The Implications of Labor Market Heterogeneity on Unemployment Insurance Design*

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Abstract

We digitize state-level and time-varying unemployment insurance (UI) laws on initial eligibility, payment amount, and payment duration and combine them with microdata on labor market outcomes to estimate UI eligibility, take-up, and replacement rates at the individual level. We document how levels of income and wealth affect unemployment risk, eligibility, take-up, and replacement rates both upon job loss and over the course of unemployment spells. We evaluate whether these empirical findings are important for shaping UI policy design using a general equilibrium incomplete markets model combined with a frictional labor market that matches our empirical findings. We show that a nested alternative model that fails to match these findings yields a substantially less generous optimal UI policy compared with the baseline model. Our empirical results are also relevant for researchers estimating the effects of UI policy changes on labor market outcomes.

Keywords: Unemployment Insurance, Fiscal Policy and Household Behavior, Job Search
JEL Classification: E24, H31, J64, J65

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1 Introduction

Unemployment insurance (UI) benefits in the U.S. have been a primary source of fiscal transfers to jobless individuals. Researchers have long been interested in understanding the trade-off between UI's distortionary effects on the job-search activities of recipients and its insurance value for these individuals. This interest has generated a crowded and still-active literature analyzing the positive and normative implications of UI policy changes.

While this literature aims to understand the insurance-incentive trade-off of UI for recipients, quantitative papers on this policy fall short of adequately capturing the unique characteristics of the pool of UI recipients in their models. In particular, it is common to assume that all individuals are equally likely to become unemployed, UI-eligible, and eventually UI recipients, as well as receive the same amount of UI payments. As we will demonstrate, these assumptions ignore the selection that arises from differential job loss risk, eligibility rules, and UI take-up decisions across individuals and are inconsistent with the data. Motivated by this gap in the literature, we revisit the longstanding question of how to design UI policy through a novel approach. Our analysis employs a quantitative framework that is informed by microdata on the relationship of unemployment risk, UI eligibility, take-up, and wage replacement rates with income and wealth, both at the time of job loss and throughout the duration of unemployment.

Our first task is to document these data patterns. While past research has shown that unemployment risk is higher for low-income workers (Krusell et al., 2017, Guvenen et al., 2021), what remains unclear is how income and wealth influence the UI eligibility rate (the share of unemployed who qualify), the UI take-up rate (the share of UI-eligible who receive benefits), and the UI replacement rate (the share of past earnings replaced by UI). This link is difficult to establish due to the lack of microdata containing both eligibility and replacement rate information.

The UI laws in the U.S. determine (i) the eligibility of a new UI application, (ii) the UI payment amount, and (iii) the UI payment duration. An unemployed person's eligibility upon submitting a new UI application is determined based on non-monetary and monetary eligibility rules. The non-monetary eligibility rule requires that the person's reason for unemployment not be quitting the job voluntarily or being fired due to misconduct. The monetary eligibility rule requires that the unemployed person meets certain employment and earnings thresholds during the base period (BP)—typically the first four of the last five completed calendar quarters preceding the job loss. Importantly, these monetary eligibility rules vary greatly both across states and over time within a state. States may choose to require (i) a certain number of quarters with employment in the BP, (ii) a certain level of earnings in the BP, or (iii) the quarter or two quarters with the highest earnings in the BP, and (iv) qualifying for a minimum UI weekly benefit amount (WBA). While most states impose the employment requirement, they may impose one or combine multiple earnings requirements and a minimum WBA requirement. They set different earnings thresholds for these requirements and sometimes change these requirements over time.

To illustrate how monetary eligibility rules differ across states and over time, we provide an example. In 2005 and 2009, both Illinois and Georgia required positive earnings in at least two BP quarters, but their specific requirements differed significantly. For these years, Illinois required at least $1,600 in the BP, with at least $440 outside the quarter with the highest earnings in the BP. In contrast, Georgia, in 2005, implemented the same criteria as Illinois but required a minimum of $1,600 in the BP, with at least $920 outside the quarter with the highest earnings in the BP. However, in 2009, Georgia eliminated requirements for earnings in the BP and outside the highest quarter and instead imposed a minimum earnings requirements in the two BP quarters with the highest earnings, as well as in the BP quarter with the highest earnings. Specifically, Georgia in 2009 required at least $1,134 in the two quarters with the highest earnings and at least $756 in the quarter with the highest earnings.[1]

In addition to these differences in determining the eligibility of a new UI claim, states also differ in terms of the amount and duration of UI payments. In terms of the amount, states differ in their methods of computing the WBA and their maximum WBA payments. In terms of the duration, while regular benefits are typically paid for 26 weeks, with a range between 13 and 30 weeks, longer payment durations are made available depending on a state's unemployment rate.

The state and time variation in UI laws imply that one must track these UI laws to predict an unemployed individual's UI eligibility and replacement rate. For this reason, we combine state-level and time-varying UI laws on eligibility rules for initial UI applications, UI payment amounts, and UI payment durations with microdata from the Survey of Income and Program Participation (SIPP) between 1996 and 2016 that provide monthly data on employment, labor earnings, state of residence, reason for job loss, UI receipt, and annual data on assets. Using the information in the SIPP, we compare each individual's outcomes against these laws to predict their UI eligibility and replacement rate at the individual level. We then use the information on UI receipt in the SIPP to distinguish job losers who are UI-ineligible from those who are eligible but do not collect benefits. Importantly, we not only document the average eligibility, take-up, and replacement rates but also use information on income and wealth in the SIPP to examine how levels of earnings prior to job loss (i.e., previous earnings) and wealth affect eligibility, take-up, and replacement rates both upon job loss and over the unemployment spell.

Using our data, we show that the average eligibility rate increases in previous earnings but declines over unemployment duration. The rise in the eligibility rate in previous earnings is due to the fact that some low-income workers who potentially assign higher insurance value to UI are unable to satisfy monetary eligibility rules, while the decline in the eligibility rate over duration is mostly driven by the expiration of UI benefits. We also show that the average take-up rate

[1] This means that Georgia implemented less strict eligibility requirements in 2009 than in 2005. For example, someone in Georgia who had $1,140 in the two quarters of the BP, with $760 in the highest quarter of the BP and no other earnings in the BP, would satisfy the monetary eligibility rules in 2009 but not in 2005.

declines in the level of available self-insurance upon job loss but increases as unemployment duration prolongs. The decline in the take-up rate in self-insurance level is potentially driven by the lower insurance value of UI to wealth-rich individuals, while the rise in the take-up rate over duration is due to workers who are unable to find a job quickly deciding to opt for UI over time.

To evaluate whether accounting for these eligibility and take-up dynamics matters for UI policy design, we develop a general-equilibrium, heterogeneous-agent, directed-search model with incomplete markets. In this model, individuals are heterogeneous in their productivity, affecting job-finding and job-separation rates. Unemployed individuals search for jobs in submarkets indexed by wages and productivity. UI policy instruments cover the probability of being UI ineligible upon job loss and how this probability changes with previous wages, the replacement rate that depends on the previous wage, and the expiration rate of UI eligibility. Further, the decision to take up UI is endogenous and UI benefits are financed via labor income taxation. Overall, in this model, unemployment, eligibility, and take-up dynamics are not random but instead tied to the level of income and wealth, and the unemployment duration endogenously affects job-finding, eligibility, and take-up rates through wealth changes and UI payment duration.

We calibrate this model to match average monthly labor market flow rates as well as UI eligibility, take-up, and replacement rates. We then put this model to a serious test and validate its predictions on (i) how eligibility and take-up rates change over unemployment duration both on average and across income and wealth groups, (ii) levels of wealth by employment and UI status, and (iii) job-finding rate dynamics over unemployment duration and upon UI exhaustion. Overall, we show that the model is broadly consistent with the data along these dimensions. Specifically, it generates the decline in the eligibility rate and the rise in the take-up rate as the unemployment spell prolongs, as in the data. It also matches the data in terms of the magnitude and persistence of the gap in eligibility rates among the unemployed with different levels of previous earnings as well as gaps in wealth levels between the unemployed and the employed and between those who take up UI and those who do not. Finally, the model also generates the decline in the job-finding rate over unemployment duration and its rise upon UI exhaustion.

We then solve for the optimal UI policy in our model. Because solving for a Ramsey problem in this model is computationally infeasible, we work with parameterized UI policy instruments and solve for the combination of these instruments that maximizes a utilitarian welfare function, which we call the optimal policy. We find that, relative to the current policy in the U.S., the optimal policy features more generous replacement and eligibility rates, especially for those at the bottom quintile of the wage distribution, and a much longer payment duration. This policy generates a higher eligibility rate, especially among the long-term unemployed, and a higher take-up rate at the onset of unemployment, especially among the eligible with low wealth, and it provides higher replacement rates. Under the optimal policy, the average consumption of the long-term unemployed increases. On the other hand, the negative effects of the optimal policy on job-finding rates of recipients are limited. This is because the pool of recipients—when disciplined by the data—comprises mainly wealth-poor individuals who are close to the borrowing constraint and thus have a large surplus from employment relative to unemployment. As such, the borrowing constraint acts as a self-disciplining device to limit the negative impact of the optimal policy on their job-search activities. Overall, the optimal policy yields 1.3 percent average consumption-equivalent welfare gains, and around two-thirds of the population experience positive gains relative to the current policy. These welfare gains are very heterogeneous, as the unemployed in the bottom quintiles of wage and wealth distributions experience much larger gains, while most of the employed in the top quintiles experience welfare losses. The former group enjoys a more generous UI policy, while the latter group does not have much to gain from this policy, as they are unlikely to become unemployed but suffer from higher taxes.

The key quantitative result of our work is to show that matching the dynamic heterogeneity within the unemployed is pivotal for optimal UI policy prescription. To demonstrate this, we consider an alternative (nested) model that assumes full take-up and homogeneous job-separation, job-finding, eligibility, and replacement rates. We calibrate this model to match the same heterogeneity in income and wealth as in the baseline model but to only the average job-finding, job-separation, eligibility, take-up, and replacement rates. Thus, the alternative model severs the link between the heterogeneity in income and wealth and the heterogeneity in unemployment risk, as well as eligibility, take-up, and replacement rates. The optimal policy in this model is much less generous than the optimal policy in the baseline model, especially in terms of replacement rates. This difference is precisely because the alternative model cannot capture the characteristics of UI recipients. In the alternative model, individuals with high income and wealth are equally likely to become unemployed and receive UI as those with low income and wealth, which is inconsistent with the data. Here, the insurance value of UI is smaller since wealthy agents already have sufficient self insurance. On the other hand, the incentive costs of UI amplifies because UI recipients who are sufficiently far from the borrowing constraint reduce search efforts and look for high-wage jobs that are difficult to find when UI generosity increases. The optimal policy in this model yields lower and more homogeneous welfare gains, welfare losses for most of the unemployed, and welfare gains for most of the employed. These results are drastically different from the effects of the optimal policy in the baseline model.

