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# On households and unemployment insurance

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We study unemployment insurance in a framework where the main source of heterogeneity among agents is the type of household they live in: some agents live alone while others live with their spouses as a family. Our exercise is motivated by the fact that married individuals can rely on spousal income to smooth labor market shocks, while singles cannot. We extend a version of the standard incomplete-markets model to include two-agent households and calibrate it to the US economy with special emphasis on matching differences in labor market transitions across gender and marital status as well as aggregate wealth moments. Our central finding is that changes to the current unemployment insurance program are valued differently by married and single households. In particular, a more generous unemployment insurance reduces the welfare of married households significantly more than that of singles and vice versa. We show that this result is driven by the amount of self-insurance existing in married households, and thus, we highlight the interplay between self- and government-provided insurance and its implication for policy.

**KEYWORDS.** Households, marriage, family, unemployment, unemployment insurance, worker flows, heterogeneous agents.

**JEL CLASSIFICATION.** D91, E24, J64, J65.

## 1. INTRODUCTION

This paper studies the welfare effects of publicly provided Unemployment Insurance (UI) in an environment where the main source of heterogeneity among individuals is the type of household they live in: some agents live alone while others live with their

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spouses as a family. While the standard framework used to study the effects of UI focuses on single-agent models, this paper provides a more complete picture because of three reasons. First, as pointed out in [Choi and Valladares-Esteban \(2017\)](#), married and single individuals display striking differences in labor market dynamics and performance, even after controlling for observable differences.<sup>1</sup> Married individuals have lower unemployment rates than their single counterparts, suggesting that the two groups may have different needs with respect to UI. Second, the family can be an important source of insurance since, when one family member is laid off, the other can start working to smooth consumption. Third, labor supply decisions might depend on the presence of a spouse in the household and the economic situation of this spouse. Hence, the aggregate labor supply response to a change in UI can mask rich heterogeneity in the reaction of different groups of people.

The framework we use here extends the Aiyagari–Bewley–Huggett economy in [Krusell, Mukoyama, Rogerson, and Şahin \(2017\)](#).<sup>2</sup> In our model, households decide labor supply along the extensive margin, agents are subject to noninsurable income and working opportunity shocks, cannot borrow, and can only save using a risk-free asset. Moreover, there is exogenous heterogeneity in terms of gender and marital status. Married agents make joint decisions within a unitary framework and pool income, consumption, and savings.<sup>3</sup> The unemployment insurance program is run by a government that taxes labor income and keeps a balanced budget. Finally, the model accounts for general equilibrium in aggregate prices.

To discipline the model, we use a sample of the Current Population Survey for the US economy where we remove the influence of observable characteristics (with the exception of gender and marital status) as well as other common issues found in the literature, such as time aggregation bias and misclassification of labor market states.<sup>4</sup> We also discipline the model in terms of the overall heterogeneity in the distribution of assets across households of different gender and marital status. The model is not only able to account for the monthly transitions across labor market states and the labor market stocks associated to these transitions, it also generates realistic outcomes for overall asset inequality and matches facts regarding the “added worker effect.”<sup>5</sup>

Our main quantitative exercise with the model consists in modifying the level of unemployment benefits (funded through income taxes) and computing household-specific welfare changes across different steady-state economies.<sup>6</sup> Our central finding is

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<sup>1</sup>Throughout this paper, the terms single and nonmarried are used interchangeably, referring to any person who is labeled as “never married,” “separated,” “divorced,” or “widowed” in the Current Population Survey (CPS). We ignore cohabiting individuals, given the inability to distinguish them in a nonarbitrary way.

<sup>2</sup>See [Aiyagari \(1994\)](#) and [Huggett \(1993\)](#).

<sup>3</sup>Throughout our analysis, we take marital status as exogenous. Some authors focus on the explicit relationship between marriage decisions and labor market risk. See, for example, [Gould and Paserman \(2003\)](#), [Hess \(2004\)](#), [Gemici and Laufer \(2011\)](#), [Knowles \(2013\)](#), and [Santos and Weiss \(2016\)](#).

<sup>4</sup>See the details in [Choi and Valladares-Esteban \(2017\)](#).

<sup>5</sup>See [Lundberg \(1985\)](#) as the inception of the literature on the “added worker effect.”

<sup>6</sup>We focus on comparing steady states as we are interested in understanding the role that the family plays determining welfare rather than a strict policy evaluation of the current UI system. [Joseph and Weitzenblum](#)

that the welfare responses to changes in the generosity of the UI are significantly different between single and married households because of the role of the family. Increasing unemployment benefits leads, in the steady state, to higher welfare losses for married households than for singles and vice versa. In several counterfactual experiments, we show that this result does not depend on the fact that married households face less unemployment risk than singles, nor that married households hold more assets, nor that the UI program redistributes from married to single households. Our interpretation of these results is that married households value UI much less than singles because of the insurance already provided by the family. We also show that the employment and unemployment rates of married and single agents respond differently to changes in the generosity of the UI. That is, the response of the aggregate labor market stocks to changes in UI masks rich heterogeneity in the responses of agents by gender and marital status.

There is a vast literature that studies the welfare implications of unemployment insurance programs. Some authors have focused on representative-agent models which highlight a few of the many relevant trade-offs related to UI provision in order to characterize the optimal UI. [Shavell and Weiss \(1979\)](#) study the welfare-maximizing sequence of benefits when the behavior of unemployed workers affects the job-finding probability and the public sector cannot monitor choices of the unemployed. [Hopenhayn and Nicolini \(1997\)](#) model a repeated principal-agent problem with a risk-averse unemployed agent and a risk-neutral principal who cannot monitor the agent's search effort. [Fredriksson and Holmlund \(2001\)](#) set up a model with worker-firm bargaining over wages, free entry of new jobs, and endogenous search effort. [Shimer and Werning \(2008\)](#) highlighted the role of unemployment insurance as a liquidity provision device. [Lentz \(2009\)](#) estimated a job search model using a rich database on wealth and labor market outcomes to anchor the role of assets in the search behavior of the unemployed.

Other authors have studied the effects of unemployment insurance in models with a matching technology between vacancies and workers. [Nakajima \(2012\)](#) looked at the effect of extending the UI on the unemployment rate. [Jung and Kuester \(2015\)](#) studied optimal labor market policies throughout the business cycle. [Vejlin \(2017\)](#) highlighted the role of the demand for labor when studying the optimality of the UI. [Landais, Michaillat, and Saez \(2018a, 2018b\)](#) characterized the optimal unemployment insurance in a class of matching models and evaluate the UI in place in the United States relative to their framework taking into account the policy changes that occur in booms and recessions.

Our paper is also connected to the strand of the literature that studies unemployment insurance in heterogeneous agent models with incomplete markets. [Hansen and Imrohoroglu \(1992\)](#) used a model with exogenous heterogeneity in employment shocks and a moral hazard problem between the unemployed and the public sector. [Gomes, Greenwood, and Rebelo \(2001\)](#) studied a search-theoretic model embedded into an Aiyagari–Bewley–Huggett economy with idiosyncratic and aggregate shocks to job opportunities. [Pallage and Zimmermann \(2001\)](#) studied the distributional effects of the UI by analyzing which type of agents would support different changes to the UI. [Abdulkadiroglu, Kuruşçu, and Şahin \(2002\)](#) extended the model of [Hansen and Imrohoroglu](#)

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(2003) used a more tractable model to show that the transition path can be relevant for understanding the welfare implications of changes in the UI.

(1992) to study the implications of hidden assets. Wang and Williamson (2002) analyzed a dynamic model with moral hazard in which agents make unobservable effort decisions both when employed and when unemployed, thus affecting both the job-losing and job-finding margins. Young (2004) revisited the analysis in Wang and Williamson (2002) to include the welfare implications along the transition path. Pollak (2007) investigated the distributional effects of moving to an optimal UI scheme taking into account transition dynamics. Mukoyama (2013) extended the analysis in Krusell, Mukoyama, and Şahin (2010) to include transition dynamics and decomposes the welfare effects of a reform that increases permanently the benefit level of the UI. Lifschitz, Setty, and Yedid-Levi (2018) extended the model in Krusell, Mukoyama, and Şahin (2010) with exogenous heterogeneity in skill and the productivity process in order to find the optimal level of UI.

Much less work has been done on the effects of unemployment insurance in frameworks where the family plays an important role, although there are some exceptions. The closest study to ours is Ortigueira and Siassi (2013), who use an Aiyagari–Bewley–Huggett economy to analyze the amount of insurance provided by married households against non-employment risks. Our analysis differs from theirs in several dimensions. Our model accounts for the labor stocks and transitions across employment, unemployment, and nonparticipation associated with the four types of individuals considered (single females, single males, married females, and married males). Also, the UI system we consider incorporates a past-employment requirement resembling one of the eligibility conditions existing in the US system. This element plays an important role in the employment decisions of the agents.

Some other authors have also analyzed unemployment insurance in multiagent environments. Ek and Holmlund (2010) studied optimal unemployment insurance of couples in a Diamond–Mortensen–Pissarides framework. Our paper differs from their work in two dimensions. First, we do not consider unemployment benefits as the outside option of a worker in a bargaining process and, second, the model used here is able to account for multiple moments of the data associated with the different labor market dynamics between singles and married individuals in the US economy. Di Tella and MacCulloch (2002) studied the provision of unemployment insurance in a context where agents form networks to share risk (these networks are what they consider families). We consider the family as the union generated by the contract of marriage and we abstract from commitment issues between spouses. Moreover, instead of a theoretical approach, we propose a quantitative exercise to test the effect of public intervention.

Although single-agent environments are predominant in quantitative macroeconomic and public policy analysis, there is a growing literature which is moving toward two-agent frameworks. Guner, Kaygusuz, and Ventura (2012) studied the welfare implications of changes in the US tax code in a model where decisions are taken by two-earner households. Heathcote, Storesletten, and Violante (2010) explored the quantitative and welfare implications of the rise in the college premium, the narrowing of the gender wage gap, and the increase of wage volatility using a model in which the decision unit is a two-agent household. Hong and Ríos-Rull (2007) analyzed social security with two-member households. Kleven, Kreiner, and Saez (2009) studied optimal taxation modeling explicitly second-earner decisions.

This paper is also related to the literature that studies household interactions and frictions in the labor market. [Mankart and Oikonomou \(2016\)](#) showed that a household search model can account for some regularities of the US data that cannot be replicated by single-agent search models. [Guler, Guvenen, and Violante \(2012\)](#) theoretically analyzed a [McCall \(1970\)](#)-type search problem for a two-member household, under different types of preferences. [Dey and Flinn \(2008\)](#) studied the implications of health insurance coverage in a search model where the decision unit is the household. [Flabbi and Mabli \(2018\)](#) analyzed the bias in structurally estimated parameters in search models where the misspecification is related to joint-search.

