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Spousal Labor Supply Response to Job Displacement and Implications for Optimal Transfers

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Abstract

I document a small spousal earnings response to the job displacement of the family head. The response is even smaller in recessions, when earnings losses are larger and additional insurance is valuable. Using cross-state differences in transfer generosity, I find that generous transfers substantially crowd out the spousal earnings response. To study its policy implications, I develop an incomplete markets model with family labor supply and aggregate fluctuations, where predicted labor supply elasticities to taxes and transfers are in line with empirical estimates both in aggregate and across income groups. Counterfactual experiments indeed reveal that generous transfers in recessions discourage spousal earnings. I show that the optimal policy features procyclical means-tested and countercyclical employment-tested transfers, unlike the existing policy that maintains generous transfers of both types in recessions. Abstracting from the incentive costs of transfers on the spousal labor supply changes both the level and the cyclicality of optimal transfers.

Keywords: Unemployment, Business Cycles, Fiscal Policy and Household Behavior, Job Search
JEL Codes: E24, E32, H31, J64

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1 Introduction

Job displacement has large negative and long-lasting effects on individual labor earnings. These effects are more pronounced when the displacement happens in recessions. The impact of earnings losses on family consumption is mitigated through both public insurance and private insurance, a crucial component of which is spousal labor supply adjustments.[1] Importantly, the magnitude of the spousal labor supply response to unexpected earnings fluctuations depends on the generosity of government transfers made available to these households. Thus, while generous transfers in recessions are intended to alleviate earnings losses in the event of the family head's job displacement, they may crowd out private insurance in the form of the spousal labor supply and, in effect, leave households worse off because of higher tax rates resulting from generous transfers. Given that the substitutability of public and private insurance has implications for the household labor market and welfare outcomes, I ask the following questions: how much do government transfers affect the magnitude of the spousal labor supply response to the family head's job displacement over the business cycle? What is the optimal design of transfers over the business cycle when the spousal labor supply is endogenous to government policy?

To answer these questions, I make two contributions. First, I measure the magnitude of spousal insurance upon a family head's job displacement both in recessions and in expansions. I find that while the *presence* of a working spouse substantially reduces the magnitude of earnings losses upon the head's displacement, the *change* in spousal insurance is very small following the head's displacement especially in recessions, when the head's earnings losses are larger and additional insurance is most valuable. I investigate three primary reasons behind this limited change in spousal insurance: correlated shocks between the head and the spouse, crowding-out effects of government transfers, and lower job finding rates. Using cross-state differences in transfer generosity, I find that generous transfers substantially crowd out spousal insurance. Second, I develop a quantitative framework that is capable of generating the observed level and cyclicality of earnings losses upon the head's job displacements, magnitude of spousal insurance, and magnitudes of female labor supply elasticities to taxes and transfers. I use this model to analyze spousal insurance under counterfactual transfer policies and study the optimal design of means-tested and employment-tested transfers over the business cycle. I find that the optimal policy features procyclical means-tested and countercyclical employment-tested transfers, unlike the existing policy that maintains generous transfers of both types in recessions. Importantly, I show that abstracting from the endogeneity of the spousal labor supply to transfers changes both the level and the cyclicality of optimal transfers.

My empirical analysis focuses mainly on quantifying the magnitude of spousal insurance following the head's displacement in recessions and in expansions. I use data from the Panel

[1] For example, Blundell, Pistaferri, and Saporta-Eksten (2016) show that family labor supply provides sizeable consumption insurance against wage shocks within the family.

Study of Income Dynamics (PSID) to analyze both the level of spousal insurance due to the presence of a working spouse and the change in spousal insurance due to the change in the labor earnings of the spouse upon the head's displacement. I find that families enjoy substantial insurance from a second earner simultaneously employed with the head prior to his displacement. Having the spouse retain employment mitigates close to one-third of the head's earnings losses upon job displacements both in recessions and in expansions. However, I also find that the change in spousal earnings upon the head's displacement is very small especially in recessions. This result shows that the spousal labor supply – a key private insurance mechanism – is muted during times when earnings losses are larger and additional insurance is valuable.

I investigate three potential reasons behind the lack of change in spousal earnings upon the head's displacements in the data: correlated shocks between the head and the spouse, crowding-out effects of government transfers, and lower job finding rates. First, I find no evidence of correlated displacement spells across the head and the spouse either in recessions or in expansions. Second, I compare differential spousal earnings responses in U.S. states with the most-generous transfers and the least-generous transfers. I find that the increase in spousal earnings upon the head's displacement is significantly larger for families living in the least-generous states than for those living in the most-generous states. Specifically, additional dollar of transfers crowds out 17 cents of spousal earnings upon the head's displacement. Importantly, while the spousal earnings response is slightly lower in states with a higher unemployment rate (or lower job finding rate), the estimated magnitude of the gap in the spousal earnings response between the most- and least-generous states remains similar, even after controlling for state-level differences in unemployment rates or job finding rates. Hence, lower job finding rates cannot fully explain the limited spousal response observed. I conclude that the crowding-out effects of transfers are the key reason behind the small spousal earnings response upon the head's displacements.

Next, I develop an incomplete markets model with family labor supply and labor productivity-driven business cycles, where the labor supply decisions are endogenous to changes in government transfers. In the model, employed individuals are subject to idiosyncratic job displacement risk, while unemployed individuals face the risk of long durations of joblessness because of frictions in the labor market that prevent the formation of matches. The strength of these frictions varies over the business cycle: job displacement rates increase, while job finding rates endogenously decrease in recessions since firms reduce vacancy postings when labor productivity is lower. This mechanism recognizes that besides crowding-out effects of generous transfers, spousal labor supply responses can be muted also because of lower job finding rates in recessions. I show that when the model is calibrated to match the level and the cyclicality of i) the head's earnings losses upon displacement, ii) job finding rates, and iii) government transfers, it generates a small change in spousal earnings upon the head's displacement especially in recessions, as in the data.

To ensure that the role of government transfers in explaining the small change in spousal earnings upon the head's displacement is not overstated in the model, I compare the magnitudes of model-implied female labor supply elasticities to changes in taxes or transfers against the estimates obtained by the microeconomic studies and the estimate I present using cross-state differences in transfer generosity. First, several microeconomic studies estimate the magnitude of the female labor force participation elasticity with respect to net wages identified from unexpected changes in taxes or tax credits. Overall, these estimates are between 0.15 and 0.43, and the magnitude of this elasticity is decreasing in household income. In the model, I find that female participation elasticity with respect to net wages is 0.33, and, importantly, it is also decreasing in household income. For this reason, in the model, the spousal labor supply is more elastic to changes in government policies in recessions, when the head's earnings losses are larger and household income is lower. Second, the magnitude of the elasticity of the spousal earnings response upon the head's displacement to transfer generosity in the model is also comparable to that in the PSID. Importantly, the model reveals that spousal earnings change the most when the amount of means-tested transfers is varied, while spousal earnings are almost inelastic to the generosity of employment-tested transfers.[2] This is because the eligibility for means-tested transfers requires low family labor income, which puts an implicit income tax on spousal labor supply and thus discourages it when the transfer amount is large. On the other hand, eligibility for employment-tested transfers do not impose any earnings threshold for the spouse and such transfers pay only small amounts for a short duration.

Using this model, I implement a counterfactual experiment that allows me to isolate the effects of government policy changes on the spousal labor supply. In this experiment, where government transfers are designed to be less generous in recessions and more generous in expansions (i.e., procyclical), I find that spousal earnings increase significantly following the head's displacement in recessions but remain low in expansions. This outcome is a result of the larger magnitude of female labor supply elasticities when household income is lower, which happens in recessions due to larger earnings losses upon the head's displacement. The procyclical policy leaves the marginal utility of consumption high after job loss in recessions and induces spouses to supplement family earnings by working. In expansions, earnings losses are relatively smaller and the marginal value of increasing spousal earnings is lower. Hence, during these times, the spousal earnings response to the head's displacement is small and less elastic to transfer generosity. This result sheds light on why the change in spousal insurance upon the job loss of the primary earner of the household, otherwise known as the "added worker effect," is small in the data. I argue that female earnings are in fact responsive to *both* the earnings loss of the primary earner and the changes in transfer generosity, but in opposite ways. As a result, the measured female earnings response from the

[2]The Supplemental Nutrition Assistance Program (SNAP), Earned Income Tax Credit (EITC), and Temporary Assistance for Needy Families (TANF) are examples of means-tested transfers, while unemployment insurance (UI) is an example of employment-tested transfers. These types of government transfers are typically available to families with displaced members.

data is masked by the crowding-out effects of transfers.

I then study the optimal design of means-tested and employment-tested transfers over the business cycle in the model. I find that the optimal policy features procyclical means-tested and countercyclical employment-tested transfers. Overall, however, total government transfers under the optimal policy are procyclical, which is in contrast to the current policy that maintains generous transfers in recessions. Means-tested transfers are procyclical because lower transfers in recessions induce a large increase in spousal entry into the labor force upon a head's displacement. This is a direct implication of the higher incentive costs of generous means-tested transfers, especially when household income is lower. The provision of insurance is better accomplished through more-generous employment-tested transfers in recessions, given that these transfers have lower incentive costs on the spousal labor supply.

In an economy in which the optimal policy is implemented, labor force participation of married women is 3 percentage points higher compared to an economy in which the current policy is implemented. Higher employment reduces the income tax required to finance a similar average level of transfers.[3] Moreover, the economy under the optimal policy is wealthier and has a lower fraction of families with non-positive net liquid wealth. These differences lead to a higher average consumption level and slightly lower consumption volatility. Overall, the optimal policy yields an ex-ante welfare gain of around 0.85 percent additional lifetime consumption compared with the current policy. Most of the welfare gains are enjoyed by wealth-poor families with females who have high earnings potential and males who have high displacement risk. It is precisely for this family that a spouse's participation in the labor force brings higher income to the family, which is especially valuable when the displacement risk of the head is larger.

Finally, to explore whether accounting for the endogeneity of the spousal labor supply to transfers is critical in determining the optimal policy, I modify the model such that the spousal labor supply is exogenous to transfers. Abstracting from the incentive costs of transfers on the spousal labor supply results in an optimal policy that is more generous on average than the optimal policy in the model with endogenous spousal labor supply. Furthermore, the optimal policy now features slightly countercyclical means-tested and employment-tested transfers because the optimal cyclicality of transfers is now driven largely by the cyclicality of insurance benefits, which are larger in recessions. This exercise shows that endogenizing the spousal labor supply to changes in transfer policy is critical in determining both the optimal level and the optimal cyclicality of transfers. As a result, policy makers should recognize that married households have an important source of self-insurance through adjustments in the spousal labor supply, and generous payments to these households make them worse off due to large crowding out.

[3] I will show in Section 5 that the optimal policy has levels of average transfers similar to those in the current policy.

Related literature Two separate strands of literature analyze the role of the female labor supply: one focuses on how the female labor supply acts as an insurance mechanism against idiosyncratic earnings risk within the family (Blundell, Pistaferri, and Saporta-Eksten, 2016; Busch, Domeij, Guvenen, and Madera, 2020; Wu and Krueger, 2021), and the other focuses on how income taxation affects married women's labor supply (Kaygusuz, 2010; Guner, Kaygusuz, and Ventura, 2012; Bick and Fuchs-Schündeln, 2017; Bick and Fuchs-Schündeln, 2018). This paper aims to combine these two strands of work, as it analyzes the magnitude of private insurance provided by the secondary earner against the earnings loss of the primary earner and studies how transfer policies affect the magnitude of this insurance channel. I document that the presence of a working spouse provides substantial insurance to the household. However, I also find that the active response of the secondary earner upon the head's displacement (i.e., the change in earnings of the secondary earner) is small especially in recessions. This result is in line with the previous findings on the limited change in spousal insurance upon the primary earner's job loss (e.g., Heckman and MaCurdy, 1982; Lundberg, 1985; Cullen and Gruber, 2000; Stephens, 2002; Hendren, 2017) and recent findings of Busch, Domeij, Guvenen, and Madera (2020), who also document the lack of active insurance using data from the U.S., Sweden, and Germany. Importantly, I investigate the underlying reasons behind this result and emphasize the *interaction* between private and public insurance. Empirically, I document substantial crowding-out effects of public insurance on the spousal earnings response to the head's displacement. Quantitatively, I develop a framework that accounts for the observed interaction between public and private insurance and use it to study the optimal design of transfers over the business cycle.

This paper also contributes to the growing literature on the effects of job displacement on earnings. Empirically, it is documented that job displacement has large negative and persistent effects on individual labor earnings (Jacobson, LaLonde, and Sullivan, 1993; Ruhm, 1991; Stevens, 1997). More recently, Davis and von Wachter (2011) show that earnings losses are larger when displacement happens in recessions. Krolikowski (2017), Jung and Kuhn (2019), Huckfeldt (2021), and Jarosch (2021) develop models that can endogenously generate persistent and negative effects of job displacement on earnings. In this paper, I calibrate my model to generate the observed level and cyclicality of earnings loss upon displacements of the household head and focus on the effects of the head's displacements over the business cycle on the labor supply behavior of the secondary earner. I first measure the impact of a head's job displacement in recessions and in expansions on the spousal earnings and hours and document substantial crowding-out effects of transfers on spousal earnings response. I then use these empirical findings in a model to analyze spousal earnings response under counterfactual transfer policies and study the optimal design of transfers over the business cycle.

Finally, a separate literature studies the optimal design of transfer programs. It is possible to divide this large literature into two groups. The first group of papers studies the optimal design of transfers using models with endogenous family labor supply but without aggregate fluctuations (Ortigueira and Siassi, 2013; Mankart and Oikonomou, 2017; Choi and Valladares-Esteban, 2020; Fernández-Blanco, 2020; Haan and Prowse, 2020). The second group studies the optimal design of taxes or transfers using models with aggregate fluctuations but without endogenous family labor supply as a private insurance mechanism (Mitman and Rabinovich, 2015; Landais, Michaillat, and Saez, 2018; Bhandari, Evans, Golosov, and Sargent, 2021; Birinci and See, 2021; McKay and Reis, 2021). This paper combines these two groups of studies, as it analyzes the optimal level and cyclicality of means-tested and employment-tested transfers using a model with endogenous family labor supply and aggregate fluctuations. Relative to the first group of papers, I find that more than half of the welfare gains from the optimal policy are attributable to its cyclicality. Relative to the second group of papers, I show that endogenizing the spousal labor supply to policy changes the optimal level and cyclicality of transfers.

This paper is organized as follows. Section 2 documents empirical findings on the effects of the head's displacement on the household's labor market outcomes. Section 3 presents the model. Section 4 explains the calibration strategy and discusses the model's validation against untargeted data moments. Section 5 analyzes the effects of government transfers on the spousal labor supply response to the head's displacement and studies the optimal design of transfers over the business cycle. Section 6 provides a list of extensions and robustness checks. Finally, Section 7 concludes. The Appendix provides more details on the data, model, and results.

2 Empirical Findings

In this section, I use data from the PSID for 1968-2015 to study the changes in head earnings and hours, spousal earnings and hours, and family earnings upon a family head's job displacement over the business cycle. The PSID is the main publicly available dataset that has been used to study the long-run effects of displacements on individuals (Ruhm, 1991; Stevens, 1997; Stephens, 2004; Huckfeldt, 2021). The main advantage of the PSID when compared to other publicly available datasets for the purposes of this paper is that it provides panel data (at an annual frequency until 1997 and biannual frequency since then) on labor earnings and hours worked of the family head and the spouse as well as the amount of transfers received from different types of government policies. On the other hand, the main disadvantage of the PSID is the small sample size, which limits some of my analysis in Sections 2.2 and 2.3 as I discuss later.[4]

For my analysis using the PSID, I restrict the sample to married or cohabiting families in which both the husband and the wife are between the ages of 20 and 60 and not in the Latino sample.[5] I drop families with only one year of observations and those above the 99th percentile

[4] For example, while the Current Population Survey (CPS) provides information on monthly employment status and annual earnings and hours worked for a larger sample, it does not follow individuals for a long duration, which is necessary to understand the dynamic effects of job displacement.

[5] Between 1968 and 2015, the PSID has used the term "Head" to refer to the husband in a heterosexual married

of the family labor income distribution. I create variables for involuntary job displacement using a question that asks the reason for losing the previous job to individuals who are either without a job or have been employed in their current job for less than a year. Following the literature, I define an involuntary job loss as a separation due to a firm closure, layoff, or firing.[6] The resulting unbalanced sample contains 86,541 observations on 9,383 families: 1,204 with at least one displacement in a recession and 2,269 with at least one displacement in an expansion. The family heads of 674 families had at least one displacement in a recession and one in an expansion. In this sample, there are 1,573 displacements in recessions and 3,517 displacements in expansions. Appendix A discusses more details about the data and provides additional results.

2.1 Earnings loss upon job displacement

I first study the effects of the head's job displacement on his own earnings and hours using the specification in Jacobson, LaLonde, and Sullivan (1993) and Stevens (1997) given as follows:

$$y_{it} = \beta X_{it} + \sum_{k\geq -2}^{10} \psi_R^k D_{it}^{R,k} + \sum_{k\geq -2}^{10} \psi_E^k D_{it}^{E,k} + \alpha_i + \gamma_t + \epsilon_{it}. \tag{1}$$

For two different regressions, the outcome variable y_{it} will separately be the real annual labor earnings of the head and his annual working hours.[7] The variable X_{it} is a vector of time-varying family characteristics, including a quadratic term of the head's experience, a quadratic term of the spouse's experience, the number of children, and the number of children younger than 6 years of age. The variable α_i captures a time-invariant unobserved error component associated with family i, and γ_t is an error component common to all families in the sample at year t.

To measure the differential effects of job displacements in recessions and in expansions on outcome variables, I group displacements into those that occurred in recessions and those that occurred in expansions using NBER business cycle definitions. In the above specification, the indicator variable ζ_t^R is equal to 1 if year t is a recession year and 0 otherwise; and ζ_t^E is equal to 1 if year t is a non-recession year and 0 otherwise. The vector of dummy variables $D_{it}^{q,k}$ for $q \in \{R, E\}$ indicates a job displacement in a future, current, or previous year. For example, $D_{it}^{R,3} = 1$ if individual i is displaced at time $t-3$ when t is a recession year and zero otherwise.

I estimate the impact of a head's displacement on his earnings and hours in the two years

couple. In my sample, only 49 observations have a female head among the 86,541 observations. Alternatively, one could specify the family head based on the earnings level at the start of the household's entry into the sample. Since both strategies have a large overlap especially at the early periods of my sample, the results presented in this section do not change under these two definitions of the family head.

[6] The latter category includes workers who report that they have been fired, which is typically not considered an exogenous job displacement event. However, Boisjoly, Duncan, and Smeeding (1994) report that only 16 percent of the workers in the layoff or fired categories have indeed been fired.

[7] Labor earnings include wages and salaries, bonuses, overtime, tips, commissions, professional practice or trade, market gardening, miscellaneous labor income, and extra job income.

preceding the job loss ($k = -2, -1$), during the year of the job loss ($k = 0$), and in every year until 10 years after the job loss ($k = 1, 2, ..., 10$).[8] Thus, ψ_R^k and ψ_E^k capture the effect of job displacement on outcome variables in families whose head was displaced k years prior/after (treatment group) relative to non-displaced heads (control group) in recessions and expansions, respectively. In the results below, the relative change of an outcome variable refers to the change in the outcome variable of the treatment group relative to the change in the outcome variable of the control group. The regressions are estimated with fixed effects and robust standard errors clustered at the family level. In the following figures, I report estimated ψ_R^k and ψ_E^k as a percent of the pre-displacement mean of the outcome variable separately for recessions and expansions.

Figure 1 shows the change in relative labor earnings of the family head upon job displacement in recessions and expansions. The solid-blue lines show the estimated coefficients $\left\{\psi_R^k\right\}_{k=-2}^{10}$ and $\left\{\psi_E^k\right\}_{k=-2}^{10}$ as a percent of the pre-displacement mean labor earnings of displaced heads in recessions and expansions, respectively, and the dashed light-blue lines show the 90 percent confidence intervals. I compare the results obtained from the PSID with the estimates of Davis and von Wachter (2011), who use Social Security Administration (SSA) data between 1974-2008.[9] I find that the magnitude of the drop in the head's relative labor earnings is larger when the head is displaced in recessions. In the year following the job displacement, the relative earnings drop by 39 percent in recessions but only 22 percent in expansions. These results are consistent with the findings of Davis and von Wachter (2011), as they also document larger earnings losses upon displacements in recessions (39 percent) than in expansions (25 percent).

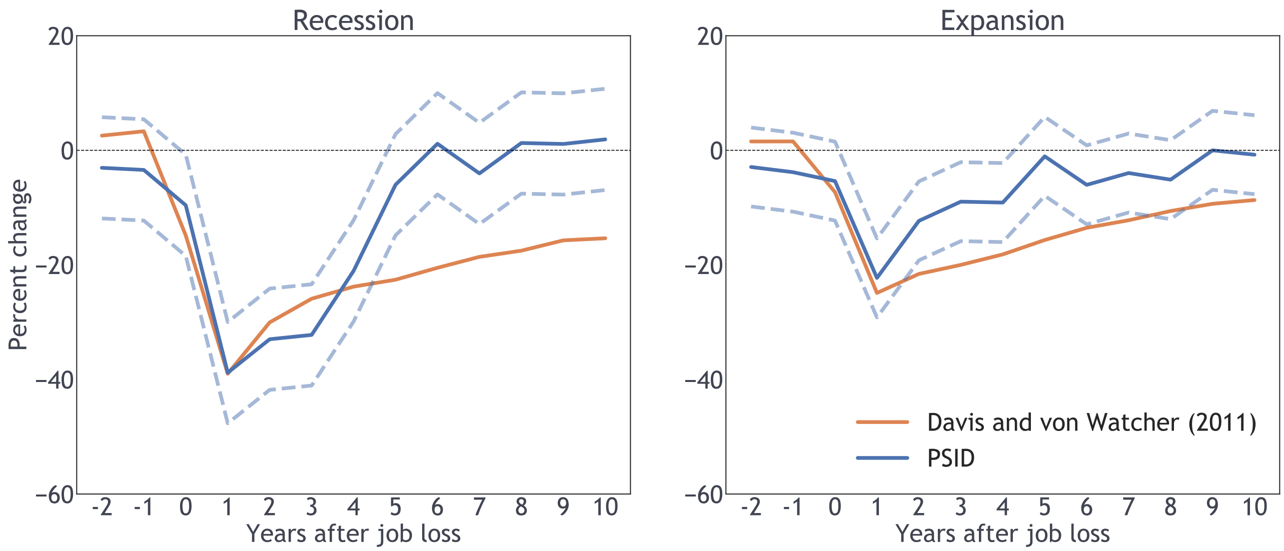
A notable difference between my results and the results in Davis and von Wachter (2011) is that the persistence of earnings losses is not as prolonged in my results. The difference is due to different definitions of job displacement in the administrative data and the PSID. Davis and von Wachter (2011) define a displacement as a job separation of a long-tenured worker in a mass-layoff event at firms with more than 50 employees. Here, a mass-layoff event is defined as a more than 90 percent reduction in such firms' number of employees in a year.[10] Thus, their definition identifies permanent layoffs of long-tenured workers (with at least 3 years of job tenure). On the

[8] When estimating this regression, some lags and leads around around a job displacement can be missing for two reasons. First, individuals may move in and out of the sample over time. Second, after 1997, the PSID provides data biannually. This means that for any displacements after 1997, I can at most have observations in $k = -2, 0, 2, 4, ..., 10$, while the other dummies would be missing in my specification, as in Saporta-Eksten (2014). Despite this data limitation, I still incorporate this time period into my analysis to increase my sample size given that there are many displacement events, especially around the Great Recession.

