and therefore we use simulation methods to solve for an equilibrium at given parameters values.

The model is solved by evaluating the value functions in a discretized grid of wages and marriage match-specific values, given the set of parameter values and the model's steady state equilibrium conditions. The model's steady state equilibrium conditions are particularly challenging in our context since the equilibrium distribution of single is endogenous and it is necessary to compute the value functions. Notice that we have to keep track not only of the proportion of single but of their equilibrium distribution over labor market states (including over accepted wages while employed) since the labor market state while single has an impact on marriage market decisions.

The procedure works as follow. Given a set of parameters and a guess of the relevant steady state equilibrium distribution, a first set of value function is found by solving the fixed point problem. The fixed point problem is over a quite long vector of values since we have to jointly iterate over value functions in the marriage market and the labor market for each value of the discretized wage and value of marriage grid and for each gender and education level. The fixed point over the value functions for given steady state equilibrium distribution constitutes the "inner loop" of our simulation procedure. Given the value functions, we can obtain an updated value of the steady state equilibrium distribution that can be compared with the starting distribution and, in case of lack of convergence, can be used to find a new set of value functions. The computation of the steady state equilibrium distribution for given value function constitutes the "outer loop" of our simulation procedure. The process is iterated until convergence is reached using usual tolerance criteria.

Given this general structure, additional details of the simulation procedure need to be solved.. First, we have to decide if simulating jointly both sides of the marriage market or exploiting directly the steady state distributions. To speed up the computational burden we choose the second alternative. As a result, when a marriage offer is received by a given individual of gender g, a potential spouse is drawn from the steady state distribution of single agents of gender g'.

Second, our leader-follower approach cannot solve the issue of two single employed agents meeting in the marriage market. In this particular case, we choose the randomization implemented by some of the previous literature: when the agent is single-employed and another single-employed agent is drawn as a potential spouse the leader of the marriage game is chosen randomly assigning a 50% chance to each agent to be picked.

Third, the simulation is done agent by agent storing each agent's state. The state of an agent is determined by her schooling level, wage and marriage status. If the agent is married, the spouse's schooling level and wage and the couple's match-specific marriage utility are also stored. Mirroring the data we will use in estimation, we store each agent's state every three periods.

Finally, the steady state used in the "outer loop" is computed using the final 30% of the total number of periods simulated. A total of 5,000 agents of each type (gender-schooling) are simulated for 540 periods. Consistently with the data we will use in estimation, each period can be interpreted as one month.

3 Data

We use the *Current Population Survey* (CPS) to extract moments referring to: proportion across labor market states, unemployment durations, mean and standard deviations of accepted wages, correlations between spouses accepted wages. We use the *American Community Survey* (ACS) to extract moments referring to: proportion across marriage market states, transitions between marriage market states over time. All the moments are computed by gender and schooling level.

We impose the following restrictions on the sample:

- Age: 25-49;
- Education:
  - High level of schooling: College completed or more;
  - Low level of schooling: Associate degree, some college, HS completed or less;
- Race: White;
- Year: 2007.

The states in the two markets are defined as follows. Married individuals are individuals who declare to be currently married. We classify all the individuals who are not married as single, including those cohabiting. Employed individuals are individuals currently working. All the other individuals are considered searching in the labor market even if they declare to be out of the labor force.

4 Econometric Issues

The identification of the model requires a set of additional functional form assumptions. As shown by Flinn and Heckman (1982), we need to assume recoverable wage offers distributions if we want to identify them from accepted wages information. We assume the wage offers distributions to be lognormal with gender- and schooling-specific parameters $\mu(g,s)$ and $\sigma(g,s)$.

The marriage match-specific value θ is unobservable but the equilibrium shows it has an impact on the "type" of marriage that is realized,[6] where type is defined by the labor

[6] See in particular Figure 2.

market state and schooling level of the spouses. We assume a normal distribution with parameters μ_θ and σ_θ.

The cost of acquiring the high schooling level with respect to the low schooling level has only an impact on the schooling level acquired before entering the marriage and labor market. This simple threshold-crossing impact forces to assume a one-parameter distribution. We assume a negative exponential but with gender-specific parameters $\tau(g)$.