## 2. THE MODEL

Time is discrete and the time horizon is infinite. The economy is populated by a continuum of infinitely lived households with total mass equal to one. There are agents of two genders, females ( $f$ ) and males ( $m$ ). Agents may live alone, in single households ( $\mathcal{S}$ ) or with their spouse, in married households ( $\mathcal{M}$ ).

Single households can be composed of either one female or one male agent, while married households consist of two members, one of each gender. Hence, there are four types of agents: single females ( $\mathcal{S}, f$ ), single males ( $\mathcal{S}, m$ ), married females ( $\mathcal{M}, f$ ), and married males ( $\mathcal{M}, m$ ). A fraction  $\Phi_{\mathcal{S},f}$  of the households corresponds to single females, a fraction  $\Phi_{\mathcal{S},m}$  to single males, and the rest ( $1 - \Phi_{\mathcal{S},f} - \Phi_{\mathcal{S},m} = \Phi_{\mathcal{M}}$ ) are married households.<sup>7</sup> We assume household type and gender to be exogenous.

Households discount the future at rate  $0 < \beta < 1$ , derive utility from consumption streams over time and suffer a utility cost when working or when searching for a job: this is represented by parameters  $\{\alpha_{\mathcal{S},g}, \alpha_{\mathcal{M},g}\}$  and  $\{\gamma_{\mathcal{S},g}, \gamma_{\mathcal{M},g}\}$  for  $g \in \{f, m\}$ , respectively. We further assume that if the two members of a married household work at the same time, an extra utility cost ( $\alpha_{\mathcal{M}}$ ) is incurred, which may reflect child care needs or missed home production. The disutility of job search is assumed to be an i.i.d. random variable, in order to capture the high level of transitions between unemployment and inactivity status observed in the data. Notice that our assumptions imply that there only exists an extensive margin of labor supply in our economy.

We use the notion of unitary households when we model the decision-making process of married couples.<sup>8</sup> This assumption implies that the utilities of both members of the household coincide, which can be interpreted as both the husband and the wife being perfectly altruistic between each other. This assumption is not without loss of generality. On the one hand, it is easy to implement and provides us with a clear notion of welfare for individuals inside married households. On the other hand, it implies that levels of consumption insurance across household members are maximized.

With respect to consumption, preferences are different across single and married households. For singles, it is a standard log utility,  $\log(c)$ , while for married households,

<sup>7</sup>We make appropriate adjustments, for example, when we account for total population as opposed to just households.

<sup>8</sup>See [Heathcote, Storesletten, and Violante \(2010\)](#), [Guner, Kaygusuz, and Ventura \(2012\)](#), and [Domeij and Klein \(2013\)](#) for similar setups using this assumption.

preferences are given by

$$\log\left(\frac{c - \underline{c}}{\phi}\right).$$

Our assumption above implies that consumption is a public good adjusted by an adult equivalence factor  $\phi$ . Within married households, the *individual* disutilities of working ( $\alpha_{\mathcal{M},g}$ ) and searching ( $\gamma_{\mathcal{M},g}$ ) are suffered by the household as a whole (following the unitary assumption). Additionally, we assume that married households need to sacrifice some consumption each period, in the form of a consumption floor  $\underline{c}$ . This parameter represents inherent costs of living inside a couple, and its presence introduces extra risk sensitivity for married households, which helps in matching asset moments.

The individual labor income of any agent in the economy, irrespective of gender or household type, is given by

$$(1 - \tau)wz,$$

where  $\tau$  is a linear labor income tax,  $w$  is the equilibrium wage rate per efficiency unit of labor, and  $z$  is a random variable representing efficiency units of labor. The idiosyncratic shock  $z$  is also independent of demographics and follows an AR(1) stochastic process in logs:

$$\log z' = \rho \log z + \varepsilon', \quad (1)$$

where  $\rho$  represents the persistence parameter of the process and  $\varepsilon \sim N(0, \sigma_\varepsilon)$  is the innovation shock in the current period.

Besides the discrete labor supply and search choice, households decide how much to consume and how much to save for the future. The only technology available for saving is a risk-free asset which pays a real interest rate  $r$ . Households are not allowed to borrow against future income.

### 2.1 The labor market

Labor income shocks are not the only source of uncertainty in this economy. To capture frictions in the labor market, agents are subject to shocks to their working opportunities that determine whether an agent has the possibility to work or not in a given period. Hence, individuals can be in three mutually exclusive labor market states: employed, unemployed, or out of the labor force, which we represent by  $E$ ,  $U$ , and  $N$ , respectively. Employed agents lose their jobs with probability  $\delta_{\mathcal{H},g}$ . Agents who are currently not working, receive job offers with probability  $\lambda_{\mathcal{H},g}^i$ , where  $i \in \{N, U\}$ . Generically,  $\lambda_{\mathcal{H},g}^N < \lambda_{\mathcal{H},g}^U$ , which means that the rate at which agents receive job offers is different whether they are in the inactive (not searching) or unemployment (searching) state. This is reflected below, where agents can choose whether to be in either  $N$  or  $U$ , with the subsequent consequence on job arrival rates.

The fact that both the job-arrival and the job-losing probabilities depend on gender and household type captures potential differences among single females, single males, married females, and married males in the composition of unobservable characteristics that these groups might present in the data. For example, if there is some unobservable

characteristic that leads people to both be more likely to get married and less likely to be unemployed, this parametrization should be able to capture this idea.

Agents in our model may *quit* their jobs. The decision to work or not, in the case of single households, is mainly determined by the amount of assets, productivity, and the unemployment eligibility status of the agent. For married individuals, the labor market situation of the spouse plays also a very important role along with the factors listed for singles.

## 2.2 The government and the unemployment insurance

In this economy, there is a government that taxes labor income, finances an unemployment insurance program, and balances its budget period by period. We assume that all agents who are hit by the job-losing probability ( $\delta_{\mathcal{H},g}$ ) and do not find a new working opportunity ( $1 - \lambda_{\mathcal{H},g}$ ) are compensated with a transfer  $b(z)$  from the government. Agents who endogenously quit their jobs, are not eligible for this transfer, as are those who choose to be inactive over unemployed, as in Krusell et al. (2017).

The UI policy is defined by two parameters: a replacement rate  $b$  and a benefit cap  $\bar{b}$ . In case of losing a job, individuals receive either  $(1 - \tau)bwz$  or  $(1 - \tau)\bar{b}w$  as unemployment insurance payments while searching for a new opportunity. The benefit cap is enforced when  $bz > \bar{b}$ . We also control the length of unemployment benefit eligibility through a constant probability  $\mu$  of becoming ineligible. Finally, we assume that the government collects labor taxes from the entire population at rate  $\tau$  and gives out lump-sum transfers in amount  $T$  per household. That is, tax revenues are used both to finance the UI program and the unconditional transfer  $T$ .

## 2.3 Single households

Five factors define the situation of a single household. First, whether the agent in the household is working or not. Second, the level of assets held by the agent ( $a$ ). Third, her/his labor income shock ( $z$ ), which evolves according to the process described in equation (1). Fourth, the agent's eligibility for unemployment benefits in case of not being at work and, fifth, the realization of the disutility cost of job search  $\gamma$ .

We set up the problem of single households recursively. We denote by  $W_g$ ,  $U_g$ , and  $N_g$  the value function of a single agent of gender  $g$  who is employed, unemployed, and out of the labor force, respectively. The state space for each function is given by  $\{a, z, \gamma, i\}$ , where  $i$  is an indicator variable on the eligibility for unemployment benefits.

Using these definitions, we can further define the value of *not* having a job opportunity as  $J_g = \max\{U_g, N_g\}$  and the value of having one,  $V_g = \max\{W_g, J_g\}$ . Now, the value of inactivity can be defined as

$$N_g(a, z, \gamma, i) = \max_{c, a' \geq 0} \log(c) + \beta E[\lambda_{S,g}^N V_g(a', z', \gamma', i') + (1 - \lambda_{S,g}^N) J_g(a', z', \gamma', i')] \\ \text{s.t. } c + a' = (1 + r)a + T.$$



The value of unemployment is given by

$$\begin{aligned}
 U_g(a, z, \gamma, i) = \max_{c, a' \geq 0} & \log(c) - \gamma_{S,g} \\
 & + \beta E[\lambda_{S,g}^U V_g(a', z', \gamma', i') + (1 - \lambda_{S,g}^U) J_g(a', z', \gamma', i')] \\
 \text{s.t. } & c + a' = (1 + r)a + (1 - \tau)b(z)i + T.
 \end{aligned} \tag{2}$$

Note that the difference between the value of inactivity versus the value of unemployment is given by the i.i.d. variable that represents the disutility cost  $\gamma_{S,g}$  of searching, the different job arrival probabilities, and the potential extra income in the form of the unemployment benefits that those that are jobless (but search for a job) may receive.

For single households, the value of being employed is

$$\begin{aligned}
 W_g(a, z, \gamma, i) = \max_{c, a' \geq 0} & \log(c) - \alpha_{S,g} \\
 & + \beta E[(1 - \delta_{S,g}) V_g(a', z', \gamma', 0) + \delta_{S,g} \lambda_{S,g}^U V_g(a', z', \gamma', 0) \\
 & + \delta_{S,g} (1 - \lambda_{S,g}^U) J_g(a', z', \gamma', 1)] \\
 \text{s.t. } & c + a' = (1 + r)a + (1 - \tau)wz + T.
 \end{aligned}$$

From this problem, note that employed individuals who receive a separation shock, may receive a job opportunity within the period at rate  $\lambda_{S,g}^U$ .

As in [Krusell et al. \(2017\)](#), the mapping between model and data in terms of labor force status is direct: agents who are working in the model are employed. Of those not in employment, we label as unemployed those who choose to incur the search cost  $\gamma_{S,g}$ , while the rest are the inactive population.

## 2.4 Married households

The state space for married households depends on the working prospects of both members of the household, as well as the level of joint savings. Thus, households need to consider  $\{a, z, z^*, \gamma, \gamma^*, i, i^*\}$  as states, where we use asterisk to denote information from the second member of the household. Without loss of generality, we take females as the first member and males as the second member of the household.

Expanding on the notation for single households, the following value functions define joint labor supply decisions:

$$\begin{aligned}
 JJ\{a, z, z^*, \gamma, \gamma^*, i, i^*\} &= \max\{UU, UN, NU, NN\}, \\
 JV\{a, z, z^*, \gamma, \gamma^*, i, i^*\} &= \max\{UW, NW, JJ\}, \\
 VJ\{a, z, z^*, \gamma, \gamma^*, i, i^*\} &= \max\{WU, WN, JJ\}, \\
 VV\{a, z, z^*, \gamma, \gamma^*, i, i^*\} &= \max\{WW, WU, WN, UW, NW, JJ\}.
 \end{aligned}$$

For example, take value  $JJ$ : it is the value of a household in which none of the members has a job opportunity. In that case, they need to decide who looks for a job and who stays at home. On the other hand, the value  $JV$  represents the value for a household where

the female (first member) is jobless, while the male (second member) can become employed. The rest of the value functions can be defined accordingly. For exposition, below we present a subset of the associated bellman equations omitting symmetric cases between household members.