[9] My econometric model is slightly different from the model that Davis and von Wachter (2011) use. In their analysis, they regress Equation (1) for every year, obtain ψ_k for each of these years, and then report the average values of ψ_k across recession and expansion years. Given that my sample size from the PSID is smaller, I follow the baseline specification applied by Jacobson, LaLonde, and Sullivan (1993) and Stevens (1997), who also use the PSID. However, I still compare my results to the results in Davis and von Wachter (2011) because they provide the only benchmark for the cyclicality of the magnitude of earnings losses upon displacement in the U.S.

[10] More specifically, their mass-layoff definition in any year t requires 50 or more employees in $t-2$, a reduction in employment of 30 to 99 percent from $t-2$ to t, employment in $t-2$ is to be no more than 130 percent of employment in $t-3$, and employment in $t+1$ to be less than 90 percent of employment in $t-2$.

Figure 1: Labor Earnings of Family Head upon Job Displacement



Note: This figure plots the changes in relative labor earnings of the family head upon job displacement in recessions (left panel) and expansions (right panel). I estimate the changes in relative earnings from a distributed lag-regression model using the PSID. The solid-blue lines show the point estimates, and the dashed light-blue lines show the 90 percent confidence intervals. For comparison, the orange lines show the estimates of Davis and von Wachter (2011).

other hand, in the PSID, a displacement is defined as a job loss due to a firm closure, layoff, or firing without any firm size or worker tenure restrictions.[11] Hence, my sample incorporates displacements of short-tenured workers due to reasons other than mass-layoff, leading to less persistent earnings losses. In fact, my estimates are much closer to the estimates of Stevens (1997), who also uses PSID and finds less persistent effects of displacement on earnings.[12]

In order to identify whether the earnings losses arise because of lower wages or lower hours, Figure A1 in Appendix A measures the effect of a head's displacement over the business cycle on his annual hours worked. I find that the decline in hours upon displacements in recessions (18 percent) is close to that in expansions (14 percent) and that hours recover relatively quickly. When considered together, these results suggest that both the cyclical gap in earnings losses upon displacement over the business cycle and the persistence of earnings losses are largely explained by a drop in wages rather than a drop in hours.

[11] Adding these additional restrictions on the definition of displacement substantially reduces the number of job displacement observations in the PSID. For this reason, I do not incorporate worker tenure or firm size restrictions into my displacement definition. However, to understand the implications of these definition differences, I estimate Equation (1) for the displacement of workers with at least 3 years of job tenure, without differentiating between recession and expansion displacements, given the small sample size. In this case, I find that the persistence of earnings losses become closer to the estimates of Davis and von Wachter (2011). This persistence may be partially explained by the higher reliance of long-tenured workers with firm-specific human capital built while working for the collapsed employer.

[12] To make this comparison, I estimate a version of Equation (1) where I do not differentiate between displacements in recessions and expansions, given that Stevens (1997) does not focus on differential effects of displacements that occur in recessions and expansions. In this case, labor earnings drop by around 30 percent in the year following the job displacement and earnings recover after 5 years, as in Stevens (1997).

2.2 Spousal insurance upon job displacement

The main focus of my empirical analysis is to quantify the magnitude of spousal insurance following the head's job displacement in recessions and in expansions.[13] In doing so, I analyze both the level of spousal insurance due to the presence of a working spouse, which I label as *passive* insurance, and the change in spousal insurance due to the change in labor earnings of the spouse upon the head's displacement, which I label as *active* insurance.

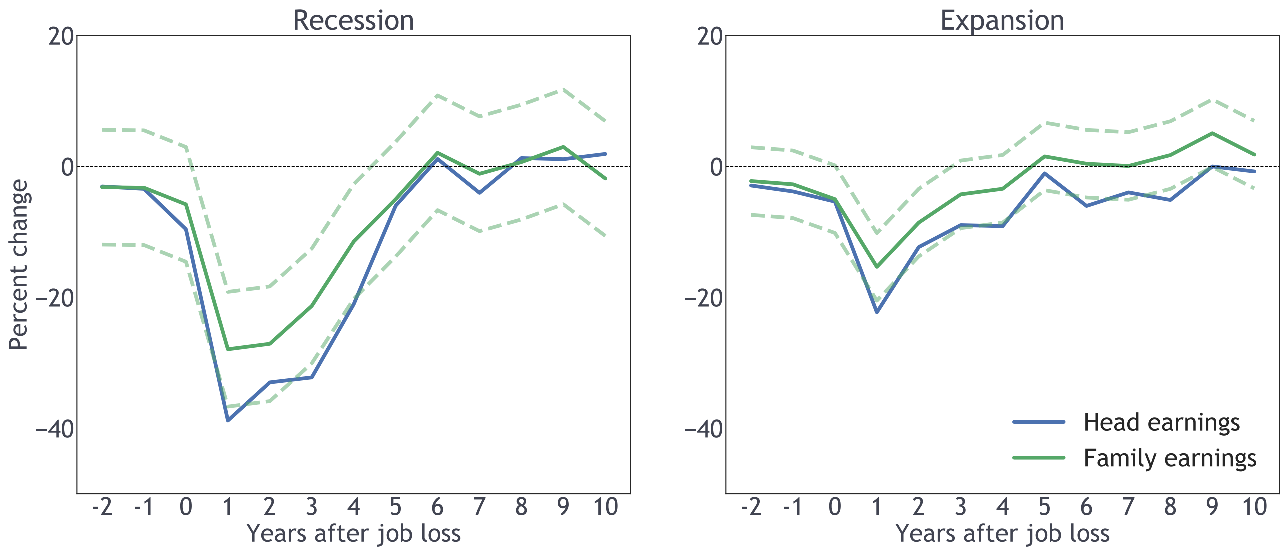
I first estimate Equation (1) by replacing the dependent variable with the family labor earnings, which is defined as the sum of head and spouse labor earnings. Figure 2 shows the changes in relative earnings of the family upon the head's displacement in recessions and expansions and compares it to the changes in the relative earnings of the head. I highlight three results. First, I find that family earnings drop by 28 percent when the head's displacement occurs in recessions and by 15 percent when it occurs in expansions in the year following the displacement. Second, the initial cyclical gap of family earnings losses upon the head's displacement in a recession versus in an expansion ($28 - 15 = 13$ pp) is not very different from the initial cyclical gap of the head's earnings losses ($39 - 22 = 17$ pp). Finally, family earnings recover earlier than the head's earnings. However, notice that the slopes of the recoveries of the head's earnings and the family earnings look similar. This finding suggests that earlier recoveries of family earnings are due to the passive insurance rather than the active insurance.

In order to isolate the magnitude of active insurance, I estimate Equation (1) when the dependent variable is the labor earnings of the spouse. The small behavioral response of spouses is confirmed by Figure 3, which shows the change in relative spousal earnings upon the head's displacement in recessions and in expansions. I find that the change in relative spousal earnings upon the head's displacement is small and mostly insignificant both in recessions and in expansions. The mean of the post-displacement coefficients is only 2.6 percent for displacements in recessions and 4 percent for displacements in expansions. Furthermore, the p-values of a joint significance test of the post-displacement coefficients allows me to reject the hypothesis that they are jointly significant ($p = 0.50$ in recessions and $p = 0.29$ in expansions).

I acknowledge that error bounds around the estimated coefficients for displacements in recessions are large. One concern with this could be that if various subgroups of spouses respond differently to the head's displacement, we may observe a small average response with large error bounds. In order to understand whether this is the case, I estimate a similar regression for different subgroups of spouses (college vs non-college, age groups, and those with less than vs more

[13] Pruitt and Turner (2020) measure the spousal earnings response to earnings fluctuations of the household head both in recessions and in expansions using SSA data but do not focus on measuring the response to job displacement shocks specifically. Job displacement events are particularly relevant because their effects are large and long-lasting compared with temporary earnings fluctuations. My paper focuses on measuring the dynamic response of spousal earnings and hours specifically in response to a head's job displacement and how this response varies over the business cycle.

Figure 2: Labor Earnings of the Head and Family upon Job Displacement



Note: This figure plots the changes in relative labor earnings of the head (blue line) and relative labor earnings of the family (green line) – defined as the sum of head and spouse labor earnings – upon the head's job displacement in recessions (left panel) and expansions (right panel). The dashed light-green lines show the 90 percent confidence intervals for family earnings. I estimate the changes in relative labor earnings of the head and the family from a distributed lag-regression model using the PSID.

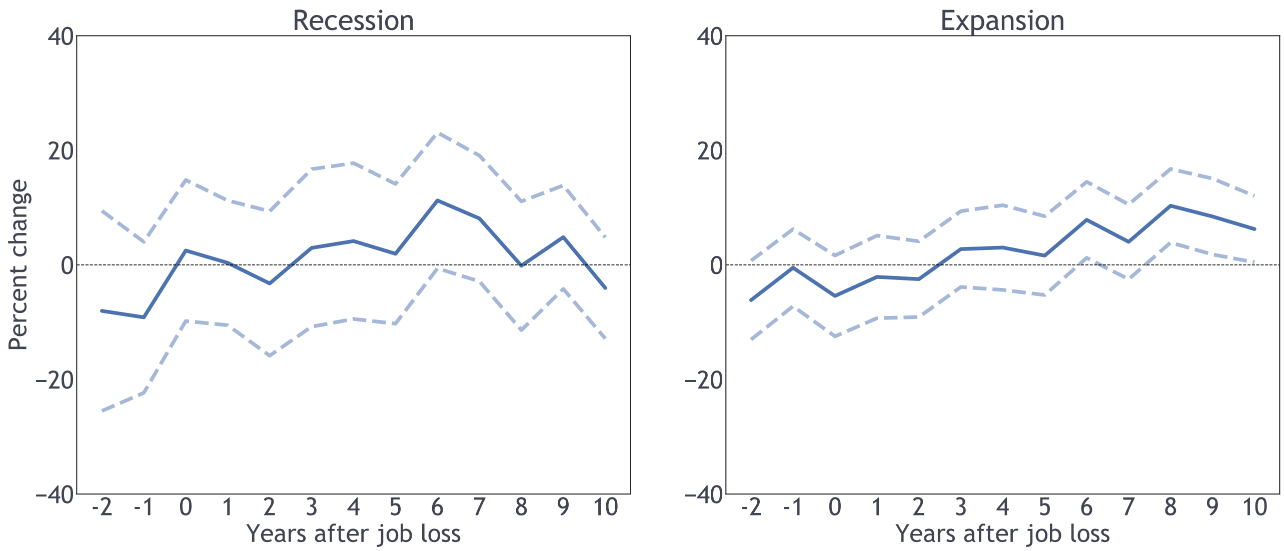
than part-time hours at the time of the head's displacement) without separating displacements across recessions and expansions due to the small sample size. In all of these cases, I observe a small average spousal earnings response to the head's displacement. In addition, I also measure the change in spousal earnings upon the head's displacement using Survey of Income and Program Participation (SIPP) data. Figure A4 in Appendix A shows that the change in spousal earnings upon the head's displacement is also small according to the SIPP data. Importantly, given the larger sample size in SIPP, the point estimates are also more tightly estimated.[14]

Figure A2 in Appendix A measures the effect of the head's job displacement over the business cycle on annual hours worked of spouses. I also find that the change in spousal hours upon the head's displacement in recessions is very small, with a mean post-displacement coefficient of only -0.01 percent ($p = 0.99$). On the other hand, spousal hours in expansions become significantly positive 2 years after the head's displacement and later increase by up to 10 percent. The mean of the post-displacement coefficients in expansions is 7.1 percent ($p = 0.04$).

The small initial response of hours is consistent with previous "added worker effect" literature that studies the contemporaneous change in spousal hours upon the head's unemployment without conditioning on the timing of the unemployment over the cycle (Heckman and MaCurdy, 1982; Cullen and Gruber, 2000). More recently, Busch, Domeij, Guvenen, and Madera (2020) also document the lack of active spousal insurance upon changes in the head's earnings especially

[14] While the SIPP offers a relatively larger sample size than the PSID, it follows individuals for a shorter period of time. For this reason, it is not possible to measure the long-run effects of displacement on labor market outcomes.

Figure 3: Spousal Earnings Response to the Head's Job Displacement



Note: This figure plots the changes in relative labor earnings of the spouse upon the family head's job displacement in recessions (left panel) and expansions (right panel). I estimate the changes in relative spousal labor earnings from a distributed lag-regression model using the PSID. The solid-blue lines show the point estimates, and the dashed light-blue lines show the 90 percent confidence intervals.

in recessions, using data from the U.S., Sweden, and Germany.

Overall, my findings imply that families enjoy substantial insurance from a second earner simultaneously employed with the head prior to his displacement. Having the spouse retain employment mitigates close to one-third of the head's earnings losses upon job displacements both in recessions and in expansions.[15] However, I also show that the active spousal insurance upon the head's displacement is small especially in recessions.

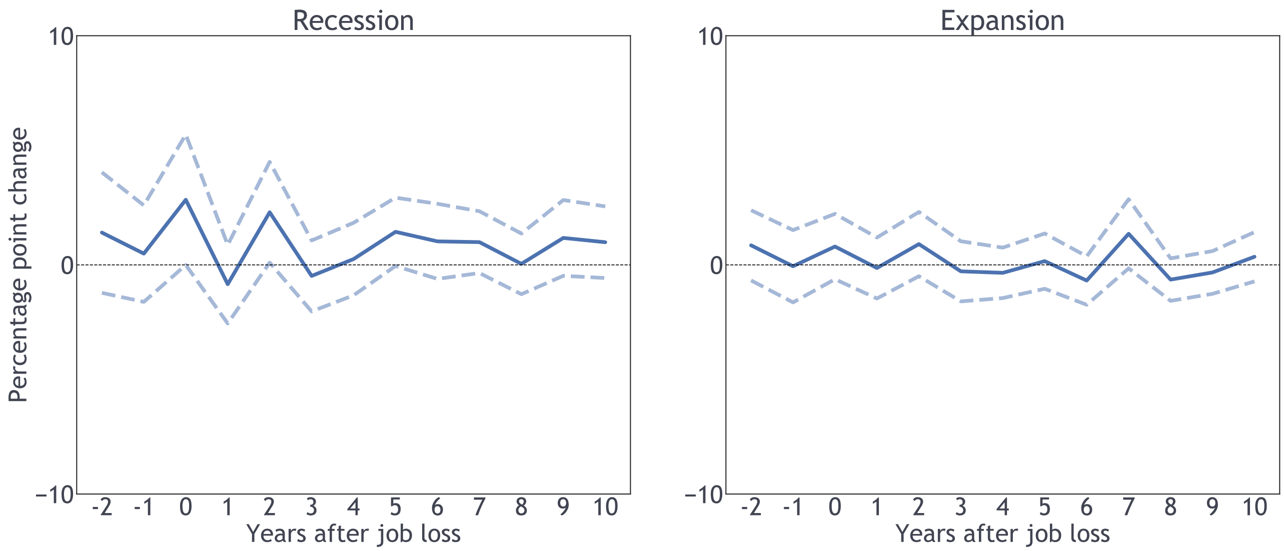
2.3 Investigating reasons behind the small spousal earnings response

Beyond documenting the small spousal responses following the head's displacements in recessions and expansions, I also investigate the reasons behind this result using the PSID. Specifically, I consider three primary reasons: correlated shocks between the head and the spouse, crowding-out effects of government transfers, and lower job finding rates.

Correlated shocks If the spouse is also displaced around the year of the head's displacement and also experiences earnings losses, then we would not expect to observe positive spousal earnings and hours responses upon the family head's job displacement. In order to test whether this is the case in the data, I estimate Equation (1) in which the dependent variable is now a dummy variable that takes a value of 1 if the spouse is displaced and 0 otherwise. Figure 4

[15]The presence of a second earner reduces the initial earnings losses by $(39-28)/39 = 28$ percent in recessions and $(22-15)/22 = 32$ percent in expansions. This result is consistent with the findings of Blundell, Pistaferri, and Saporta-Eksten (2016), who also find that employed spouses provide substantial insurance against wage shocks faced by the husband.

Figure 4: Change in Spousal Displacement Probability upon Head's Displacement



Note: This figure plots the changes in the probability of job displacement of the spouse upon the head's job displacement in recessions (left panel) and expansions (right panel). I estimate the percentage point change in the relative spousal displacement probability from a distributed lag-regression model using the PSID. The solid blue lines show the point estimates, and the dashed light-blue lines show the 90 percent confidence interval.

presents the percentage point change in the spousal displacement probability upon the head's displacement in recessions and expansions. It shows no evidence of correlated displacement spells across the head and the spouse both in recessions and in expansions.

While this result shows that job displacement shocks are not correlated between the employed head and the employed spouse, wage shocks may be correlated between the two in the sense that the wage of a spouse can be lower upon the head's displacement. Importantly, Blundell, Pistaferri, and Saporta-Eksten (2016) estimate very small and mostly insignificant covariances of permanent and transitory wage shocks of the two spouses across the life cycle using the PSID. Furthermore, the findings of Busch, Domeij, Guvenen, and Madera (2020) also imply that lack of active insurance is unlikely to be driven by correlated shocks across spouses.[16]

Overall, these results allow me to eliminate the hypothesis that the spousal earnings response may be muted especially in recessions, due to correlated displacement or wage shocks.

Crowding-out effects of government transfers Next, I analyze whether the small response is an outcome of the crowding-out effects of transfers. To do so, I compare differential spousal

[16] Specifically, Busch, Domeij, Guvenen, and Madera (2020) compare spousal earnings in "synthetic households" to those in actual households to quantify the extent of active spousal insurance. They create "synthetic households" by pairing the head of each household with a "synthetic" spouse who has similar observable characteristics (such as region, age, education, and average income). Thus, their strategy conditions for observable characteristics when forming synthetic couples, to control for common labor market shocks across the two spouses. Similar to my results, they also document a small active insurance, even after partly controlling for common shocks across the two spouses. This suggests that correlated shocks cannot explain the limited active insurance observed.

earnings responses in higher and lower transfer environments using the following specification:

$$y_{it} = \beta X_{it} + \sum_{k \geq -2}^{10} \psi_G^k D_{it}^{G,k} + \sum_{k \geq -2}^{10} \psi_{NG}^k D_{it}^{NG,k} + \kappa u_{st} + \alpha_i + \gamma_t + \epsilon_{it}, \tag{2}$$

where the dependent variable is spousal labor earnings. I rank U.S. states based on their average transfer payment per family using the PSID, and label the top three states as "generous states" G and the bottom three states as "non-generous states" NG.[17] Here, ψ_G^k and ψ_{NG}^k capture the effect of displacement on spousal earnings for families living in generous states and non-generous states, respectively.[18] Finally, κ captures the effect of the state-level unemployment rate u_{st} on spousal earnings.[19] Table 1 reports the estimated dollar changes in spousal earnings in the year following the head's displacement in generous and non-generous states, i.e., ψ_G^1 and ψ_{NG}^1.[20]

Across all specifications, I find that the increase in spousal earnings upon the head's displacement is significantly larger in families living in non-generous states when compared to those in generous states. Put differently, generous public insurance substantially crowds out private insurance through spousal labor supply adjustments. Based on column (6) of Table 1, which is my preferred specification as given in Equation (2), relative spousal earnings increase by around $\$2,700$ in the year following the head's displacement for families living in non-generous states, while spousal earnings remain roughly unchanged for families living in generous states. The average pre-displacement spousal earnings in non-generous states is around $\$12,750$, implying that spousal earnings increase by around 21 percent in the year following the head's displacement.

Importantly, controlling for the state-level unemployment rate in the above specification partly quantifies the role of lower job finding rates in explaining the small spousal earnings response upon the head's displacement. To the extent that lower job finding rates are the main reason behind the small spousal earnings response especially in recessions, one would expect that

[17] Based on this classification, Vermont, the District of Columbia, and New Hampshire are the generous states and Rhode Island, New Mexico, and Idaho are the non-generous states. Besides these groupings, I also consider alternative groupings of states based on total transfer payments. As shown in column (7) of Table 1, the conclusions remain similar in this case.

[18] Ideally, one would also want to estimate these coefficients separately for displacements in recessions and expansions. However, I am unable to do so, given the small sample size left after focusing only on several states. For this reason, in Section 5, I use my quantitative model to explore how the interaction between public and private insurance varies over the business cycle.

[19] I use data from the CPS to calculate the monthly level of unemployment rates across states and over time. Then, for each year, I take the average unemployment rate across months to obtain the average unemployment rate for the year across states. I also calculate state-level job finding rates over time using the CPS data and estimate Equation (2) using job finding rates instead of unemployment rates. In this case, the results provided in this section remain similar.

[20] Here, even if I report the estimates for $k = 1$, I estimate the regression by including all lags and leads; i.e., $k = -2, -1, 0, 1, ..., 10$, as shown in column (6) of Table 1, which is my preferred specification as given in Equation (2). I focus on the estimates for $k = 1$ because this allows me to demonstrate the contemporaneous elasticity of the spousal earnings response upon the head's displacement to transfer generosity, which I later use in Table 2 to compare with the model-implied elasticity.

Table 1: Spousal Earnings Response across States with Different Transfer Generosity

Dependent variable: Spousal earnings upon family head's job displacement

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
ψ^1_{NG}	5253.13	3547.76	3555.14	3033.70	3013.53	2726.30	2736.53
	(0.089)	(0.005)	(0.005)	(0.008)	(0.009)	(0.058)	(0.057)
ψ^1_{G}	1443.95	1319.64	1307.53	649.7	572.36	-34.69	640.28
	(0.679)	(0.623)	(0.625)	(0.787)	(0.813)	(0.990)	(0.049)
State-level unemployment rate			-32.42	-31.46	-28.40	-30.47	-35.96
			(0.566)	(0.567)	(0.605)	(0.579)	(0.513)
Individual and time fixed effects	No	Yes	Yes	Yes	Yes	Yes	Yes
Controls for spouse	No	No	No	Yes	Yes	Yes	Yes
Controls for head	No	No	No	No	Yes	Yes	Yes
All leads and lags	No	No	No	No	No	Yes	Yes
Alternative grouping of states	No	No	No	No	No	No	Yes

Note: This table provides results on the spousal earnings response upon the head's job displacement across states with different transfer generosity. ψ^1_{NG} and ψ^1_{G} provide estimated dollar changes in relative spousal earnings in the year following the head's displacement in non-generous and generous states, respectively. Values in parenthesis denote the p-values.

the effect of transfer generosity on the spousal earnings response should be smaller or insignificant once we control for differences in labor market conditions. However, as shown in Table 1, while the spousal earnings response is slightly lower in states with a higher unemployment rate, this effect is always small and insignificant. Furthermore, columns (3) to (7) of Table 1 show that the estimated gap between ψ^1_{NG} and ψ^1_{G} remains significant and between \$2,100 and \$2,700, even after controlling for labor market conditions. Hence, lower job finding rates in recessions cannot fully explain the small spousal response observed. I conclude that the crowding-out effects of transfers are the important reason behind the small spousal earnings response.

Finally, I calculate the elasticity of contemporaneous spousal earnings responses upon the head's displacement to changes in transfer generosity. This allows me to understand the extent to which an additional dollar of transfers crowds out spousal earnings. To do so, I estimate Equation (2) when the outcome variable is the total annual transfers received by the family. I find that the estimated gap between the total transfers received in the year of the head's displacement across families in generous and non-generous states is around \$16,400. Thus, the ratio of the estimated gap in the spousal earnings response to the estimated gap in transfers received is $-\$2,700/\$16,400 = -0.17$. This implies that additional dollar of transfers crowds out 17 cents of spousal earnings following the family head's job displacement.[21]

[21] Bredtmann, Otten, and Rulff (2018) provide cross-country evidence on the crowding-out effects of transfers on spousal insurance. They use data from 28 European countries between 2004 and 2013, and show that a wife's labor supply in response to her husband's unemployment is strongest in less-generous welfare states (i.e., the Mediterranean, Central, and Eastern European countries), while it is weakest in more-generous welfare states (i.e., the Continental European and Nordic countries).