Finally, we evaluate whether other model features—beyond the heterogeneity within the unemployed—that vary across studies in the literature are pivotal for optimal UI. In particular, we focus on the role of general equilibrium in the asset market, allowing individuals to borrow, the taxation system, and the calibrated value of unemployment. We show that while the first two features are not at all important, the last two are quantitatively relevant for optimal UI.

We note that while our model contains many important features that are relevant to the insurance-incentive trade-off of UI, there may be other potentially relevant mechanisms missing from our model. For example, our model does not incorporate individual productivity changes via human capital dynamics or heterogeneity in productivity across firms. However, our main conclusion is that the optimal policy prescriptions in a model *with* and *without* heterogeneity within the unemployed are largely different. While these extensions of our baseline model may quantitatively affect the optimal policy in the baseline model, it is unlikely that our main conclusion would be overturned if we further enrich both the baseline and alternative models.[2]

Related literature. Our paper is closely related to a large literature quantitatively studying positive and normative questions pertaining to UI under incomplete markets (Hansen and Imrohoroğlu, 1992; Shimer and Werning, 2008; Nakajima, 2012b; Jung and Kuester, 2015; Koehne and Kuhn, 2015; Mitman and Rabinovich, 2015; Kroft and Notowidigdo, 2016; McKay and Reis, 2016; Landais et al., 2018; McKay and Reis, 2021; Pei and Xie, 2021; Ferraro et al., 2022; Braxton et al., 2023; Kekre, 2023). These papers often assume that individuals are equally likely to become unemployed and are all eligible for and receive UI. While some of these papers account for imperfect eligibility and take-up, they assume that individuals are equally likely to be eligible for and receive UI. Relative to these papers, we document how eligibility, take-up, and replacement rates vary by income and wealth and over unemployment duration and show that accounting for these empirical moments is crucial for optimal UI policy prescription. The closest paper to our work is Krusell, Mukoyama, and Şahin (2010), as they also use a general equilibrium incomplete markets model combined with a frictional labor market. We show that a similar model that abstracts from our empirical findings yields an optimal policy similar to theirs. However, our baseline model with the heterogeneity within the unemployed suggests a largely different optimal policy. Finally, this paper closely builds on our earlier work (Birinci and See, 2023), which documents heterogeneity among the unemployed *upon* job loss. Focusing on the positive implications, it demonstrates that incorporating this heterogeneity affects a model's ability to match the empirical elasticity of the job-finding rate to changes in UI generosity. We extend the empirical analysis in our earlier work to provide novel empirical findings on how the heterogeneity within the unemployed dynamically changes over the unemployment spell, which is a non-trivial task, as discussed earlier and more in Section 2. We also extend the model in our earlier work to a general-equilibrium setting and generalize the fiscal system, as we discuss in Section 3. These steps allow us to study the normative and welfare implications of heterogeneity within the unemployed on UI policy design, which (Birinci and See, 2023) do not focus on.

This paper also contributes to a large and active empirical literature estimating the effects of UI policy changes on job-finding and unemployment rates (Rothstein, 2011; Amaral and Ice, 2014; Farber and Valletta, 2015; Chodorow-Reich et al., 2019; Hagedorn et al., 2019; Dieterle

[2]In fact, if we were to incorporate human capital dynamics, the decline in human capital over the spell would widen the gap between the optimal policies in the two models. This is because, in the baseline model, lower human capital for the long-term unemployed would further increase the insurance value of UI and lower incentive costs of UI given that the surplus from employment relative to unemployment would be even larger.

et al., 2020; Boone et al., 2021; Hornstein, Karabarbounis, Kurmann, Lalé, and Ta, 2023; Acosta, Mueller, Nakamura, and Steinsson, 2024). This literature often utilizes state-level changes in maximum UI payment duration to estimate these effects. In doing so, however, this analysis often ignores substantial differences in UI eligibility rules and payment amounts across states, as these data are not readily available. However, such differences potentially matter for estimating the adverse effects of changes in UI generosity. This is because, for example, when one state increases the maximum UI payment duration by more than another state, it may not immediately translate into an overall more-generous UI system in the former state if the former state imposes stricter eligibility rules and/or less-generous replacement rates. In this case, if one finds that a longer extension of UI duration does not generate a higher unemployment rate, it may simply be because states are also different in other dimensions of UI generosity.

Implementing our empirical analysis required substantial effort, and we believe that it has broader applications beyond our work. The first step involved collecting and digitizing state-level UI laws on initial eligibility, payment amounts, and payment durations for 20 years. This task is surprisingly complex as states (i) use a variety of methods in determining a worker's initial eligibility, (ii) impose different eligibility thresholds under these methods, (iii) use a variety of methods in calculating a worker's WBA, (iv) offer UI payments for different durations, and, importantly, (v) unsystematically change any of these rules over time. In the second step, we combine UI laws with the microdata from the SIPP for 20 years to impute UI eligibility and replacement rates at the individual level. These steps allow us to document how the composition of the unemployed changes over the unemployment spell. We also provide state-level eligibility, take-up, and replacement rates and show that they differ even among neighboring states that are expected to have similar economic performances. It is our desire that the data will be useful for researchers when estimating the effects of changes in UI generosity on labor market outcomes.

The rest of this paper is organized as follows. Section 2 explains our data work and presents our empirical findings, and Section 3 presents our model. Section 4 provides calibration details. Section 5 discusses model validation, and Section 6 and 7 present the results from the baseline model and the alternative model, respectively. Section 8 provides a discussion on how optimal policy conclusions change under different model specifications, and Section 9 concludes.

2 Empirical Findings

Motivation. In this section, we link data from two sources: the SIPP and state-specific time-varying UI policy rules from the Department of Labor Employment and Training Administration. Because the SIPP provides information on UI receipt but not on UI eligibility status or replacement rates, we need to use observables from the SIPP to predict one's eligibility and replacement rate based on UI laws. This enables us to document the heterogeneity within the unemployed based on income, wealth, and, importantly, UI outcomes (eligibility, take-up, and replacement rates). While we established the heterogeneity within unemployed *upon* job loss in earlier work, Birinci and See (2023), we now extend this analysis to provide novel empirical findings on how the heterogeneity within the unemployed dynamically changes over the unemployment spell. As we will discuss below, this extension is a non-trivial task as it requires us to follow changes in (i) state-level laws on eligibility and replacement rate policies over time and (ii) labor market outcomes and UI receipts for all unemployment spells in the microdata over time. These steps allow us to account for not only the cross-sectional heterogeneity within the unemployed upon job loss but also how outcomes evolve throughout the spell. Because UI policy is a combination of how much, how long, and whom to provide insurance, our empirical findings in this section guide our modeling choices and are used to discipline our model. Ultimately, we will show that accounting for these empirical findings is critical for determining the optimal UI policy.

2.1 Data and measurement

We start by providing details on our two data sources and our measurement of UI eligibility, take-up, and replacement rates over unemployment duration.

2.1.1 SIPP

The SIPP provides monthly data on demographics, employment, labor earnings, state of residence, reason of job separation, and UI receipt. Importantly, the SIPP also provides (typically) annual data on wealth holdings. In each SIPP panel, respondents provide information on various types of wealth for two or three waves, usually one year apart. Using SIPP data between 1996 and 2016, we restrict our sample to individuals aged 25 to 65 who are not business owners. Appendix A.1 and A.2 provide more details on the SIPP data and measurement, respectively.

2.1.2 State-level and time-varying UI policies

The UI laws in the U.S. determine (i) the eligibility of a new UI application, (ii) the duration of UI payment (i.e., how many weeks an eligible unemployed may collect UI benefits in a single unemployment spell), and (iii) the UI payment amount. Importantly, as detailed below, all these rules under each category vary *between* states, as well as over time *within* a state.[3]

UI eligibility of a new application. A person's eligibility upon submitting a new application is determined by both monetary and non-monetary rules. The non-monetary criterion assesses the reason for job loss, ensuring that the individual did not leave their job voluntarily or was not terminated due to misconduct. This requirement is invariant across states and over time.[4]

The monetary eligibility rules require that the applicant meets certain earnings and employment thresholds during the base period (BP). While almost all states require a certain number

[3] We obtain detailed information on state UI eligibility rules, payment durations, and payment amounts over time from the website of the Department of Labor Employment and Training Administration.

[4] However, during the COVID-19 episode—which is outside of our period of analysis in this paper—individuals who quit their jobs due to health-related concerns were often considered as eligible across many states.

of quarters with positive earnings in the BP, some states impose a minimum amount of earnings during the BP, and others impose a combination of requirements based on quarter-specific earnings and the expected weekly benefit amount (WBA). Importantly, states not only often change their earnings thresholds but also sometimes change their eligibility rules altogether. Thus, we cannot assume the same eligibility rules for all unemployed and instead must keep track of these location- and time-based rules between 1996 and 2016 during our SIPP sample. The rules used to determine monetary eligibility vary greatly across states, as we describe below.

Employment. Most states require two quarters with positive earnings (i.e., employment) in the BP.[5] Some states such as California and Colorado never imposed this requirement between 1996 and 2016, while other states opted in or out of it over time. For instance, Minnesota implemented it only between 2013 and 2016, while Vermont removed it after 2001.

BP earnings. Many states use BP earnings thresholds for UI eligibility. However, the formula to calculate the minimum BP earnings varies greatly across states and over time. Specifically, states calculate the minimum BP earnings using any of the following methods: (i) certain (arbitrarily chosen) dollar amount, (ii) multiple of highest quarter earnings (typically at least 1.5 times of the highest quarter earnings), or (iii) multiple of the worker's WBA.[6]

Highest quarter or two highest quarter earnings. Some states impose that workers must earn a certain dollar amount in the quarter with the highest earnings or in two quarters with the highest earnings of their BP. As discussed in our earlier example on Illinois and Georgia, it is often the case that highest-quarter or two-highest-quarter earnings requirements are combined with either a BP earnings requirement or a certain dollar amount outside the highest quarter.

Qualifying for minimum WBA. A few states require that a worker's calculated WBA should be larger than a minimum WBA threshold for eligibility.