The problem of a household where both members are out of the labor force is given by

$$\begin{aligned}
 NN(a, z, z^*, \gamma, \gamma^*, i, i^*) = \max_{c, a' \geq 0} & \log\left(\frac{c - \underline{c}}{\phi}\right) \\
 & + \beta E[\lambda_{\mathcal{M},f}^N \lambda_{\mathcal{M},m}^N VV(a', z', z^*, \gamma', \gamma^*, i', i^*) \\
 & + (1 - \lambda_{\mathcal{M},f}^N) \lambda_{\mathcal{M},m}^N JV(a', z', z^*, \gamma', \gamma^*, i', i^*) \\
 & + \lambda_{\mathcal{M},f}^N (1 - \lambda_{\mathcal{M},m}^N) VJ(a', z', z^*, \gamma', \gamma^*, i', i^*) \\
 & + (1 - \lambda_{\mathcal{M},f}^N) (1 - \lambda_{\mathcal{M},m}^N) JJ(a', z', z^*, \gamma', \gamma^*, i', i^*)] \\
 \text{s.t. } & c + a' = (1 + r)a + T.
 \end{aligned}$$

In this problem, we see that households are subject to twice as many employment shocks as single households, as seen from the comparison of the term in brackets of this problem versus the one in equation (2).

The problem of a household where both members are unemployed is given by

$$\begin{aligned}
 UU(a, z, z^*, \gamma, \gamma^*, i, i^*) = \max_{c, a' \geq 0} & \log\left(\frac{c - \underline{c}}{\phi}\right) - \gamma_{\mathcal{M},f} - \gamma_{\mathcal{M},m} \\
 & + \beta E[\lambda_{\mathcal{M},f}^U \lambda_{\mathcal{M},m}^U VV(a', z', z^*, \gamma', \gamma^*, i', i^*) \\
 & + (1 - \lambda_{\mathcal{M},f}^U) \lambda_{\mathcal{M},m}^U JV(a', z', z^*, \gamma', \gamma^*, i', i^*) \\
 & + \lambda_{\mathcal{M},f}^U (1 - \lambda_{\mathcal{M},m}^U) VJ(a', z', z^*, \gamma', \gamma^*, i', i^*) \\
 & + (1 - \lambda_{\mathcal{M},f}^U) (1 - \lambda_{\mathcal{M},m}^U) JJ(a', z', z^*, \gamma', \gamma^*, i', i^*)] \\
 \text{s.t. } & c + a' = (1 + r)a + (1 - \tau)[b(z)i + b(z^*)i^*] + T.
 \end{aligned}$$

The main differences between this and the definition of the  $NN$  Bellman equations is the existence of i.i.d. search costs (for the female and the male) and different job arrival probabilities  $\lambda_{\mathcal{M},g}^U$ .

Next, consider the problem of a household where the first member (female) is working while the second member (male) is out of the labor force:

$$\begin{aligned}
 WN(a, z, z^*, \gamma, \gamma^*, i, i^*) = \max_{c, a' \geq 0} & \log\left(\frac{c - \underline{c}}{\phi}\right) - \alpha_{\mathcal{M},f} \\
 & + \beta E[(1 - \delta_{\mathcal{M},f}) \lambda_{\mathcal{M},m}^N VV(a', z', z^*, \gamma', \gamma^*, 0, i^*)]
 \end{aligned}$$

$$\begin{aligned}
& + \delta_{\mathcal{M},f} \lambda_{\mathcal{M},f}^U \lambda_{\mathcal{M},m}^N VV(a', z', z^{*'}, \gamma', \gamma^{*'}, 0, i^{*'}) \\
& + \delta_{\mathcal{M},f} (1 - \lambda_{\mathcal{M},f}^U) \lambda_{\mathcal{M},m}^N JV(a', z', z^{*'}, \gamma', \gamma^{*'}, 1, i^{*'}) \\
& + (1 - \delta_{\mathcal{M},f}) (1 - \lambda_{\mathcal{M},m}^N) VJ(a', z', z^{*'}, \gamma', \gamma^{*'}, 0, i^{*'}) \\
& + \delta_{\mathcal{M},f} \lambda_{\mathcal{M},f}^U (1 - \lambda_{\mathcal{M},m}^N) VJ(a', z', z^{*'}, \gamma', \gamma^{*'}, 0, i^{*'}) \\
& + \delta_{\mathcal{M},f} (1 - \lambda_{\mathcal{M},f}^U) (1 - \lambda_{\mathcal{M},m}^N) \\
& \quad \times JJ(a', z', z^{*'}, \gamma', \gamma^{*'}, 1, i^{*'})]
\end{aligned}$$

$$\text{s.t. } c + a' = (1 + r)a + (1 - \tau)wz + T.$$

The problem where the female is working while the male is unemployed is quite similar and is given by

$$\begin{aligned}
WU(a, z, z^*, \gamma, \gamma^*, i, i^*) = \max_{c, a' \geq 0} & \log\left(\frac{c - \underline{c}}{\phi}\right) - \alpha_{\mathcal{M},f} - \gamma_{\mathcal{M},m} \\
& + \beta E[(1 - \delta_{\mathcal{M},f}) \lambda_{\mathcal{M},m}^U VV(a', z', z^{*'}, \gamma', \gamma^{*'}, 0, i^{*'}) \\
& + \delta_{\mathcal{M},f} \lambda_{\mathcal{M},f}^U \lambda_{\mathcal{M},m}^U VV(a', z', z^{*'}, \gamma', \gamma^{*'}, 0, i^{*'}) \\
& + \delta_{\mathcal{M},f} (1 - \lambda_{\mathcal{M},f}^U) \lambda_{\mathcal{M},m}^U JV(a', z', z^{*'}, \gamma', \gamma^{*'}, 1, i^{*'}) \\
& + (1 - \delta_{\mathcal{M},f}) (1 - \lambda_{\mathcal{M},m}^U) VJ(a', z', z^{*'}, \gamma', \gamma^{*'}, 0, i^{*'}) \\
& + \delta_{\mathcal{M},f} \lambda_{\mathcal{M},f}^U (1 - \lambda_{\mathcal{M},m}^U) VJ(a', z', z^{*'}, \gamma', \gamma^{*'}, 0, i^{*'}) \\
& + \delta_{\mathcal{M},f} (1 - \lambda_{\mathcal{M},f}^U) (1 - \lambda_{\mathcal{M},m}^U) \\
& \quad \times JJ(a', z', z^{*'}, \gamma', \gamma^{*'}, 1, i^{*'})]
\end{aligned}$$

$$\text{s.t. } c + a' = (1 + r)a + (1 - \tau)[wz + b(z^*)i^*] + T.$$

Finally, consider the value for a household with two working members:

$$\begin{aligned}
WW(a, z, z^*, \gamma, \gamma^*, i, i^*) = \max_{c, a' \geq 0} & \log\left(\frac{c - \underline{c}}{\phi}\right) - \alpha_{\mathcal{M},f} - \alpha_{\mathcal{M},m} - \alpha_{\mathcal{M}} \\
& + \beta E[(1 - \delta_{\mathcal{M},f})(1 - \delta_{\mathcal{M},m}) \\
& \quad \times VV(a', z', z^{*'}, \gamma', \gamma^{*'}, 0, 0) \\
& + \delta_{\mathcal{M},f} \lambda_{\mathcal{M},f}^U (1 - \delta_{\mathcal{M},m}) VV(a', z', z^{*'}, \gamma', \gamma^{*'}, 0, 0)
\end{aligned}$$

$$\begin{aligned}
& + \delta_{\mathcal{M},f}(1 - \lambda_{\mathcal{M},f}^U)(1 - \delta_{\mathcal{M},m}) \\
& \times JV(a', z', z^{*'}, \gamma', \gamma^{*'}, 1, 0) \\
& + (1 - \delta_{\mathcal{M},f})\delta_{\mathcal{M},m}\lambda_{\mathcal{M},m}^U VV(a', z', z^{*'}, \gamma', \gamma^{*'}, 0, 0) \\
& + \delta_{\mathcal{M},f}\lambda_{\mathcal{M},f}^U \delta_{\mathcal{M},m}\lambda_{\mathcal{M},m}^U VV(a', z', z^{*'}, \gamma', \gamma^{*'}, 0, 0) \\
& + \delta_{\mathcal{M},f}(1 - \lambda_{\mathcal{M},f}^U)\delta_{\mathcal{M},m}\lambda_{\mathcal{M},m}^U \\
& \times JV(a', z', z^{*'}, \gamma', \gamma^{*'}, 1, 0) \\
& + (1 - \delta_{\mathcal{M},f})\delta_{\mathcal{M},m}(1 - \lambda_{\mathcal{M},m}^U) \\
& \times VJ(a', z', z^{*'}, \gamma', \gamma^{*'}, 0, 1) \\
& + \delta_{\mathcal{M},f}\lambda_{\mathcal{M},f}^U \delta_{\mathcal{M},m}(1 - \lambda_{\mathcal{M},m}^U) \\
& \times VJ(a', z', z^{*'}, \gamma', \gamma^{*'}, 0, 1) \\
& + \delta_{\mathcal{M},f}(1 - \lambda_{\mathcal{M},f}^U)\delta_{\mathcal{M},m}(1 - \lambda_{\mathcal{M},m}^U) \\
& \times JJ(a', z', z^{*'}, \gamma', \gamma^{*'}, 1, 1)
\end{aligned}$$

$$\text{s.t. } c + a' = (1 + r)a + (1 - \tau)[wz + wz^*] + T.$$

The bracketed term in the problem above shows all possible scenarios a household with two working members may face next period. Our exposition makes explicit the different paths in which a two agent household may end up with, for example, two job opportunities, and also how unemployment insurance eligibility changes from case to case. As mentioned in Section 2.2, only those who experience a job destruction shock are entitled to unemployment insurance payments, thus the eligibility dummy  $i$  equals zero in cases where a member of the household may consider quitting his/her job.

The rest of the Bellman equations are analogous or symmetrical and vary on three dimensions: disutility costs of working/search, probability trees for each future value function, and the budget constraint faced by the household.

### 2.5 Equilibrium

Output in the economy is produced by an aggregate Cobb–Douglas production function  $K^\theta L^{1-\theta}$ . In standard fashion, we assume a continuum of competitive firms who hire capital and efficient units of labor in spot markets, leading to aggregate prices:

$$\begin{aligned}
r &= \theta K^{\theta-1} L^{1-\theta} - \delta_K \quad \text{and} \\
w &= (1 - \theta) K^\theta L^{-\theta},
\end{aligned}$$

where  $K$  is the weighted sum of assets by all types of households and  $L$  is the weighted sum of supplied efficient units of labor by all types of agents.

As for the government, it manages the unemployment insurance payments, according to parameters  $b$  (replacement rate),  $\bar{b}$  (cap on unemployment insurance payments), and  $\mu$  (hazard probability of UI benefits ending), while taxing labor income at rate  $\tau$  and giving transfers  $T$  to each household.