2.4 Summary

It is useful to summarize empirical findings of this section. First, I find that there are large negative effects of the head's job displacement on his own labor earnings and that the magnitude of the earnings losses is larger when the displacement occurs in a recession. Second, the mere presence of a second earner already mitigates close to one-third of the head's earnings losses upon displacements both in recessions and in expansions. Third, there is no evidence for significantly positive spousal earnings and hours responses to the head's displacement especially in recessions, when the drop in the head's earnings is much larger. Finally, I identify substantial crowding-out effects of government transfers on the spousal earnings response to the head's displacement. These crowding-out effects are likely to be an important reason behind limited active spousal insurance especially in recessions, when the family needs insurance the most.

3 Model

In this section, I develop a quantitative framework that is capable of accounting for the empirical findings provided in the previous section. I use the model to analyze spousal earnings responses under counterfactual transfer policies and study the optimal design of means-tested and employment-tested transfers over the business cycle.

3.1 Environment

Setting Time t is discrete and runs forever. The economy is populated by a large number of ex-ante identical households j that consist of a male m and a female f individual i; i.e., $i \in \{m, f\}$ $\forall\, j$.[22] An individual can be either employed or non-employed. Households die exogeneously with probability ζ, and they discount the future at rate β.

Households are heterogeneous in terms of their assets $a \in \mathcal{A} \equiv [a_L, a_H] \subseteq \mathbb{R}$; the human capital $h_i \in \mathcal{H} \equiv \{h_L, ..., h_H\}$ of each member; and the employment status l_i of each member, who can be employed E, non-employed and eligible for employment-tested UI benefits U_b, or non-employed and ineligible for such benefits. Households have access to incomplete asset markets where they can save or borrow up to a limit at an *exogenous* interest rate r.[23] They make joint choices of savings and labor supply of the non-employed members. Preferences are given by

$$U\left(c,\, s_m,\, s_f\right) = u\left(c\right) + \sum_i \eta_i \left(1 - s_i\right),$$

where $u\left(\cdot\right)$ is a strictly increasing and strictly concave utility function over household consump-

[22] Throughout the paper, I suppress the index j when it is clear that a variable is a household variable. Instead, I use the index i for individual variables to differentiate them from household variables.

[23] As such, I do not model the general equilibrium effects of changes in savings behavior on capital accumulation and output. This restriction allows my model to retain block recursivity and makes it feasible to solve for optimal means-tested and employment-tested transfers over the business cycle.

tion level c that satisfies Inada conditions; $s_i \in \{0, 1\}$ is the labor supply decision of individual i at the extensive margin; and η_i is the value of leisure.[24] The only parameter that defines gender in this model is η_i. This implies that the utility cost of work or search is different between males and females to capture the employment differences between them. Furthermore, employed individuals work full-time and there is no on-the-job search. Thus, the above functional form assumes that individuals only enjoy the value of leisure if they do not look for jobs when non-employed.[25] The aggregate state variables of the economy are summarized by $\mu = (z, \Gamma)$, where z is exogenous aggregate productivity and Γ is the endogenous distribution of households across states. The law of motion for the aggregate states is given by $z' \sim \Phi(z' \mid z)$ and $\Gamma' = \Lambda(\mu, z')$.

Labor market The labor market is segmented in human capital h; i.e., jobs are characterized by their human capital requirement level h. Vacant firms post job openings in specific human capital submarkets after paying a fixed cost κ of posting a vacancy. Non-employed individuals look for jobs that are compatible with their own human capital level.

The labor market tightness of submarket h is defined as the ratio of vacancies v posted in the submarket to the number of non-employed searching for a job within that submarket; i.e., $\theta(h;\, \mu) = \frac{v(h;\mu)}{u(h;\mu)}$. Let $M(v, u)$ be a constant-returns-to-scale matching function that determines the number of matches in a submarket, give the number of non-employed u and number of vacancies v. Then, $p(h;\, \mu) = \frac{M(v(h;\mu),u(h;\mu))}{u(h;\mu)}$ is the job finding rate and $q(h;\, \mu) = \frac{M(v(h;\mu),u(h;\mu))}{v(h;\mu)}$ is the vacancy filling rate in submarket h when the aggregate state is μ. The constant-returns-to-scale assumption guarantees that the equilibrium object θ suffices to determine the job finding and vacancy filling rates since $p(\theta) = \frac{M(v,u)}{u} = M(\theta, 1)$, while $q(\theta) = \frac{M(v,u)}{v} = M\left(1, \frac{1}{\theta}\right)$.

Once matched, the firm-worker pair converts one unit of labor into $g(h,\, z)$ units of consumption goods, where $g(\cdot)$ is a strictly increasing function of a worker's human capital level h and aggregate productivity z. The firm pays a wage $w(h,\, z)$ to the worker. I assume that the period output is shared between the firm and the worker. In particular, the worker receives an α share of the period output as a wage, which implies that $w(h,\, z) = \alpha g(h,\, z)$.[26] The firm-worker pair continues to operate until the match exogenously dissolves with probability $\delta(h,\, z) \in [0, 1]$ or the worker dies with probability ζ.[27] The $\delta(\cdot)$ is a decreasing function of both h and z.

[24] Given that eligibility for means-tested transfers requires a very low household income in the U.S., most of the transfers are received by non-employed individuals. For this reason, I focus on the extensive margin and abstract from the intensive margin. Moreover, the extensive margin is the main driver of the labor supply changes of women in the U.S. In particular, Blundell, Bozio, and Laroque (2011) show that around 80 percent of the total increase in hours of worked of prime-aged women in the U.S. over time is due to extensive margin adjustment.

[25] In Section 6, I also analyze the effect of a utility function with non-separable consumption and leisure on my main results, following Blundell, Browning, and Meghir (1994) and Attanasio and Weber (1995).

[26] This assumption is similar to that in Herkenhoff, Phillips, and Cohen-Cole (2019), and it implies that varying the government policy does not affect equilibrium wages and firm vacancy posting decisions. This assumption allows me to isolate the effect of transfers on the labor supply. In Section 6, I extend the model to endogenize wage choices of the non-employed and analyze the effects of this assumption on my main results.

[27] Thus, I assume that employed workers cannot quit their job. Notice that because of the human capital

Human capital dynamics Human capital level h lies in equispaced grid $\mathcal{H}$. All newborn individuals begin with the lowest skill level, and their human capital endogenously evolves over time depending on their employment status. In particular, for a non-employed individual with human capital level h, human capital evolves as follows:

$$h' = \begin{cases} h & \text{with probability} \quad 1 - \pi^U \\ h - \Delta^U(z) & \text{with probability} \quad \pi^U. \end{cases}$$

Similarly, the human capital level of an employed individual evolves as follows:

$$h' = \begin{cases} h + \Delta^E & \text{with probability} \quad \pi^E \\ h & \text{with probability} \quad 1 - \pi^E. \end{cases}$$

Relative to Ljungqvist and Sargent (1998), I make an additional assumption and allow Δ^U to vary over the business cycle z to exogeneously generate larger earnings losses upon job displacements in recessions.[28] Thus, I do not attempt to model the underlying reasons behind the level and cyclicality of earnings losses upon job displacements. Huckfeldt (2021) documents important novel evidence that the earnings loss upon displacement is concentrated among individuals who find a new job in lower-skill occupations and that the risk of such occupation displacement is higher upon displacement in recessions. Motivated by this finding, when calibrating the model in Section 4, I allow a larger depreciation of human capital during non-employment spells in recessions. Then, taking the observed earnings losses upon displacement over the business cycle as given, I study the endogenous response of the spousal labor supply to the head's displacement over the cycle across various transfer policies.

Government transfers Government runs two transfer programs: means-tested transfers and employment-tested transfers.

Eligibility for means-tested transfers is determined at the household level, similar to the implementation of means-tested transfers in the U.S. A household is eligible for means-tested transfers if the total amount of net household labor income y, which is defined below, is lower than income threshold $\underline{y}$, which is a policy instrument.[29] Eligibility for these transfers never

depreciation when non-employed, quitting a job would lower human capital and thus future job finding rates and wages. For this reason, there is no reason to leave employment. However, some individuals who are at the margin of employment during normal times may choose non-employment over employment during a deep recession. Under my baseline calibration, the share of such households is negligible when I allow them to quit.

[28] In principle, the model generates larger earnings losses upon displacements in recessions relative to displacements in expansions due to endogenously lower job finding rates in recessions. However, this alone is insufficient to generate the observed difference in magnitude.

[29] For some means-tested transfers, states check the amount of liquid assets to determine eligibility. However, for SNAP, for example, as of 2015, 36 states have used a waiver to eliminate the asset test and 4 states have used waivers to raise the asset limit. For this reason, I do not model an asset test as an eligibility criteria.

expires as long as the income test is satisfied. The amount of means-tested transfers may vary over the business cycle, and it is given as follows[30]:

$$\phi\left(z;\, y\right)=\begin{cases}\phi\left(z\right) & \text{if} \quad y<\underline{y}\\ 0 & \text{otherwise.}\end{cases}$$

On the other hand, eligibility for employment-tested transfers is determined at the individual level as in the UI program in the U.S. An individual may be eligible U_b or ineligible U_n for employment-tested transfers upon job displacement, and the eligible individual only starts receiving these transfers if he/she is actively searching for a job; i.e., $s_i>0$.[31] These transfers stochastically expire at rate $e\left(z\right)\in\left[0,1\right]$, as in Mitman and Rabinovich (2015). The amount of employment-tested transfers also varies over the business cycle, and it is given as follows:

$$b\left(z;\, l_i,\, s_i\right)=\begin{cases}b\left(z\right) & \text{if} \quad l_i=U_b,\, s_i>0\\ 0 & \text{otherwise.}\end{cases}$$

Hence, there is an important difference between eligibility rules of means-tested and employment-tested transfers. The eligibility for means-tested transfers requires low labor earnings at the household level, while the eligibility for employment-tested transfers requires unemployment (i.e., no labor earnings at the individual level). These requirements imply that when a household head losses his job, he is likely to be eligible for employment-tested transfers, but that the household's eligibility for means-tested transfers requires his spouse to have very low, if any, labor earnings. Thus, the eligibility for means-tested transfers puts an implicit income tax on spousal earnings, while the eligibility for employment-tested transfers does not. This difference between eligibility rules of these two programs will be important when I discuss my results.

To finance these programs, the government implements joint progressive taxation.[32] For any total gross household labor income through wages x, net household labor income is given by $y=\tau x^{1-\Upsilon}$, where τ captures the level of taxation and $\Upsilon\geq 0$ captures the rate of tax progressivity, as in Benabou (2002) and Heathcote, Storesletten, and Violante (2014).[33]

[30] I restrict the policy instruments to depend on the aggregate state of the economy μ only through the current aggregate productivity z and not through the distribution of individuals across states Γ. This restriction allows my model to retain block recursivity, which I explain in Section 3.4.

[31] Here, I assume that the government can observe the search behavior of the non-employed. In the U.S., UI offices may verify job search activities of UI recipients by asking them to fill out a form requiring the name, location, and contact information of any employer recently contacted. In Section 6, I remove the assumption that search effort is observable to the government and check the implications on my main results.

[32] Progressive taxation is especially relevant for my analysis given that the job displacement of the household head may increase the incentives of the spouse to work due to the decline of the implied tax rate on her.

[33] According to U.S. tax policy, while means-tested transfers are mostly non-taxable, the UI benefits are subject to income tax. Here, I assume that UI benefits are non-taxable too. I assume this because, given that after-tax household income determines the eligibility for means-tested transfers, when taxable income includes both wages

The government balances the following budget constraint in expectation:

$$\sum_{t=0}^{\infty}\left(\frac{1}{1+r}\right)^{t}\times\left[\sum_{j}x_{jt}-\tau x_{jt}^{1-\Upsilon}-\sum_{i}\mathbf{1}\left(l_{it}=U_{b},s_{it}>0\right)b_{t}-\sum_{j}\mathbf{1}\left(y_{jt}<\underline{y}\right)\phi_{t}\right]=0. \qquad (3)$$

In particular, the net present value of total tax revenues generated through taxes on wages should be equal to the the net present value of total employment-tested and means-tested transfers paid to eligible individuals or households.

Timing Every period t is divided into three stages. In the first stage, a ζ fraction of households die and are replaced with new households. Then, aggregate productivity z is realized and the level of z determines i) the generosity of employment-tested transfers $b\left(z\right)$, the expiration rate $e\left(z\right)$ of employment-tested transfers, the generosity of means-tested transfers $\phi\left(z\right)$ and ii) the exogenous job separation rate $\delta\left(h,\,z\right)$ in each submarket h such that a $\delta\left(h,\,z\right)$ fraction of those employed in $t-1$ in each submarket h lose their job and must spend at least one period non-employed. Among these job losers, $e\left(z\right)$ fraction become ineligible for employment-tested transfers.

Search and matching in the labor market occurs in the second stage. Vacant firms decide the human capital submarket in which to post a vacancy, while non-employed individuals who chose to search for a job do so in a submarket that is compatible with their own human capital level. Then, $p\left(h,\,z\right)$ fraction of non-employed individuals searching for a job in submarket h find a job. Human capital stochastically evolves based on labor market outcomes. The third stage is the production and consumption stage. Each firm-worker pair produces $g\left(h,\,z\right)$ units of goods. Wages are paid to workers and transfers are paid to eligible households, and the households make their joint saving/borrowing decision. Finally, households jointly decide whether their non-employed members will look for a job in the labor market stage at time $t+1$, where the forgone utility of leisure for the member with a positive labor supply is incurred at time t.

3.2 Household Problem

There are nine types of households in terms of the employment statuses of their members. Here, I lay out the recursive problem of three types of households: i) one member is employed, the other is non-employed and eligible for UI; ii) both members are non-employed and UI-eligible; and iii) both members are employed; and discuss the rest briefly in here and in Appendix B.

Let $V^{l_m l_f}$ denote the value function of a household when the male's employment status is l_m and the female's employment status is l_f after search and matching has occurred. Let $\mathbf{h}\equiv\left(h_m,\,h_f\right)$ and $\mathbf{l}\equiv\left(l_m,\,l_f\right)$ be the human capital and employment state vectors of the household, respectively. To simplify the notation further in the recursive formulations below, let

and UI benefits, changes in UI generosity affects households' eligibility for means-tested transfers. In order to study the two policies in isolation, I assume that the taxable income excludes UI benefits. Making UI benefits taxable does not significantly alter my results given that these payments are made only for a short duration.

$\delta_i \equiv \delta(h_i,\, z)$ and $p_i \equiv p(h_i,\, z)$ be the job displacement rate and job finding rate, respectively, of individual $i \in \{m,\, f\}$, and δ'_i and p'_i denote the respective probabilities in the next period. Finally, let $\lambda_b = 1 - e(z)$ be the probability that eligibility for employment-tested benefits does not expire, and $\lambda_n = e(z)$ be the expiration probability. Similarly, λ'_b and λ'_n denote the respective probabilities in the next period.

Employed–non-employed household First, consider a household in which the head is employed and the spouse is non-employed and UI eligible. The problem of this household is[34]:

$$V^{EU_b}(a,\, \mathbf{h};\, \mu) \;=\; \max_{a' \geq a_L,\, s_f \in \{0,1\}} \; u(c) + \eta_f (1 - s_f) + \beta (1 - \zeta)\, \mathbb{E}_{\mathbf{l}',\mathbf{h}',\mu'} \left[V^{\mathbf{l}'}(a',\, \mathbf{h}';\, \mu') \,\middle|\, s_f, \mathbf{l}, \mathbf{h}, \mu \right]$$

subject to (4)

$$\begin{aligned} & c + a' \leq (1 + r)\, a + y + \phi(z;\, y) + b(z;\, U_b,\, s_f) \\ & y = \tau \left[w(h_m,\, z) \right]^{1-\Upsilon} \\ & \Gamma' = \Lambda(\mu,\, z') \quad \text{and} \quad z' \sim \Phi(z' \,|\, z)\,. \end{aligned}$$

The household decides their savings and the female's job search since she is the non-employed member. If the household does not die with probability $1 - \zeta$, the household takes expectation over the transition of employment statuses, the human capital levels of both members, and the aggregate state, conditional on the current employment statuses and the human capital levels of both members, the job search decision for the female, and the aggregate state.

It is also insightful to discuss the expectation over the transition of employment statuses of this household, which I lay out below[35]:

$$\begin{aligned} \mathbb{E}_{\mathbf{l}',\mathbf{h}',\mu'} \left[V^{\mathbf{l}'}(a', \mathbf{h}'; \mu') \right] = \mathbb{E}_{\mathbf{h}',\mu'} \Bigg[& s_f (1 - \delta'_m) \left(p'_f V^{EE}(a', \mathbf{h}'; \mu') + \left(1 - p'_f\right) \sum_{k \in \{b,n\}} \lambda'_k V^{EU_k}(a', \mathbf{h}'; \mu') \right) \\ & + s_f \delta'_m \left(p'_f \sum_k \lambda'_k V^{U_k E}(a', \mathbf{h}'; \mu') + \left(1 - p'_f\right) \sum_{k,d \in \{b,n\}} \lambda'_k \lambda'_d V^{U_k U_d}(a', \mathbf{h}'; \mu') \right) \\ & + (1 - s_f)(1 - \delta'_m) \sum_k \lambda'_k V^{EU_k}(a', \mathbf{h}'; \mu') \\ & + (1 - s_f)\, \delta'_m \sum_{k,d \in \{b,n\}} \lambda'_k \lambda'_d V^{U_k U_d}(a', \mathbf{h}'; \mu') \Bigg) \,\Bigg|\, \mathbf{h}, \mu \Bigg], \end{aligned}$$

where I drop the conditions of the expectation on the left-hand side to save space. The first line on the right-hand side is the case when the female is non-employed and searching for a job and the male keeps his current job. In this case, if she finds a job, the household will be an

[34]The problem of the symmetric household is identical to this household's problem with the change of indices for m and f.

[35]Expectations over human capital levels and aggregate states were discussed in earlier sections.

employed–employed household, otherwise the household will continue to be an employed–non-employed household, but she may retain or lose eligibility for employment-tested transfers. The second line describes the case when the female is searching for a job and the male loses his job. Then, if she finds a job, the household will be a non-employed–employed household where the male may or may not be eligible for employment-tested transfers.[36] If she cannot find a job, then both members of the household will be non-employed, and they will both face eligibility risk for the employment-tested transfers. The third line is the case when she does not search for a job and continues to be non-employed with or without eligibility, and he keeps his current job. Finally, the last line shows the case when she does not search for a job and he loses his job.

For the household in which the male is employed but the female is non-employed and ineligible, the above equations are the same except that she does not receive employment-tested transfers and stays ineligible if she does not find a job.[37]

In this model, the spousal labor supply adjustment is endogenous and it is affected by the magnitude of the earnings loss upon the head's displacement, the human capital level of the spouse (which affects wages and job finding rates), and the generosity of transfers. A higher earnings loss of the head, a higher human capital level of the spouse, and a less-generous transfer policy is more likely to induce a higher spousal labor supply response upon the head's job loss.[38]

Non-employed–non-employed household Next, the recursive problem of a household in which both members are non-employed and eligible for UI is given as follows:

$$
\begin{aligned}
V^{U_b U_b}\left(a, \mathbf{h}; \mu\right) &= \max_{a' \geq a_L,\, s_m, s_f \in \{0,1\}} u\left(c\right) + \sum_{i \in \{m,f\}} \eta_i \left(1 - s_i\right) \\
&+ \beta\left(1-\zeta\right) \mathbb{E}_{\mathbf{l}', \mathbf{h}', \mu'} \left[V^{\mathbf{l}'}\left(a', \mathbf{h}'; \mu'\right) \middle| s_m, s_f, \mathbf{l}, \mathbf{h}, \mu \right] \\
\text{subject to} & \qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad (5) \\
& c + a' \leq \left(1+r\right) a + \phi\left(z;\, 0\right) + b\left(z;\, U_b,\, s_m\right) + b\left(z;\, U_b,\, s_f\right) \\
& \Gamma' = \Lambda\left(\mu,\, z'\right) \quad \text{and} \quad z' \sim \Phi\left(z' \,|\, z\right).
\end{aligned}
$$

[36]According to the UI policy in the U.S., not all workers transitioning into unemployment qualify for UI. In particular, individuals do not qualify for UI if they voluntarily quit their job or if they do not meet requirements for wages earned or time worked during an established period of time, referred to as the base period.

[37]This captures the fact that according to UI policy in the U.S., non-employed individuals receive UI benefits only for a certain number of weeks – which varies over the business cycle – and once that threshold is reached, the non-employed cannot continue to collect UI benefits.

[38]Extensive margin adjustment of the labor supply implies that both non-employment-to-unemployment and unemployment-to-employment transitions are active in the model. For example, a non-employed spouse who is not searching for a job prior to head's job loss can decide to join the labor force and find a job. Overall, in this paper, I focus on the resulting magnitude of the earnings change of the secondary earner because I want to quantify the magnitude of consumption insurance available to households through spousal labor supply adjustments. Only entering into the labor force without finding a job, i.e., a non-employment-to-unemployment transition, would not provide any consumption insurance.

Given that both members of the household are now non-employed, the household chooses the labor supply of both members. They enjoy leisure if they do not look for a job, in which case they do not receive employment-tested transfers. In the current period, the household does not have any labor income. In Appendix B, I lay out and discuss the expectation over the transition of employment statuses of this household.

Employed–employed household Finally, the recursive problem of an employed–employed household is given as follows:

$$\begin{aligned} V^{EE}(a,\, \mathbf{h};\, \mu) \;&=\; \max_{a' \geq a_L} \quad u(c) + \beta(1-\zeta)\,\mathbb{E}_{\mathbf{l}',\mathbf{h}',\mu'}\left[V^{\mathbf{l}'}(a',\, \mathbf{h}';\, \mu')\,\middle|\,\mathbf{l}, \mathbf{h}, \mu\right] \\ \text{subject to} & \qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad (6) \\ & c + a' \leq (1+r)\,a + y + \phi(z;\, y) \\ & y = \tau\left[w(h_m,\, z) + w(h_f,\, z)\right]^{1-\Upsilon} \\ & \Gamma' = \Lambda(\mu,\, z') \quad \text{and} \quad z' \sim \Phi(z' \,|\, z)\,. \end{aligned}$$

This household chooses only consumption vs savings. Individuals of this household are not eligible for employment-tested transfers. Taxable labor earnings are equal to the sum of the wages of the male and female. Appendix B provides details on the expectation term.

3.3 Firm Problem

First, consider a firm that is matched with a worker in submarket h when the aggregate state is μ. The pair operates under a constant-returns-to-scale technology and produces $g(h,\, z)$ units of output, and the worker is paid a wage of $w(h,\, z)$. The match dissolves either through job displacement with probability $\delta(h,\, z)$ or the worker's death with probability ζ. Let $J(h;\, \mu)$ be the value of this firm. Then, the recursive problem of this firm is given as follows:

$$\begin{aligned} J(h;\, \mu) \;&=\; g(h,\, z) - w(h,\, z) + \frac{1}{1+r}(1-\zeta)\,\mathbb{E}_{h',\mu'}\left[(1-\delta(h',\, z'))\, J(h';\, \mu')\,\middle|\, h,\, \mu\right] \\ \text{subject to} & \qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad (7) \\ & \Gamma' = \Lambda(\mu,\, z') \quad \text{and} \quad z' \sim \Phi(z' \,|\, z)\,. \end{aligned}$$

Meanwhile, the value of a vacant firm that posts a vacancy in submarket h under aggregate state μ is given by

$$V(h;\, \mu) = -\kappa + q(\theta(h;\, \mu))\, J(h;\, \mu)\,, \tag{8}$$

where κ is a fixed cost of posting a vacancy.