Finally, we need to impose a functional form to the matching function. Since we can observe gender and schooling specific transitions, we can identify marriage market meeting rates that are gender-specific and schooling-specific in both spouses schooling. As a result we can identify a two-parameters matching function which we will assume has the following frequently used Cobb-Douglas specification:

$$\Gamma\left[S(g,s), S(g',s')\right] = \beta(s,s') \, S(g,s)^{\nu(s,s')} \, S(g,s)^{(1-\nu(s,s'))} \tag{14}$$

The estimation procedure involves three main steps. First, we fix the following parameters:

$$\Theta_1 = \{\rho, T, h(g,s)\}_{g\in\{f,m\}, s\in\{L,H\}} \tag{15}$$

The discount rate is fixed to 5% a year, the time endowment to 80 hours per week, and the job hours requirements to the mean of each specific gender-schooling group.

Second, we use the Method of Simulated Moments (MSM) to estimate the following set of parameters:

$$\Theta_2 = \left\{ \begin{matrix} \lambda(g,s) \\ \eta(g,s) \\ \mu(g,s) \\ \sigma(g,s) \end{matrix}, \begin{matrix} \lambda_M(g,s,s') \\ \eta_M(s) \\ \mu_\theta \\ \sigma_\theta \end{matrix}, \alpha(g) \right\}_{g\in\{f,m\}, s\in\{L,H\}, s'\in\{L,H\}} \tag{16}$$

where the first column refers to labor market parameters, the second to marriage market parameters, and the third to the utility function parameter.

Third, we recover the following set of parameters:

$$\Theta_3 = \left\{\tau(g), \beta(s,s'), \nu(s,s')\right\}_{g\in\{f,m\}, s\in\{L,H\}, s'\in\{L,H\}}$$

by solving identities (1) and by inverting the identity equating the observed proportion in the high schooling level group with the equilibrium proportion implied by the model.

5 Preliminary Estimation Results

Preliminary results from the estimation procedure are presented in Tables 2 through 6. Table 2 reports the estimated parameters, Table 3 some relevant implied values, and Tables 4 through 6 assess the fit of the model.

6 Conclusion

The paper presents a tractable framework to analyze simultaneous search in the labor and marriage markets in presence of an endogenous schooling decision. We propose an identification and estimation strategy of the structural parameters. We implement it using data from the *Current Population Survey* (CPS) to describe the labor market dynamic and from the *American Community Survey* (ACS) to to describe the marriage market dynamic.

A set of simulations and preliminary estimates of the model show the potential of the framework in implementing counterfactual and policy experiments. We have the intention to perform counterfactual experiments in order to: separate the impact of labor and marriage markets on lifetime returns to schooling; explore the impact of gender-specific labor market characteristics on marriage and schooling outcomes; assess the importance of marital status in determining labor market outcomes. We have the intention to perform policy experiments in order to compare the effect of individual vs joint taxation of labor income.

References

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

[2] Flabbi, L., and J. Mabli (2012), "Household Search or Individual Search: Does it Matter? Evidence from Lifetime Inequality Estimates", *IZA Discussion Paper No.*, 6908.

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

[4] Gemici, A. (2011), "Family Migration and Labor Market Outcomes", mimeo, NYU.

[5] Guler, B; F. Guvenen and G. Violante (2012), "Joint-Search Theory: New Opportunities and New Frictions", *Journal of Monetary Economics*, Vol. 59(4): 352-369.

Table 1: Descriptive Statistics CPS Sample

Gender:	Female			Male		
Education:	Low	High	Tot	Low	High	Tot
Marriage Market:						
Single	32.8	16.2	48.9	37.5	13.6	51.1
Married	31.2	19.9	51.1	32.4	16.5	48.9
with Low	26.7	7.1	33.8	25.6	4.2	29.8
with High	4.4	12.8	17.2	6.8	12.3	19.1
Total	63.9	36.1	100.0	69.9	30.1	100.0
Labor Market:						
Unemployed	3.3	0.8	4.1	3.7	0.7	4.4
Employed	60.6	35.3	95.9	66.2	29.4	95.6
Total	63.9	36.1	100.0	69.9	30.1	100.0
Wages:						
Mean	13.4	23.2		16.2	26.3	
SD	5.8	11.2		7.4	13.5	
U Durations:						
Mean	4.2	4.3		3.9	3.2	
SD	5.5	5.2		4.9	4.2	
N. Observations	31,565	17,828	49,393	36,056	15,521	51,577