Our equilibrium concept is standard. In a steady state, we find the interest rate  $r$ , real wages  $w$ , and transfers  $T$ , such that aggregate quantities ( $K$  and  $L$ ) are compatible between the problem of each household and the problem of the representative firm, and the budget of the government is balanced. This is a simple extension of the equilibrium concepts in models with only single agents.

### 3. MAPPING THE MODEL TO US DATA

A model period is 1 month. The model considers four types of individuals: single females, single males, married females, and married males. We take their weights from the data, which in the year 2000 in the US economy, amounts to roughly equal shares of each group in the population. The objective of our calibration is to match labor market transitions across different market states for each of the four groups, along other salient features of the US economy.

We take some parameters directly from [Krusell et al. \(2017\)](#): the AR(1) process for income shocks (equation (1)) is parameterized using  $\rho = 0.996$  and  $\sigma_\epsilon = 0.096$ .<sup>9</sup> The unemployment insurance is defined by a replacement rate of  $b = 0.23$ , the cap on benefits equals  $\bar{b} = 0.465$  of the average wage in the steady state, and the hazard rate of extinction of UI benefits is set to  $\mu = 1/6$ . We also set labor taxes to  $\tau = 0.3$  and find the transfer  $T$  which balances the government budget in the steady state equilibrium. The capital-share parameter in the Cobb–Douglas production function  $\theta$  is set to 0.3 and the aggregate depreciation rate is  $\delta_K = 0.0067$ . We use the standard OECD equivalence scale for households with two adults, thus  $\phi = 1.7$ . All the parameters that are set exogenously are reported in Table 1.

We calibrate  $\beta$  targeting a monthly interest rate of 0.33%, which amounts to a 4% annual interest rate. As for household assets, we target the empirical ratio between average assets of married households to single households of 2.8482, which in the model is related to the minimum consumption floor  $\underline{c}$ .<sup>10</sup>

For each household type in the model, transitions in and out of each labor market state are determined simultaneously by five parameters: the disutility of work  $\alpha_{\mathcal{H},g}$ , job offer probabilities out of unemployment and out of inactivity ( $\lambda_{\mathcal{H},g}^U$  and  $\lambda_{\mathcal{H},g}^N$ , resp.), the job-losing probability  $\delta_{\mathcal{H},g}$ , and the spread in the variability of the job search cost, a parameter which we label  $\epsilon_{\mathcal{H},g}^\gamma$ . We again follow [Krusell et al. \(2017\)](#) and parameterize the

<sup>9</sup>We discretize this process using the method in [Kopecky and Suen \(2010\)](#), which is suitable for highly persistent processes.

<sup>10</sup>The empirical ratio between average assets of married households to single households is computed from the data by [Kuhn and Ríos-Rull \(2016\)](#), which is available at <https://sites.google.com/site/kuhnecon/home/us-inequality>.

TABLE 1. Exogenously set parameters.

Symbol	Description	Value
$b$	Replacement rate of UI	0.23
$\bar{b}$	Cap on UI benefits	0.465
$\mu$	Probability ineligibility of UI	1/6
$\theta$	Capital share	0.3
$\delta_K$	Depreciation rate	0.0067
$\tau$	Labor income tax	0.3
$\Phi_{\mathcal{S},m}$	Fraction of single males	0.25
$\Phi_{\mathcal{S},f}$	Fraction of single females	0.25
$\rho$	Persistence income shocks	0.996
$\sigma_\epsilon$	S.d. income shocks	0.096
$\phi$	Equivalence scale consumption	1.7

search cost variable as a three point distribution. More specifically, we set the distribution of the search disutility for each household type  $(\mathcal{H}, g)$  to be one of the following values:

$$\{\bar{\gamma}_{\mathcal{H},g} - \epsilon_{\mathcal{H},g}^\gamma, \bar{\gamma}_{\mathcal{H},g}, \bar{\gamma}_{\mathcal{H},g} + \epsilon_{\mathcal{H},g}^\gamma\},$$

where  $\bar{\gamma}_{\mathcal{H},g} = (3.5/40)\alpha_{\mathcal{H},g}$ , which reflects time-use information from [Mukoyama, Paterson, and Şahin \(2018\)](#). Although these parameters influence directly transitions for different households, they interact with asset accumulation and labor supply decisions to determine transitions, so the above parameters need to be calibrated jointly to match empirical moments.

For each type of agent, there are nine transition probabilities between employment, unemployment, and nonparticipation. However, only six of them are independent since transitions from the same starting state must add up to one. In the model, these six moments determine the fraction of agents in each state by a simple steady state argument. In the data, this is a very good approximation, as noted, for example, by [Shimer \(2012\)](#). Our calibration exercise targets these twenty-four data moments (six transitions times four types of agents). More specifically, we choose parameter values to minimize the square difference between model simulated data and the empirical transition moments. Given a set of parameter values, we solve the model, finding the equilibrium in both prices and taxes, and simulate a history of 5000 periods for a total of 30,000 agents. From the simulated data, we compute transition probabilities and other statistics.<sup>11</sup>

We follow [Choi and Valladares-Esteban \(2017\)](#) to compute labor market transitions by using monthly data from the Current Population Survey (CPS) controlling for observable characteristics and adjusting for other known empirical issues: we correct the data for classification errors and time aggregation bias. Transition probabilities are cleaned from the effect of race, age, census division, education, and the number of children in the household. We use a subsample from January 2000 to December 2005, because the unemployment rate, the female labor supply, and the fraction of households in each

<sup>11</sup>Further details regarding the computation are in Appendix B.

TABLE 2. Benchmark calibrated parameter values.

Symbol	Description	Value
$\beta$	Discount factor	0.9950
Single male households		
$\alpha_{S,m}$	Disutility of work	0.5185
$\epsilon_{S,m}^\gamma$	Dispersion search cost	0.0433
$\lambda_{S,m}^u$	Arrival probability unemployed	0.3178
$\lambda_{S,m}^n$	Arrival probability OLF	0.2602
$\delta_{S,m}$	Losing probability	0.0210
Single female households		
$\alpha_{S,f}$	Disutility of work	0.5117
$\epsilon_{S,f}^\gamma$	Dispersion search cost	0.0427
$\lambda_{S,f}^u$	Arrival probability unemployed	0.2875
$\lambda_{S,f}^n$	Arrival probability OLF	0.2375
$\delta_{S,f}$	Losing probability	0.0143
Married households		
$\alpha_{M,m}$	Disutility of work male	0.1716
$\alpha_{M,f}$	Disutility of work female	0.3620
$\alpha_M$	Disutility of joint work	0.0260
$\underline{c}$	Consumption floor	1.7010
$\epsilon_{M,m}^\gamma$	Dispersion search cost male	0.0140
$\epsilon_{M,f}^\gamma$	Dispersion search cost female	0.0304
$\lambda_{M,m}^u$	Arrival probability unemployed male	0.7861
$\lambda_{M,f}^u$	Arrival probability unemployed female	0.4065
$\lambda_{M,m}^n$	Arrival probability OLF male	0.6982
$\lambda_{M,f}^n$	Arrival probability OLF female	0.3577
$\delta_{M,m}$	Losing probability male	0.0266
$\delta_{M,f}$	Losing probability female	0.0178

household type are stable during that period. Since we consider a steady state framework for our model, this sample period suits us best: there were significant increases in the supply of labor by females (especially married) from the late 1970s, which stabilized during the early 2000s.

Table 2 presents all parameter values along a brief description. We separate parameters by household type. For singles, the calibration exercise returns values which are in the ballpark of previous studies, especially for the job-arrival and job-losing probabilities.<sup>12</sup> As for married households, we find two nonstandard results: the level of the consumption floor  $\underline{c}$  is significant at 1.7010, in an economy where transfers  $T$  are 1.75 and average wages are 3.02. Second, the job-arrival probability for married males is calibrated to a high value, at 0.7886 when unemployed and 0.7007 when inactive. This parameterization reflects the fact that married men have high participation rates in the US economy. In the model, job-arrival rates for married males need to be relatively high to match the empirical unemployment-to-employment and inactivity-to-employment transitions for this group. Married males in the model have strong incentives not to

<sup>12</sup>See Krusell et al. (2017).

work, given the insurance provided inside the household, both because of the relatively high level of assets (with respect to singles) and the added worker effect.

#### 4. MODEL FIT

Table 3 compares the performance of the simulated model with the data for single females while Table 4 does it for single males. Similarly, Table 5 compares the performance of the model with the data for married females while Table 6 does it for married males.

The model does a good job replicating the data in terms of matching the transitions between labor market states for different types of household. The model has a especially good fit for both males and females in married households, and some difficulty to match some moments for single females, where the model overestimates the unemployment rate. Since in our model labor supply and job-search decisions are intertwined with consumption and savings decisions (which are nonlinear) there is no mechanical link between transition rates and job-arrival and job-losing probabilities ( $\lambda$ s and  $\delta$ s, resp.). Thus, the fact that we can match relatively well all these moments is no minor feat. This is of special relevance when we think of the problem of married households, where two sets of employment shocks must be considered, along with a joint asset allocation decision with a fixed consumption floor.

In terms of aggregate asset accumulation and the endogenous interest rate, the model also performs well: the interest rate in the model is 0.38% versus 0.33% in the data. As for the ratio of assets between married and single households, the model produces a value of 2.41 while the empirical figure (taken from the companion website to Kuhn and Ríos-Rull (2016)) is 2.85.

In Figure 1, we present the asset distribution in the baseline economy, by marital status. The histogram shows that single households are slightly more concentrated toward zero assets, while average asset accumulation in the married group is higher.

Table 7 shows a comparison between predictions from our model and the data with respect to some additionally non-targeted statistics. The first one is the overall Gini index for assets in the economy.<sup>13</sup> As it is common in incomplete-markets models, our model underpredicts overall wealth inequality: the Gini index is 0.85 in the data versus 0.73 in the model. The same is true when we make the comparison by marital status (second and third rows). Nevertheless, our model replicates well the fact that the inequality of assets in the married population is slightly lower than in the single population, as seen in the fourth row of Table 7. The next two statistics of interest in Table 7 (fifth and sixth rows) are related to the coverage of unemployment benefits. In the US economy, the average duration of unemployment benefits amounts to 3.82 months, while in the model, the number is 3.06.<sup>14</sup> On the other hand, 39.16% of the unemployed are covered by unemployment insurance in the data while the model predicts that 63.35% of those looking for a job take up unemployment benefits.<sup>15</sup>

<sup>13</sup>Taken from the companion website of Kuhn and Ríos-Rull (2016).

<sup>14</sup>The data on unemployment duration comes from the FRED database (Saint Louis FED).

<sup>15</sup>The data is from the US Department of Labor, Employment, and Training Administration.



TABLE 3. Data versus model (%). Single females. CPS 2000–2005.