When vacant firms decide on the submarket in which to post a vacancy to maximize profits, they face the trade-off between the probability of filling a vacancy and the level of surplus from a match. This trade-off exits because if a firm posts a vacancy in a high human capital submarket, then the firm's surplus from the match in that submarket will be higher given that the period output net of wages is non-decreasing in h and job displacement rate $\delta(\cdot)$ is decreasing in h. However, the probability of filling the vacancy is lower in high human capital submarkets given that there are only a few non-employed individuals with high human capital who are able to visit such submarkets to search for a job.

The free-entry condition implies that profits are just enough to cover the cost of filling a vacancy in expectation. As a result, the owner of the firm makes zero profits in expectation. Thus, $V(h;\, \mu) = 0$ for any submarket h such that $\theta(h;\, \mu) > 0$. Then, imposing the free-entry condition to Equation (8) yields the market tightness:

$$\theta(h;\, \mu) = \begin{cases} q^{-1}\left(\frac{\kappa}{J(h;\mu)}\right) & \text{if} \quad h \in \mathcal{H}(\mu) \\ 0 & \text{otherwise.} \end{cases} \tag{9}$$

The equilibrium market tightness contains all the relevant information needed by households to evaluate the job finding probabilities at each submarket.

3.4 Equilibrium

Definition of the Recursive Equilibrium: Given government policies $b(\cdot)$, $e(\cdot)$, $\phi(\cdot)$, $\underline{y}$, τ, and Υ, a recursive equilibrium is a list of policy functions for assets $\left\{a'^{l_m l_f}(a,\, \mathbf{h},\, \mu)\right\}_{l_m, l_f \in \{E, U_b, U_n\}}$ and the labor supply of non-employed members of the household $\left\{s_i(a,\, \mathbf{h},\, \mu)\right\}_{i \in \{m,\, f\}}$, a market tightness function $\theta(h;\, \mu)$, and an aggregate law of motion $\mu' = (z',\, \Gamma')$ such that:

1. Given government policy, shock processes, and the aggregate law of motion, the household's policy functions solve their respective dynamic programming problems (4), (5), (6), and similar problems for other types of households.

2. Labor market tightness is consistent with the free-entry condition (9).

3. The government budget constraint (3) is satisfied.

4. The law of motion of the aggregate state is consistent with household policy functions.

To solve this recursive equilibrium, one must keep track of an infinite dimensional object Γ, making the solution infeasible. To address this issue, I utilize the structure of the model and use the notion of a block recursive equilibrium (BRE) developed by (Menzio and Shi, 2010, 2011).

Definition of the BRE: A BRE is an equilibrium in which the value functions, policy functions, and labor market tightness depend on the aggregate state of the economy μ, only through the aggregate productivity z and not through the aggregate distribution of agents across states Γ.

In Appendix B, I provide a proof for the existence of a BRE and discuss the computational algorithm for solving a BRE. The block recursivity of the model is useful because it allows me to solve the model without keeping track of the distribution of agents. This becomes especially important when I solve for the optimal transfers, which requires solving the equilibrium and finding the tax rate that balances the government budget over a long simulation for any policy.

4 Calibration and Validation

I calibrate the model to match the level and cyclicality of i) heads' earnings losses upon displacement, ii) government transfers, and iii) job finding rates, among others. It is important to match the depth and cyclicality of heads' earnings losses because the magnitude of earnings losses determines how critical the roles of both public and private insurance are when a displacement occurs. Likewise, matching the average generosity of transfers and how it varies over the cycle allows me to correctly quantify the insurance benefits of transfers as well as the incentive costs of transfers on the family labor supply. Finally, the model must also match well how job finding rates vary over the cycle since job finding rates directly affect the strength of private insurance mechanisms through spousal earnings. Spouses may find it difficult to find a job in recessions and may thus not be able to provide insurance.

Next, I show that the calibrated model generates the observed small spousal earnings response to the head's displacement especially in recessions. Furthermore, the model-implied female labor supply elasticities with respect to changes in taxes and transfers are in line with estimates from the microeconomic studies and the cross-state evidence presented in Section 2.

4.1 Calibration

Functional forms The model period is set to a quarter. The utility function over consumption is $u\left(c_t\right) = \frac{c_t^{1-\sigma}}{1-\sigma}$ with risk aversion parameter σ. The labor market matching function is $M\left(v,\, u\right) = \frac{uv}{\left[u^\gamma + v^\gamma\right]^{1/\gamma}}$, as in den Haan, Ramey, and Watson (2000), implying that the job finding rate $p\left(\theta\right) = \theta\left(1+\theta^\gamma\right)^{-1/\gamma}$ and vacancy filling rate $q\left(\theta\right) = \left(1+\theta^\gamma\right)^{-1/\gamma}$ are between 0 and 1.

As in Shimer (2005), I use a process for the job displacement rate that depends on labor productivity, which is extended to incorporate that displacement rates across jobs with various skill levels may differ: $\delta\left(h,\, z\right) = \bar{\delta} \times \exp\left(\omega_z^\delta \times \left(z - \bar{z}\right)\right) \times \exp\left(\omega_h^\delta \times \left(h - \bar{h}\right)\right)$, where $\bar{\delta}$ is the mean of the displacement rate over time; ω_z^δ captures the volatility of the job displacement rate over time; ω_h^δ captures the variation of the job displacement rate across skills; and $\bar{z}$ and $\bar{h}$ are average labor productivity and human capital levels, respectively. These separation shocks can be interpreted as idiosyncratic match quality shocks that drive down the productivity of a match to a low enough level so that the match endogenously finds it optimal to dissolve, as in Lise and Robin (2017). Finally, the production function is $g\left(h,\, z\right) = hz$.

I restrict the policy instruments to take the form of the means-tested transfer amount and the employment-tested transfer amount as linear functions of current aggregate labor productivity. I set $\phi\left(z\right) = \bar{\phi} - \omega_\phi\left(z - \bar{z}\right)$ and $b\left(z\right) = \bar{b} - \omega_b\left(z - \bar{z}\right)$. This implies that if, for example, $\omega_\phi > 0$, then means-tested policy is countercyclical.

The logarithm of the aggregate labor productivity z_t follows an AR(1) process:

$$\ln z_{t+1} = \rho \ln z_t + \sigma_\epsilon \epsilon_{t+1},$$

where $0 \leq \rho < 1$, $\sigma_\epsilon > 0$ and ϵ are independent and identically distributed standard normal random variables. I take z_t as the average seasonally adjusted quarterly real output per person in the non-farm business sector, which is constructed by the Bureau of Labor Statistics (BLS). The data for the time period 1948:I-2007:IV is logged and Hodrick-Prescott (HP) filtered to obtain deviations from trend.[39] Estimation of this process yields $\rho = 0.7612$ and $\sigma_\epsilon = 0.0086$.

External calibration Having specified functional forms and the law of motion of the productivity process, I now calibrate several parameters outside of the model. Table A2 in Appendix C summarizes these parameters and their values.

I choose a risk aversion parameter of $\sigma = 2$. I set the value of leisure for males to $\eta_m = 0$, implying that they are always searching for a job and that changes in government transfers do not affect the search behavior of the household's primary earner in the model.[40] Next, I set $r = 0.5$ percent, which generates an annual return on assets of around 2 percent. I set $\zeta = 0.625$ percent, implying a 40-year average working lifetime. I set the worker's share of output α to match the ratio of wages and salaries to GDP.

I use 20 equally spaced grid points for human capital, $h \in \{h_L, ..., h_H\}$. I set $h_L = 0.2$ and $h_H = 1.8$. I assume that human capital increases by one step with probability π^E when employed. This implies $\Delta^E = 0.084$. Moreover, I set the probability of human capital depreciation when non-employed π^U to 0.75.[41]

I also calibrate the income threshold $\underline{y}$ for means-tested transfers and the benefit expiration rate $e(\cdot)$ for employment-tested transfers externally. I incorporate three means-tested transfers: SNAP, EITC, and TANF. I acknowledge that each of these programs has different income thresholds and specific eligibility requirements. For example, TANF has work requirements such that individuals are expected to have some work attachment and also meet the income threshold for eligibility. However, individuals can receive TANF payments even if they do not gain employment within two years, while they cannot receive TANF if they do not satisfy the income test.

[39] I exclude the Great Recession period from this data due to the increase in the value of this measure of productivity, since the reconciliation of this is beyond the scope of my paper. Standard deviations of quarterly time series are computed as log deviations from an HP trend with parameter 1600. For standard deviations of annual times series, I use the same object with parameter 100.

[40] The average labor force participation rate of married men is 92 percent, implying that η_m would be small if anything. Moreover, this assumption allows me to focus on the effects of government transfers on the spousal labor supply.

[41] Ljungqvist and Sargent (1998) set $\pi^U = 0.2$ in the calibration of their model, where the model period is 2 weeks. For a quarterly calibration (i.e., around a 6-period unemployment spell), this implies that the probability of experiencing human capital loss is around 0.75.

On the other hand, EITC requires positive earnings and introduces a non-linear relationship between earned income and the transfer amount received by the household. However, the household becomes ineligible for EITC when labor earnings exceed the income threshold for eligibility. For these reasons, I merge these three programs into a general means-tested transfer policy.[42]

Using the reports published by the U.S. Department of Agriculture for SNAP, the U.S. Internal Revenue Service for EITC, and the U.S. Department of Health and Human Services for TANF, I first calculate the weighted-average of income limits for these three programs in 2007. I find that the average quarterly income limit is around $\$7,000$. In order to convert this value into model units, I calculate the ratio of the weighted-average of this income limit in the data to quarterly minimum labor earnings and find a ratio of 2.58.[43] Then, I set $\underline{y}$ in the model so that the ratio of the income limit $\underline{y}$ to quarterly minimum labor earnings in the model is the same as its data counterpart.[44]

The average duration of UI payments is around 26 weeks (or two quarters), which is typically extended during recessions. For example, during the Great Recession, it was extended to 99 weeks. Hence, I set the expiration rate of employment-tested transfers to 0.5 (i.e., 1/2) when the labor productivity is greater than or equal to its mean, and set it to 0.13 (i.e., $1/(99/13)$) when labor productivity is at its lowest level.[45] Finally, I set the progressivity parameter of the tax system TO $\Upsilon = 0.151$, as in Heathcote, Storesletten, and Violante (2014), and calibrate the level parameter τ to balance the government budget in expectation.

Internal calibration I jointly estimate the remaining 14 parameters using the model. Table A3 in Appendix C summarizes the results.

I choose two parameters, the discount factor β and borrowing limit a_L, to match two data moments of the asset-to-income distribution: the fraction of households with non-positive liquid wealth and the median ratio of the credit limit to quarterly labor income. In the data, I calculate the former from both the PSID and the Survey of Consumer Finances (SCF), and the latter from the SCF given that only the SCF provides information on the credit limit. Appendix A provides the details of calculating these moments from the data.

The utility value of leisure for females η_f controls the level of the opportunity cost of searching for a job. I choose η_f to match the female labor force participation rate (LFPR) relative to the

[42]Modeling the details of these programs introduces additional policy parameters that need to be taken into account when solving for the optimal set of policies over the business cycle. To reduce the number of such policy instruments, I refrain modeling them separately.

[43]Between 2000 and 2006, the federal minimum hourly wage was \$5.15, and in 2007 it was \$5.85. For these years, I calculate the total quarterly minimum labor earnings as min hourly wage $\times$ 40 hours/week $\times$ 13 weeks/quarter. Next, I divide the average of the income limit by the average quarterly minimum labor earnings in the data.

[44]Notice that the quarterly minimum labor earnings in the model are invariant to policy changes. This allows me to calibrate $\underline{y}$ outside of the model.

[45]Specifically, the grid for e is set to $[1/(99/13), 1/(75/13), 1/(26/13), 1/(26/13), 1/(26/13)]$, where 75 weeks reflects the Extended Benefits Program of UI transfers.

male LFPR in the data. I use data from the 2000-2007 CPS to compute the average LFPR of males and females for a sample of married or cohabiting couples between ages 20 and 60, i.e., a sample similar to the PSID sample used in Section 2. I find that the average LFPR is 71 percent for females and 92 percent for males, which implies a relative female LFPR of 77 percent.

The next five parameters are calibrated to discipline five labor market moments of the model. I choose the cost of posting a vacancy κ to match the average unemployment rate. I target the volatility of the job finding rate in the data by choosing the elasticity of matching function γ.[46] I use the three parameters $\bar{\delta}$, ω_z^δ, and ω_h^δ of the job displacement process in the model to match three moments in the data: the average job displacement rate, its volatility over time, and its variation across the earnings distribution.[47] I calculate the ratio of the median pre-displacement labor earnings of displaced household heads (i.e., labor earnings one year prior to displacement) to the median labor earnings of never-displaced heads using the PSID data. I find that this ratio is 76 percent in the data, which implies that the median earnings of displaced heads is 76 percent of the median earnings of never-displaced heads; i.e, the displacement risk is relatively higher for lower-paying jobs. In the model, ω_h^δ controls the heterogeneity in displacement risk across workers with different human capital, and thus different wages, given that skill level directly affects wages in the model. Hence, I choose ω_h^δ to match the same earnings ratio in the model.

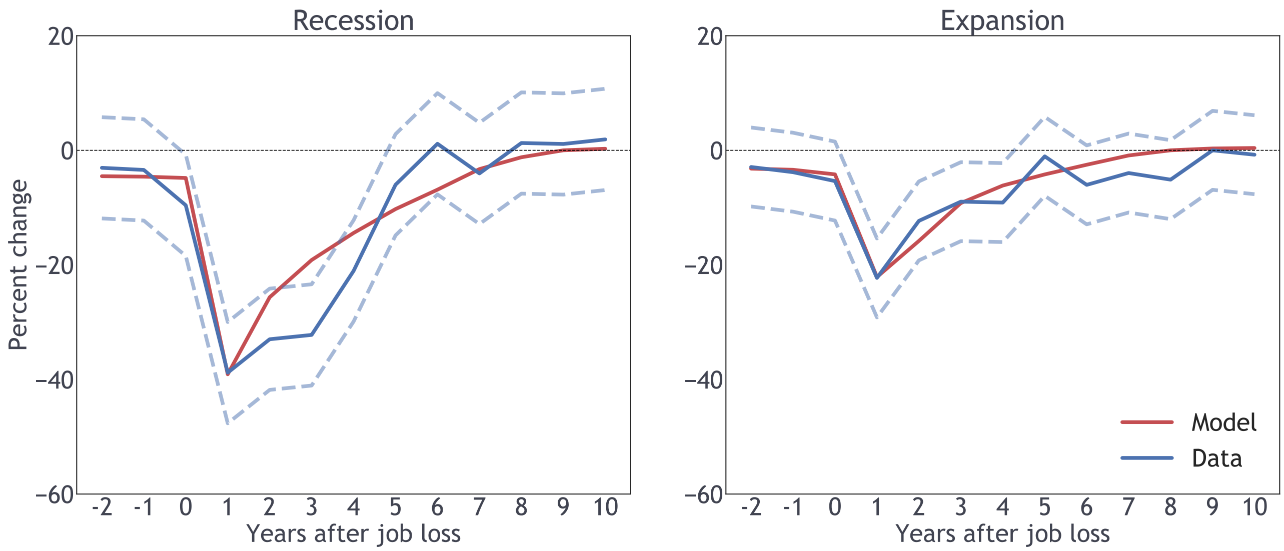
I choose two parameters of the human capital process to discipline the cyclicality of the initial drop in head earnings upon job loss and the labor earnings distribution across employed individuals. Recall that the magnitudes of the declines in human capital Δ^U vary over the cycle so that the model exogeneously generates the cyclicality of the initial drop in head earnings upon job loss. I set $\Delta^U = 0.59$ for realizations of z that are lower than its mean value $\bar{z}$ and $\Delta^U = 0.34$ for realizations of z that are greater than or equal to $\bar{z}$.

Figure 5 compares head earnings losses upon job displacement in recessions and in expansions between the data and the model, where model estimates are obtained from the same regression as in Equation (1) using the model-simulated data, which are aggregated to yearly periods. Although not targeted, the model captures well the magnitude of persistence in earnings loss upon displacement. Recall that, in the data, the persistence and the cyclical gap between the initial earnings loss upon displacements in recessions and expansions are mainly driven by the wage losses. The model is also consistent with the data along this dimension. This is because, as discussed above, the larger initial earnings losses are driven by larger depreciation of human capital during recessions, which directly affects the productivity and wages in the next job. The decline in employment (i.e., hours) is also an outcome of a displacement shock, given that human

[46] The job finding rate data were constructed by Robert Shimer. For additional details, see Shimer (2012). The data from June 1967 to December 1975 were tabulated by Joe Ritter and made available by Hoyt Bleakley.

[47] I calculate the first two moments from the CPS and the last moment from the PSID. I do so because the CPS provides monthly employment status information, while the PSID does not. Using this data, I calculate monthly labor flow rates, the unemployment rate, and the labor force participation rate over time and aggregate them to a quarterly frequency.

Figure 5: Labor Earnings of the Head upon Displacement: Model vs Data



Note: This figure plots the changes in relative labor earnings of the family head upon job displacement in recessions (left panel) and expansions (right panel) both in the model and in the data. I estimate the changes in relative labor earnings from a distributed lag-regression model using the PSID. The solid-blue lines show the point estimates, and the dashed light-blue lines show the 90 percent confidence intervals. I compare these results to the estimates obtained from the same regression using the model-simulated data, which are aggregated to yearly periods. Earnings losses one year after displacements both in recessions and in expansions are targeted in the model calibration.

capital depreciation also lowers the job finding rate in the model.

Next, the probability of human capital accumulation π^E controls the earnings distribution. For example, if π^E is very large, then workers would quickly accumulate their human capital, and the resulting dispersion of earnings would be small. I choose π^E to match the ratio of the 90th to the 10th percentiles of labor earnings distribution of the employed from the PSID 2007.

Finally, the remaining four parameters of the model are related to government transfers. I measure the average generosity of means-tested transfers by the ratio of total quarterly means-tested transfers per recipient to quarterly minimum labor earnings using NIPA data for 1976 - 2007 and NIPA reports.[48] The average ratio across these years in the data is 0.74, implying that, on average, the means-tested transfers amount is 74 percent of minimum earnings. I choose the average level of means-tested transfers $\bar{\phi}$ so that this statistic in the model is the same as in the data. Similarly, I calculate the average ratio of total quarterly UI transfers per unemployed individual to quarterly minimum labor earnings, using data on UI transfer amounts from NIPA and data on the total number of unemployed from the BLS for 1948 - 2007, and find a ratio of

[48] For each program, the program reports published by the government agencies provide information on the number of recipients each year. Using these data together with data from NIPA, I calculate the total transfer amount per recipient for each program in a given year and then sum these amounts to obtain the total means-tested transfer amount per recipient for that year. The year that we observe positive transfer amounts paid under each of the three programs in NIPA is 1976. I divide the annual amounts of total means-tested transfers per recipient by 4 to obtain the quarterly amounts. Then, I divide this amount by the quarterly minimum labor income to obtain the ratio of total quarterly means-tested transfers per recipient to minimum labor earnings in the data.

0.36. Again, I choose the average level of employment-tested transfers $\bar{b}$ so that this statistic in the model is the same as in the data.[49] Then, I choose ω_ϕ and ω_b to match the standard deviations of total means-tested transfers per recipient and total UI transfers per unemployed individual in the data. Under this parametrization, the level of income taxation that satisfies Equation (3) becomes $\tau = 0.81$.

4.2 Validation

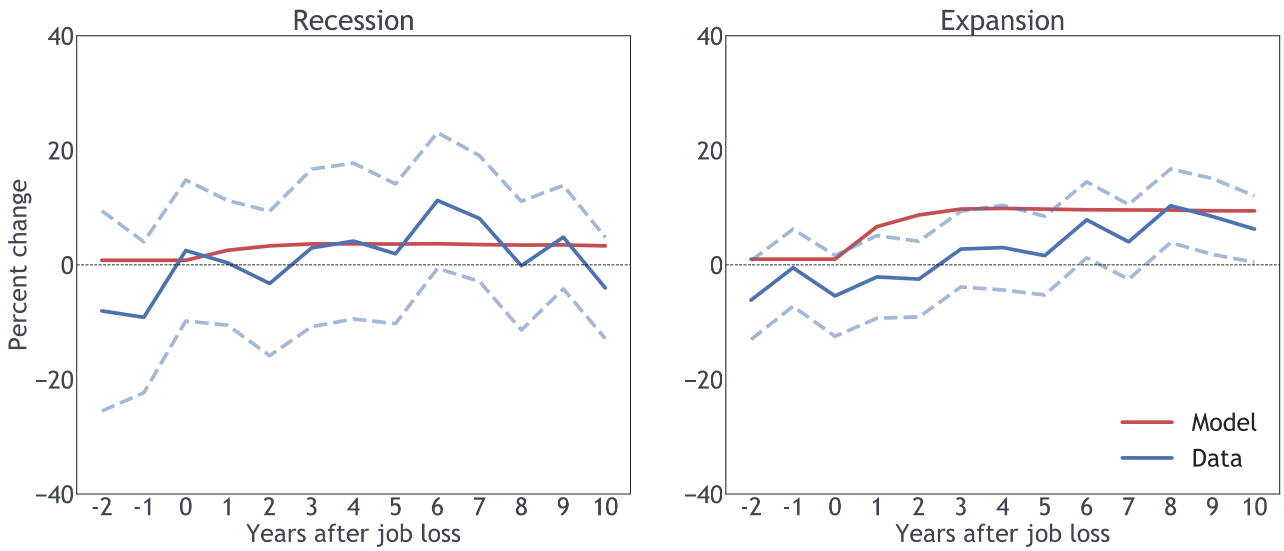
Next, I show that the model endogenously generates a small spousal earnings response to the job displacement of the family head. I then benchmark model-implied female labor supply elasticities with respect to tax reforms against microeconomic estimates as well as the cross-state evidence on the elasticity of contemporaneous spousal earnings response upon the head's displacement to changes in transfer generosity, as presented in Section 2. Appendix C also compares model outcomes with a list of other important untargeted data moments, including the consumption drop upon job loss, the asset-to-income distribution, and the extent to which displacement events are correlated across the head and the spouse over the business cycle. These supplement the discussion in the main text on how the model is able to generate the observed spousal earnings response as well as a reasonable magnitude of elasticity of the spousal labor supply to taxes and transfers. For example, generating the left tail of the asset-to-income distribution is critical for obtaining a large magnitude of the female participation elasticity with respect to net wages, as in the data, because, according to the microeconomic estimates, the labor supply of women in low-income households is more elastic to changes in taxes than that of women in high-income households.

Spousal earnings upon the head's job displacement Figure 6 compares the change in spousal earnings upon the head's job displacement in recessions and in expansions between the model and the data. In the model, the change in spousal earnings upon the head's displacement is small especially in recessions, as in the data. In recessions (expansions), the mean of the post-displacement coefficients is 3.4 (9.2) percent in the model compared with 2.6 (4) percent in the data. This comparison shows that when the model is calibrated to match the levels and cyclicalities of i) the head's earnings losses upon job displacement, ii) government transfers, and iii) job finding rates, it is able to generate a small change in spousal earnings upon the head's displacement, especially in recessions, as in the data.

Female labor supply elasticities To ensure that the role of crowding-out effects of transfers in explaining the small spousal earnings response is not overstated in the model, I compare the

[49] Using micro data from SIPP for 1996 - 2014, I find that, on average, around 35 percent of total means-tested transfers and 60 percent of total UI transfers are paid to married households. Also, married households constitute around 33 percent of all means-tested transfer recipients and 58 percent of all UI recipients. Finally, around 60 percent of all transfers received by married households are means-tested transfers. Figure A3 in Appendix A presents these results.