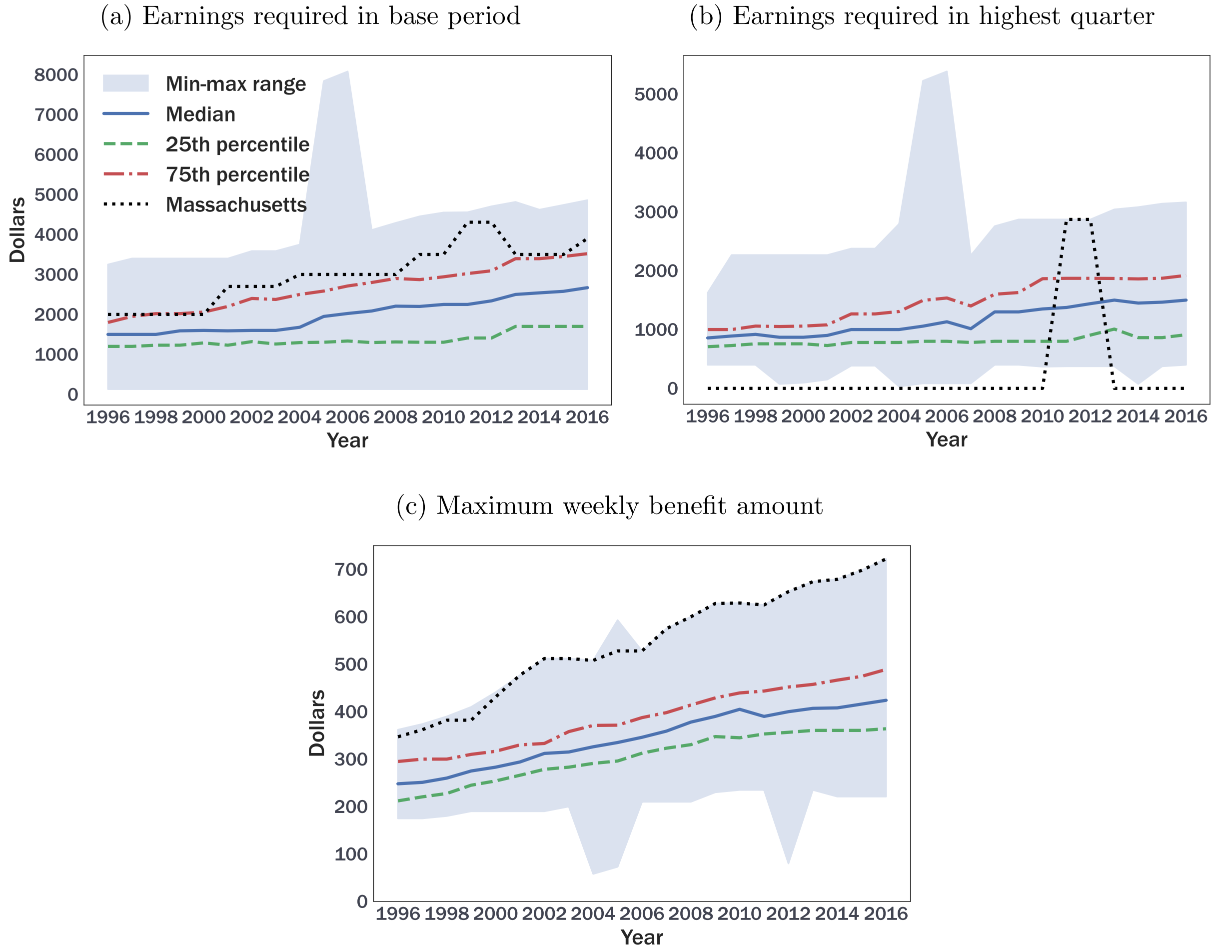
To illustrate the extent of differences in monetary eligibility requirements across states and over time, Figure 1 presents the minimum amount of earnings required in the BP (Panel (a)) and in the highest quarter of the BP (Panel (b)). In particular, among states that implement these rules, it shows the minimum and maximum nominal dollar amounts of these minimum earnings requirements (in BP or the highest quarter) as well as the median, 25th, and 75th percentiles of the (unweighted) distributions of these requirements for each year between 1996 and 2016. We also present these requirements for one state as an example—for which we chose Massachusetts (MA)—to show how these requirements change over time within a state.

We highlight two important takeaways. First, even among states that implement either of these two requirements, there are large differences in minimum earnings thresholds for any given year. For instance, in 2016, the minimum and maximum earnings requirement in the BP (Panel

[5]Between 2004 and 2007, Nevada required three quarters of employment in the BP. Other than this case, no other state required more than two quarters of employment in the BP.

[6]Under the third method, a state first computes the worker's WBA. The worker must have earned a multiple—often 40—of this amount during the BP.

Figure 1: State-level and time-varying UI eligibility requirements and maximum benefit amounts



(a) Earnings required in base period

(b) Earnings required in highest quarter

(c) Maximum weekly benefit amount

Note: Panels (a) and (b) present the minimum amount of earnings required in the base period (BP) and in the highest quarter of the BP across states, respectively. Among states that implement these rules, we show minimum and maximum nominal dollar amounts of these minimum earnings requirements as well as the median, 25th, and 75th percentiles of distributions of these requirements. We also present these requirements for one state—for which we chose Massachusetts—to demonstrate how these requirements change over time within a state. Panel (c) repeats these moments for maximum weekly benefit (nominal dollar) amounts.

(a)) varied across states between \$130 (HI) and \$4,860 (OH) with the median value of \$2,670 (MT), and the minimum and maximum earnings requirement in the highest quarter (Panel (b)) varied across states between \$400 (NV) and \$3,162 (MI) with the median value of \$1,500 (MO). Second, even within a state, there are large and unsystematic changes in these thresholds. For example, relative to the year prior, MA increased the BP earnings threshold by 35 percent in 2001 and by 23 percent in 2011—both of which are beyond inflationary adjustments—but reduced it by 19 percent in 2013. Further, MA did not impose any earnings requirement for the highest quarter in all years except 2011 and 2012. Thus, in 2011, MA made eligibility criteria stricter by increasing both the BP earnings threshold and imposing a highest-quarter earnings requirement.[7] Then, in 2013, it reduced the BP earnings threshold substantially and removed the earnings requirement in the highest quarter, making the eligibility criteria less strict again.

[7]In fact, MA had the highest earnings required in the highest quarter in 2011 and 2012 together with Michigan.

UI payment amount. The WBA replaces a certain fraction of previous earnings. However, states differ in their (i) methods of computing WBA and (ii) maximum WBA payments.

We first explain the differences in methods of computing WBA across states.

High-quarter method. Around half of the states determined the WBA by utilizing earnings in the highest quarter in the BP. Under this method, average weekly wages (AWW) are calculated by dividing this amount by 13—the number of weeks in a calendar quarter. Then, the WBA is calculated by multiplying the AWW with the percentage of the weekly earnings the state replaces. For instance, if a state replaces 50 percent of weekly earnings, then the WBA is obtained by multiplying the earnings in the highest quarter by 1/26. While 1/26 is the most common multiple used by states, it varies across states as some use a fraction generating a higher WBA (e.g., 1/23) given that even the highest quarter may include some unemployment.

Multi-quarter method. The WBA is obtained as a percentage of the total or average quarterly earnings in more than one quarter—often two quarters—in the BP.

Annual-earnings method. The WBA is calculated as a percentage of BP annual earnings.

Once the WBA is calculated under either of these methods, the WBA is then checked against the maximum WBA amount paid by the state. If the calculated WBA is greater than the maximum WBA, then the worker only receives the maximum WBA as UI payment. Although all states maintained a maximum WBA threshold between 1996 and 2016, the levels of this threshold varied significantly, as illustrated by Panel (c) in Figure 1. In particular, in 2016, the maximum WBA varied between $221 (LA) and $722 (MA) with the median value of $424 (MN). Further, this threshold changed over time within a state: Relative to one year ago, MA increased it by 13 percent in 2000 but reduced it by 1 percent both in 2004 and 2011.

UI payment duration. Finally, the maximum UI payment duration also differs across states as well as over time within a state. Regular benefits are typically paid for 26 weeks in most states, with a range between 13 and 30 weeks. However, longer UI payment durations are made available during periods of high unemployment rates in a state through the Extended Benefits (EB) program or discretionary programs such as the Temporary Emergency Unemployment Compensation (TEUC) program between March 2002 and December 2003 and the Emergency Unemployment Compensation (EUC) program between July 2008 and December 2013.[8] For instance, the maximum payment duration peaked between 81 and 99 weeks in many states during the Great Recession due to the extensions made under EB and EUC programs.

2.1.3 Estimation of UI eligibility, take-up, and replacement rates

Because the SIPP does not provide information on UI eligibility or the replacement rate of an unemployed individual, we construct a program that combines information from the SIPP with

[8]Because the EB program is triggered based on state-level unemployment rate, we incorporate this data into our analysis when determining maximum UI payment durations across states and over time. We also incorporate UI extensions made under all tiers of TEUC and EUC programs.

state-level and time-varying UI laws to predict a person's UI eligibility and replacement rate.

First, we link the information on employment, earnings, reason for unemployment, and state of residence from the SIPP with monetary and non-monetary eligibility rules across states between 1996 and 2016. Using respondents' labor market histories, this allows us to estimate a person's UI eligibility upon unemployment. This way, we are able to distinguish in the microdata job losers who are UI ineligible from those who are eligible but do not collect benefits.

We then define an unemployed individual to be *UI ineligible* if the individual's outcomes in the SIPP do not satisfy any of these eligibility rules in her state at that time. On the other hand, an unemployed individual is defined to be *UI eligible* if her outcomes satisfy all eligibility rules. Furthermore, we define UI-eligible individuals who report non-zero UI income in SIPP as eligible unemployed who *take up* UI, and those who report zero UI income in SIPP as eligible unemployed who *do not take up* UI or, simply, *non-take up*.

Next, because UI laws dictate a certain payment duration, our program changes a UI-eligible individual's status to be UI ineligible if she has collected UI income for the entire payment duration. An unemployed individual whose UI benefits expire is defined to be a *UI exhaustee*.

Finally, using rules on UI payment amounts together with information from the SIPP, we estimate an unemployed individual's UI replacement rate by dividing the WBA with the AWW.

Given these definitions, we calculate our measures of interest for this paper: the fraction of UI eligible (FEU), i.e., $\frac{\text{Eligible unemployed}}{\text{Unemployed}}$; the fraction who take up among the UI eligible, i.e., the take-up rate (TUR) $\frac{\text{UI recipients}}{\text{Eligible unemployed}}$; and the average replacement rate among UI eligible, i.e., the average of individual-specific replacement rates obtained by $\frac{\text{WBA}}{\text{AWW}}$. We use individual weights in SIPP to calculate these moments for each month between 1996 and 2016.

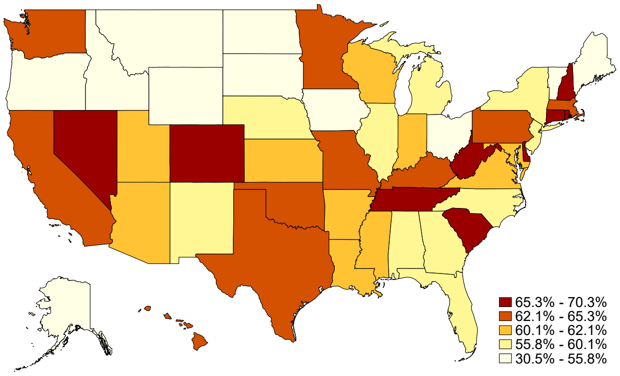
Because our empirical work involves many detailed steps, it is important to comment on how we can validate the correctness of the UI program we constructed to predict eligibility, take-up, and replacement rates. We provide three reasons for this purpose. First, our program rarely classifies an unemployed individual who reports receiving UI in the SIPP as ineligible. Second, our estimates on average eligibility and take-up rates are comparable with earlier findings in Blank and Card (1991). Finally, when we estimate eligibility and take-up rates over unemployment duration separately for non-recession vs recession episodes, as we will mention in Section 2.2, we find intuitive differences between the two: Eligibility rates do not decline over the spell during a recession due to UI extensions made during this episode, while take-up rates increase even more over the spell during a recession as lower job-finding rates raise incentives to take up.