Table 2: MSM Estimated Parameters

Gender (g):	Female		Male	
Schooling (s):	Low	High	Low	High
$\alpha(g)$	0.833		0.826	
$\lambda(g,s)$	0.320	0.370	0.352	0.446
$\eta(g,s)$	0.022	0.015	0.020	0.019
$\mu(g,s)$	2.445	2.980	2.483	3.009
$\sigma(g,s)$	0.423	0.309	0.468	0.337
$\lambda_M(g,s,L')$	0.0031	0.0021	0.0028	0.0020
$\lambda_M(g,s,H')$	0.0020	0.0031	0.0020	0.0039
η_M	0.009			
μ_θ	0.307			
σ_θ	0.465			

Table 3: Exogenous Heterogeneity implied by MSM Estimates

Gender (g):	Female		Male	
Schooling (s):	Low	High	Low	High
Wage Offers:				
$E(w\|g,s)$	20.64	12.61	21.45	13.36
$V(w\|g,s)$	42.61	31.14	55.18	43.66
Marriage Match Values:				
$E(\theta)$		0.307		
$V(\theta)$		0.217		

Table 4: Model Fit: Accepted Wages

Gender (g):	Female		Male	
Schooling (s):	Low	High	Low	High
Estimated:				
Mean				
Single	15.18	23.55	16.52	24.26
Married	16.50	25.69	18.45	27.25
SD				
Single	5.26	6.22	6.63	6.81
Married	5.19	6.18	6.75	7.02
Sample:				
Mean				
Single	13.40	23.16	16.18	26.34
Married	14.12	23.87	19.12	30.12
SD				
Single	5.83	11.16	7.41	13.51
Married	6.01	11.25	7.91	13.82

Table 5: Model Fit: Steady State Proportions (%)

Gender (g):	Female			Male		
Schooling (s):	Low	High	Total	Low	High	Total
Estimated:						
Single:	30.1	16.9	46.9	34.3	13.8	48.1
U	3.0	0.9	3.9	2.8	0.7	3.5
E	27.1	16.0	43.1	31.5	13.1	44.7
Married:	29.3	23.7	53.1	31.0	20.9	51.9
UU	0.4	0.2	0.5	0.3	0.2	0.5
UE	5.6	1.8	7.3	5.9	1.9	7.9
EU	2.9	5.2	8.0	3.2	3.9	7.2
EE	20.6	16.6	37.2	21.5	14.8	36.3
Total	59.4	40.6	100.0	65.3	34.7	100.0
Sample:						
Single:	32.8	16.2	48.9	37.5	13.6	51.1
U	2.2	0.4	2.6	2.7	0.5	3.1
E	30.6	15.7	46.3	34.8	13.1	48.0
Married:	31.2	19.9	51.1	32.4	16.5	48.9
UU	0.2	0.0	0.2	0.2	0.0	0.2
UE	1.0	0.4	1.4	0.9	0.2	1.1
EU	0.9	0.3	1.1	1.0	0.3	1.3
EE	29.1	19.3	48.4	30.4	15.9	46.4
Total	63.9	36.1	100.0	69.9	30.1	100.0

Table 6: Model Fit: Transitions (%)

	Single		Married				Total
	SL	SH	MLL	MLH	MHL	MHH	
Estimated:							
Males:							
SL	91.1	0.0	5.5	3.3	0.0	0.0	100.0
SH	0.0	85.9	0.0	0.0	6.9	7.2	100.0
ML	6.8	0.0	55.2	37.9	0.0	0.0	100.0
MH	0.0	4.5	0.1	0.0	46.6	48.8	100.0
Females:							
SL	90.3	0.0	6.3	3.4	0.0	0.0	100.0
SH	0.0	87.3	0.0	0.0	6.6	6.1	100.0
ML	5.7	0.0	60.7	33.6	0.1	0.1	100.0
MH	0.0	4.3	0.1	0.1	51.8	43.7	100.0
Sample:							
Males:							
SL	95.3	0.0	3.3	1.3	0.0	0.0	100.0
SH	0.0	92.3	0.0	0.0	1.6	6.1	100.0
ML	3.8	0.0	73.7	22.5	0.0	0.0	100.0
MH	0.0	2.1	0.0	0.0	24.4	73.4	100.0
Females:							
SL	95.0	0.0	4.2	0.8	0.0	0.0	100.0
SH	0.0	91.9	0.0	0.0	2.9	5.3	100.0
ML	4.3	0.0	81.2	14.5	0.0	0.0	100.0
MH	0.0	2.5	0.0	0.0	35.3	62.2	100.0