Figure 6: Spousal Earnings Response to the Head's Job Displacement: Model vs Data



Note: This figure plots the changes in relative labor earnings of the spouse upon the head's job displacement in recessions (left panel) and in expansions (right panel) both in the model and in the data. I estimate the changes in relative spousal earnings from a distributed lag-regression model using the PSID. The solid-blue lines show the point estimates, and the dashed light-blue lines show the 90 percent confidence intervals. I compare these results to the estimates obtained from the same regression using the model-simulated data, which are aggregated to yearly periods.

model-implied spousal labor supply elasticities with respect to changes in net wages or transfers to those found in microeconomic studies and the cross-state evidence presented in Section 2.

The first panel of Table 2 compares female participation elasticity with respect to net wages in the data and the model. Chetty, Guren, Manoli, and Weber (2013) summarize the magnitudes of these elasticity estimates identified from permanent wage changes resulting from unexpected tax reforms across seven different studies.[50] They report female participation elasticity as the change in log employment rates divided by the change in log net-of-tax wages. For example, to obtain this elasticity, Eissa and Hoynes (2004) compare the labor market outcomes across households who received more generous tax credits and those who did not, as a consequence of the 1993 tax reform in the U.S. Overall, the magnitudes of these empirical estimates on female participation elasticity with respect to net wages lie between 0.15 and 0.43.

These empirical estimates are calculated using various natural or quasi-natural experiments that exploit cross-sectional or time variation in tax reforms. The underlying goal of these methods is to approximate a randomized experiment design for causal inference. Under the assumption of a statistically independent treatment status, these experiments estimate the average treatment effect. Model-predicted elasticity that is comparable with these empirical estimates arises from a similar randomized experiment implemented using model-generated data. To obtain such an elasticity in the model, I simulate a large number of households in the model and implement

[50] Chetty, Guren, Manoli, and Weber (2013) summarize results from nine different papers. However, two of these papers focus on men in their sample. Hence, I consider the remaining seven papers as my comparable benchmarks.

Table 2: Magnitudes of Female Labor Supply Elasticities: Data vs Model

	All households	Low-income households	High-income households
	Female participation elasticity with respect to net wages		
Data	$0.15 - 0.43$	$0.27 - 0.43$	0.15
Model	0.33	0.40	0.23
	Female labor earnings elasticity with respect to transfers		
Data	-0.17		
Model $\bar{\phi}$	-0.12	-0.20	-0.02
Model $\bar{b}$	-0.01	-0.02	-0.001

Note: This table compares female participation elasticity with respect to net wages and the elasticity of the female labor earnings response upon the head's displacement to transfer generosity in the data and the model. Comparisons are made for all females, females in low-income households, and females in high-income households. Empirical estimates of the participation elasticities are summarized by Chetty, Guren, Manoli, and Weber (2013), and the empirical estimate of the earnings elasticity is calculated by the author from the PSID. Please refer to the main text for the details on the calculation of these elasticities in the data and the model.

an unexpected and permanent increase in tax level τ for a randomly selected subsample of households. I then compute the differences in outcomes between the treated and untreated agents to identify the elasticity in the model. Specifically, I increase τ so that the average net wages of the employed among the treated households increases by 10 percent.[51] I then calculate the model-implied female participation elasticity with respect to net wages as the ratio of the difference in log female employment rates between the two groups to the difference in log average wages of the employed between the two groups. I find that the magnitude of female participation elasticity with respect to net wages is 0.33 in the model, which lies in between the range of the values found in the literature.

Importantly, it is possible to divide a subset of these empirical estimates summarized by Chetty, Guren, Manoli, and Weber (2013) into two groups based on the demographics and characteristics of their sample. On one hand, we can group estimates by Eissa and Liebman (1996), Meyer and Rosenbaum (2001), and Eissa and Hoynes (2004) as participation elasticities of females in low-income households. This grouping works because these three studies focus on either married women in low-income households or single women receiving government transfers, both of whom can be interpreted as spouses in low-income households from the lens of my model. On the other hand, Liebman and Saez (2006) estimate the participation elasticity of females who are married to high-income males whose income is above 75th percentile of the income distribution. A comparison of the magnitudes of elasticities reveals that the participation

[51] Notice that according to the tax system I use in this model, a higher τ implies higher after-tax labor income.

elasticity is much larger for females in low-income households than in high-income households.

In the model, I compute the elasticity separately for females across the income distribution using the same experiment as above.[52] The model generates the declining profile of the magnitude of this elasticity in household income. However, the model overestimates the magnitude for high-income households. This is because, as shown in Table A4 in Appendix C, the model does not generate the high amount of wealth held by the households in the right tail of the asset-to-income distribution, for whom the magnitude of this elasticity is excepted to be very low.

The second panel of Table 2 compares the magnitude of contemporaneous elasticity of spousal earnings response upon the head's displacement to transfer generosity in the model to the empirical estimate I present in Section 2 using cross-state variation in transfer generosity from the PSID. Recall that in the data, I estimate that additional dollar of transfers crowds out 17 cents of spousal earnings following the family head's job displacement.

In the model, I implement an unexpected increase in the average generosity of means-tested transfers $\bar{\phi}$ and employment-tested transfers $\bar{b}$ for a randomly selected subsample of households. I then calculate the same elasticity as the ratio of the difference in average spousal earnings in the year following the head's displacement and the difference in the average transfer receipt upon the head's displacement across the treatment and the control groups. While the model-implied magnitude of this elasticity is close to its data counterpart, the model reveals that most of the response is driven by changes in means-tested transfers and that female earnings response is almost inelastic to the generosity of employment-tested transfers. This inelasticity occurs because, in the model, as in the current U.S. policy, eligibility of the head for employment-tested transfers does not include an earnings threshold for the spouse and such transfers pay only small amounts for a short duration. Thus, changes in employment-tested transfers have little effect on the spouse's labor supply decision following the head's displacement. On the other hand, the eligibility for means-tested transfers requires a low family labor income, which puts an implicit income tax on the spousal labor supply and thus discourages it when the transfer amount is large. Thus, a more generous means-tested transfer policy crowds out a larger spousal earnings response following the head's displacement. Finally, this mechanism is stronger for low-income households given that the head of a low-income household is more likely to be displaced and that the insurance value of transfers are larger for such households in the model.

[52] Eissa and Hoynes (2004) report the average gross hourly wages of husbands and wives as \$12.09 and \$7.56 in 1995 dollars, respectively, for their entire sample. These wages imply that the ratio of the total gross hourly wage of the household (\$19.65) to the hourly minimum wage in 1995 (\$4.25) is equal to 4.62 in their sample. To discipline the model sample of low-income households, I consider low-income households as those with total gross labor earnings less than or equal to 4.62 times the model's minimum wage. On the other hand, the data sample in Liebman and Saez (2006) includes family heads whose earnings are above the 75th percentile. Hence, in the model, I classify households as high income if the head's gross wage is greater than or equal to the 75th percentile of the wage distribution of the employed.

5 Results

In this section, I present two main results. First, I implement a counterfactual experiment to explore the role of more-generous government transfers during recessions in explaining the small change in spousal earnings upon the head's displacement especially in recessions. Second, I study the optimal design of means-tested and employment-tested transfers over the business cycle.

5.1 Effects of transfers on the spousal earnings response

What explains the small spousal earnings response upon the head's job displacements especially in recessions, when the family needs insurance? In the model, as in the data, I consider three potential mechanisms: correlated shocks between the head and the spouse, crowding-out effects of government transfers, and lower job finding rates.

First, Figure A5 in Appendix C shows that the displacement shocks are not correlated between the head and the spouse in the model, as in the data. This is unsurprising given that, in the model, the displacement risk is a function of an individual's own human capital and the aggregate state. Since the model does not assume a correlation of human capital across the head and the spouse, the head's displacement does not increase the spouse's displacement risk.

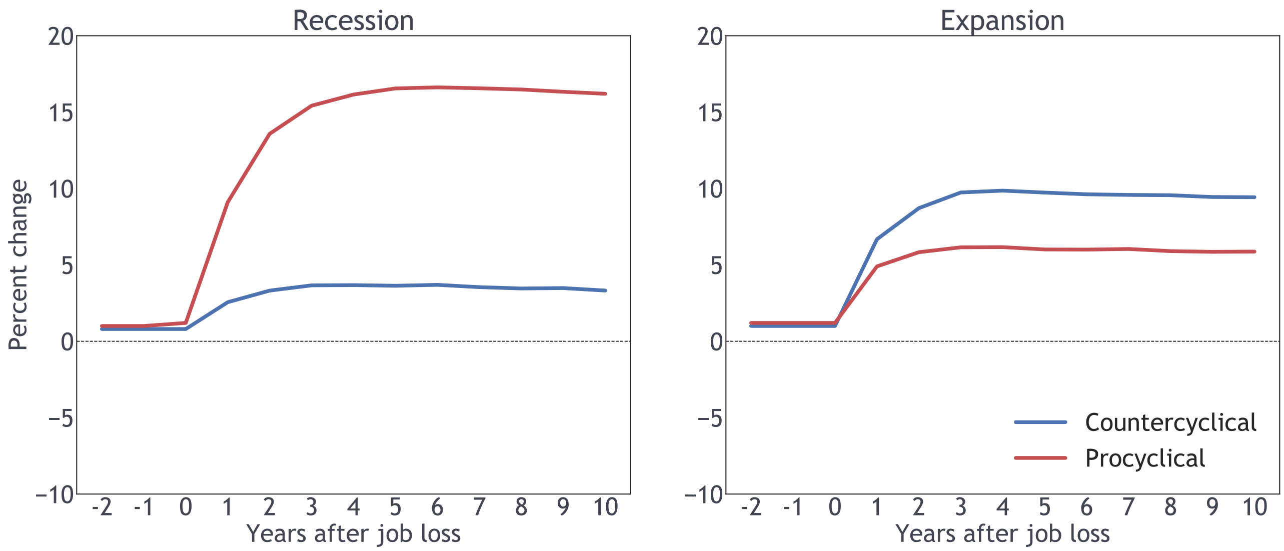
Note that while the empirical evidence I present in Section 2 provides an important result on the extent to which generous transfers crowd out the spousal earnings response, I am unable to measure how the strength of the crowding-out effect varies over the business cycle in the data, given the small sample size when I group displacements not only by the timing of displacements (recessions vs expansions) but also by the generosity of transfers available to households living in different locations (generous vs non-generous states).

For this reason, I use the model to analyze how these crowding-out effects vary over the business cycle. The model also allows me to distinguish between the two remaining potential sources that could generate the limited active spousal insurance: the lack of labor supply (due to the crowding-out effects of transfers) and the lack of labor demand (due to lower vacancy creation). I can make this distinction because the calibrated model is designed to isolate the effect of varying transfers on the spousal labor supply. I achieve this in two steps. First, I set the value of leisure for males η_m to be 0 to make male workers inelastic to changes in transfers. Second, I assume that wages are a fraction of the aggregate productivity. This assumption implies that wages and labor demand (i.e., the number of vacancies created across the submarkets) do not change when government transfers vary.[53] Hence, by varying transfer policies, I can isolate the crowding-out effects of transfers on the spousal labor supply response to the head's displacement.

Figure 7 compares the changes in spousal earnings upon the head's job displacement in recessions and expansions in the model under the countercyclical baseline/existing policy and

[53] In Section 6, I explore the implications of allowing for endogenous wage choices by households, to also incorporate the effects of transfers on labor demand.

Figure 7: Labor Earnings of the Spouse upon the Head's Displacement: Policy Counterfactuals



Note: This figure plots the changes in relative spousal labor earnings upon the head's job displacement in recessions (left panel) and in expansions (right panel) in the model under the countercyclical baseline policy and under a procyclical policy. The procyclical policy here is the optimal policy obtained in the next section. I estimate the changes in spousal earnings from a distributed lag-regression model using model-simulated data, which are aggregated to a yearly period.

a procyclical policy.[54] I find that the mean of the post-displacement coefficients in recessions is 15.3 percent under the procyclical policy as opposed to 3.4 percent under the countercyclical policy. For expansions, it is 5.9 percent under the procyclical policy and 9.2 percent under the countercyclical policy. Hence, under the procyclical policy, spousal insurance is now much larger in recessions, when the household needs it the most.

This result is driven by the fact that, in recessions, the head's job displacement causes a larger drop in household income. Larger income loss makes the spousal labor supply more elastic to changes in transfers because the elasticity is larger for low-income households as shown, in Table 2. Hence, reducing the generosity of transfers in recessions significantly increases the spousal earnings response to the head's displacement. In contrast, expansions are periods when earnings losses are not as pronounced. As such, the spousal earnings response is small and less elastic to the generosity of government transfers.

This experiment contributes to our understanding of why the change in the female labor supply upon earnings loss within the family, otherwise known as the "added worker effect," is small (Heckman and MaCurdy, 1982; Lundberg, 1985; Cullen and Gruber, 2000; Stephens, 2002; Hendren, 2017; Busch, Domeij, Guvenen, and Madera, 2020). First, Table 2 reveals that, in both the model and the data, the female labor supply responds to changes in transfer generosity. Second, the model shows that, absent the generous transfers in recessions, spousal earnings increase significantly upon the head's displacement in recessions. These findings imply that the female labor supply is in fact responsive to *both* the earnings loss of the primary earner and

[54]The procyclical policy here is the optimal policy obtained in the next section.

the changes in government transfer generosity, but in opposite ways. As a result, the measured female labor supply response from the data is masked by the crowding-out effects of transfers.

5.2 Optimal policy in the baseline model

The results in the previous section show that the incentive costs of transfers on the spousal labor supply are larger in recessions and smaller in expansions. Since existing transfers are more generous in recessions, it implies that there may be potential welfare gains from changing the generosity of transfers over the business cycle. Motivated by this observation, I now study the optimal design of means-tested and employment-tested transfers over the business cycle.

The government chooses the policy instruments to maximize the ex-ante lifetime utility of a household who is born (under the veil of ignorance) into the stationary equilibrium under the existing/current policy, subject to the government budget constraint. Specifically, the government's objective is to maximize a utilitarian social welfare function subject to Equation (3) by choosing a set of policy instruments. The policy reform implemented at this time is unanticipated and permanent. Moreover, the welfare analysis incorporates the effects of the transition path from the stationary distribution of the economy under the current policy to that under the proposed policy. Appendix D provides formal expressions of the welfare calculation.

In my main optimal policy analysis, the focus is to obtain the optimal level and cyclicality of means-tested and employment-tested transfer amounts. Thus, I jointly search over four policy parameters $\left(\bar{\phi},\, \omega_\phi,\, \bar{b},\, \omega_b\right)$ together with the implied tax level parameter τ to solve for the optimal transfer policy. In Section 6, I extend this analysis by also optimizing over the income threshold $\underline{y}$ of the means-tested transfers and the expiration rate $e\left(\cdot\right)$ of the employment-tested transfers, taking as given the optimal policy instruments obtained in this section.

Table 3 compares the per-recipient transfer amounts as a multiple of the minimum wage in the model paid under means-tested and employment-tested transfers in the current policy with those in the optimal policy. Separate comparisons are presented for when the aggregate labor productivity z is at its average level and its lowest level, i.e., in a deep recession. The minimum wage in the model is exogeneous to changes in policy, and thus reporting each transfer amount as a multiple of the minimum wage presents a useful interpretation.

I find that the optimal policy and current policy feature similar levels of total transfers when labor productivity is at its average level. What is different between the optimal policy and the current policy is the cyclicality of transfers. In particular, in a recession, the optimal policy provides less-generous means-tested transfers (procyclical), while the current policy provides more-generous means-tested transfers (countercyclical). Less-generous means-tested transfers in recessions alleviate the large incentive costs on the labor supply of spouses. This induces higher female labor force participation in response to the larger increase in the marginal utility of consumption from the head's larger earnings losses upon displacement in recessions. On the

Table 3: Current Policy vs Optimal Policy in the Baseline Model

Labor productivity	Means-tested	Employment-tested	Total
	Current policy		
Average	1.61	0.86	2.48
Recession	1.90	1.04	2.94
	Optimal policy		
Average	1.47	1.12	2.59
Recession	0.46	1.35	1.81

Note: This table compares per-recipient transfer amounts as a multiple of the minimum wage in the model paid under the means-tested and under the employment-tested transfers in the current policy and the optimal policy. Separate comparisons are presented for when aggregate labor productivity z is at its average level $\bar{z}$ and its minimum level, i.e., in a deep recession. The minimum wage in the model is exogeneous to changes in policy, and thus reporting transfer amounts as a multiple of the minimum wage presents a useful interpretation.

other hand, the optimal policy provides more-generous employment-tested transfers in recessions (countercyclical) and of comparable cyclicality with those from the current policy. The provision of insurance benefits in recessions is better accomplished through employment-tested transfers because the eligibility for employment-tested transfers is based on an individual's employment status, and it does not check spousal earnings. Moreover, these transfers are smaller payments and, more importantly, limited in duration. These differences lead to lower crowding-out effects of employment-tested transfers on the spousal labor supply. This finding is corroborated by the results of Table 2, where I show that the magnitude of female labor supply elasticity with respect to changes in $\bar{b}$ is small.

These results show that the optimal policy incorporates both types of transfers. One might think that, given its large implicit income tax on spousal earnings, it may be welfare improving to completely eliminate means-tested transfer programs and provide public insurance only through employment-tested transfers. However, this proposal turns out to be suboptimal for two reasons. First, the incentive costs of transfers on spousal earnings are highly cyclical, as discussed in the previous section, such that they are much larger in recessions. Thus, reducing the amount of means-tested transfers during recessions is sufficient to induce a higher job search effort of women upon the head's job displacement. Second, females with low human capital – who have been non-employed for a long time – are not able to find a job especially during recessions, even if they are induced to look for a job under the optimal policy. Hence, the optimal policy better targets insurance toward such long-term non-employed with high marginal utility of consumption through permanent means-tested transfers.

Table 4: Macroeconomic Effects of the Optimal Policy

	Current policy	Optimal policy
Labor market and taxation		
Unemployment rate (%)	5.4	5.5
Relative female LFPR (%)	71	74
Median skill of females	0.98	1.13
Level of income tax parameter τ	0.81	0.83
Asset-to-income distribution		
Median asset-to-income ratio	1.16	1.47
Fraction with non. pos. wealth (%)	11	9.2
Consumption		
Mean	0.84	0.85
Median	0.75	0.77
Std. dev. of mean	0.0180	0.0177
Gini	0.42	0.42

Note: This table compares the average values of macroeconomic outcomes under the current policy and the optimal policy. These values are obtained by using model-simulated data under these two policies. The volatility of average consumption is measured by the standard deviation of log deviations from an HP trend with parameter 1600.

Effects of optimal policy on macroeconomic outcomes Table 4 compares the average values of macroeconomic outcomes under the current policy with those under the optimal policy across two steady states. Compared with the economy under the current policy, the economy under the optimal policy has a similar unemployment rate but much higher relative LFPR of married women, 74 percent versus 71 percent. As a result, the median skill of females is larger under the optimal policy, as they spend more time employed. The increase in employment reduces the income tax required to finance a similar level of total government transfers (as shown in Table 3). Thus, the level parameter of income taxation τ increases, which leads to higher after-tax labor earnings. The wealth distribution also shifts right under the optimal policy, as we observe a sizeable decline in the fraction of families with non-positive net liquid wealth and an increase in the median value of the asset-to-income distribution. These changes in the macroeconomy increase the average consumption level under the optimal policy. I find that the mean and the median of consumption across these families are respectively 1 and 2 percentage points larger under the optimal policy. While the Gini of the consumption distribution is the same under these two policies, the volatility of average consumption is only slightly lower under the optimal policy because of the offsetting effects of the increase in spousal earnings and the decline in transfer receipts under the optimal policy in recessions.

Table 5: Heterogeneous Welfare Gains from the Optimal Policy

Family employment: Only head employed

		Female skill		Male skill	
		$\leq p50$	$> p50$	$\leq p50$	$> p50$
Asset	$\leq p50$	0.69	1.19	0.84	0.46
	$> p50$	0.35	0.47	0.42	0.35

Family employment: Both non-employed

		Female skill		Male skill	
		$\leq p50$	$> p50$	$\leq p50$	$> p50$
Asset	$\leq p50$	1.40	1.86	1.45	1.00
	$> p50$	0.40	0.85	0.84	0.60

Note: This table shows the heterogeneous welfare gains from the optimal policy for various groups. Cutoffs for the asset and skill groups are obtained from the stationary distribution of the economy before the government changes the policy to the optimal policy. Welfare gains are in percent lifetime-equivalent consumption terms and computed relative to the current policy.

Heterogeneous welfare gains from the optimal policy The optimal policy yields welfare gains equivalent to around 0.85 percent of additional lifetime consumption compared with the current policy.[55] But, ex-post welfare gains are heterogeneous. To demonstrate this, I group families by their employment status, asset level, and male and female skill levels based on their states in the stationary distribution prior to policy reform and obtain an aggregate welfare for each group by only integrating over families that belong to that group. Appendix D provides formal expressions for this calculation.

Table 5 shows that most of the welfare gains are enjoyed by wealth-poor families with an unskilled male and a skilled female. It is precisely for this family that a female's participation in the labor market brings the largest gains in consumption, given that the displacement probability of the unskilled male and potential earnings of the skilled female are larger. In contrast, the lowest welfare gains are enjoyed by wealth-rich families with a skilled male and an unskilled female for whom spouses are less likely to enter the labor market.

5.3 Optimal policy in the exogenous labor supply model

I now explore the implications of abstracting from the endogeneity of private insurance (i.e., spousal labor supply) to public insurance in determining the optimal policy. In particular, I consider an alternative environment in which female labor force participation decisions are

[55] Roughly half of these welfare gains are attributable to optimizing over the average level of transfers, and the rest are attributable to optimizing over the cyclicality of transfers.

Table 6: Optimal Policy in the Baseline vs Exogeneous Spousal Labor Supply Model

Labor productivity	Means-tested	Employment-tested	Total
Optimal policy in the baseline model			
Average	1.47	1.12	2.59
Recession	0.46	1.35	1.81
Optimal policy in the exogenous spousal labor supply model			
Average	2.61	0.35	2.96
Recession	2.70	0.47	3.17

Note: This table compares per-recipient transfer amounts as a multiple of the minimum wage under the optimal policy of the baseline model and under the optimal policy in the exogenous spousal labor supply model. Separate comparisons are presented for when aggregate labor productivity z is at its average level $\bar{z}$ and its minimum level, i.e., in a deep recession. The minimum wage in the model is exogeneous to changes in policy, and thus reporting transfer amounts as a multiple of the minimum wage presents a useful interpretation.

invariant to changes in government policy. In order to do so, I fix spousal labor supply decisions to be those under the current (old) policy o for any new (proposed) policy n; i.e., $s_f^n = s_f^o \; \forall n$. Then, I solve for the optimal policy of this model using the same methodology as before. Table 6 compares per-recipient transfer amounts as a multiple of the minimum wage under the optimal policy of the baseline model with endogenous female labor supply and under the optimal policy of this alternative model with exogenous female labor supply.

I find that the optimal policy in the exogenous spousal labor supply model is different from the optimal policy of the baseline model in two ways. First, total transfers paid are more generous. Second, the optimal policy in this case features countercyclical means-tested and employment-tested transfers. The optimal policy is countercyclical because the incentive costs of transfers are now unaccounted for and thus the optimal cyclicality of transfers is mostly determined by the cyclicality of insurance benefits, which is larger in recessions when unemployment risk is higher. Moreover, according to this optimal policy, around 90 percent of total transfers are means-tested since means-tested transfers better target insurance toward families who need it the most and for whom incentive costs are now disregarded.