2.1.4 State-level average UI eligibility, take-up, and replacement rates

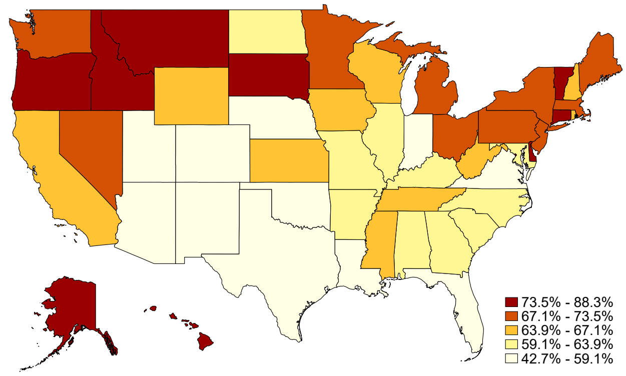
Before proceeding to our results on how the composition of unemployed changes over the unemployment spell, we first illustrate the extent of variations in UI eligibility, take-up, and replacement rates across states. In Figure 2, we present the average eligibility (Panel (a)), take-up (Panel (b)), and replacement rates (Panel (c)) between 1996 and 2016 across states, where lighter

Figure 2: State-level average eligibility, take-up, and replacement rates

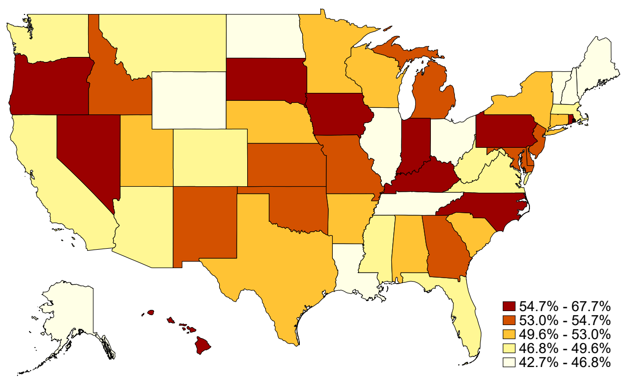
(a) Eligibility rate



(b) Take-up rate



(c) Replacement rate



Note: This figure plots the average eligibility (Panel (a)), take-up (Panel (b)), and replacement rates (Panel (c)) between 1996 and 2016 across states. We obtain these averages by taking the mean of monthly rates between 1996 and 2016, separately for each state. In each panel, we group states based on the quintiles of unweighted distributions of average rates across states. Lighter colors represent lower values and darker colors indicate higher values of these rates.

colors represent lower values and darker colors indicate higher values of these rates.[9]

Figure 2 reveal substantial differences in the average UI eligibility, take-up, and replacement rates across states.[10] Specifically, the average eligibility, take-up, and replacement rates vary across states between 30.5 percent and 70.3 percent (Panel (a)), 42.7 percent and 88.3 percent (Panel (b)), and 42.7 percent and 67.7 percent (Panel (c)), respectively. Importantly, these rates differ even among neighbor states that are expected to have similar economic performances.

2.1.5 Relevance of our empirical analysis for estimating disincentive effects of UI

We argue that our empirical analysis and results presented in Figure 1 and Figure 2 are highly relevant for the broader literature on estimating disincentive effects of UI. In particular, this active literature utilizes state-level changes on maximum UI payment duration to the estimate effects of UI generosity on job-finding probability and the unemployment rate (Rothstein, 2011; Amaral and Ice, 2014; Farber and Valletta, 2015; Chodorow-Reich et al., 2019; Hagedorn et al.,

[9] For each state, we obtain these averages by taking the mean of monthly rates between 1996 and 2016.

[10] These differences are driven by both differences in UI systems and compositions of unemployed individuals.

2019; Dieterle et al., 2020; Boone et al., 2021; Hornstein et al., 2023; Acosta et al., 2024). In doing so, however, this analysis ignores substantial differences in state- and time-varying features of UI eligibility rules on initial eligibility and payment amounts, as discussed in Section 2.1.2.

Why do differences in UI eligibility and payment amounts across states matter for estimating the potential adverse effects of changes in UI generosity? Imagine that state A increased the maximum payment duration from 26 weeks to 99 weeks, while at the same time state B increased it from 26 weeks to 60 weeks. Imagine also that, during the same period, state A imposes a much higher BP eligibility threshold and pays a much lower WBA than state B. Now, suppose that we estimate the differential impact of a more generous extension of UI payment duration in state A relative to state B on the unemployment rate, without accounting for the differences in eligibility rules and WBA payments. If our estimates imply that a relatively larger extension of payment duration in state A did not create a relatively larger unemployment rate in state A, we would mistakenly conclude that increasing UI generosity did not cause higher unemployment. However, this result may be driven by the fact that state A, to begin with, imposes stricter eligibility rules and offers less-generous weekly payments, implying that a longer UI extension may not immediately translate into an overall more-generous UI system in state A.

Differences in UI eligibility rules and payment amounts across states were previously acknowledged as important drawbacks when analyzing state-level differences in UI payment duration on labor market outcomes. For instance, Rothstein (2011) and Farber and Valletta (2015) try to account for UI eligibility at the individual level using the Current Population Survey (CPS). They do so by assuming that individuals who involuntarily lose their jobs are eligible and thus abstract from monetary eligibility requirements that require combining work-history information—which is not available in the CPS—with state-level and time-varying differences in UI eligibility rules.

2.2 Composition of unemployed over unemployment duration

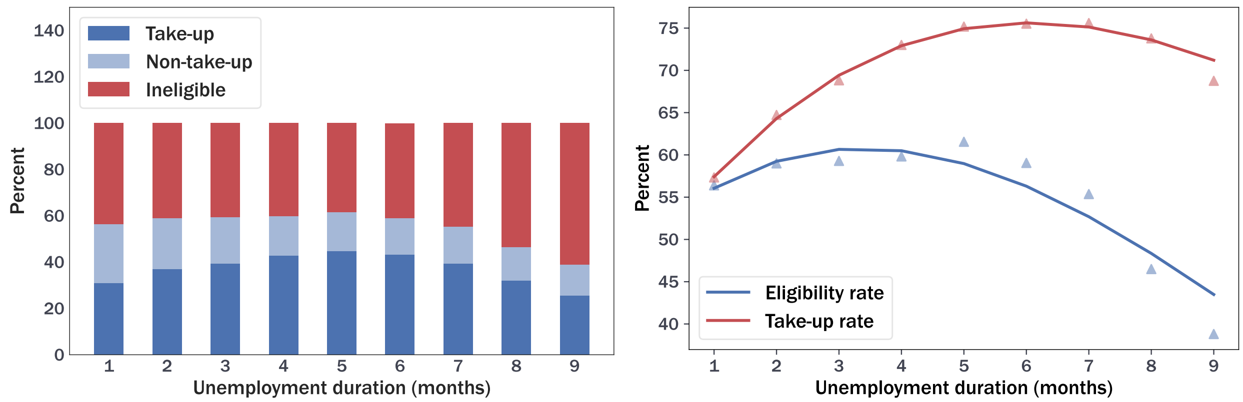
We now start presenting results on how the composition of unemployed changes over the unemployment spell using our data.

Eligibility and take-up dynamics. First, we pool all observations in our data from the 2004 SIPP panel and create an individual-level dataset of the unemployed with detailed labor market history and spell information.[11] For each duration of unemployment (in months), we calculate the share of individuals who are UI-ineligible, those who take up UI, and those who do not. Panel (a) of Figure 3 shows how the proportions of UI-ineligible, take-up, and non-take-up groups among the unemployed shift with unemployment duration. We note two main observations. The fraction of UI-ineligible individuals rises significantly as the duration of the unemployment spell extends. At the start of unemployment, an average of 44 percent are ineligible, but for spells

[11] Because we calibrate our model to the episode between 2004 and 2007 in the U.S., we present results in this section from the 2004 SIPP panel, covering all months between 2004 and 2007.

Figure 3: Eligibility and take-up dynamics over unemployment duration

(a) Distribution of unemployed by UI status | (b) Eligibility and take-up rate



Note: Panel (a) shows how fractions of ineligible, eligible who take up UI, and eligible who do not take up UI within the unemployed change over months of unemployment. Panel (b) documents how eligibility rate (FEU)—measured as the fraction of eligible within the unemployed—and take-up rate (TUR)—measured as the fraction of eligible who take up within the eligible—change over months of unemployment. To generate FEU dynamics in Panel (b), we restrict our data to unemployed individuals and first regress an eligibility dummy on unemployment duration dummies (in months) using individual weights. We then fit a cubic polynomial (solid blue line) to the resulting coefficients of the duration dummies (blue triangles). We repeat the same steps to obtain TUR dynamics where we use the same data but restrict the sample to eligible individuals and change the dependant variable to a UI-receipt dummy.

lasting nine months, this fraction increases to 61 percent. The rise in the fraction of ineligible is observed especially after the sixth month of unemployment, which is the typical maximum payment duration in the U.S. during non-recessionary periods. Second, the fraction of those who do not take up UI despite being eligible declines over the unemployment duration. The average fraction of non-take up within the unemployed declines from 26 percent in the first month of unemployment to 13 percent in the ninth month of unemployment.

Panel (b) puts these results into perspective by presenting the dynamics of average FEU and TUR. Our analysis follows Kroft et al. (2016) and Jarosch and Pilossoph (2019) who study changes in the average job-finding rate over unemployment duration. In particular, to generate the dynamics of average FEU in Panel (b), we restrict our panel data to unemployed individuals and first regress a UI eligibility dummy on unemployment duration dummies (in months) using individual weights. We then fit a cubic polynomial (solid blue line) to the resulting coefficients of the duration dummies (blue triangles). We repeat the same process to obtain the dynamics of TUR where we use the same data but restrict the sample to those who are UI eligible and change the dependant variable to a dummy of UI receipt instead. We note that even when we control for the characteristics of individuals in our regressions, dynamics of FEU and TUR (as well as the job-finding rate in Figure 5) remain mostly similar, as shown by Figure A1 in Appendix A.3.[12]

We find that the average FEU declines from 56 percent to 43 percent over months of unemployment, while the average TUR increases from 57 percent in the first month of unemployment

[12]Kroft et al. (2016) and Jarosch and Pilossoph (2019) find that job-finding rate dynamics do not change significantly when they control for observables in their regressions. Our finding that FEU and TUR dynamics (as well as job-finding rate dynamics) with and without controls are similar is consistent with their results.

to 76 percent in the sixth month of unemployment and remains mostly similar after that month.[13]

Eligibility and take-up dynamics by earnings and wealth. While previous work (e.g., Blank and Card, 1991) documents average FEU and TUR, our data allow us to explore their dynamics over the unemployment spell across income and wealth groups.