Figure 1: Job Offer to Married UE couples - Husband leads

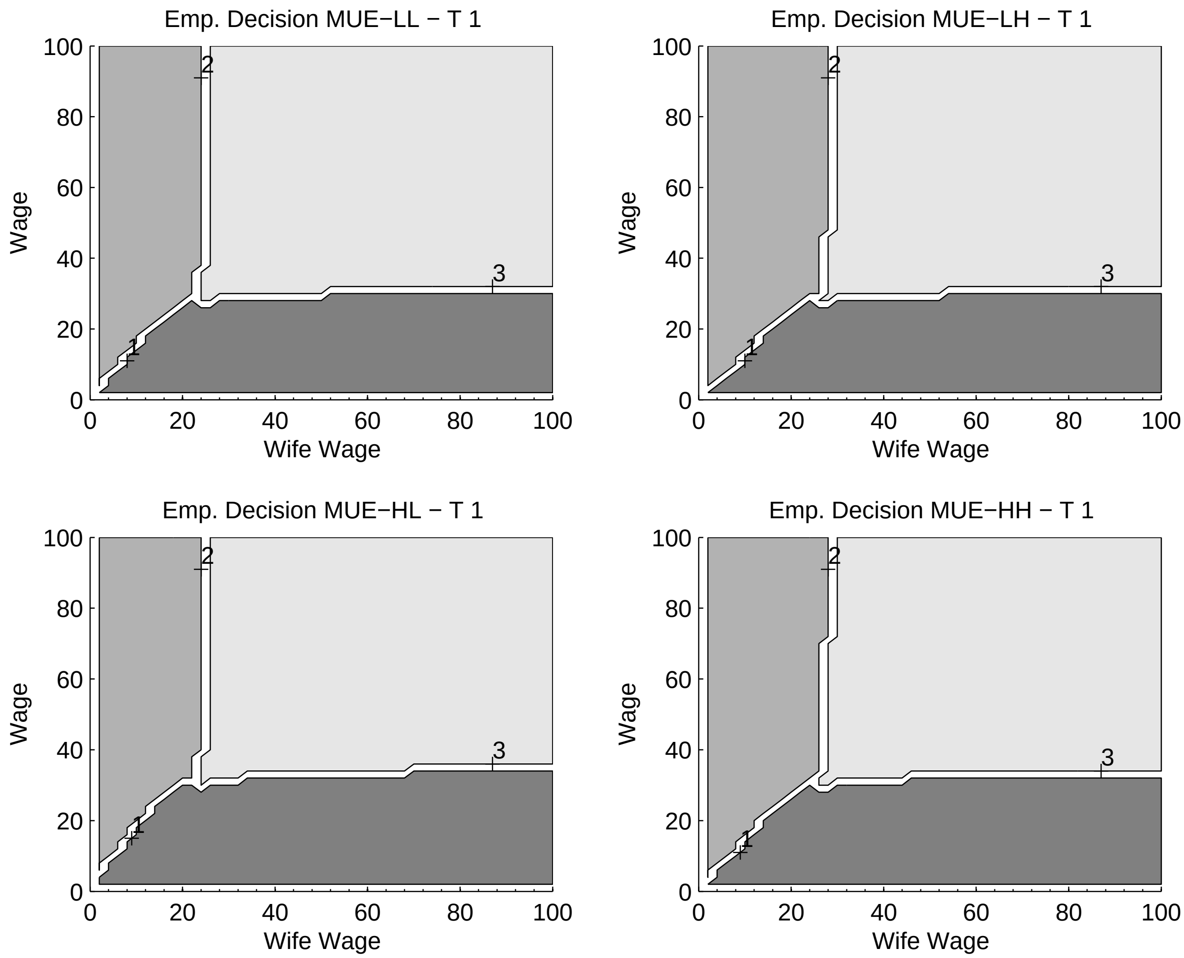

Figure 2: Marriage Offer between