Data				Model			
From/To	<i>E</i>	<i>U</i>	<i>N</i>	From/To	<i>E</i>	<i>U</i>	<i>N</i>
<i>E</i>	96.29	1.55	2.16	<i>E</i>	95.93	1.62	2.45
<i>U</i>	25.86	57.33	16.81	<i>U</i>	22.08	62.50	15.42
<i>N</i>	3.58	1.93	94.50	<i>N</i>	3.04	1.91	95.05
Unemployment rate			5.88	Unemployment rate			7.52

TABLE 4. Data versus model (%). Single males. CPS 2000–2005.

Data				Model			
From/To	<i>E</i>	<i>U</i>	<i>N</i>	From/To	<i>E</i>	<i>U</i>	<i>N</i>
<i>E</i>	96.81	1.10	2.09	<i>E</i>	96.61	1.13	2.27
<i>U</i>	24.72	53.61	21.67	<i>U</i>	21.11	60.45	18.44
<i>N</i>	3.10	1.74	95.16	<i>N</i>	2.92	1.72	95.36
Unemployment rate			4.87	Unemployment rate			5.67

TABLE 5. Data versus model (%). Married females. CPS 2000–2005.

Data				Model			
From/To	<i>E</i>	<i>U</i>	<i>N</i>	From/To	<i>E</i>	<i>U</i>	<i>N</i>
<i>E</i>	97.60	0.92	1.48	<i>E</i>	98.08	0.84	1.08
<i>U</i>	29.88	56.58	13.53	<i>U</i>	30.00	57.03	12.97
<i>N</i>	3.37	1.16	95.47	<i>N</i>	3.67	1.10	95.23
Unemployment rate			2.96	Unemployment rate			2.65

TABLE 6. Data versus model (%). Married males. CPS 2000–2005.

Data				Model			
From/To	<i>E</i>	<i>U</i>	<i>N</i>	From/To	<i>E</i>	<i>U</i>	<i>N</i>
<i>E</i>	96.18	0.77	3.05	<i>E</i>	96.45	0.83	2.73
<i>U</i>	26.78	47.02	26.20	<i>U</i>	23.58	53.42	23.00
<i>N</i>	3.30	1.13	95.57	<i>N</i>	3.27	1.26	95.47
Unemployment rate			3.24	Unemployment rate			3.79

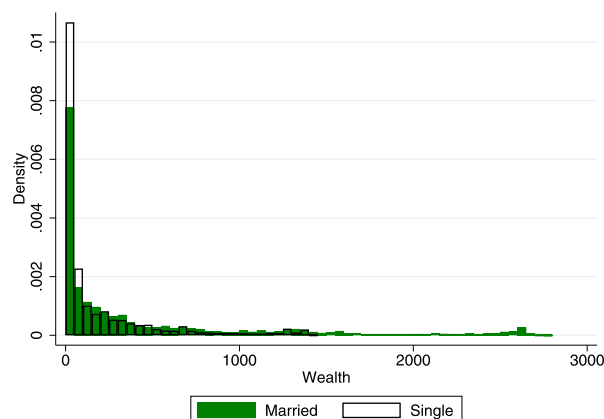


FIGURE 1. Asset distribution in the baseline economy by marital status.

The last moment in Table 7 is related to the *added worker effect* literature.<sup>16</sup> We take the statistic from Mankart and Oikonomou (2016), who run a linear probability model using transition probabilities of married females from inactivity to either unemployment or employment as a dependent variable on a number of controls. Using data from the Panel Study of Income Dynamics, they find that the coefficient associated to an employment-to-unemployment transition of the husband is 0.076. From our simulated data, we run a probit regression on the same two variables and report the average marginal effect which is remarkably close at 0.075. The fact that the added worker effect found in our model is consistent with the one measured in the data is relevant for two reasons. First, it shows that the parametrization of the model is accurate enough to be consistent with conditional transitions that are not targeted. Second, it indicates that the assumption of a unitary household and the particular implementation chosen to model household decisions is consistent with one of the most important margins considered

TABLE 7. Nontargeted moments.

	Data	Model
Gini assets	0.85	0.73
Gini assets, married	0.82	0.70
Gini assets, singles	0.87	0.72
Ratio Gini married to singles	0.94	0.97
Duration UI benefits (months)	3.8	3.1
Unemployed covered by UI (%)	39.1	63.3
Added worker effect	0.076	0.075

<sup>16</sup>See Lundberg (1985).

TABLE 8. Transitions by quintiles ( $Q$ ) of the asset distribution.

	Data						Model				
	$Q1$	$Q2$	$Q3$	$Q4$	$Q5$		$Q1$	$Q2$	$Q3$	$Q4$	$Q5$
<i>EU</i>	1.82	1.15	0.87	0.70	0.54	<i>EU</i>	1.20	1.03	1.00	0.94	0.93
<i>EN</i>	1.15	0.92	0.91	0.97	1.09	<i>EN</i>	2.03	2.77	0.27	0.28	0.31
<i>UE</i>	0.88	1.08	1.04	1.10	1.06	<i>UE</i>	1.08	1.02	0.89	1.04	0.91
<i>UN</i>	1.06	0.94	0.99	0.94	1.04	<i>UN</i>	1.42	0.75	0.78	0.81	0.95
<i>NE</i>	1.05	1.34	0.99	0.89	0.84	<i>NE</i>	1.13	2.95	0.50	0.30	0.32
<i>NU</i>	1.79	1.37	0.86	0.63	0.47	<i>NU</i>	1.84	0.75	0.78	0.55	0.58

by the literature regarding joint labor supply. The added worker effect when the female is the one transiting from employment to unemployment is 0.013.<sup>17</sup>

Besides predictions on average asset allocations and labor market transitions, our model has implications for the joint determination of savings and labor supply decisions. The performance of our model when compared to the data is observed on Table 8. The first five columns are taken directly from Krusell et al. (2017), who use information from the Survey of Income and Program Participation (SIPP) in order to compute joint statistics of labor market transitions by quintiles of the asset distribution. The numbers in each quintile  $Q$  are relative to the overall transition rate in the economy. For example, the employment to unemployment ( $EU$ ) transition rate for those households in the first quintile ( $Q1$ ) of the asset distribution is 82% higher than the average  $EU$  rate for the economy. As seen from the table, the model does a fair job matching the data moments. As in Krusell et al. (2017), the model replicates qualitatively the declining job separation rate  $EU$  with respect to assets in the household. It also matches the nonmonotonic relationship between assets and household decisions to become inactive ( $EN$  and  $UN$  transitions): as we move from  $Q1$  to  $Q5$ , these transitions decline and then go up.<sup>18</sup>

## 5. IMPLICATIONS OF UNEMPLOYMENT INSURANCE

In this section, we use the calibrated model to compute different counterfactual experiments to understand the effects of changes in UI. All our experiments focus on the same policy question: we ask what happens, in the steady state, if the generosity of the UI system changes. Our baseline experiment consists of computing the steady-state equilibrium of several alternative economies defined over a grid of values of the replacement rate  $b$  in  $[0, 1]$ .<sup>19</sup> For each value of the replacement rate, we modify  $\bar{b}$  proportionally, in

<sup>17</sup>To the best of our knowledge, there is no literature measuring the added worker effect when the man is the second earner, the outcome of our model is consistent with priors based on the general role of men and women in the labor market.

<sup>18</sup>In Appendix G, Figures 11 and 12, we provide extra exercises with respect to assets.

<sup>19</sup>That is, for each  $b$  we find the level of income taxes that balances the budget of the government and the prices that satisfy our equilibrium definition of Section 2.5.

order to obtain the same ratio  $b/\bar{b}$  as in the benchmark economy. In order to have a reference point, we make sure that the set of replacement rates over which we iterate contain the value of the replacement ratio of the benchmark calibration ( $b = 0.23$ ). Additionally, we maintain the level of unconditional transfers  $T$  to its equilibrium level in the benchmark economy of Section 4.

### 5.1 *The role of the family*

In what follows, we report comparisons in endogenous variables *across steady states* given different generosity levels of the UI system and the implied changes in equilibrium prices ( $w$  and  $r$ ) and income taxes ( $\tau$ ).

In the left panel of Figure 2, we show welfare comparisons between the average household for each type (single males, single females, and married) with respect to the benchmark steady state (that of  $b = 0.23$ ). We perform a steady state to steady state welfare comparison using the standard notion of *consumption equivalent variation* (CEV).<sup>20</sup> For example, if the marker in Figure 2(a) is negative for a particular household type, it means that the average household of that type in the benchmark economy would need to have its consumption decreased in each time period and state of the world in order to achieve the same average welfare than its counterpart receives in the alternative economy. In other words, the alternative economy provides *less* welfare than the benchmark does to the average household of this type.<sup>21</sup>

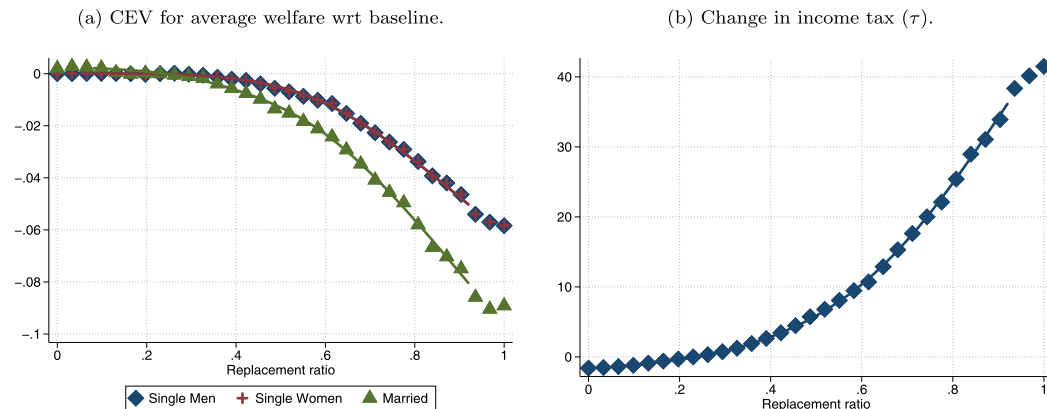


FIGURE 2. Changes with respect to the benchmark UI generosity ( $b = 0.23$ ) of welfare and the income tax in the baseline experiment (CEV and % change, resp.). Lines fit a cubic spline.

<sup>20</sup>We focus on steady states comparisons because of two reasons. First, given the size of our model transition paths between steady states are unreasonably costly to compute. Second, we are interested in how the family shapes welfare responses. Hence, we do not aim to provide a strict policy evaluation of a particular UI reform but rather a comprehensive analysis of the interplay between the protection provided by the family and that provided by the UI.

<sup>21</sup>For further details, see Appendix A.