Overall, this exercise shows that endogenizing the spousal labor supply response to changes in government policy is a critical determinant of both the optimal level and the optimal cyclicality of transfers. Interestingly, from the lens of my model, when we disregard this mechanism, the optimal policy looks similar to the current policy in the U.S., given that both provide more-generous employment-tested and means-tested transfers in recessions. However, when we take into account the endogenous spousal labor supply response to policy, the optimal policy turns out to be substantially different. As a result, policy makers should recognize that married households have an important source of self-insurance through adjustments in the spousal labor supply, and

Table 7: Welfare Gains from the Optimal Policy under Alternative Assumptions

Baseline	0.85
Incorporating Medicaid into means-tested transfers	0.73
Removing job search requirements for employment-tested transfers	0.70
Non-separable preferences	0.92
Endogenous wages	0.89

Note: This table shows the welfare gains from the optimal policy for the baseline model (first row) and welfare gains from the same optimal policy when an assumption of the baseline model is changed. Welfare gains are in percent lifetime-equivalent consumption terms and computed relative to the current policy.

generous payments to these households make them worse off due to large crowding-out.

6 Extensions and Robustness

In this section, I first extend the set of policy instruments on the optimal policy analysis. In particular, taking as given the optimal policy instruments in the previous section, (i.e., under the optimal levels and cyclicalities of the means-tested and employment-tested transfers for the baseline model), I optimize over the income threshold $\underline{y}$ of eligibility for means-tested transfers and the level and the cyclicality of the employment-tested transfer expiration rate $e(\cdot)$ one at a time. I find that the optimal income threshold is less restrictive (i.e., it allows families with slightly higher total labor income to be eligible for means-tested transfers). In this case, welfare gains increase from 0.85 percent to around 0.95 percent. On the other hand, optimizing over the UI expiration rate barely affects welfare gains, given the presence of permanent means-tested transfers for the long-term unemployed.

Next, I relax a list of assumptions in the baseline model and compute the welfare gains from the optimal policy.[56] Results are summarized in Table 7.[57] Details on the implementation of these exercises are provided in Appendix E. Overall, welfare gains from the optimal policy remain similar in magnitude when each of these assumptions are changed one at a time.

7 Conclusion

This paper documents that the spousal earnings response to the family head's job displacement is small, especially in recessions when the head's earnings losses are larger. Using cross-state

[56] I also check the implications of these exercises on the results of Section 5. Sizeable welfare gains from the baseline optimal policy in these cases imply that less-generous transfers in recessions still induce spouses to supplement family earnings by working.

[57] I acknowledge that the optimal policy of the baseline model may not be the optimal policy of a model with assumptions that differ from the baseline model. However, this exercise at least shows us if there is a large quantitative effect of assumptions on the welfare results.

differences in transfer generosity, I provide evidence on the presence of substantial crowding-out effects of government transfers. Next, I develop an incomplete markets model with family labor supply and aggregate fluctuations, where the model-implied female labor supply elasticities with respect to taxes and transfers are in line with empirical estimates. I find that existing generous transfers in recessions discourage the spousal labor supply significantly after the head's displacement. In this framework, the optimal policy features procyclical means-tested and countercyclical employment-tested transfers, unlike the existing policy. Overall, the optimal policy is procyclical because there are welfare gains of reducing means-tested transfers in recessions to induce spouses to work more when the head experiences larger earnings losses. This finding is a direct implication of the model's prediction that the spousal labor supply is more elastic to means-tested transfers especially in recessions when household income is lower, which is in line with the data.

In an alternative model where the spousal labor supply is invariant to transfer generosity, I show that the average transfer generosity of the optimal policy increases. Moreover, the optimal policy in this case would instead feature countercyclical transfers of both types since insurance benefits are larger in recessions and the incentive costs on the spousal labor supply are now unaccounted for. As a result, I argue that endogenizing the spousal labor supply response to changes in government policy is critical in determining both the optimal level and the optimal cyclicality of government transfers.

In this paper, I made several simplifying assumptions in order to keep the analysis computationally feasible. For example, all households in the model are assumed to be married, and thus the model abstracts from endogenous marriage and divorce decisions. It may be particularly interesting to incorporate these decisions because changes in transfer generosity may affect the incentives to get married or stay married. Moreover, my model also abstracts from the general equilibrium effects of policy changes on savings behavior and thus capital accumulation and output. I leave these to future research.

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Appendix

A Data

In this section, I first discuss sample selection and construction of some of the important variables from the PSID data. Second, I document the relative change in annual working hours of the head and the spouse upon the head's displacement. Third, I explain the details of calculating the asset-to-income distribution from the PSID and SCF data, as well as the amount and incidence of means-tested and employment-tested transfer receipts by married households from the SIPP data. Finally, I document the change in spousal earnings following the family head's job loss using data from the SIPP. These supplement the discussions in Section 2 and 4.

A.1 PSID Data

The PSID is a nationally representative survey that was conducted in the U.S. annually from 1968 to 1997 and biannually since 1997. The PSID provides information on labor market outcomes such as annual labor earnings and working hours, as well as characteristics of the family such as age, education, and number of children. Labor earnings include wages and salaries, bonuses, overtime, tips, commissions, professional practice or trade, market gardening, miscellaneous labor income, and extra job income.

While I take many of the variables I use in the main analysis directly from the PSID, there are several variables I must create using the other available information in the data. First, to address inconsistencies of the variable defining the age of the individuals, I create a new age variable separately for the head and the spouse by increasing the ages based on those reported in the first observation of the family. Next, I use completed years of education to create potential years of labor market experience for both the head and the spouse as $Age - Education - 6$ if the individual's number of years of completed education is larger than or equal to 12, and as $Age - 18$ if otherwise. This way, individuals with fewer years of completed education are not assigned large values for their labor market experience. I also create the total number of children and young children (defined as children less than 6 years of age) in the family using the relation of each individual in the family unit to the head of the family.

I create variables for involuntary job displacement using a question that asks the reason for the loss of the previous job of the individuals who are either without a job or have been employed in their current job for less than a year. Following the literature, I define an involuntary job loss as a separation due to firm closure, layoff, or firing. As Stevens (1997) and Stephens (2002) point out, the timing of displacement is not precisely identified in all years of the survey. This is because while the earnings and hours questions are designed to obtain information for the previous year, the question that I use to determine job displacement is not year specific. To better understand this issue, consider a head of the family who reports being displaced according to the definition

Table A1: Summary Statistics for Families with and without Job Displacement

	Never displaced*	Displaced°
Head's age	36.49	32.90
Spouse's age	34.38	30.99
Head's education	15.49	13.19
Spouse's education	15.02	13.07
Whites (%)	67.96	57.03
Number of children	1.30	1.52
Number of young children	0.51	0.65
Head's annual hours	2,154	1,851
Spouse's annual hours	1,288	1,142
Head's industry - Manufacturing (%)	18.38	19.76
Number of families	6,584	2,799

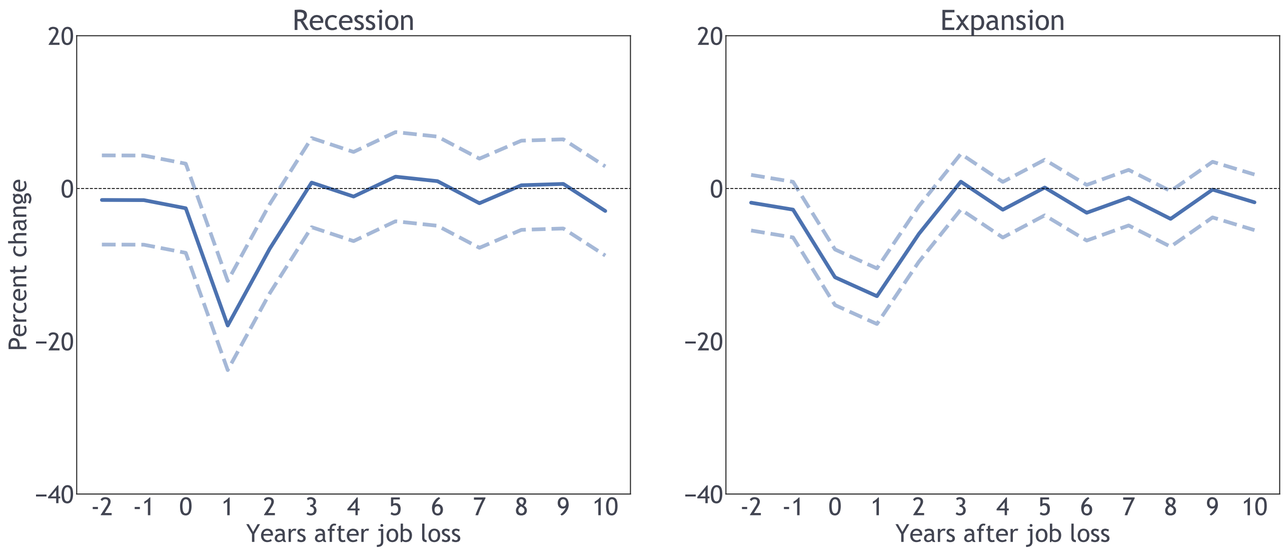
Note: This table shows unweighted averages of selected characteristics for never-displaced families (i.e., families in which the head of the family is never displaced during any time the family is observed in the survey) and displaced families (i.e., families in which the head of the family is displaced at least once). The data are obtained from the PSID 1968-2015 surveys for families in which both the husband and the wife are between the ages of 20 and 60 and not in the Latino sample.
* Averages are obtained using all observations for families with a never-displaced head.
° Averages are obtained from the survey year prior to the displacement year of the head.

above in the 1992 survey of the PSID. This implies that the head may be displaced any time between January 1991 and the survey date in 1992. Thus, the econometrician may assign such displacement either in 1991 (previous calendar year) or in 1992 (survey year). In my analysis, following Stephens (2002), I assume that displacements occur in the previous calendar year, to align the displacement year with the earnings and hours information.

Given that I also use the data from biannual survey years of the PSID (1997-2015), displacements that occur in between these years have information only for every other year. However, I still prefer to keep this time period in my main sample, especially to incorporate the Great Recession period into my analysis to better analyze the differential effects of displacement over the business cycle on the labor market outcomes of couples. Thus, when a displacement occurs in this time frame, I observe relevant variables used in my regressions biannually. Furthermore, given that the 1968 survey only identifies workers who have been displaced within the past 10 years, it is not possible to determine the exact year of displacement within these 10 years. Therefore, I do not incorporate displacements that occur in 1968 into my analysis.

Table A1 compares the characteristics of families in which the head had never been displaced with characteristics of families in which the head had been displaced at least once. Couples of the families in which the head had been displaced are slightly younger and less educated. Importantly, the average working hours and earnings of displaced heads are lower than those of non-displaced heads, implying that displacement risk is larger for those who are at the lower

Figure A1: Working Hours of Family Head upon Job Displacement



Note: This figure plots the changes in relative working hours of the family head upon his job displacement in recessions (left panel) and expansions (right panel). I estimate the changes in relative working hours from a distributed lag-regression model using PSID. The solid-blue lines show the point estimates, and the dashed light-blue lines show the 90 percent confidence interval.

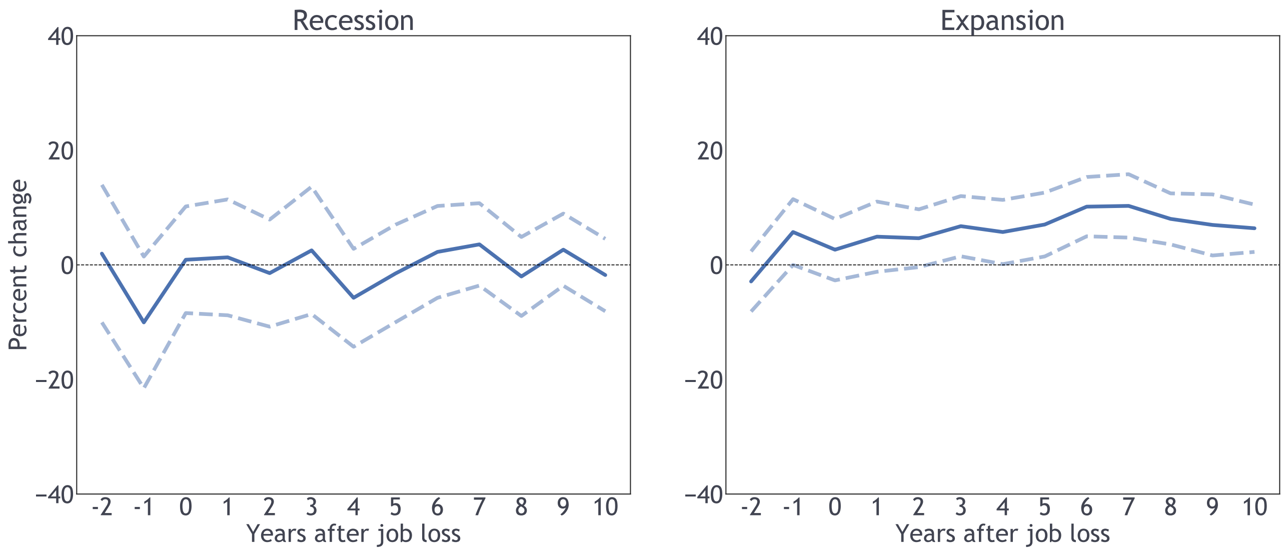
end of the earnings distribution. However, once we control for observable characteristics, the average pre-displacement earnings and hours of displaced heads becomes only around 2 to 4 percent lower than those of non-displaced heads, as shown in Figures 1 and A1.

Head and spousal hours upon the head's job displacement Figure A1 shows that the magnitude of the drop in the head's relative hours when the head is displaced in recessions (18 percent) is similar to that in expansions (14 percent) in the year following displacement. Moreover, the relative hours recover just after 2 years both in recessions and in expansions. Hence, both the cyclical gap in earnings losses upon displacement over the cycle and the persistence of the earnings losses are largely explained by a drop in wages rather than a drop in hours. Ruhm (1991), Stevens (1997), and Huckfeldt (2021) also document this quick recovery of relative hours of displaced workers using the PSID. My findings complement their results, as I provide additional evidence that hours recover relatively quickly upon displacement both in recessions and in expansions and that wage losses explain most of the cyclical gap in earnings losses.

Figure A2 shows the change in spousal hours upon the head's displacement in recessions and expansions. I find that the average change in spousal hours upon the heads' displacements in recessions is small, while the average change in spousal hours in expansions increases by up to 10 percent, and the coefficients remain significant after 2 years following displacement. The average post-displacement change is -0.01 percent in recessions and 7 percent in expansions.

Asset-to-income distribution Starting from a 1999 survey, the PSID provides information on asset holdings of households every two years. However, the amount of credit card debt is

Figure A2: Working Hours of Spouse upon the Head's Job Displacement



Note: This figure plots the changes in relative working hours of the spouse upon the family head's job displacement in recessions (left panel) and expansions (right panel). I estimate the changes in relative spousal hours from a distributed lag-regression model using PSID. The solid-blue lines show the point estimates, and the dashed light-blue lines show the 90 percent confidence interval.

only available after 2011. I calculate the net liquid wealth of each household by adding the amount in checking and savings accounts, the amount of bonds and other assets, the amount of stocks, and the amount of vehicle equity, and then deducting the amount of credit card debt. Then, the fraction of families with non-positive net liquid wealth is simply given by the ratio of the total number of families with non-positive values of this net-liquid-wealth measure to the total number of families. Next, I calculate the net liquid wealth to quarterly labor income ratio by dividing this measure of net liquid wealth by total quarterly family labor income (i.e., the sum of head and spouse labor income) for each family with positive total family labor income.[58] Finally, I calculate the ratio of the weighted distribution of this net liquid wealth to quarterly labor income across these families. The percentiles of the PSID 2015 distribution given in Table A4 below are obtained from this calculation.

A.2 SCF Data

I also calculate the net liquid asset-to-income distribution from the SCF 2007. To do so, I first construct a sample of family heads with the following restrictions: i) marital status is married or cohabiting and ii) ages of the head and spouse are between 20 and 60. This way, the SCF sample will be similar to the PSID sample.

The SCF provides information on the i) amount in up to seven different checking accounts; ii) amount in up to seven different savings/money market accounts; iii) value of all certificates of deposits; iv) total value of all types of mutual funds; v) total value of all savings bonds; vi) total

[58] I obtain the total quarterly labor income by dividing the annual amount of total labor income by 4.

value of all bonds other than saving bonds; vii) total value of publicly traded stocks; viii) total value of all cash or call money (brokerage) accounts; ix) amount in annuity and trust accounts; x) other assets such as money owed to family or gold, silver, and other jewelry, and xi) value in vehicle equity. The summation of these values gives the total liquid wealth of the family. I then subtract the total credit card debt to obtain the net liquid wealth of each family. Next, I calculate the fraction of families with non-positive net liquid wealth and the distribution of the net liquid wealth to quarterly labor income ratio, as in the PSID. The percentiles of the SCF 2007 distribution given in Table A4 below are obtained from this calculation. Finally, the median ratio of the credit limit to quarterly labor income in Table A3 is also obtained from this dataset, using the information on the total credit limit and total quarterly labor income.

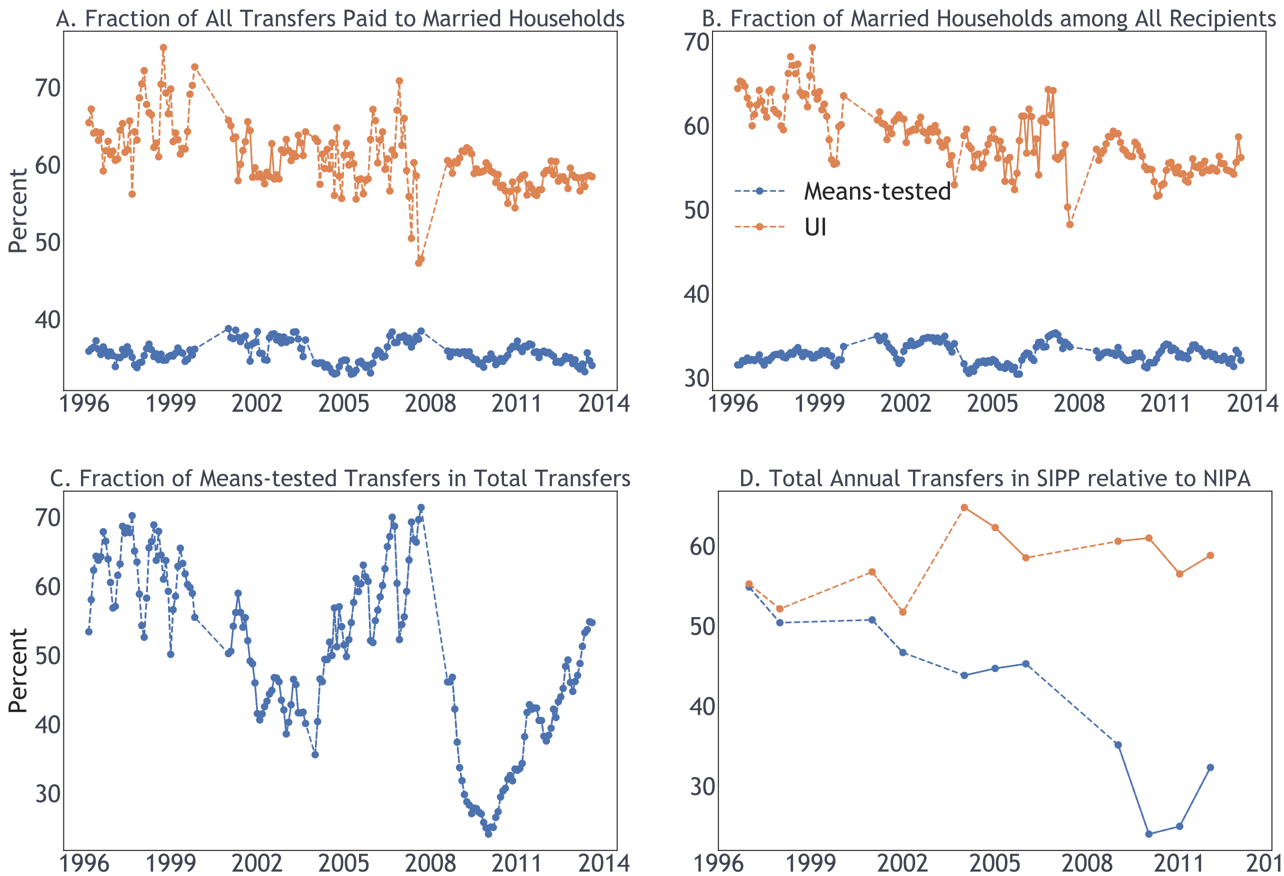
A.3 SIPP Data

Amount and incidence of transfer receipts by married households Here, I document the amount and incidence of transfer receipts by married households. To do so, I use monthly data from the SIPP between 1996 and 2013 that provide information on monthly amounts of means-tested and UI transfers receipts of married households. Panel A of Figure A3 separately plots the total means-tested and employment-tested (UI) transfers paid to married households as a fraction of total transfers. On average, around 35 percent of all means-tested transfers and 60 percent of total UI transfers are paid to married households. According to Panel B, married households constitute around 33 percent of all means-tested transfer recipients and 58 percent of all UI recipients. Finally, Panel C shows that around 60 percent of all transfers received by married households are means-tested transfers. However, this value drops to as low as 30 percent after 2008. This drop occurs because, starting in this year, the survey data drastically underestimates total annual means-tested transfers when compared to total government means-tested transfers in the NIPA tables, as shown in Panel D. Overall, Figure A3 documents that means-tested transfers consitute a large fraction of total transfer receipts of married households.

Spousal earnings response in SIPP Finally, I measure the change in spousal earnings upon the family head's job displacement using the SIPP data between 1996 and 2013. The SIPP data provide monthly information on employment status, earnings, and reasons job loss. The SIPP is also a longitudinal survey that follow individuals but for a shorter duration (up to five years) than the PSID. It also offers a larger sample size. Thus, given the smaller sample size of the PSID, it is useful to also document the magnitude of spousal insurance upon the head's job displacement using the SIPP data.