two Employed - Husband leads

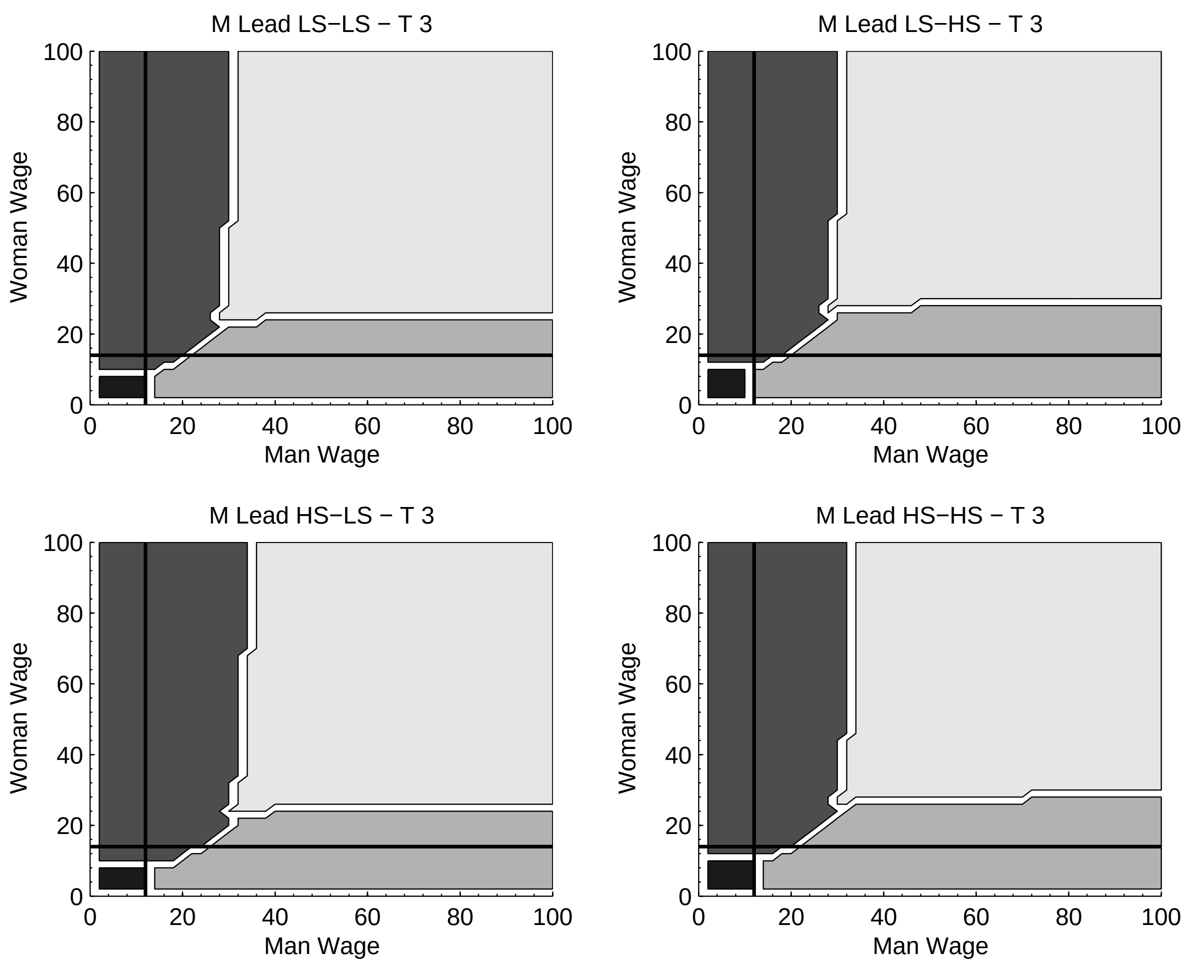

Figure 3: Joint Accepted Wages distribution - Married couple