Figure 2(a) shows that, on average, single households are indifferent between the UI generosity of the benchmark and no UI at all ( $b = 0$ ).<sup>22</sup> Instead, if there is no UI ( $b = 0$ ), married households would be slightly better off than in the benchmark. We interpret the results in Figure 2 as follows. First, the current level of UI is close to being optimal, that is, a reduction of the generosity of UI would lead to minor gains in welfare and an increase in the level of UI would imply an average welfare loss when comparing steady states. Second, single and married households present very different welfare responses to changes in UI benefits. A reduction in UI would modestly increase the welfare of married households and leave singles almost indifferent. While both types of households dislike increases in the UI, married households present bigger losses than singles.

The main forces that determine the welfare response to a change in the generosity of UI are of the same nature both for married and single households. On the one hand, a more generous UI implies that it is easier to smooth consumption across time since in the event of unemployment, the drop in income is lower.<sup>23</sup> On the other hand, a more generous UI implies higher income taxes to finance it. However, apart from the publicly provided UI, both single and married households can build insurance against unemployment risk privately. Hence, behind the welfare evaluation of each level of UI generosity there is an implicit comparison between the cost and the benefit of publicly providing a given level of UI versus the private alternative.<sup>24</sup>

For single households, the only private mechanism to self-insure against unemployment risk is the risk-free asset. However, married households have access to an additional form of private insurance, in the form of the added worker effect (the family). Simultaneously, given the parametrization of the model, married agents are less likely to be unemployed than singles and the probability that a married household has both agents out of work is lower than the probability that a single agent is not employed. These two factors rise the question of whether the different response of single and married households to changes in the generosity of UI is due to the different private alternatives available to each type of household or to the fact that married agents have better labor market prospects than singles. To tackle this question, we run a similar policy experiment but now we subject all agents in the economy to the same shocks regarding labor market opportunities. In particular, all agents face the same job-arrival probabilities ( $\lambda^u$  and  $\lambda^n$ ) and job-losing probability ( $\delta$ ) as single men. Figure 3 presents the results of this exercise. Qualitatively, the responses are the same as in the baseline. There are modest welfare improvements when UI is reduced (mainly for married households) and

<sup>22</sup>Note that the markers and lines associated to male and female single households are on top of each other. The precise welfare measures vary slightly although it is difficult to assess it in the graph.

<sup>23</sup>In Figure 6, in Appendix C, we show the same exercise of changing the generosity of UI but in an economy in which the UI is not funded through taxes but simply falls from the sky. In that economy, taxes solely fund the unconditional transfer  $T$  so they still change in the same direction as the change in the replacement ratio because a more generous UI implies a lower employment rate, and hence, less taxable income. In that scenario, all types of households welcome increases in the level of UI.

<sup>24</sup>Notice that the tax burden changes both because a higher replacement ratio means that each worker covered by UI is more costly and because less workers are employed, there is less taxable income in the economy.

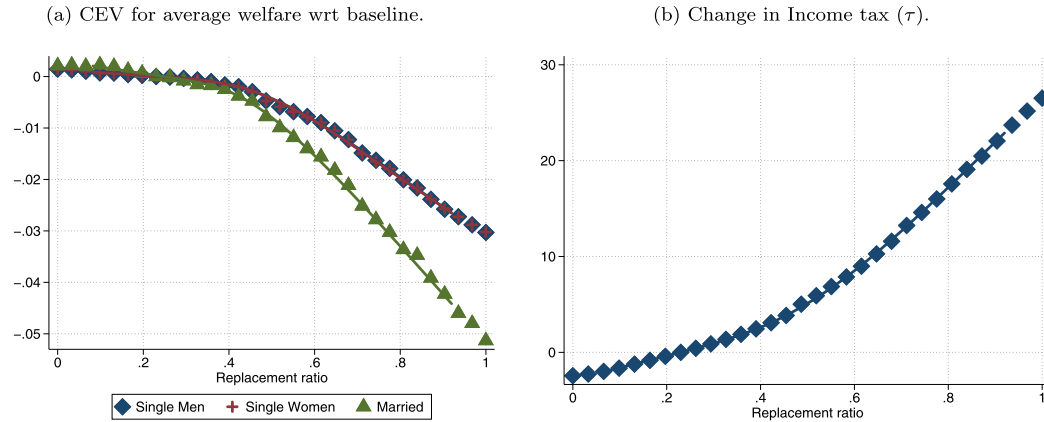


FIGURE 3. Changes with respect to the benchmark UI generosity ( $b = 0.23$ ) of welfare and the income tax (CEV and % change, resp.) when all agents face the same arrival probabilities ( $\lambda^u$  and  $\lambda^n$ ) and losing probability ( $\delta$ ) as single men. Lines fit a cubic spline.

there is a significant disparity in the magnitude of the welfare loss between married and single households when UI becomes more generous. Taken together with the baseline results (Figure 2), this experiment indicates that despite the fact that single agents face higher unemployment rates than their married counterparts quantitatively, the insurance inside married households must account for a significant fraction of their different welfare responses.

The fact that singles are more likely to receive UI payments than married households (because of higher unemployment rates) while both finance the publicly provided UI, raises the question of whether the response of each household is shaped by the implicit cross subsidy from married to single households. To answer this question, in Appendix D, we run our policy experiment in an economy with only single men. The welfare response in this bachelor economy is qualitatively identical to the baseline experiment. Another source of heterogeneity is the fact that the benchmark calibration, as it is the case in the data, assigns a higher level of assets to married households than to singles in order to match the wealth patterns of the data. In Appendix F, we compare the results of the baseline experiment in Figure 2(a) to a subsample of married households which has the same wealth distribution as singles. Even for these married households, the qualitative welfare response goes in the same direction as in the baseline experiment.

### 5.2 The heterogeneous responses of labor market stocks

In Figure 4, we plot the employment-to-population ratios and the unemployment rates under different values of the replacement rate  $b$  in order to shed further light in the mechanisms behind our central result. As expected, overall employment levels decline, while unemployment increases when the generosity of the UI increases. An important implication of the patterns observed in Figure 4 is that the responses of the employment and unemployment rates for each type of agent are remarkably heteroge-

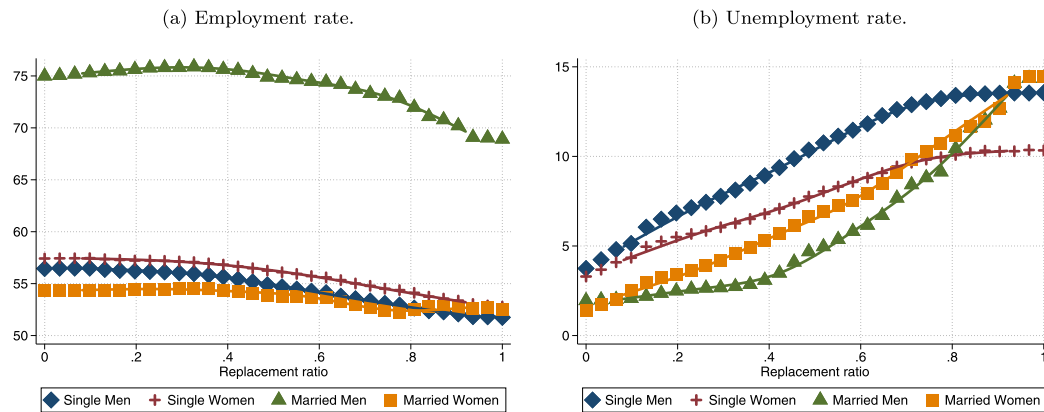


FIGURE 4. Labor market stocks levels in the baseline experiment. Lines fit a cubic spline.

neous. In Figure 5, we report the same data as in Figure 4 but as a percentage change from the benchmark steady state in which the UI is that of the benchmark calibration ( $b = 0.23$ ).

The patterns in Figure 5 show that focusing only on the aggregate employment or unemployment rate when analyzing UI programs can mask relevant heterogeneous responses. Figure 5(a) shows that when the generosity of the UI is decreased, the employment rate of singles increases while that of married agents decreases. This result reflects the different mechanisms that dominate the responses of single and married agents. For singles, a reduction of UI implies that the increase in disposable income due to lower taxes (see Figure 2(b)) does not compensate the lost income when unemployment hits. Hence, single agents respond by working more to accumulate more assets. Instead, married households respond by working less as their risk of nonemployment is unchanged with respect to the benchmark economy but they can build the same level of assets (insurance) by working slightly less (more post-tax income). When the UI generosity in-

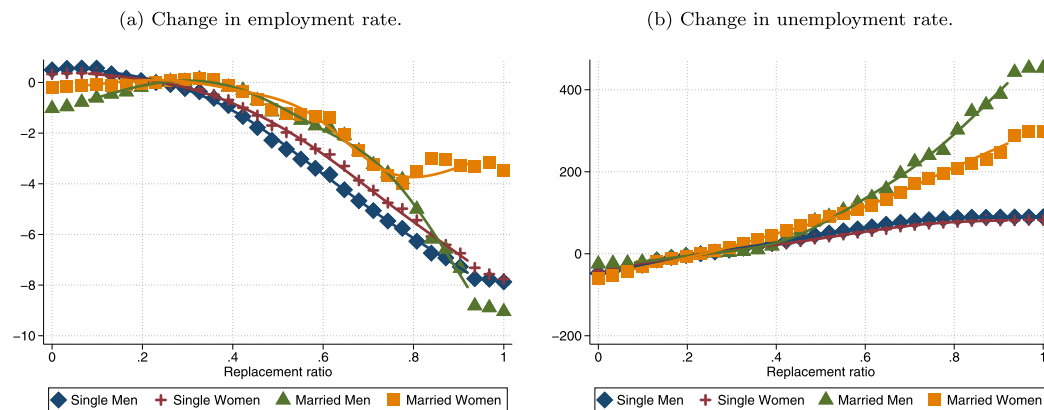


FIGURE 5. Changes with respect to the benchmark UI generosity ( $b = 0.23$ ) of the labor market stocks in the baseline experiment (in %). Lines fit a cubic spline.

creases, all types of agents respond by working less. However, the magnitude of the response is different for each type of agent. A similar pattern is observed in Figure 5(b). The direction of the change of the unemployment rate with respect to changes to the generosity of UI is the same across the four types of agents but the slope of the change is different. In particular, married agents present a much higher change in unemployment rates than singles.<sup>25</sup>

## 6. CONCLUSIONS

In this paper, we propose a framework where we make explicit the coexistence of single and married workers in a labor market with frictions. Our quantitative model is an extension of a standard incomplete markets model with frictional labor markets and can replicate the differences in labor market dynamics observed in the US economy across marital status and gender. We use the model to study the welfare properties of the US unemployment insurance program and find that the program is valued very differently depending on marital status. First, married households experience welfare losses (when comparing steady states) which almost double those experienced by single households when the unemployment insurance program becomes more generous. Second, married households have slightly higher welfare if the generosity of the unemployment insurance is reduced while singles are almost indifferent.