To do so, I first create a job displacement variable in the SIPP. The SIPP provides richer information on the reasons for job loss. In order to explore whether the magnitudes of spousal insurance vary across the reason's for the head's job loss, I create two types of displacement variables. First, I define displacement as a separation due to a layoff, which includes layoffs,

Figure A3: Transfer Receipts by Married Households

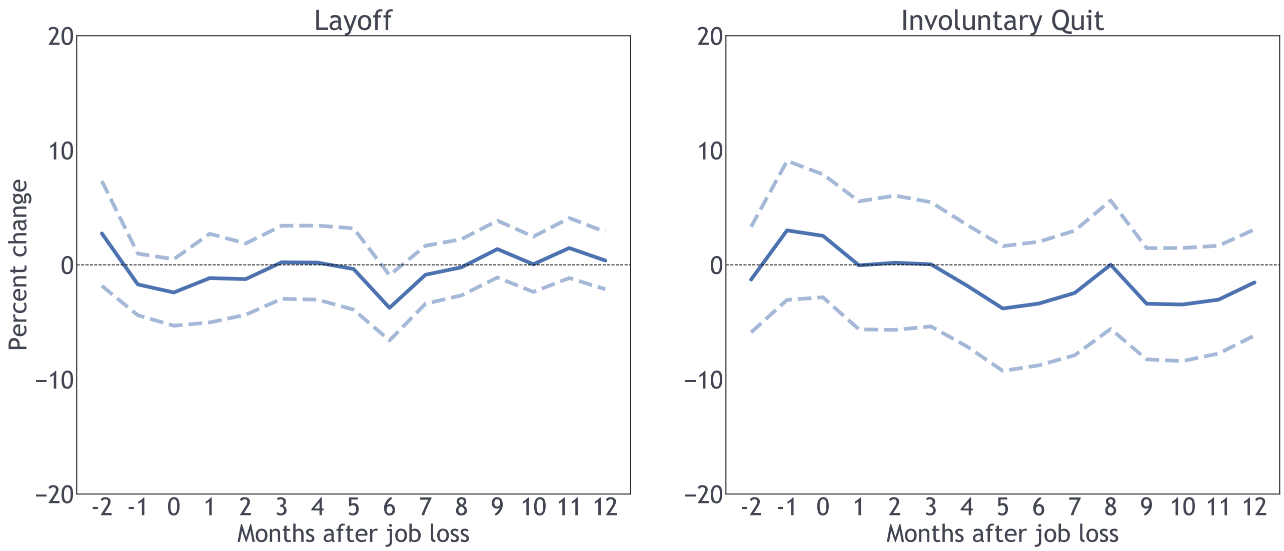


Note: Panel A separately plots the total means-tested and employment-tested (UI) transfers paid to married households as a fraction of total transfers. Panel B shows the total number of married household heads receiving means-tested and employment-tested transfers as a fraction of all recipients. Panel C shows the ratio of total means-tested transfers to total transfers (sum of means-tested and UI) received by married households. Finally, Panel D separately plots the total annual transfer amounts in SIPP data as a fraction of aggregate transfer amounts in NIPA tables for means-tested and employment-tested transfers. Values in Panels A-C are obtained from SIPP data between 1996 and 2013. NIPA amounts in Panel D are obtained from Table 3.12 in the NIPA tables, where I classify EITC, SNAP, and TANF payments as means-tested transfers and UI as employment-tested transfers. Dashed lines indicate time periods when data are not available.

discharges, or job loss because of employer bankruptcy, business closure, slack work, or business conditions. Second, I define displacement as a separation due to an involuntary quit because of unsatisfactory work arrangements (hours, pay, etc.) or other reasons. Then, I estimate the same regression specification at a monthly frequency, as in Equation (1) where the dependent variable is spousal earnings, under these two different definitions for the head's job displacement.

Figure A4 shows that the change in spousal earnings upon the head's displacement is also small according to the SIPP data, as in the PSID data. Moreover, this result remains the same following the head's job loss due to a layoff or an involuntary quit. Importantly, given the larger sample size of the SIPP, the point estimates are now more tightly estimated, especially when displacement is defined as a job loss due to a layoff, which is closer to the definition of job displacement in the PSID.

Figure A4: Spousal Earnings Response to the Head's Job Displacement in the SIPP



Note: This figure plots the changes in relative labor earnings of the spouse upon the family head's job displacement due to layoffs (left panel) and due to involuntary quits (right panel). I estimate the changes in relative spousal labor earnings from a distributed lag-regression model using the SIPP. The solid-blue lines show the point estimates, and the dashed light-blue lines show the 90 percent confidence intervals.

B Model

B.1 Baseline model

In this section, I lay out and discuss the expectation over the transition of the employment statuses of non-employed–non-employed and employed-employed households in the baseline model.

Non-employed–non-employed household The expected value of a non-employed-non-employed household is given by

$$
\begin{aligned}
\mathbb{E}_{\mathbf{l}',\mathbf{h}',\mu'}\left[V^{\mathbf{l}'}\left(a',\mathbf{h}';\mu'\right)\right] = \mathbb{E}_{\mathbf{h}',\mu'}\Bigg[& s_m s_f p'_m \left(p'_f V^{EE}\left(a',\mathbf{h}';\mu'\right) + \left(1-p'_f\right)\sum_{k\in\{b,n\}} \lambda'_k V^{EU_k}\left(a',\mathbf{h}';\mu'\right)\right) \\
& + s_m s_f\left(1-p'_m\right)\left(p'_f \sum_k \lambda'_k V^{U_k E}\left(a',\mathbf{h}';\mu'\right) + \left(1-p'_f\right)\sum_{k,d\in\{b,n\}} \lambda'_k \lambda'_d V^{U_k U_d}\left(a',\mathbf{h}';\mu'\right)\right) \\
& + s_m\left(1-s_f\right)\left(p'_m \sum_k \lambda'_k V^{EU_k}\left(a',\mathbf{h}';\mu'\right) + \left(1-p'_m\right)\sum_{k,d\in\{b,n\}} \lambda'_k \lambda'_d V^{U_k U_d}\left(a',\mathbf{h}';\mu'\right)\right) \\
& + \left(1-s_m\right)s_f\left(p'_f \sum_k \lambda'_k V^{U_k E}\left(a',\mathbf{h}';\mu'\right) + \left(1-p'_f\right)\sum_{k,d\in\{b,n\}} \lambda'_k \lambda'_d V^{U_k U_d}\left(a',\mathbf{h}';\mu'\right)\right) \\
& + \left(1-s_m\right)\left(1-s_f\right)\sum_{k,d\in\{b,n\}} \lambda'_k \lambda'_d V^{U_k U_d}\left(a',\mathbf{h}';\mu'\right) \Bigg|\, \mathbf{h},\mu\Bigg],
\end{aligned}
$$

where I drop the conditions of the expectation in the left-hand side to save space. The first line on the right-hand side shows the case when both the male and the female search for a job in the current period and he finds a job. In this case, if she also finds a job, the household will be an employed-employed household, otherwise the household will be an employed-non-employed household, but she may retain or lose eligibility for employment-tested transfers. The second line is the case when both of them search for a job and he does not find one. Then, if she finds a job, the household will be a non-employed-employed household where he may retain or lose eligibility for employment-tested transfers. If she cannot find a job, then both members of the household will continue to be non-employed, and they will both face eligibility risk for the employment-tested transfers. The third and fourth lines are cases when one of them searches for a job and the other does not. In these cases, if the searcher finds a job, then the household will have one employed member and the other will face eligibility risk; otherwise, both members will continue to be non-employed and face eligibility risk. Finally, the last line shows the case when neither member searches for a job, continue to be non-employed, and face eligibility risk.

Similarly, for the household in which any non-employed member is ineligible, the above expectation is the same except that this member stays ineligible for employment-tested transfers if he/she does not find a job.

Employed–employed household The expected value of an employed-employed household is given by

$$\begin{aligned}\mathbb{E}_{\mathbf{l}',\mathbf{h}',\mu'}\left[V^{\mathbf{l}'}\left(a',\,h';\,\mu'\right)\right] = \mathbb{E}_{\mathbf{h}',\mu'}\Bigg[&\left(1-\delta'_m\right)\left(\left(1-\delta'_f\right)V^{EE}\left(a',\mathbf{h}';\mu'\right)+\delta'_f\sum_{k\in\{b,n\}}\lambda'_k V^{EU_k}\left(a',\mathbf{h}';\mu'\right)\right)\\&+\delta'_m\left(\left(1-\delta'_f\right)\sum_{k}\lambda'_k V^{U_kE}\left(a',\mathbf{h}';\mu'\right)+\delta'_f\sum_{k,d\in\{b,n\}}\lambda'_k\lambda'_d V^{U_kU_d}\left(a',\mathbf{h}';\mu'\right)\right)\Bigg|\,\mathbf{h},\mu\Bigg].\end{aligned}$$

The first line on the right-hand side shows cases when the male keeps his job and the female may lose her job and face eligibility risk. The second line gives cases in which he loses his job and faces eligibility risk, and again the female may or may not lose her job and face eligibility risk if she loses it.

B.2 Model with endogenous wages

In this section, I present an extension of the baseline model with endogenous wages. This is a directed search model in which wage choices of non-employed individuals are endogenous. In this model, submarkets are indexed by the wage offer w of firms and human capital level h of workers. This means that non-employed individuals now direct their search efforts toward a specific wage offered by a job that is compatible with their own skill level. In this case, the wages of the employed members of the household become additional state variables. Below, I first lay out the dynamic problems. Next, I prove the existence of the BRE of this model.

Household problem I present the problems of several types of households, and the rest follows similarly, as in the baseline model. First, consider a household in which the male is employed and the female is eligible and non-employed. The problem of this household is

$$\begin{aligned} V^{EU_b}\left(a,\, w_m,\, \mathbf{h};\, \mu\right) &= \max_{a' \geq a_L,\, s_f \in \{0,1\}} \quad u\left(c\right) + \eta_f\left(1 - s_f\right) \\ &+ \max_{\widetilde{w}_f} \left\{ \beta\left(1-\zeta\right) \mathbb{E}_{\mathbf{l}',\mathbf{h}',\mu'} \left[V^{\mathbf{l}'}\left(a',\, w_m,\, \mathbf{h}';\, \mu'\right) \middle| s_f,\, \widetilde{w}_f,\, \mathbf{l},\, \mathbf{h};\, \mu \right] \right\} \\ \text{subject to} & \\ & c + a' \leq \left(1+r\right)a + y + \phi\left(z;\, y\right) + b\left(z;\, U_b,\, s_f\right) \\ & y = \tau w_m^{1-\Upsilon} \\ & \Gamma' = \Lambda\left(\mu,\, z'\right) \quad \text{and} \quad z' \sim \Phi\left(z' \,|\, z\right), \end{aligned}$$

where we now keep track of the wages of the employed member of the household. Notice also that the wages of the employed member are not a direct function of the human capital level. Instead, non-employed individuals direct their search efforts toward any wage submarket $\widetilde{w}_f$, but the job finding rate for that submarket varies across the human capital levels of the non-employed. Thus, we can think of different human capital submarkets as being present in each wage submarket. Moreover, the expectation is also indexed by the wage choice of the non-employed member of the household, given that her job finding rate will be affected by her wage choice. The rest of the explanation of this problem is similar to its counterpart in the baseline model.

It is also insightful to show the expectation over the transition of employment statuses of this household, which I lay out below:

$$\begin{aligned} \mathbb{E}_{\mathbf{l}',\mathbf{h}',\mu'} \left[V^{\mathbf{l}'}\left(a',\, w_m,\, \mathbf{h}';\, \mu'\right) \middle| s_f,\, \widetilde{w}_f,\, \mathbf{l},\, \mathbf{h},\, \mu \right] = \mathbb{E}_{\mathbf{h}',\mu'} \Bigg[& s_f\left(1-\delta_m'\right) \Big(p_f'\left(\widetilde{w}_f, h_f\right) V^{EE}\left(a', w_m, \widetilde{w}_f, \mathbf{h}'; \mu'\right) \\ & + \left(1 - p_f'\left(\widetilde{w}_f, h_f\right)\right) \sum_{k\in\{b,n\}} \lambda_k' V^{EU_k}\left(a', w_m, \mathbf{h}'; \mu'\right) \Big) \\ & + s_f \delta_m' \Big(p_f'\left(\widetilde{w}_f, h_f\right) \sum_k \lambda_k' V^{U_k E}\left(a', \widetilde{w}_f, \mathbf{h}'; \mu'\right) \\ & + \left(1 - p_f'\left(\widetilde{w}_f, h_f\right)\right) \sum_{k,d\in\{b,n\}} \lambda_k' \lambda_d' V^{U_k U_d}\left(a', \mathbf{h}'; \mu'\right) \Big) \\ & + \left(1-s_f\right)\left(1-\delta_m'\right) \sum_k \lambda_k' V^{EU_k}\left(a', w_m, \mathbf{h}'; \mu'\right) \\ & + \left(1-s_f\right)\delta_m' \sum_{k,d\in\{b,n\}} \lambda_k' \lambda_d' V^{U_k U_d}\left(a', \mathbf{h}'; \mu'\right) \Big) \,\Bigg|\, \mathbf{h}, \mu \Bigg], \end{aligned}$$

where $p_i'(\widetilde{w}_i, h_i) \equiv p(\theta(\widetilde{w}_i,\, h_i';\, \mu'))\ \forall i \in \{m,\, f\}$. The explanation of the terms on the right-hand side is similar to its counterpart in the baseline model.

Next, consider a household in which the both male and the female are eligible non-employed. The problem of this household is given as follows:

$$
\begin{aligned}
V^{U_bU_b}(a,\, \mathbf{h};\, \mu) \quad &= \quad \max_{a' \geq a_L,\, s_m, s_f \in \{0,1\}} \quad u(c) + \sum_i \eta_i (1 - s_i) \\
&+ \quad \max_{\widetilde{w}_m, \widetilde{w}_f} \left\{ \beta (1-\zeta)\, \mathbb{E}_{\mathbf{l}', \mathbf{h}', \mu'} \left[V^{\mathbf{l}'}(a',\, \mathbf{h}';\, \mu') \,\middle|\, s_m,\, s_f,\, \widetilde{w}_m,\, \widetilde{w}_f,\, \mathbf{l},\, \mathbf{h},\, \mu \right] \right\}
\end{aligned}
$$

subject to

$$
\begin{aligned}
& c + a' \leq (1+r)\, a + \phi(z;\, 0) + b(z;\, U_b,\, s_m) + b(z;\, U_b,\, s_f) \\
& \Gamma' = \Lambda(\mu,\, z') \quad \text{and} \quad z' \sim \Phi(z' \,|\, z).
\end{aligned}
$$

The expectation over the transition of the employment statuses of this household is

$$
\begin{aligned}
\mathbb{E}_{\mathbf{l}', \mathbf{h}', \mu'} \left[V^{\mathbf{l}'}(a', \mathbf{h}'; \mu') \right] = \mathbb{E}_{\mathbf{h}', \mu'} \Bigg[& s_m s_f p_m'(\widetilde{w}_m, h_m) \Bigg(p_f'(\widetilde{w}_f, h_f)\, V^{EE}(a', \widetilde{w}_m, \widetilde{w}_f, \mathbf{h}'; \mu') \\
& + \left(1 - p_f'(\widetilde{w}_f, h_f)\right) \sum_{k \in \{b,n\}} \lambda_k' V^{EU_k}(a', \widetilde{w}_m, \mathbf{h}'; \mu') \Bigg) \\
& + s_m s_f \left(1 - p_m'(\widetilde{w}_m, h_m)\right) \Bigg(p_f'(\widetilde{w}_f, h_f) \sum_k \lambda_k' V^{U_kE}(a', \widetilde{w}_f, \mathbf{h}'; \mu') \\
& + \left(1 - p_f'(\widetilde{w}_f, h_f)\right) \sum_{k,d \in \{b,n\}} \lambda_k' \lambda_d' V^{U_kU_d}(a', \mathbf{h}'; \mu') \\
& + s_m (1 - s_f) \Bigg(p_m'(\widetilde{w}_m, h_m) \sum_k \lambda_k' V^{EU_k}(a', \widetilde{w}_m, \mathbf{h}'; \mu') \\
& + \left(1 - p_m'(\widetilde{w}_m, h_m)\right) \sum_{k,d \in \{b,n\}} \lambda_k' \lambda_d' V^{U_kU_d}(a', \mathbf{h}'; \mu') \Bigg) \\
& + (1 - s_m)\, s_f \Bigg(p_f'(\widetilde{w}_f, h_f) \sum_k \lambda_k' V^{U_kE}(a', \widetilde{w}_f, \mathbf{h}'; \mu') \\
& + \left(1 - p_m'(\widetilde{w}_m, h_m)\right) \sum_{k,d \in \{b,n\}} \lambda_k' \lambda_d' V^{U_kU_d}(a', \mathbf{h}'; \mu') \Bigg) \\
& + (1 - s_m)(1 - s_f) \sum_{k,d \in \{b,n\}} \lambda_k' \lambda_d' V^{U_kU_d}(a', \mathbf{h}'; \mu') \Bigg) \,\Bigg|\, \mathbf{h}, \mu \Bigg].
\end{aligned}
$$

The explanation of the terms on the right-hand side is similar to its counterpart in the baseline model.

Next, consider a household in which both male and female are employed. The recursive problem of this household is given as follows:

$$\begin{aligned} V^{EE}\left(a,\, w_m,\, w_f,\, \mathbf{h};\, \mu\right) \;&=\; \max_{a'\geq a_L} \quad u\left(c\right) + \beta\left(1-\zeta\right)\mathbb{E}_{\mathbf{l}',\mathbf{h}',\mu'}\left[V^{\mathbf{l}'}\left(a',\, w_m,\, w_f,\, \mathbf{h}';\, \mu'\right)\Big|\mathbf{l},\, \mathbf{h},\, \mu\right] \\ \text{subject to} & \\ & c + a' \leq \left(1+r\right)a + y + \phi\left(z;\, y\right) \\ & y = \tau\left[w_m + w_f\right]^{1-\Upsilon} \\ & \Gamma' = \Lambda\left(\mu,\, z'\right) \quad \text{and} \quad z' \sim \Phi\left(z' \,|\, z\right). \end{aligned}$$

Similarly, I lay out the expectation over the transition of the employment statuses of this household:

$$\begin{aligned} \mathbb{E}_{\mathbf{l}',\mathbf{h}',\mu'}\left[V^{\mathbf{l}'}\left(a',\, w_m,\, w_f,\, \mathbf{h}';\, \mu'\right)\Big|\mathbf{l},\, \mathbf{h},\, \mu\right] = \mathbb{E}_{h',\mu'}\Bigg[&\left(1-\delta'_m\right)\Bigg(\left(1-\delta'_f\right)V^{EE}\left(a', w_m, w_f, \mathbf{h}'; \mu'\right) \\ &+ \delta'_f \sum_{k\in\{b,n\}} \lambda'_k V^{EU_k}\left(a', w_m, \mathbf{h}'; \mu'\right)\Bigg) \\ &+ \delta'_m \Bigg(\left(1-\delta'_f\right)\sum_{k} \lambda'_k V^{U_kE}\left(a', w_f, \mathbf{h}'; \mu'\right) \\ &+ \delta'_f \sum_{k,d\in\{b,n\}} \lambda'_k \lambda'_d V^{U_kU_d}\left(a', \mathbf{h}'; \mu'\right)\Bigg) \,\Bigg|\, \mathbf{h}, \mu\Bigg]. \end{aligned}$$

The explanation of the terms on the right-hand side is similar to its counterpart in the baseline model.

Firm Problem First, consider a firm that is matched with a worker in submarket $(w,\, h)$ when the aggregate state is μ. The pair operates under a constant-returns-to-scale technology and produces $g\,(h,\, z)$ units of output, and the worker is paid wages w. The match dissolves either through job displacement with probability $\delta\,(h,\, z)$ or the worker's death with probability ζ. Then, the recursive problem of this firm is given as follows:

$$\begin{aligned} J\left(w,\, h;\, \mu\right) \;&=\; g\left(h,\, z\right) - w + \frac{1}{1+r}\left(1-\zeta\right)\mathbb{E}_{h',\mu'}\left[\left(1-\delta\left(h',\, z'\right)\right)J\left(w,\, h';\, \mu'\right)\Big|h,\, \mu\right] \quad \text{(A1)} \\ \text{subject to} & \\ & \Gamma' = \Lambda\left(\mu,\, z'\right) \quad \text{and} \quad z' \sim \Phi\left(z' \,|\, z\right). \end{aligned}$$

Meanwhile, the value of a firm that posts a vacancy in submarket $(w,\, h)$ under aggregate state μ is given by

$$V\left(w,\, h;\, \mu\right) = -\kappa + q\left(\theta\left(w,\, h;\, \mu\right)\right)J\left(w,\, h;\, \mu\right).$$

The free-entry condition implies that profits are just enough to cover the cost of filling a vacancy in expectation. As a result, the owner of the firm makes zero profits in expectation. Thus, $V(w,\, h;\, \mu) = 0$ for any submarket $(w,\, h)$ such that $\theta(w,\, h;\, \mu) > 0$. Then, imposing the free entry condition yields the following equilibrium market tightness:

$$\theta(w,\, h;\, \mu) = \begin{cases} q^{-1}\left(\frac{\kappa}{J(w,\, h;\, \mu)}\right) & \text{if} \quad w \in \mathcal{W}(\mu) \text{ and } h \in \mathcal{H}(\mu) \\ 0 & \text{otherwise.} \end{cases} \tag{A2}$$

The equilibrium market tightness contains all the relevant information needed by households to evaluate the job finding probabilities in each submarket.

Equilibrium The definition of the recursive equilibrium is very similar to that in Section 3 of the main text. The directed search feature of this model, together with the other assumptions discussed in Section 3, allows this model to admit a BRE as well. This time the non-employed endogenously choose wage submarkets compatible with their own skills, rather than being automatically assigned to skill submarkets based on their skills. This extra feature of the extended model deserves a proof on the existence of BRE.[59]

Proposition: *If i) utility function $u(\cdot)$ is strictly increasing, strictly concave, and satisfies Inada conditions; ii) choice sets $\mathcal{W}$ and $\mathcal{A}$, human capital set $\mathcal{H}$, and sets of exogenous process $\mathcal{Z}$ are bounded; iii) matching function M exhibits constant returns to scale; and iv) government policy instruments are restricted to be only a function of current aggregate labor productivity, then there exists a BRE for this economy.*

Proof: Let $\mathcal{J}(\mathcal{W}, \mathcal{H}, \mathcal{Z})$ be the set of bounded and continuous functions J such that J : $\mathcal{W} \times \mathcal{H} \times \mathcal{Z} \to \mathbb{R}$, and let T_J be an operator associated with (A1) such that $T_J : \mathcal{J} \to \mathcal{J}$. Then, using Blackwell's sufficiency conditions for a contraction and the assumptions of the boundedness of sets of exogenous process $\mathcal{Z}$, choice set $\mathcal{W}$, and human capital set $\mathcal{H}$, we know that T_J is a contraction and has a unique fixed point $J^* \in \mathcal{J}$. Thus, the firm's value function satisfying (A1) depends on the aggregate state of the economy μ only through aggregate labor productivity z. This means that the set of wages posted by firms in equilibrium $\mathcal{W}$ for each element in the set of possible skill levels $\mathcal{H}$ is determined by aggregate labor productivity z as well. Then, plugging J^* into (A2) yields

$$\theta^*(w,\, h;\, z) = \begin{cases} q^{-1}\left(\frac{\kappa}{J^*(w,\, h;\, z)}\right) & \text{if} \quad w \in \mathcal{W}(z) \text{ and } h \in \mathcal{H}(z) \\ 0 & \text{otherwise.} \end{cases}$$

Hence, I show that equilibrium market tightness θ^* also does not depend on the distribution

[59] Here, I provide a proof on the existence of the BRE for the extended model with endogenous wages. The proof for the baseline model is identical.

of households across states Γ.

Next, using this result and the assumption that government policy only depends on z, I show that the household's value functions do not depend on the aggregate distribution of households across states Γ. To do so, I first collapse the household's problem into one functional equation and show that it is a contraction. Then, I show that the functional equation maps the set of functions that depend on the aggregate state μ only through z.

Let Ω denote the possible realizations of the aggregate state μ and define a value function $K : \{0,1\} \times \{0,1\} \times \{0,1\} \times \{0,1\} \times \mathcal{A} \times \mathcal{W} \times \mathcal{W} \times \mathcal{H} \times \mathcal{H} \times \Omega \to \mathbb{R}$ such that

$$\begin{aligned}
K\left(l_m = 1, l_f = 1, d_m = 0, d_f = 0, a, w_m, w_f, h_m, h_f; \mu\right) &= V^{EE}\left(a, w_m, w_f, h_m, h_f; \mu\right) \\
K\left(l_m = 1, l_f = 0, d_m = 0, d_f = 1, a, w_m, w_f, h_m, h_f; \mu\right) &= V^{EU_b}\left(a, w_m, h_m, h_f; \mu\right) \\
K\left(l_m = 1, l_f = 0, d_m = 0, d_f = 0, a, w_m, w_f, h_m, h_f; \mu\right) &= V^{EU_n}\left(a, w_m, h_m, h_f; \mu\right) \\
K\left(l_m = 0, l_f = 0, d_m = 1, d_f = 0, a, w_m, w_f, h_m, h_f; \mu\right) &= V^{U_bU_n}\left(a, h_m, h_f; \mu\right),
\end{aligned}$$

and so on for other types of households with different employment statuses.