For the heterogeneity in the profile of the FEU, because UI eligibility is primarily determined by earnings prior to unemployment, we group the unemployed by their previous labor earnings. In particular, using previous labor earnings for each unemployment spell in the SIPP 2004 panel, we classify spells into those that originate from below the median of the earnings distribution of the employed in that month and those from above the median of the same distribution. We then calculate the FEU for each group across different unemployment durations.

For the heterogeneity in TUR, since we are interested in how the level of available self-insurance at the onset of unemployment influences UI take-up decisions, we categorize the unemployed based on their self-insurance levels at that time. Our measurement involves the following steps. Using the third wave of the SIPP 2004 panel, which provides information on asset holdings, we measure net liquid assets—the summation of liquid assets net of revolving debt—of each individual. To evaluate the level of self-insurance, we use the asset-to-income ratio as our metric, which is obtained by dividing net liquid assets by current labor earnings for the employed or by previous labor earnings for the unemployed. Then, as in our measurement of the heterogeneity in FEU, we assign each spell into those that originate below or above the median of the economy-wide asset-to-income ratio distribution in that month.

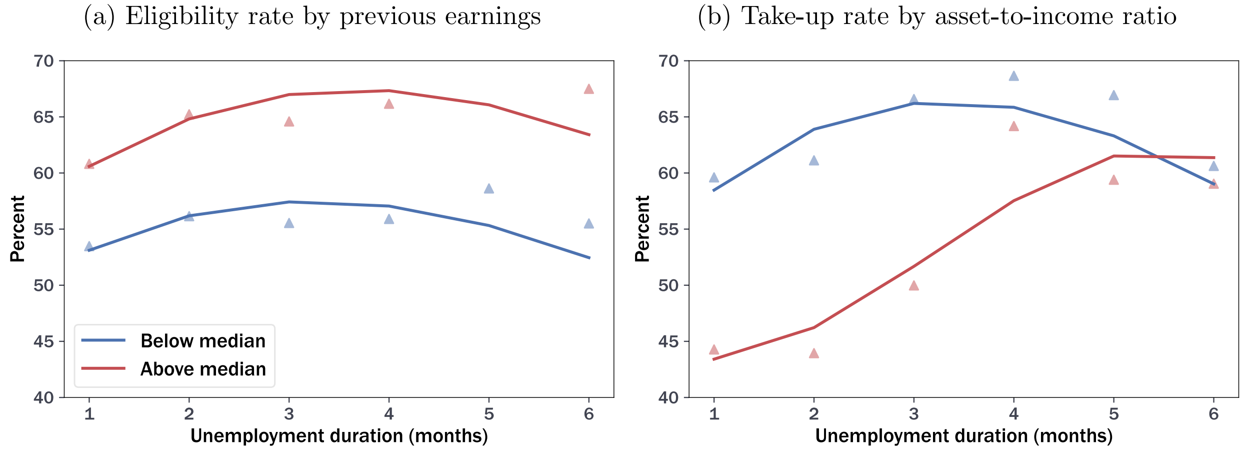
Panel (a) in Figure 4 plots the FEU for spells originating from below or above the median of the earnings distribution. We find that the eligibility rate is lower among low-income workers. In particular, at the onset of the unemployment spell, the FEU of separations originating from below the median of the earnings distribution is 8 percentage points (pp) lower than that of those originating from above the median. The lower eligibility rate among separations below the median is expected as monetary eligibility rules require a certain level of earnings. The gap between the FEU of the two groups remains mostly similar over the unemployment spell.

Panel (b) in Figure 4 presents the TUR for spells originating from below or above the median of the asset-to-income ratio distribution. We find that the TUR upon job loss is substantially higher among wealth-poor workers. Specifically, the TUR in the first month of unemployment is 58 percent for separations below the median, while it is 43 percent for those above the median.[14] This suggests that, among UI-eligible job losers, incentives to claim public insurance are inextricably linked to the level of available private insurance. We supplement this result with

[13]To illustrate how FEU and TUR change over unemployment spell during an economic downturn, Figure A2 in Appendix A.3 generates the same moments in Figure 3 when we instead use data between 2008 and 2013.

[14]Notice that because we want to measure the level of available self insurance at the moment of job loss as much as possible, we use the third wave of the SIPP 2004 panel for this result. For this reason, the economy-wide TUR may not be identical between Figure 4 and Figure 3, where we use all months of the SIPP 2004 panel.

Figure 4: Heterogeneity in eligibility and take-up rates over unemployment duration



Note: Panel (a) plots the eligibility rate (FEU)—measured as the fraction of UI eligible within the unemployed—over unemployment duration separately for spells originating from below or above the median of the earnings distribution of the employed. Panel (b) plots the take-up rate (TUR)—measured as the fraction of UI eligible who take up UI within the UI eligible—over unemployment duration separately for spells originating from below or above the median of the economy-wide asset-to-income ratio distribution. To generate the dynamics of the FEU, we restrict our panel data to unemployed individuals and first regress a UI eligibility dummy on unemployment duration dummies (in months) using individual weights. We then fit a cubic polynomial (solid blue line) to the resulting coefficients of the duration dummies (blue triangles). We repeat the same process to obtain the dynamics of TUR where we use the same data but restrict the sample to those who are UI eligible and change the dependant variable to a UI-receipt dummy.

Table A1 in Appendix A.3 where we document that those who take up UI have lower levels of available self insurance than those who are eligible but do not take up. For example, the mean asset-to-income ratio is 1.15 for the former group, while it is 2.17 for the latter group. In Table A1, we also show that unemployed individuals have substantially lower levels of self insurance than employed individuals, implying that the incidence of unemployment is also not random.

Importantly, Panel (b) in Figure 4 also shows that the TUR gap between the two groups disappears after five months of unemployment and that this is mostly driven by the rise of the TUR among separations above the median. This result is potentially driven by changes in both the composition within this group and incentives to take up UI over the spell. In particular, as more employable workers exit unemployment earlier, the remaining workers with lower job-finding rates may start to take up as they deplete their wealth over time.

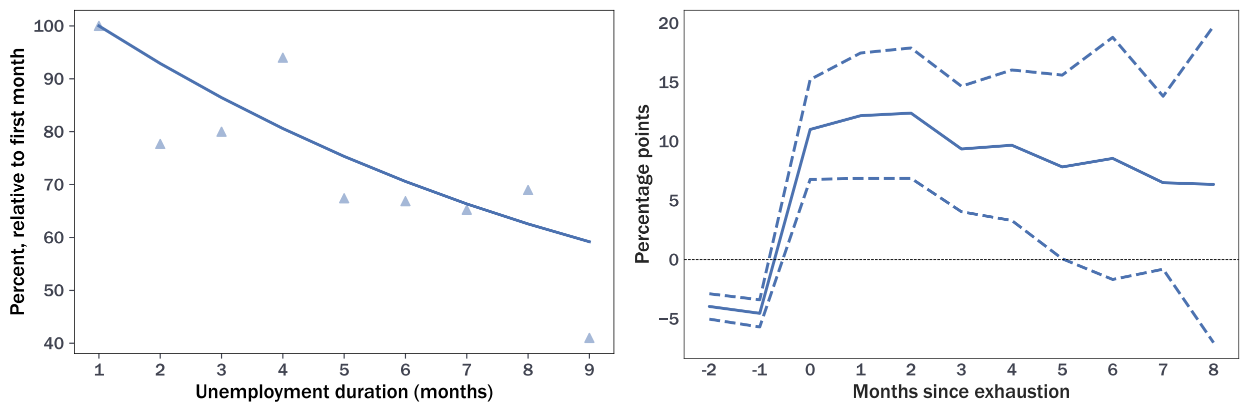
2.3 Job-finding rate over unemployment duration

Finally, we explore the potential impact of UI benefits on the job-finding rate of the unemployed. To do so, we first analyze how the average job-finding rate changes over the unemployment spell, allowing us to compare our results with existing findings. Similar to our analysis for FEU and TUR dynamics, we restrict our panel data to unemployed individuals and first regress a dummy of finding a job next month on unemployment duration dummies (in months) using individual weights. We then fit a cubic polynomial (solid blue line) to the resulting coefficients of the duration dummies (blue triangles).[15] Panel (a) in Figure 5 shows that the job-finding rate

[15]Figure A1 shows that results remain similar if we control for observable characteristics of individuals.

Figure 5: Job-finding rate over unemployment duration and upon UI exhaustion

(a) Change in job-finding rate over duration (b) Change in job-finding rate upon UI exhaustion



Note: Panel (a) presents the average job-finding rate over unemployment duration relative to the first month of unemployment. To generate job-finding rate dynamics, we restrict our data to unemployed individuals and first regress a dummy of finding a job next month on unemployment duration dummies (in months) using individual weights. We then fit a cubic polynomial (solid blue line) to the resulting coefficients of the duration dummies (blue triangles). Panel (b) plots the percentage-point change in the average job-finding rate of recipients around UI exhaustion (i.e., between two months prior to and eight months after exhaustion) relative to the average job-finding rate of recipients who do not experience exhaustion. Dashed lines represent 90 percent confidence intervals.

declines by around 30 percent from the first month to the sixth month of the spell. This result is close to those in Kroft et al. (2016) and Jarosch and Pilossoph (2019) who find a roughly 40 percent decline in the job-finding rate from the first to the sixth month of the spell.

Next, we evaluate how UI expiration during an unemployment spell affects the job-finding rate. To measure this, we estimate the following distributed-lag regression specification[16]:

$$y_{it} = \beta X_{it} + \sum_{k=-2}^{8} \psi_k D_{it}^k + \iota_i + \xi_t + \epsilon_{it}, \tag{1}$$

where the outcome variable y_{it} is a dummy variable taking the value of 1 if an unemployed individual i in month t becomes employed in time $t+1$ and 0 otherwise; the variable X_{it} is a vector of time-varying individual characteristics, including age, marital status, and education; the variable ι_i captures a time-invariant unobserved error component associated with individual i; and ξ_t is an error component common to all individuals in the sample at month t. The indicator variables D_{it}^k identify all UI recipients k periods prior to or after a UI exhaustion, where $k = 0$ is the month in which UI benefits exhaust. For instance, $D_{it}^2 = 1$ for a UI recipient i in month t whose benefits expire in month $t-2$, and it equals zero otherwise. Thus, ψ_k captures the effect of UI exhaustion on the outcome variable k months prior to or after UI exhaustion (treatment group) relative to UI recipients who do not experience UI exhaustion (control group).

Panel (b) in Figure 5 plots the estimated values of ψ_k along with 90 percent confidence intervals. We find that, prior to UI exhaustion, the average job-finding rate of UI exhaustees is around 5 pp lower than that of non-exhaustees. However, at UI exhaustion, the average job-

[16] We use individual weights in the SIPP when estimating this regression.

finding rate of exhaustees increases by around 15 pp, becoming around 10 percent higher than that of non-exhaustees and slowly declining over time. As a result, our findings indicate the presence of modest incentive costs for UI-eligible individuals who claim UI and stay unemployed until UI exhaustion. However, we also find that only 1.8 percent of all eligible spells and 3.4 percent of all eligible spells with UI receipt in our sample experience UI exhaustion, implying that these modest incentive effects are only relevant for a very small group within the unemployed.