We show that the fact that married individuals face lower unemployment risk than their single counterparts does not drive our result. Instead, the fact that married agents can rely on the family as an insurance mechanism is what shapes their welfare response. In our model, the insurance provided by the family is mainly composed by the pooling of resources between spouses, joint savings, and the added worker effect. We also show that the responses of the employment and the unemployment rate to changes in the unemployment insurance are heterogeneous with respect to marital status and gender.

Our results show the importance of studying the interplay between government provided and private (self) insurance in environments in which the source of private insurance is of heterogeneous nature across agents.

## APPENDIX A: WELFARE COMPARISONS

In this section, we discuss how we compute aggregate welfare for the steady state of each economy and how we compare welfare across economies.

For each household type (marital status and gender), we can define a measure of welfare conditional on current conditions (state variables). For single agents, let us define

$$\mathcal{W}_{S,g}(a, z, \gamma, i) = \mathbb{E} \sum_{t=0}^{\infty} \beta^t [\log(c_t) - e_t \alpha_{S,g} - s_t \gamma_{S,g}],$$

where the left-hand side is defined conditional on the current value of assets, labor income shock, search cost shock, and UI eligibility. The right-hand side is simply the

<sup>25</sup>See Appendix G for additional figures on the changes in the wealth inequality, the ratio of wealth between married and single households, and the capital to labor ratio in our baseline experiment.



expected discounted sum of per-period utilities, given current states. This formulation represents the value to an individual of following optimal policies for consumption (and savings) as well as employment and search decisions, given the aggregate government policies with respect to taxation and UI.

Similarly, for married households, let us define

$$\mathcal{W}_{\mathcal{M},g}(a, z, z^*, \gamma, \gamma^*, i, i^*) = \mathbb{E} \sum_{t=0}^{\infty} \beta^t \left[ \log \left( \frac{c_t - \underline{c}}{\phi} \right) - e_{f,t} \alpha_{\mathcal{M},f} - e_{m,t} \alpha_{\mathcal{M},m} - e_{f,t} e_{m,t} \alpha_{\mathcal{M}} - s_{f,t} \gamma_{\mathcal{M},f} - s_{m,t} \gamma_{\mathcal{M},m} \right],$$

which, given our unitary household assumption, represents both the welfare of the female *and* the male inside a married unit conditional on the aggregate conditions of the economy.

Given these definitions, one can define the average welfare (for each household type) as the average value of the above value functions given the steady state distributions of agents in each tuple:  $(a, z, \gamma, i)$  for singles and  $(a, z, z^*, \gamma, \gamma^*, i, i^*)$  for married. If we do this for the benchmark economy (replacement rate of  $b = 0.23$ ), we can label the resulting values as  $\mathcal{W}^0$ , where we drop the conditional on household type for ease of exposition. For any alternative set of government policies, we can define  $\mathcal{W}^1$ .

To compare average welfare between two different economies, we use the standard notion of a consumption equivalent variation (CEV): how much extra consumption (at each point in time) a household needs to receive in order for them to be indifferent between two alternative economies.<sup>26</sup> Given the assumption of log utility, this leads to the following equation (for a generic type of household):

$$\begin{aligned} \mathcal{W}^0 + \log(1 + \text{CEV})(1 - \beta) &= \mathcal{W}^1 \\ \Rightarrow \text{CEV} &= \exp\{(\mathcal{W}^1 - \mathcal{W}^0)(1 - \beta)\} - 1. \end{aligned}$$

When we derive this equation for married households, we consider the CEV as being net of the influence of the minimum consumption requirement  $\underline{c}$  and the equivalence scale  $\phi$ .

## APPENDIX B: COMPUTATION

As described in Section 2, the computation of a steady state in our model involves the endogenous determination of a wage rate ( $w$ ), an interest rate ( $r$ ), a level of lump-sum transfers ( $T$ ), and an average productivity level ( $\bar{z}$ ) which determines the cap on UI benefits. Given the Cobb–Douglas production function, we assume for firms, the capital–labor ratio ( $\frac{K}{L}$ ) is a sufficient statistic to compute prices. Given a set of parameters, the steps we follow to find a steady state are:<sup>27</sup>

<sup>26</sup>See Guner, Kaygusuz, and Ventura (2012) and Domeij and Klein (2013) for examples of welfare calculations involving unitary households.

<sup>27</sup>All codes can be found in the Supplementary Material (Choi and Valladares-Esteban (2020)).

1. Guess a capital-labor ratio, a lump-sum transfer, and an average level of productivity.
2. Find the policy and value functions that solve the problem of single males, single females, and married households. For all three problems, we use the value function iteration method:
  - (a) Set a grid for all state variables. For assets, we use a grid of 55 points for all households. For productivity shocks, we use a grid of 17 points for single households and 9 points for each member of a married household (81 grid points in total to consider for couples). By definition, the search shock has 3 grid points (9 for couples) and the status of the UI benefits is binary for all agents.
  - (b) Set an arbitrary value for all value functions.
  - (c) Iterate over all combinations of the discretized state variable values and compute the optimal level of asset accumulation. We use the Rouwenhurst method (see [Kopecky and Suen \(2010\)](#)) to discretize the AR(1) process for income shocks. We compute the optimal level of assets for each combination of state variable values using the golden-section search technique.
  - (d) Iterate on step (c) until the value and policy functions converge.
3. Use the policy and value functions to find a stationary distribution. We use a Monte Carlo simulation with 10,000 agents and 5001 periods for each type of household.
4. Compute aggregate moments from the output of the stationary distribution. We use the weights of each type of household to compute the simulated aggregate capital-labor ratio, the lump-sum transfer implied by the budget constraint of the government, and the average productivity shock of the economy.
5. Use the computed values from step 4 to update guesses from step 1.
6. Keep repeating all previous steps until the difference between the guessed equilibrium values and the outcome of step 4 is below a predetermined tolerance level.

#### APPENDIX C: UNFUNDED CHANGES IN UI GENEROSITY

In this section, we run an experiment in which we use the same parametrization as in our baseline experiment but we change the source of funding of the UI. In this experiment, the burden of the UI does not appear in the budget constraint of the government but UI payments are transferred to the agents that fulfill the eligibility criteria. An alternative interpretation is that  $b$  is a backyard technology which provides extra consumption goods to individuals in the case of unemployment.

Nevertheless, the tax rate ( $\tau$ ) in this economy changes with changes in UI because, as in the baseline experiment, the government needs to finance a fixed level of unconditional transfers ( $T$ ) of the benchmark economy, but the overall taxable income changes due to changes in the number of workers employed. In other words, although the tax burden of the UI is not existent in this economy, its effects regarding the (dis)incentives to work are still present.

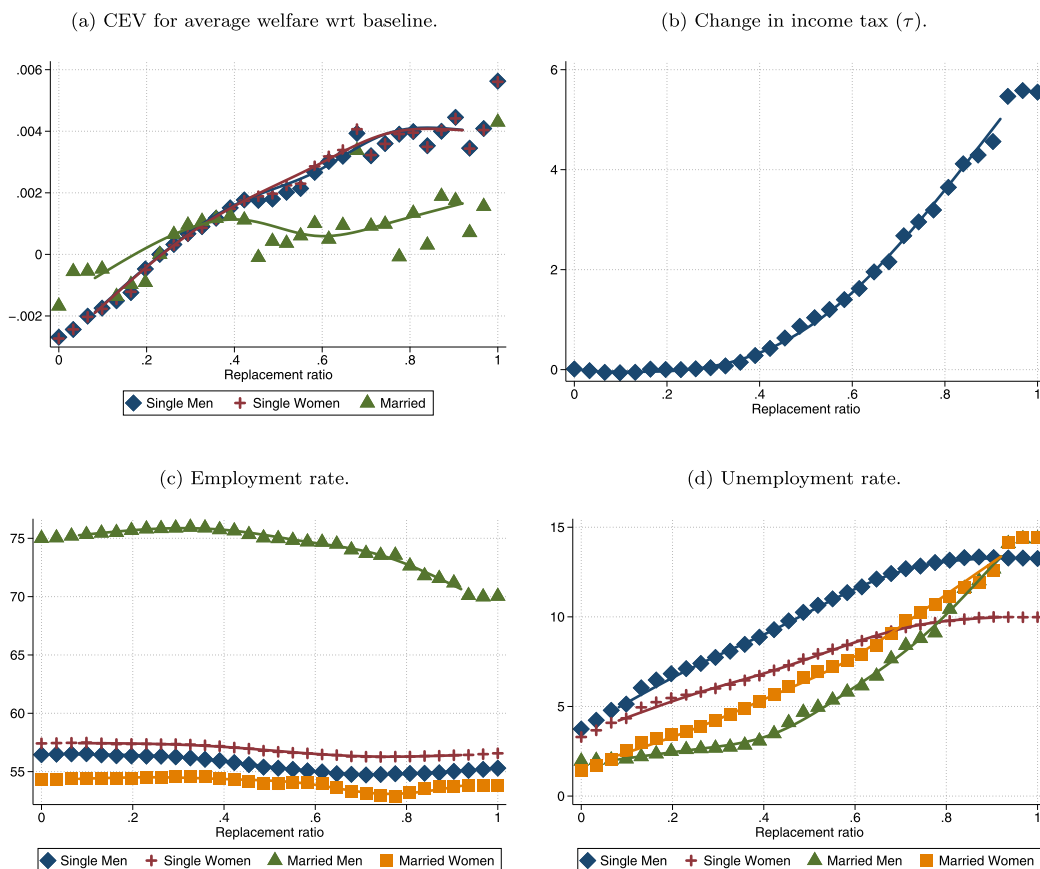


FIGURE 6. Experiments when changing benchmark UI generosity ( $b = 0.23$ ). UI not founded through income taxes. CEV for welfare, % change for taxes, and stocks for employment and unemployment. Lines fit a cubic spline.

#### APPENDIX D: THE SINGLE-AGENT (BACHELOR) ECONOMY

In this section, we perform the same policy analysis as in our baseline experiment, but we focus on an economy populated only by single men. We take their calibrated parameters from our benchmark calibration and keep the equilibrium conditions of our benchmark economy. That is, the unconditional transfer ( $T$ ) and equilibrium prices are set to the same level as the benchmark economy while the income tax ( $\tau$ ) changes throughout the different levels of the UI level to balance the budget of the government.

As seen in Figure 7, welfare changes from increasing replacement rates  $b$  are similar but not identical to our main exercise in Figure 2 in the main text.

#### APPENDIX E: GENERAL VERSUS PARTIAL EQUILIBRIUM

In this section, we compare results of performing the same policy analysis as in the main body of the text, but focusing on general equilibrium effects. In Figures 8 and 9, we compare how welfare changes when replacement rates  $b$  change, when we abstract or not from general equilibrium considerations.