Then, we define the set of functions $\mathcal{K} : \{0,1\} \times \{0,1\} \times \{0,1\} \times \{0,1\} \times \mathcal{A} \times \mathcal{W} \times \mathcal{W} \times \mathcal{H} \times \mathcal{H} \times \mathcal{Z} \to \mathbb{R}$ and let T_K be an operator such that

$$\begin{aligned}
\left(T_K K\right)\left(\mathbf{l}, \mathbf{d}, a, \mathbf{w}, \mathbf{h}; z\right) = l_m l_f &\left[\max_{a'} \quad u(c) + \beta(1-\zeta)\,\mathbb{E}_{\mathbf{l}',\mathbf{h}',\mu'}\left[K\left(\mathbf{l}', \mathbf{d}', a', \mathbf{w}, \mathbf{h}; z\right)\right]\right] \\
&+ l_m\left(1-l_f\right)\left[\max_{a',\, s_f} u(c) + \eta_f\left(1-s_f\right) + \max_{\widetilde{w}_f} \beta(1-\zeta)\,\mathbb{E}_{\mathbf{l}',\mathbf{h}',\mu'}\left[K(\cdot)\right]\right] \\
&+ \left(1-l_m\right) l_f\left[\max_{a',\, s_m} u(c) + \eta_m\left(1-s_m\right) + \max_{\widetilde{w}_m} \beta(1-\zeta)\,\mathbb{E}_{\mathbf{l}',\mathbf{h}',\mu'}\left[K(\cdot)\right]\right] \\
&+ \left(1-l_m\right)\left(1-l_f\right)\left[\max_{a',\, s_m, s_f} \quad u(c) + \sum_i \eta_i\left(1-s_i\right) + \max_{\widetilde{w}_m, \widetilde{w}_f} \beta(1-\zeta)\,\mathbb{E}_{\mathbf{l}',\mathbf{h}',\mu'}\left[K(\cdot)\right]\right]
\end{aligned}$$

subject to

$$\begin{aligned}
& c + a' \leq (1+r)\,a + y + \phi(z;\, y) + \left(1-l_m\right) d_m b\left(z;\, U_b,\, s_m\right) + \left(1-l_f\right) d_f b\left(z;\, U_b,\, s_f\right) \\
& y = \tau\left[l_m w_m + l_f w_f\right]^{1-\Upsilon} \\
& z' \sim \Phi\left(z' \,|\, z\right),
\end{aligned}$$

where none of the terms inside expectations (δ'_m, δ'_f , λ'_b, λ'_n, p'_m, or p'_f) and value functions K

inside these expectations depend on Γ.[60]

Assuming the utility function is bounded and continuous, $\mathcal{K}$ is the set of continuous and bounded functions. Then, we can show that the operator T_K maps a function from $\mathcal{K}$ into $\mathcal{K}$ (i.e., $T_K : \mathcal{K} \rightarrow \mathcal{K}$). Then, using Blackwell's sufficiency conditions for a contraction and the assumptions of boundedness of sets of exogenous process $\mathcal{Z}$, choice sets $\mathcal{W}$ and $\mathcal{A}$, and human capital set $\mathcal{H}$, we can show that T_K is a contraction and has a unique fixed point $K^* \in \mathcal{K}$. Thus, the solution to the household's problem does not depend on Γ. This solution constitutes a BRE along with the solution to the firm's problem and the implied labor market tightness that does not depend on Γ, given that government policy is a function of z only.

B.3 Computational appendix

Given that the baseline model in the main text is block recursive, none of the equilibrium value functions, policy functions, or market tightness depend on the aggregate distribution of agents across states Γ. This means that the BRE depends on μ only through z. The BRE is solved using the following steps:

1. Solve for the value function of the firm $J(h, z)$.

2. Using the free-entry condition $0 = -\kappa + q(\theta(h, z)) J(h, z)$ and the functional form of $q(\theta)$, solve for market tightness for any given human capital submarket h and aggregate productivity z:
$$\theta(h, z) = q^{-1}\left(\frac{\kappa}{J(h, z)}\right),$$
where we set $\theta(h, z) = 0$ when the market is inactive.

3. Given the function θ, solve for the household's value functions and policy functions using standard value-function iteration. To decrease computation time, I implement Howard's improvement algorithm (policy-function iteration).

4. Once the household's policy functions are obtained, simulate the aggregate dynamics of the model.

The computational algorithm of the model with endogenous wages is the same as the baseline model with the addition that the equilibrium objects are also functions of the wages and that the household with non-employed members also chooses the wages of the jobs that they look for in the labor market.

[60] Here, I refrain from writing out the expectation explicitly, to save space.

Table A2: Externally Calibrated Parameters

Parameter	Explanation	Value
ρ	Autocorrelation of productivity process	0.7612
σ_ϵ	Standard deviation of productivity process	0.0086
σ	Risk aversion	2
η_m	Value of leisure for males	0
r	Interest rate	0.5 percent
ζ	Death probability	0.625 percent
α	Worker's share of output	0.477
h_L	Lowest human capital	0.2
h_H	Highest human capital	1.8
Δ^E	Human capital increase when employed	0.084
π^U	Prob. of human capital depreciation when non-employed	0.75
$\underline{y}$	Income threshold of means-tested transfers	0.240
e	Mean expiration rate of employment-tested transfers	0.5
Υ	Progressivity of income taxation	0.151

Note: This table summarizes the parameters calibrated outside of the model. Please refer to the main text for the interpretation of the values.

C Calibration and Validation

C.1 Calibration

Table A2 and A3 summarize the externally calibrated and internally calibrated model parameters respectively.

C.2 Validation

In this section, I provide additional model validation exercises to supplement the discussion in Section 4. Specifically, I compare model outcomes with a list of other important untargeted data moments including the consumption drop upon job loss, the asset-to-income distribution, and the extent to which displacement events are correlated across the head and the spouse.

Consumption drop upon job loss Several papers in the literature estimate the average consumption drop upon job loss. Gruber (1997) estimates a decline in food expenditure of 6.8 percent using the PSID for the period up to 1987. Saporta-Eksten (2014) uses cross-sectional variation in the PSID and measures an 8 percent decline in consumption expenditure in the year during which a job loss happens.[61] Stephens (2004) estimates the average decline in food expen-

[61]However, this estimate is not conditional on the fraction of the year spent as unemployed. When we assume an average unemployment duration of 17 weeks, a decline in consumption of around 24 percent is implied.

Table A3: Internally Calibrated Parameters

Parameter	Explanation	Value	Target	Data	Model
β	Discount factor	0.984	Frac. of households with non-positive liquid wealth	0.10	0.11
a_L	Borrowing limit	-0.65	Median ratio of credit limit to labor income	0.64	0.64
η_f	Leisure value	0.51	Rel. female LFPR	0.77	0.77
		Labor Market			
κ	Vacancy cost	2.99	Unemployment rate	0.056	0.054
γ	Matching function	1.41	Std. dev of job finding rate	0.08	0.08
$\bar{\delta}$	Ave. job disp. rate	0.053	Job displ. rate	0.034	0.034
ω_z^δ	Displ. rate vol.	-5.8	Std. dev. of job disp. rate	0.06	0.06
ω_h^δ	Disp. rate across h	-0.53	Ratio of median earnings	0.76	0.77
		Human Capital Process			
Δ^U	Human capital decrease (unemp.)	$[0.59, 0.34]$	Cyclicality of head's initial earnings losses	$[0.39, 0.22]$	$[0.39, 0.22]$
π^E	Prob. of human capital increase	0.042	Labor earnings p90/p10	7.60	6.79
		Government Transfers			
$\bar{\phi}$	Ave. means-tested transfers	0.15	Ratio of total means-tested per recipient to min. wage	0.74	0.75
$\bar{b}$	Ave. emp.-tested transfers	0.08	Ratio of UI per unemp. to min. wage	0.36	0.37
ω_ϕ	Cyclicality of means-tested transfers	0.96	Std. dev. of means-tested transfers per recipient	0.06	0.08
ω_b	Cyclicality of emp.-tested transfers	0.64	Std. dev. of UI per unemployed	0.15	0.14

Note: This table summarizes internally calibrated parameters. Please refer to the main text for a detailed discussion.

diture upon job loss in the Health and Retirement Survey (HRS) and the PSID and finds that the decline is between 12 percent (PSID) and 15 percent (HRS). Browning and Crossley (2001) report a 14 percent decline using Canadian Out of Employment Panel survey data. Chodorow-Reich and Karabarbounis (2016) conduct an analysis of the effects of job loss on consumption both in the PSID and in the Consumer Expenditure Survey (CE) and find that the decline in total food expenditure is between 14 percent (PSID) and 21 percent (CE). Finally, Aguiar and Hurst (2005) measure a 19 percent decline in food expenditure among the unemployed using scanner data.

I estimate the consumption drop upon job displacement in the model using a specification similar to that in Equation (1), where the dependent variable is consumption of the household. I find that household consumption drops on average by 14 percent in the year following the head's displacement, which is in line with the available empirical estimates discussed above.

Table A4: Distribution of Net Liquid Assets Relative to Quarterly Labor Earnings

	Percentiles					Fraction of population
	10th	25th	50th	75th	90th	with non-positive wealth
PSID 2015	0.05	0.48	1.20	2.88	14.38	0.09
SCF 2007	0.02	0.48	1.20	2.71	6.45	0.10
Model	-0.09	0.41	1.16	4.45	4.97	0.11

Note: This table shows the net liquid asset to quarterly family labor earnings distribution both in the model and in the data. The empirical distributions are separately calculated from the PSID 2015 and the SCF 2007.

Asset-to-income distribution Wealth distribution in the economy is also relevant for both insurance benefits and incentive costs of transfers. Both insurance benefits and incentive costs are larger for wealth-poor families, implying that the model would overstate benefits and costs of transfers if the fraction of such families is much larger in the model than in the data. For this reason, the fraction of families with non-positive liquid wealth are taken as a calibration target in Table A3, while the percentiles of the distribution presented below are not.

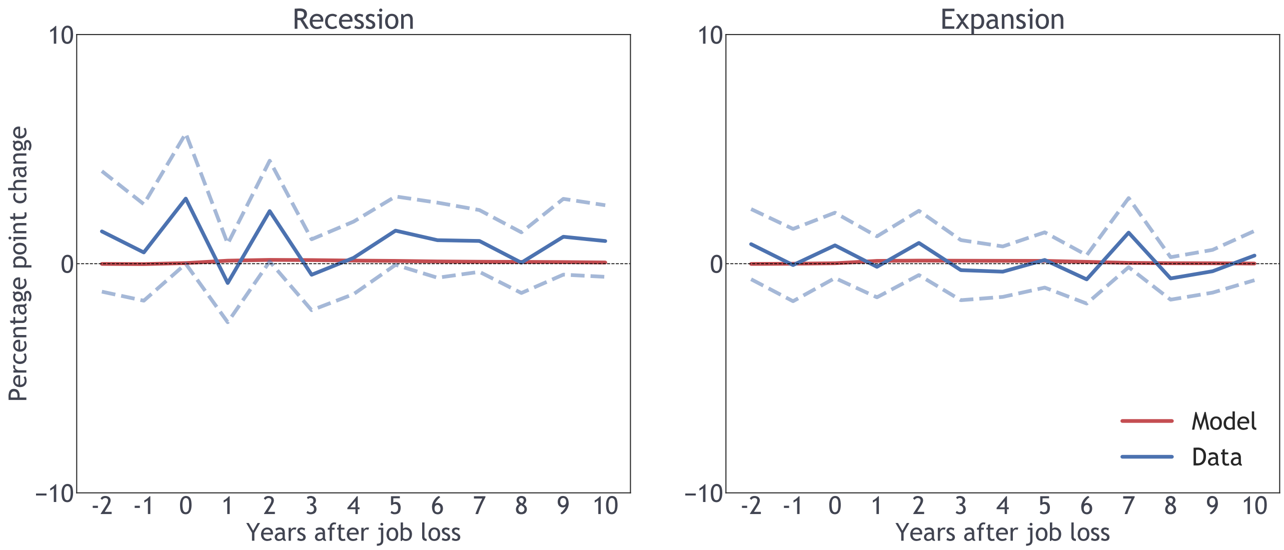
Table A4 compares the distribution of net liquid assets to the quarterly household labor earnings ratio in the model and the data. Empirical moments are calculated as discussed in Appendix A. The results show that while the model does well in generating the part of the distribution below the median, it misses both the amount of wealth owned by the richest households and the dispersion of wealth among the richest households. As I discussed in Section 4, according to the PSID, the displacement risk is much larger for low-income households, which are most likely to be in the left tail of this distribution. Hence, I argue that the model successfully generates the level of self-insurance held by the relevant group of households.

Correlated spells of family members Finally, Figure A5 compares the percentage point change in the spousal displacement probability upon the head's displacements over the business cycle in both the model and the PSID data. It shows that the displacement shocks are not correlated between the head and the spouse in the model, as in the data. This finding is expected given that the model does not assume a correlation of human capital across the head and the spouse.

D Welfare Calculation

This section defines the calculation of welfare measures discussed in Section 5. I use two measures to calculate the changes in welfare due to policy reform. The first measure, $\lambda_1(x)$, is constructed for each individual state x possible in the economy separately; i.e., $x \in \mathcal{X} \equiv \{E, U_b, U_n\} \times$

Figure A5: Change in Spousal Displacement Probability upon Head's Displacement: Model vs Data



Note: This figure plots the changes in the probability of job displacement of spouses upon the head's job displacement in recessions (left panel) and expansions (right panel) both in the model and in the data. I estimate the percentage point change in the relative spousal displacement probability from a distributed lag-regression model using the PSID. The solid-blue lines show the point estimates, and the dashed light-blue lines show the 90 percent confidence interval. I compare these results to the estimates obtained from the same regression using the model-simulated data, which are aggregated to yearly periods.

$\{E, U_b, U_n\} \times \mathcal{A} \times \mathcal{H} \times \mathcal{H}$. This measure allows me to compute the welfare gains/losses for each type of household in the economy and thus makes it possible to analyze the heterogeneous welfare effects of policy reform. Moreover, it is also possible to aggregate $\lambda_1(\cdot)$ across all individual states to obtain a welfare measure for the entire economy, which I call $\bar{\lambda}_1$. The second measure, $\bar{\lambda}_2$, is motivated by Lucas (1987). This measure provides one aggregated welfare measure for the entire economy and allows better comparison with the existing literature.

I now formally define these two measures. Let $\left\{c^o(x), s_m^o(x), s_f^o(x)\right\}_{t=T}^{\infty}$ denote the path allocations of an individual with state x at time T under the existing (old) policy o. Let $\left\{c^n(x), s_m^n(x), s_f^n(x)\right\}_{t=T}^{\infty}$ denote the path of allocations of the same individual under a proposed (new) policy n from time T onward.

$\lambda_1(x)$ is the percent additional lifetime consumption that must be endowed at all future dates and states to *a household* with individual state x under the stationary distribution of the economy where policy o is implemented so that *the household's* welfare will be the same as that under an economy where policy n is instead implemented forever. Formally, for all $x \in \mathcal{X}$, $\lambda_1(x)$ satisfies the following equation[62]:

$$E_T \sum_{t=T}^{\infty} \beta^{t-T} U\left(c_t^o(x)(1+\lambda_1(x)), s_{m,t}^o(x), s_{f,t}^o(x)\right) = E_T \sum_{t=T}^{\infty} \beta^{t-T} U\left(c_t^n(x), s_{m,t}^n(x), s_{f,t}^n(x)\right),$$

[62]Given the functional form of the utility function, there are no closed-form solutions for $\lambda_1(x)$, $\bar{\lambda}_1$, and $\bar{\lambda}_2$.

where T is the time period when the policy changes from o to n. Once we obtain $\lambda_1(x)$ for all $x \in \mathcal{X}$ by solving this equation, we obtain an aggregate welfare measure by integrating over the stationary distribution Γ^o_{ss} in the economy with policy o:

$$\bar{\lambda}_1 = \int_{x \in \mathcal{X}} \Gamma^o_{ss}(x) \times \lambda_1(x). \tag{A3}$$

$\bar{\lambda}_2$ is the percent additional lifetime consumption that must be endowed at all future dates and states to *all households* under the stationary distribution of the economy where policy o is implemented so that the *average* welfare will be the same as that under an economy where policy n is instead implemented forever. Formally, $\bar{\lambda}_2$ satisfies the following equation:

$$\begin{aligned}\int_{x \in \mathcal{X}} \Gamma^o_{ss}(x) E_T \sum_{t=T}^{\infty} \beta^{t-T} U\left(c^o_t(x)\left(1+\bar{\lambda}_2\right), s^o_{m,t}(x), s^o_{f,t}(x)\right) \\ = \int_{x \in \mathcal{X}} \Gamma^o_{ss}(x) E_T \sum_{t=T}^{\infty} \beta^{t-T} U\left(c^n_t(x), s^n_{m,t}(x), s^n_{f,t}(x)\right).\end{aligned} \tag{A4}$$

All of the aggregate welfare gains presented in Sections 5 and 6 are calculated using $\bar{\lambda}_2$, but the results remain similar when calculated using $\bar{\lambda}_1$. Furthermore, the heterogeneous welfare gains given in Table 5 are calculated by grouping households by their employment status, asset holdings, and human capital level of the head and the spouse based on the stationary distribution under the current (old) policy Γ^o_{ss}. Then, for each group k, I compute

$$\bar{\lambda}_{1,k} = \int_{x \in \mathcal{X}_k} \Gamma^o_{ss,k}(x) \times \lambda_1(x), \tag{A5}$$

where $\mathcal{X}_k$ is the set of household states in group k, and $\Gamma^o_{ss,k}(x)$ is the measure of households with type x within group k of the stationary distribution under policy o.

E Robustness

Finally, in this section, I provide a detailed discussion on the implementation of the robustness exercises presented in Section 6.

Incorporating Medicaid in means-tested transfers In the calibration of means-tested transfers, I did not incorporate Medicaid transfers given that the baseline model does not incorporate extra eligibility requirements of Medicaid such as health status or the presence of young children. Now, I incorporate Medicaid transfers into the calibration of the parameters of the means-tested transfers and include a new eligibility indicator for all means-tested transfers.

Means-tested transfers are now given as follows:

$$\phi\left(z;\, y,\, \chi\right)=\begin{cases}\phi\left(z\right) & \text{if} \quad y<\underline{y},\, \chi=1\\ \iota\phi\left(z\right) & \text{if} \quad y<\underline{y},\, \chi=0\\ 0 & \text{otherwise,}\end{cases}$$

where χ is a non-financial eligibility indicator for all means-tested transfers, which can be interpreted as the health status or the presence of young children. In the above specification, if a family is financially eligible but non-financially ineligible (i.e., $y<\underline{y}$, $\chi=0$), then I assume that the family receives only SNAP transfers, which typically do not have any non-financial eligibility requirements, and that SNAP is a ι fraction of total means-tested transfers. The variable χ is a state variable representing the household type, and a random variable is drawn from a uniform distribution each period to determine the value of χ.

I assume that 60 percent of families are non-financially eligible for means-tested transfers. I externally calibrate $\iota=0.107$ because total SNAP transfers are around 10.7 percent of total means-tested transfers on average across years. I then recalibrate the model and calculate the welfare gains from the optimal policy obtained in Section 5 under this model.[63] Here, I implement this exercise in two different ways given the large difference between the levels of $\bar{\phi}$ in the baseline model and in this model. First, I compute welfare gains directly from the baseline optimal policy, in which $\bar{\phi}=0.15$. In this case, I find the welfare gains of the baseline optimal policy relative to the new calibration of the current policy under this model (i.e., $\bar{\phi}=0.53$, $\omega_\phi=2.8$, and so on) to be as much as 1.88 percent in consumption equivalents. Next, I replace the average generosity of means-tested transfers in the optimal policy from $\bar{\phi}=0.15$ to $\bar{\phi}=0.53$ to understand the effects of changing only the cyclicality of means-tested transfers (from $\omega_\phi=2.8$ in the current policy to $\omega_\phi=-3.46$ in the optimal policy, together with the changes in the other policy parameters except $\bar{\phi}$). In this case, the welfare gains are 0.73 percent, which is the value I report in Table 7. Both of these exercises show that the less-generous and procyclical means-tested transfer policy is welfare improving, which is consistent with my main results.

Removing job search requirements for employment-tested transfers In the baseline model, I assume that the government can observe the search behavior of the unemployed. Here, I relax this assumption and check the implications on welfare gains from the baseline optimal

[63] Among the changes to the parameter values, an important one to mention is the average generosity of means-tested transfers, which is $\bar{\phi}=0.53$ instead of $\bar{\phi}=0.15$ in the baseline calibration given the inclusion of generous Medicaid transfers. Moreover, the cyclicality of means-tested transfers now becomes $\omega_\phi=2.8$ instead of $\omega_\phi=0.96$ as in the baseline model. In fact, the standard deviation of detrended means-tested transfers per recipient is still 0.06, as in the baseline calibration, but the increase in the level of means-tested transfers requires adjustments in ω_ϕ as well to make it the same value. Finally, the income tax level that balances the budget is $\tau=0.76$ instead of $\tau=0.81$.

policy. In this case, employment-tested transfers are now given as follows:

$$b(z;\, l_i) = \begin{cases} b(z) & \text{if} \quad l_i = U_b \\ 0 & \text{otherwise.} \end{cases}$$

Then, I recalibrate the model and calculate welfare gains from the baseline optimal policy. I find that in this model the optimal policy yields 0.70 percent additional lifetime consumption relative to the current policy. Thus, I find smaller welfare gains in this model. This is possibly because of the increase in incentive costs of employment-tested transfers due to the removal of the job search requirement for eligibility.

Non-separable preferences Next, I consider a utility function in which consumption and leisure are non-separable, following Blundell, Browning, and Meghir (1994) and Attanasio and Weber (1995). I define the preferences as follows:

$$U(c,\, s_m,\, s_f) \;=\; \frac{\left[c \times \prod_{i\in\{m,\,f\}} \exp\left(\eta_i\left(1 - s_i\right)\right)\right]^{1-\sigma}}{1-\sigma}.$$

This functional form is similar to that used in Low, Meghir, and Pistaferri (2010). Then, I recalibrate the model and calculate the welfare gains from the baseline optimal policy and find that this policy yields 0.92 percent additional lifetime consumption relative to the current policy, which is similar to the main result.

Model with endogenous wages Finally, in the baseline model, I assume that the wage for each human capital level is a fraction of aggregate labor productivity. This assumption implies that wages and firm vacancy posting decisions are exogenous to changes in government policy in the baseline model, which allows me to isolate the effects of transfers on the labor supply.

To analyze the quantitative effects of this assumption on the welfare gains from the optimal policy, I now consider a directed search model in which wage choices of unemployed individuals are endogenous. The details of this model are provided in Appendix B.

In this model, I find that the baseline optimal policy yields 0.89 percent additional lifetime consumption relative to the current policy. Changes in transfer generosity now affect the wage choice of the unemployed endogenously. Less-generous public insurance in recessions induces unemployed individuals to look for low-paying jobs for which job finding rates are higher. Thus, under the baseline optimal policy, reemployment wages are lower but unemployment duration is shorter than under the current policy. While the former channel reduces the welfare gains from the baseline optimal policy, the latter channel increases welfare gains. Hence, welfare gains from the baseline optimal policy in this model are similar to the welfare gains in the baseline model.