2.4 Taking stock and motivations for the model

Our novel contribution in this section is documenting how eligibility, take-up, and job-finding rates evolve as unemployment spells lengthen and how these dynamics differ across income and wealth groups. In terms of eligibility and take-up dynamics, we show that the eligibility rate declines, while the take-up rate increases as the unemployment spell lengthens. The decline in eligibility is mostly driven by the expiration of UI benefits after six months, while the rise in take-up rate is due to workers who are not able to find job quickly deciding to claim UI over time. Overall, the insurance value of UI benefits appears to be high at the moment of unemployment because, among the eligible, the take-up rate is higher among wealth poor. Importantly, the insurance value of UI potentially grows with the duration of unemployment as indicated by higher take-up rates over time. At the same time, some low-income individuals who lose their jobs—for whom UI's insurance value is potentially large—fail to become eligible for UI at the onset of unemployment or lose eligibility due to UI exhaustion. In terms of job-finding dynamics, the expiration of UI benefits leads to a sizable rise in the job-finding rate, but only a very small fraction of recipients experience long enough unemployment spells and exhaust UI.

What do these empirical findings imply for our model? First, the incidence of unemployment as well as UI-eligibility and take-up are heterogeneous across individuals and linked to heterogeneity in income and wealth. Second, the exit rate from unemployment as well as eligibility and take-up rates change as the unemployment spell lengthens, indicating that the composition of the unemployed evolves with duration. These findings motivate a model where (i) unemployment, eligibility, and take-up dynamics are not random but instead tied to heterogeneity in income and wealth and (ii) spell length endogenously affects job-finding, eligibility, and take-up rates through changes in wealth that influence job search and UI claiming decisions, as well as eligibility through prevailing UI payment durations. In the next section, we build a model capable of matching these key empirical findings. Matching these patterns is crucial for designing the UI policy, as the insurance-incentive trade-off is influenced by the composition of the unemployed.

3 Model

This section lays out the model environment as well as the individual and firm problems. The model is shares many similarities with Birinci and See (2023) but differs in three key ways.

First, we extend our previous model into a general equilibrium setting in asset markets without aggregate risk where individuals rent capital to firms for production. Clearing asset markets is needed to account for the effects of UI policy changes on the equilibrium real interest rate and output through the crowding out of private insurance (i.e., savings) when the public insurance (UI) becomes more generous. Second, we generalize the taxation system in this model, allowing us to study optimal UI policy under both linear or progressive taxation and to evaluate the extent to which the taxation system affects the optimal UI policy prescriptions. Third, under both taxation systems, we introduce an exogenous (disposed) amount of government spending to generate an empirically reasonable amount of government spending relative to output. In the absence of such spending, the equilibrium tax rate required to finance only UI benefits would be very small. Then, changes to this low level of tax rate may have unrealistically small effects on welfare. This is important when evaluating welfare effects of UI policy changes given that changes in the tax rate from a high steady-state tax level may not be favorable for some workers.

Environment. The preferences of ex-ante identical individuals are given by

$$U(c, s, d) = u(c) - \nu(s) - \mathbf{1}_{\{d=1\}}\alpha_d,$$

where $u(\cdot)$ is a utility function over consumption c, and $\nu(\cdot)$ and α_d represent the disutility associated with job-search effort $s \in [0,1]$ and UI take-up decision $d \in \{0,1\}$, respectively. Individuals discount the future at rate β and die with probability ω.

Individuals are risk-averse and are ex-post heterogeneous in terms of their employment status $l \in \{W, B, NB\}$, assets $a \in \mathcal{A} \equiv [a_l, a_h] \subseteq \mathbb{R}$, labor productivity $y \in \mathcal{Y} \equiv [y_l, y_h] \subseteq \mathbb{R}_+$, and wages $w \in \mathcal{W} \equiv [w_l, w_h] \subseteq \mathbb{R}_+$. An individual can be a worker W, unemployed and eligible for UI B, and unemployed and not eligible for UI NB. Idiosyncratic labor productivity y evolves according to a persistent process given by $y' \sim Q(y' \mid y)$. Individuals have access to a risk-free asset a used to insure against idiosyncratic employment shocks. We allow for borrowing, i.e., $a_l < 0$, following Braxton et al. (2023) who document that unemployed individuals maintain significant access to borrowing upon job loss. To generate an empirically-plausible fraction of net borrowers, we assume that there exists a fixed total asset supply of A from foreigners.[17] Further, individuals own and rent out capital to firms for use in production. Capital depreciates at rate δ and has a return r, which is determined endogenously.

Job search in the labor market is directed. Unemployed individuals direct their search toward labor submarkets indexed by idiosyncratic labor productivity y and wage w. On the other side of the labor market, firms that are owned by foreign entrepreneurs post vacancies across these submarkets to hire workers and rent capital from individuals to produce. The labor market

[17] The presence of foreign asset supply allows us to obtain an equilibrium real interest rate r that is low enough to convince individuals to borrow. Models without this assumption (see, for example, Krusell, Mukoyama, and Şahin, 2010 and Nakajima, 2012a) do not allow for borrowing and set $a_l = 0$. As we will discuss in Section 4, our model features an empirically plausible borrowing limit and fraction of individuals who are net borrowers.

tightness θ of submarket (w, y) is the ratio of vacancies v posted in the submarket to the aggregate search effort S exerted by all unemployed individuals searching for a job within that submarket. As such, the labor market tightness is given by $\theta(w,y) = \frac{v(w,y)}{S(w,y)}$. Given a constant-returns-to-scale matching function $M(v,S)$ that determines the number of matches in a submarket with vacancies v and aggregate search effort S, we can define the job-finding rate and the vacancy-filling rate as $f(w,y) = \frac{M(v(w,y),S(w,y))}{S(w,y)}$ and $q(w,y) = \frac{M(v(w,y),S(w,y))}{v(w,y)}$, respectively.[18]

Once the worker is matched with a firm in a submarket (w, y), the pair (w, y) determine the constant wage w of the worker and the exogenous job-separation probability $\gamma(y)$. The firm-worker pair produces output F, the amount of which is determined by a worker's productivity y and capital input k. Once the worker is separated from the firm, UI eligibility and UI benefit amount depend on the worker's previous wage w. In particular, to capture the fact that not all workers who become unemployed are UI eligible and that UI-eligibility requires sufficient earnings prior to unemployment, we assume that a worker with previous wage w is UI-ineligible with probability $g(w)$. A UI-eligible unemployed individual who decides to take up UI receives a fraction $b(w)$ of the previous wage w. To capture the fact that unemployed individuals receive UI benefits only for a certain period, we assume that UI eligibility expires stochastically at rate e.[19] Finally, in the baseline model, we assume that the government finances the UI program as well as some exogenous expenditure G through a flexible tax system. Following Benabou (2002) and Heathcote, Storesletten, and Violante (2014), the after-tax labor income of the individual is given by $\widetilde{x} = (1-\tau)\,x^{1-\Upsilon}$, where $x = w$ for an employed individual and $x = b(w)\,w$ for a UI recipient, τ determines the level of taxation, and $\Upsilon \geq 0$ determines the tax system's progressivity.

Timing. At the start of each period, an ω fraction of individuals dies and is replaced with newborn agents and all individuals learn their idiosyncratic labor productivity y.[20] Next, job separation, UI-eligibility, and UI-expiration shocks realize, after which individuals and firms make a series of decisions. In the labor market stage, unemployed individuals choose a wage submarket w for their own productivity y within which to look for a job, while firms select the submarket in which to post a vacancy. Then, the matching between vacancies and unemployed workers occurs where some unemployed workers find a job and some vacancies are filled with workers. Next, the production and consumption stage opens, where firms rent capital and each firm-worker pair produces, wages are paid to workers, UI benefits are paid to the UI-eligible unemployed who decide to collect UI, and all unemployed receive the monetized value of non-market activities h. Individuals then make consumption and saving or borrowing decisions.

[18] The constant-returns-to-scale assumption guarantees that the equilibrium θ is sufficient to determine job-finding rate $f(\theta) = \frac{M(v,S)}{S} = M(\theta, 1)$ and vacancy-filling rate $q(\theta) = \frac{M(v,S)}{v} = M\left(1, \frac{1}{\theta}\right)$.

[19] The benefit expiration rate e is stochastic, as in Mitman and Rabinovich (2015). This assumption simplifies the solution of the model because we do not need to carry the unemployment duration as another state variable.

[20] Newborn individuals obtain the wealth and productivity of their offspring and enter into labor market as unemployed eligible with a previous wage drawn from a uniform distribution.

Finally, the unemployed choose the search effort s they will exert in the labor market stage in the next period, where the utility cost of that search effort is incurred in the current period.

Before moving to the discussion of agents' optimization problems, we comment on specific features of the model that will allow it to generate empirical findings in Section 2. First, the heterogeneity in job-separation probability based on productivity will be used to generate higher unemployment risk for individuals with low income and wealth, while the heterogeneity in eligibility probability based on previous wages will be used to obtain lower eligibility rates for unemployed with lower previous earnings. Second, the endogenous take-up decision together with the utility cost of job search will imply that eligible individuals will select into claiming UI based on their labor market prospects and wealth holdings. Importantly, as the unemployment spell lengthens, individuals who do not claim UI upon job loss may start taking up UI once they deplete their wealth levels. Third, it will be more likely for UI recipients with long spells to lose eligibility. Overall, these model features will endogenize and shape the composition of the unemployed at job loss and, crucially, how this composition evolves over time.

Individual's problem. The recursive problem of an employed individual is given by

$$\begin{aligned} V^{W}(a,w,y) &= \max_{c,\,a'\geq a_l} \quad u(c)+\beta(1-\omega)\,\mathbb{E}\Bigg[(1-\gamma(y'))\,V^{W}(a',w,y') \\ &\qquad +\gamma(y')\Big[(1-g(w))\,V^{B}(a',w,y')+g(w)\,V^{NB}(a',y')\Big]\Bigg] \end{aligned}$$

subject to

$$c+a'\leq(1+r-\delta)\,a+(1-\tau)\,w^{1-\Upsilon}. \tag{2}$$

We note that workers may not qualify to be UI-eligible when they lose their job, which is captured by function $g(\cdot)$, consistent with the existing UI policy in the U.S. Notice also that we keep track of previous wages w only for the UI-eligible unemployed.

Unemployed individuals who are eligible for UI first decide whether to take up UI benefits and incur utility cost $\phi(d)$ if they decide to take up. We interpret the UI take-up cost as time and effort devoted to filing an initial UI claim and providing proof of ongoing compliance for UI receipt.[21] The take-up decision of these individuals is given by

$$V^{B}(a,w,y)=\max_{d\in\{0,1\}} \quad dV_{T}^{B}(a,w,y)+(1-d)\,V_{NT}^{B}(a,w,y)-\mathbf{1}_{\{d=1\}}\alpha_{d}, \tag{3}$$

where we keep track of previous wages w even if the unemployed does not to take up UI this period as she may claim UI in the future, which is consistent with the current UI policy.