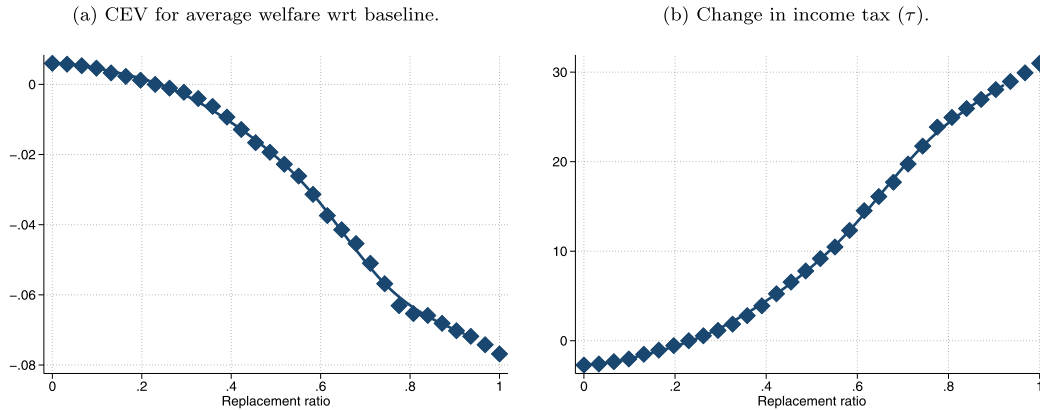


FIGURE 7. Changes with respect to the benchmark UI generosity ( $b = 0.23$ ) in welfare and income tax (CEV and in % change, resp.) when the economy is only populated by single men. Lines fit a cubic spline.

In both figures, the left panel has the “partial equilibrium” case, where we maintain equilibrium prices (wages  $w$  and the interest rate  $r$ ) as in the benchmark economy with  $b = 0.23$ . Panels on the right show what happens when equilibrium prices are allowed to move to equilibrate labor and asset markets.

As seen in Figure 9, the qualitative results for the baseline experiments for our proposed model do not change with the introduction of general equilibrium effects, while the quantitative effects are increased by movements in equilibrium prices: the welfare losses become bigger than in the case with partial equilibrium.

For the case of the bachelor economy in Figure 8, welfare losses with general equilibrium effects are not monotonic with respect to changes in  $b$ , showing a reversal at around  $b = 0.8$ . Equilibrium effects in the bachelor economy kick in when a sufficiently high fraction of individuals decides to stop working: the scarcity of workers pushes up

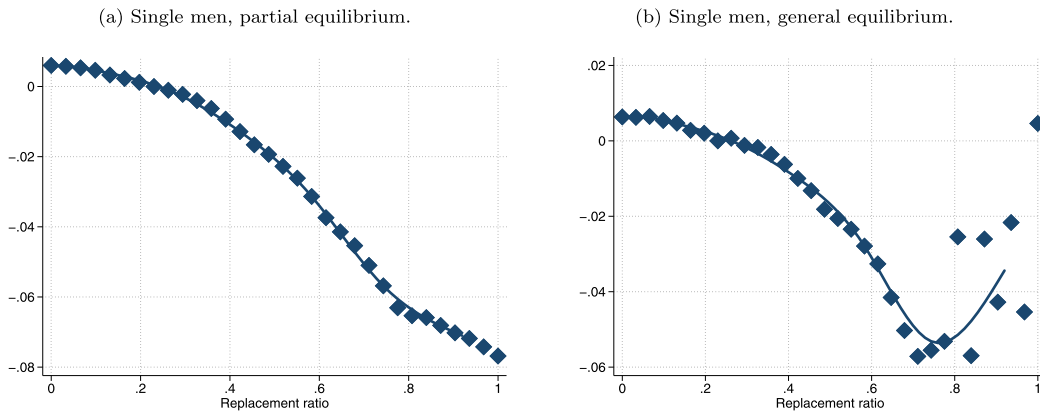


FIGURE 8. CEV with respect to the benchmark UI generosity ( $b = 0.23$ ) when the economy is only populated by single men (in %). Lines fit a cubic spline.

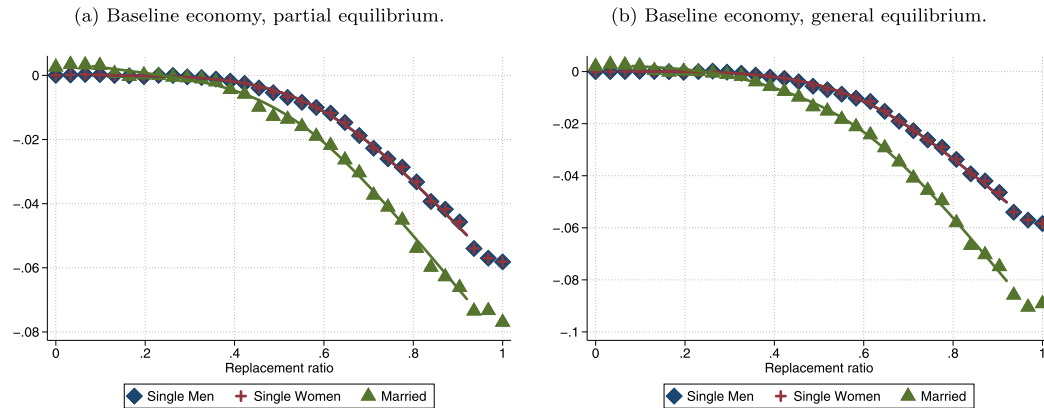


FIGURE 9. CEV with respect to the benchmark UI generosity ( $b = 0.23$ ) for economies where prices adjust given general equilibrium in each alternative economy or are left fixed at the baseline values (partial economy figures). Lines fit a cubic spline.

real wages which increases UI payments to those eligible (given the dependence of the benefit cap  $\bar{b}$  on average wages), increasing average welfare for high levels of  $b$ . This reversal in average welfare changes is not present for our benchmark economy, given the smoother movement in aggregate employment, given heterogeneous labor supply.

APPENDIX F: CHANGES IN UI BENEFITS, CONTROLLING FOR ASSETS

Our baseline economy is designed to replicate the ratio of assets between married and single households. This is clearly depicted in Figure 1. The higher level of savings inside married households allows them to be better insured if one of the members becomes unemployed.

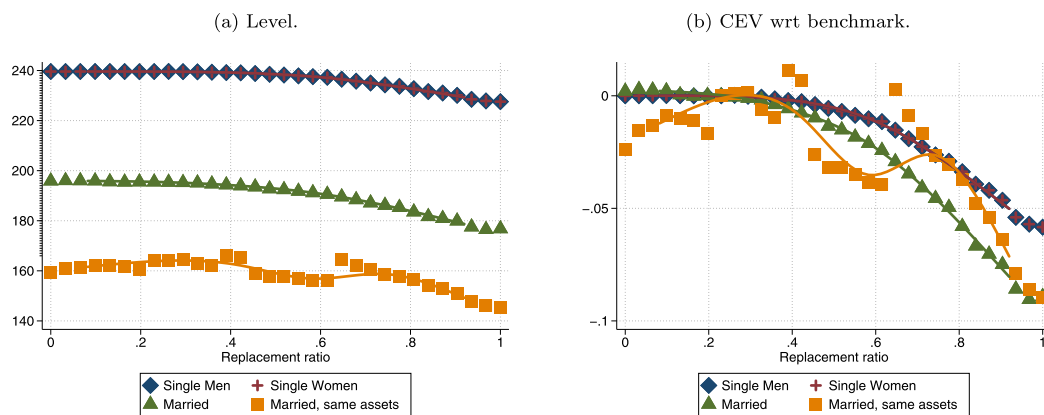


FIGURE 10. Average welfare levels and CEV with respect to the benchmark UI generosity ( $b = 0.23$ ) for a simulated sample where average household assets are equalized. Lines fit a cubic spline.

Figure 10 depicts an exercise where we control for the amount of household assets when making comparisons between single and married households. Following the procedure in Angrist (1998), for each steady state of our baseline experiment, we compute average welfare for singles and married individuals by deciles of the asset distribution of their own groups. We then reweigh the sample of singles and married agents in each decile in order to equalize the average asset in the decile across marital groups. Afterwards, we compute the group average using the reweighed sample and perform our comparisons.

APPENDIX G: ADDITIONAL FIGURES

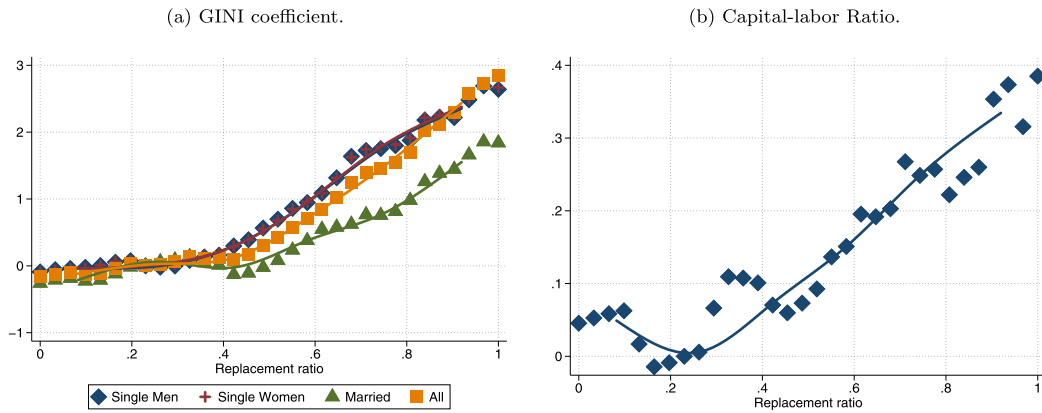


FIGURE 11. Changes with respect to the benchmark UI generosity ( $b = 0.23$ ). Lines fit a cubic spline.

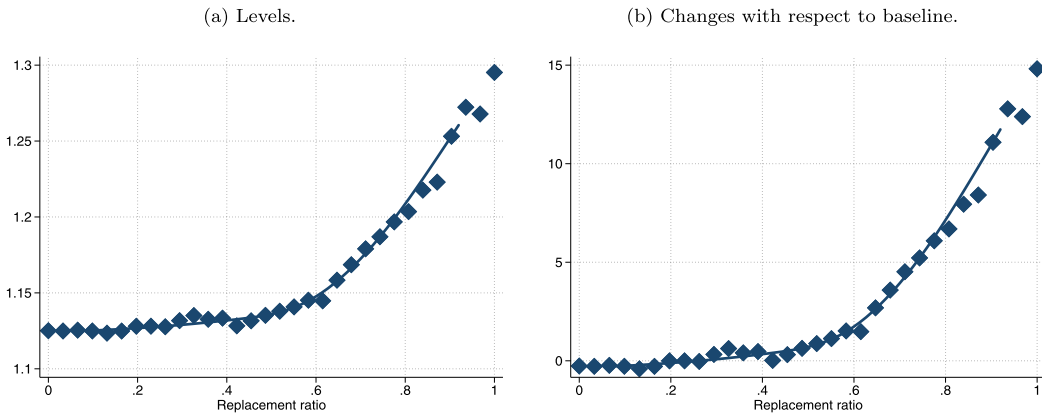


FIGURE 12. Ratio between married and single households' asset levels.

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