All unemployed individuals decide on how much search effort s to exert and they direct their search toward a wage submarket w based on their productivity y, with an associated tightness

[21] An eligible unemployed individual must file an application when she decides to take up UI. In addition, while she is taking up UI, she needs to provide proofs or documentation of ongoing job search activities.

$\theta(w,y)$ and job-finding rate $f(\theta(w,y))$. Then, the recursive problem of an eligible unemployed who takes up UI benefits V_T^B is given by

$$\begin{aligned} V_T^B(a,w,y) &= \max_{c,\, a'\geq a_l,\, s} \quad u(c)-\nu(s)+\beta(1-\omega)\,\mathbb{E}\Bigg[\max_{\widetilde{w}}\Bigg\{sf(\theta(\widetilde{w},y'))\,V^W(a',\widetilde{w},y') \\ &\quad + (1-sf(\theta(\widetilde{w},y')))\Big[(1-e)\,V^B(a',w,y')+eV^{NB}(a',y')\Big]\Bigg\}\Bigg] \end{aligned}$$

subject to

$$c+a'\leq(1+r-\delta)\,a+h+(1-\tau)\,[b(w)\,w]^{1-\Upsilon}. \tag{4}$$

The choice of wage submarket $\widetilde{w}$ is influenced by a trade-off as higher-paying jobs have lower job-finding probabilities. We note that the problem of an eligible unemployed who does not take up is the same as in Equation (4) except that UI benefits do not enter the budget constraint.

Finally, the recursive problem of an ineligible unemployed is given by

$$\begin{aligned} V^{NB}(a,y) &= \max_{c,a'\geq a_l,s} \quad u(c)-\nu(s)+\beta(1-\omega)\,\mathbb{E}\Bigg[\max_{\widetilde{w}}\Bigg\{sf(\theta(\widetilde{w},y'))\,V^W(a',\widetilde{w},y') \\ &\quad + (1-sf(\theta(\widetilde{w},y')))\,V^{NB}(a',y')\Bigg\}\Bigg] \end{aligned}$$

subject to

$$c+a'\leq(1+r-\delta)\,a+h. \tag{5}$$

Ineligible unemployed agents do not make any take-up decision and are unable to gain eligibility if their job search fails. This is in accordance with current UI policy in the U.S. where the UI eligibility is terminated once the unemployed receive UI benefits for a certain number of weeks.

Firm's problem. A firm can either be matched with a worker or be posting a vacancy to hire one. A firm that is matched with a worker decides how much capital to rent each period at interest rate r and uses it in production together with labor. The problem of a firm that is matched with a worker in submarket (w,y) is given by

$$J(w,y) = \max_{k\geq 0} \quad F(y,k)-w-rk+\frac{1}{1+r}(1-\omega)\,\mathbb{E}\Big[(1-\gamma(y'))\,J(w,y')\Big]. \tag{6}$$

Second, the value of a firm that posts a vacancy in submarket (w,y) is given by

$$V(w,y)=-\kappa+q(\theta(w,y))\,J(w,y), \tag{7}$$

where κ is a fixed cost of posting a vacancy. We assume that firms are owned by foreign entrepreneurs who pay the cost of creating a vacancy and collect firm profits.[22] When profit-

[22] If these firms were to be owned by individuals, individuals would need to make a portfolio choice decision between investing on capital (assets) or equity (claims to firm profits). As such, assuming that firms are owned by foreign entrepreneurs simplifies the computational algorithm for solving the model as it allows us to disregard firm profits and valuations and refrain from a portfolio choice decision for individuals.

maximizing firms decide which wage and productivity submarket to post vacancies in, they face a trade-off between the probability of filling a vacancy and the level of surplus from a possible match. A firm that is posting a vacancy in a high-wage submarket would enjoy a higher probability of filling the job at the expense of extracting a lower surplus from the match. Further, a firm that is posting a vacancy in a high-productivity submarket would enjoy a higher match surplus but face a tighter submarket and thus find it more difficult to fill the vacancy.

We assume free entry of firms to the labor market, implying that the expected profits are just enough to cover the cost of filling a vacancy. Thus, $V(w,y) = 0$ for any submarket such that $\theta(w,y) > 0$. The free-entry condition allows us to back out the equilibrium market tightness, which is sufficient for unemployed individuals to evaluate the job-finding rate in each submarket.

Government. The UI policy $\left\{b(\cdot), g(\cdot), e\right\}$, exogenous government spending G, and the level of labor income taxation determined by τ is such that the government budget constraint holds:

$$G + \int \left[(1-\tau)\left(b(w)w\right)^{1-\Upsilon}\right] \mathbf{1}_{\{l=B,d=1\}}\, d\mu = \int \left[w - (1-\tau)w^{1-\Upsilon}\right] \mathbf{1}_{\{l=W\}}\, d\mu, \tag{8}$$

where μ is the distribution of agents across individual states. The left-hand side shows the total government spending for *net* UI payments and other expenses, and the right-hand side shows the total government revenue generated through taxation of wages.

Equilibrium. We provide the definition of equilibrium for our model as well as the computational algorithm employed to solve it in Appendix B. When solving this model, we utilize the model structure and use the notion of a block recursive equilibrium (BRE) developed by Menzio and Shi (2010, 2011). The BRE allows us to back out the equilibrium labor market tightness using the free-entry condition from the firm's problem and feed it to the individual's problem. As such, it saves us a fixed point problem in solving for the market tightness.

4 Calibration

We calibrate our model to the period before the Great Recession in the U.S. Table 1 lists internally calibrated parameters and Table A2 summarizes externally calibrated parameters.

Preferences. We set the model period to a month and the death probability ω to 0.21 percent so that the expected duration of working life is 40 years. The utility function is given by

$$U(c,s,d) = u(c) - \nu(s) - \mathbf{1}_{\{d=1\}}\alpha_d = \frac{c^{1-\sigma}}{1-\sigma} - \alpha_s \frac{s^{1+\chi}}{1+\chi} - \mathbf{1}_{\{d=1\}}\alpha_d,$$

where σ is the coefficient of relative risk aversion, α_s and χ are level and curvature parameters of the utility cost of job search, and α_d is the utility cost of UI take-up. We set $\sigma = 2$. We normalize the level parameter of the search cost function α_s to 1.[23]

[23] This is because job-finding probability $sf(\cdot)$ is a multiplicative function of the search effort s and the matching efficiency $\lambda(\cdot)$, as discussed below. This implies that we cannot separately identify the level parameter of the

Table 1: Internally calibrated parameters

Parameter	Explanation	Value	Target	Data	Model
β	Discount factor	0.994	Fraction of individuals with non-positive net liquid wealth	0.27	0.35
χ	Curvature of utility cost of search	1.490	Elasticity of nonemp. duration with respect to UI duration	0.15	0.11
α_d	Utility cost of UI take up	0.370	Average monthly UI take-up rate	0.62	0.61
a_l	Borrowing limit	-9.100	Median ratio of credit limit to quarterly income	0.74	0.74
$\overline{\gamma}$	Average job separation rate	0.011	Average monthly EU rate	0.012	0.012
η_y^γ	Heterogeneity of job separation rate	-1.768	EU ratio of low- (Q1) vs high-income (Q5) workers	5.51	5.51
$\overline{\lambda}$	Average matching efficiency	0.908	Average monthly UE rate	0.35	0.36
η_y^λ	Heterogeneity of job finding rate	-0.453	UE ratio of low- (Q1) vs high-income (Q5) workers	0.81	0.65
σ^y	Dispersion of labor productivity	0.052	Ratio of 90th to 10th percentiles of labor earnings distribution	6.87	6.31
h	Value of nonmarket activity	0.001	Consumption drop upon job loss	0.093	0.084
m_0^b	UI replacement rate level	0.670	Average UI replacement rate	0.52	0.52
m_w^b	Heterogeneity of UI replacement rate	-0.058	Ratio of rep. rate of low- (Q1) vs high-income (Q5) workers	2.01	2.04
m_0^g	Level of UI ineligibility	1.107	Average monthly eligibility rate	0.56	0.68
m_w^g	Heterogeneity of UI ineligibility	-0.448	Ratio of elig. rate of low- (Q1) vs high-income (Q5) workers	0.57	0.53

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

We choose the curvature parameter of the search cost function χ to match the elasticity of non-employment duration with respect to changes in maximum UI duration estimated by microeconometric studies in the literature. The range of estimates for this elasticity is between an average change of 0.03 months to 0.25 months in response to a one-month change in UI duration.[24] We take the median value of 0.15 across available empirical estimates as the calibration target. To measure the same elasticity in the model, we simulate a large number of agents and extend the expected UI duration of a randomly selected group of agents by decreasing the UI expiration rate e for them. We then compute the difference in the average non-employment duration between the two groups to calculate the model-implied elasticity.

We choose the utility cost of UI take-up to match the average UI take-up rate among UI-

search cost from parameters of $\lambda(\cdot)$. Hence, we choose to normalize the former.

[24] In particular, Nekoei and Weber (2017) use the age variation for UI payment duration in Austria and estimate that a 9-week increase in UI duration leads to 0.29 week longer non-employment duration (an elasticity of 0.03). Card and Levine (2000) use the 13-week extension of UI benefits in New Jersey as a test case and identify an elasticity of 0.08. Valletta (2014) uses differences in UI duration across U.S. states and over time and Schmieder et al. (2016) exploit the age variation for UI payment duration in Germany to measure this elasticity, and they both obtain an elasticity of 0.15. Moffitt (1985) and Katz and Meyer (1990) analyze differences in UI duration across states and time, and differences in UI recipients and non-recipients, respectively, and identify an elasticity of 0.16. Finally, Johnston and Mas (2018) analyze the effects of an unexpected 16 weeks of cut in UI payment duration in Missouri and estimate an elasticity of 0.25.

eligible individuals in the data. Using our data in Section 2, we calculate the average monthly TUR between 2004 to 2007 in the SIPP as 62 percent.

Borrowing and saving, and value of nonmarket activity. We use the discount factor β to target a fraction of population with non-positive net liquid wealth of 27 percent, which we obtain using the SIPP. We choose the borrowing limit a_l to target a median value of credit-limit-to-quarterly-income ratio of 74 percent in the Survey of Consumer Finances. Capital is set to depreciate at a monthly rate of $\delta = 0.0051$, which implies an annual depreciation of 6 percent. Finally, we choose total asset supply by foreigners A such that the real monthly interest rate net of depreciation is $r - \delta = 0.0033$ in equilibrium, which implies a net annual return of 4 percent.

Next, we discuss how we calibrate the monetary value of nonmarket activity h received by unemployed individuals. Because the value of h affects the magnitude of consumption drop upon job loss in the model, we choose h to match the average consumption drop upon job loss in the data. Using data from the Panel Study of Income Dynamics (PSID) between 1999 and 2019, we estimate a distributed-lag regression specification similar to that in Equation (1).[25] We find that the average consumption drop in the year of job loss is 9.3 percent in the data.[26]

Labor productivity. We assume that the logarithm of the idiosyncratic labor productivity y follows an AR(1) process: $\ln y' = \rho^y \ln y + \sigma^y v'$ with the mean of y normalized to 1. We set $\rho^y = 0.9867$ so that individuals stay in the same productivity level for an expected duration of 40 years, i.e., during their working life. We choose σ^y to match the dispersion in labor earnings in the data, measured by the ratio of 90th to 10th percentiles of the labor earnings distribution among the employed individuals in the SIPP between 2004 and 2007, which we find as 6.87.

UI policy, other government spending, and taxation. Because the maximum duration of UI payments is typically 26 weeks in the U.S., we set the UI expiration rate as $e = 4/26$. We assume that the probability of being UI ineligible upon job loss $g(\cdot)$ and the UI replacement rate $b(\cdot)$ are linear in worker's wage w prior to job loss. Specifically, we assume the following functional forms: $g(w) = m_0^g + m_w^g w$ and $b(w) = m_0^b + m_w^b w$. We choose intercept parameters m_0^g and m_0^b to match the average monthly FEU and replacement rate in the data, respectively. Using our SIPP data between 2004 and 2007 in Section 2, we estimate the average monthly FEU as 56 percent and the average replacement rate among UI recipients as 52 percent.

Next, we discipline m_w^g and m_w^b to capture the heterogeneity in UI eligibility and replacement rates across the distribution of labor earnings prior to job loss in the data. In particular, using our data in Section 2, we first rank the unemployed based on their AWW during their base period. We then calculate the average FEU across the quintiles of AWW distribution in the data and choose m_w^g to match the ratio of the average FEU among unemployed at the first

[25] We provide details on our data, variables, and estimation of this moment in the data in Appendix C.

[26] In Section 8, we show how our main results change depending on the value of h.

quintile of AWW distribution to the average FEU among unemployed at the fifth quintile of the AWW distribution. We find this ratio as 0.57 in the SIPP between 2004 and 2007, implying that the average eligibility rate of individuals at the bottom quintile of the previous labor earnings distribution is around half of the average eligibility rate of those at the top quintile. Similarly, we use the bottom-to-top quintile ratio of the replacement rate when the unemployed are ranked according to their AWW in the data to discipline m_w^b in the model. We find that the bottom-to-top quintile ratio of the replacement rate is 2.01 in the SIPP between 2004 and 2007, implying that the average replacement rate of individuals at the bottom quintile of the previous labor earnings distribution is around twice the average replacement rate of those at the top quintile.

Finally, we discuss how we discipline the fiscal policy parameters G, τ, and Υ. We calibrate the exogenous government spending amount G to target the ratio of total government spending to total output (GDP) in the data. We measure this ratio to be 19.7 percent in the 2006 National Income and Product Accounts (NIPA). As a baseline, we adopt linear taxation, i.e., $\Upsilon = 0$, and let the tax level parameter τ satisfy the government budget constraint in Equation (8).[27]

Labor market. Hagedorn and Manovskii (2008) estimate the combined capital and labor costs of vacancy creation to be 58 percent of labor productivity. Following them, we set the vacancy cost $\kappa = 0.58$. We assume the production function as $F(y,k) = yk^{\zeta}$ and set $\zeta = 1/3$.

The job-separation probability varies with productivity such that $\gamma(y) = \overline{\gamma} \times \exp\left(\eta_y^{\gamma}(y - \overline{y})\right)$, where (i) $\overline{\gamma}$ is the average job-separation rate and $\overline{y}$ is the mean productivity, respectively; (ii) η_y^{γ} captures the variation of the job-separation rate by labor earnings in the data. We choose $\overline{\gamma}$ and η_y^{γ} to match the average monthly employment-to-unemployment (EU) rate and the heterogeneity of EU rate across the earnings distribution in the data, respectively. Because the CPS and the SIPP differ in the levels of monthly transition probabilities, as also pointed out by Fujita et al. (2007), we use the level of the average monthly EU rate from the CPS between 2004 and 2007 and the heterogeneity in monthly EU rates from the SIPP for the same period, as in Krusell et al. (2017). To calculate the latter, we first rank the employed by their current earnings and assign them into quintiles of the earnings distribution. For each quintile, we calculate the EU rate as the fraction of employed who report being unemployed in the next month. We find the bottom-to-top quintile EU rate ratio to be 5.51, indicating that job-separation probability is 5.5 times higher for workers in the bottom quintile than for those in the top.

We assume a CES labor market matching function as in den Haan et al. (2000), which is extended to incorporate the heteregeneity in matching efficiency by productivity:

$$M\left(v\left(w,y\right),S\left(w,y\right)\right) = \lambda\left(y\right)\frac{v\left(w,y\right)S\left(w,y\right)}{\left[v\left(w,y\right)^{\xi} + S\left(w,y\right)^{\xi}\right]^{1/\xi}},$$

[27] Our baseline model uses linear taxation to examine the properties of optimal UI under a tax system without redistributive motives. In Section 8, we explore how progressive taxation affects optimal UI policy.

where $\lambda(y) = \overline{\lambda} \times \exp\left(\eta_y^{\lambda}(y - \overline{y})\right)$; $\overline{\lambda}$ is the average matching efficiency; and η_y^{λ} captures the variation of the job-finding rate by labor earnings in the data. We choose $\overline{\lambda}$ and η_y^{λ} to match the average monthly unemployment-to-employment (UE) rate in the CPS between 2004 and 2007 and the heterogeneity of UE rate across the previous labor earnings distribution in the SIPP between 2004 and 2007, respectively. To calculate the latter, we first rank unemployed individuals based on their previous labor earnings—which is measured as the average labor earnings three months prior to job loss—and assign them into quintiles of the previous labor earnings distribution. For each quintile, we calculate the UE rate as the fraction of unemployed who report being employed in the next month. We find the bottom-to-top quintile ratio of the UE rate as 0.81, implying that the job-finding probability is 19 percent lower for unemployed individuals in the bottom quintile than for those in the top quintile. We also set the matching function parameter $\xi = 0.5$, which is similar to those used in Hagedorn and Manovskii (2008) and Mitman and Rabinovich (2015), who also use the CES matching function.

5 Model Predictions

Motivation. Before preceding to our normative analysis, we compare our model's positive predictions against the empirical results presented Section 2. In particular, we assess how well the model captures non-targeted moments in the data, including eligibility and take-up rates over unemployment duration, both on average and by income and wealth groups, levels of self-insurance by employment and UI status, and job-finding rate dynamics over the course of unemployment and upon UI exhaustion. We will argue in Sections 6 and 7 that a model's ability of capturing these moments has key implications for resulting optimal UI policy prescriptions.

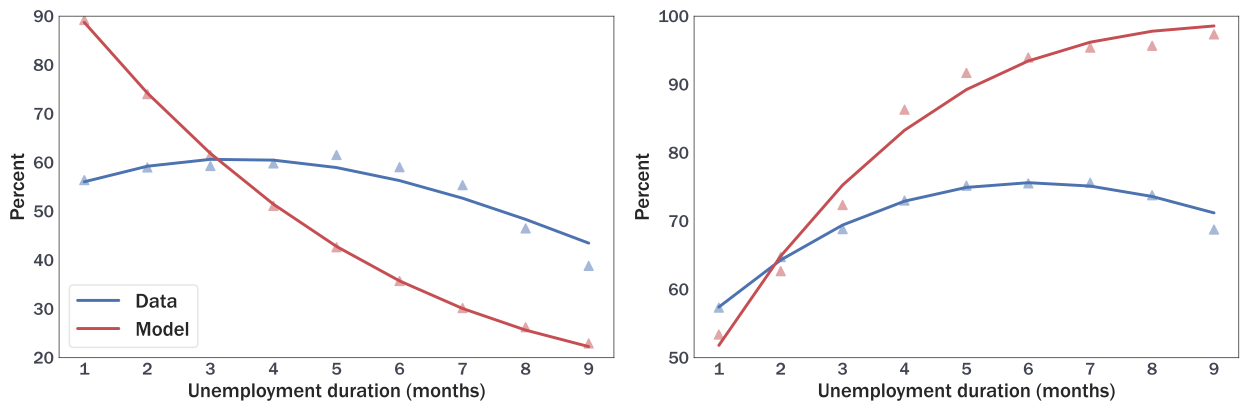
Average eligibility and take-up rates. Figure 6 compares the eligibility (Panel (a)) and take-up (Panel (b)) rates over unemployment duration in the data (blue) and the model (red).

Starting with the eligibility dynamics, we first note that our model is calibrated to match the average monthly fraction of eligible unemployed, while the fraction of eligible unemployed both upon job loss and over unemployment duration are left untargeted. Overall, we find that the model broadly captures the decline in the eligibility rate as the unemployment spell prolongs observed in the data. However, there are two differences between the eligibility rate dynamics in the model and the data: The fraction eligible unemployed upon job loss is higher in the model, and the speed at which the eligibility rate declines over months of unemployment is stronger in the model. These gaps between the data and the model are due to the following reasons.

In the data, eligibility typically expires once benefits are collected for six months, and only a very small fraction of recipients experience UI exhaustion. As such, the average fraction of eligible unemployed upon job loss is very close to the (targeted) average monthly fraction of eligible unemployed, at least until the sixth month. In the model, as UI expires probabilistically, the eligibility rate declines by a similar amount across the months of unemployment. Given this,

Figure 6: Eligibility and take-up dynamics over unemployment duration: Data vs model

(a) Eligibility rate (b) Take-up rate



Note: Panels (a) and (b) show eligibility and take-up dynamics over unemployment duration in the data and the model, respectively.

to achieve the same level of the average monthly fraction of eligible unemployed in the data, the model requires a larger average fraction of eligible unemployed *upon* job loss.

Moving to the take up dynamics, we again note that our model is calibrated to match the average monthly take-up rate, while take-up rates both upon job loss and over unemployment duration are left untargeted. The model captures the rise in the take-up rate as the unemployment spell prolongs in the data, but the magnitude of this rise is stronger in the model than in the data. As we show in Figure A4 and Table A3 in Appendix D, this is because the endogenous link between incentives to take up and the level of self insurance is stronger in the model than in the data. Thus, the model also requires a lower take-up rate upon job loss than in the data.

Heterogeneity in eligibility and take-up rates. Next, we compare how eligibility and take-up rates by earnings and wealth groups change over the spell in the data and the model.

Our model is calibrated to match the average monthly ratio of the average FEU for the first quintile of the previous earnings distribution relative to the FEU for the highest quintile. However, differences in eligibility rates of these two groups both upon job loss and over the months of unemployment are untargeted. Figure A3 shows that the model generates the magnitude and the persistence of the gap in eligibility rates among the two groups over the months of unemployment. However, for both groups, eligibility rates upon job loss are higher and declines in eligibility rates are stronger in the model than those in the data due to reasons discussed above.

Similarly, the model is calibrated to match only the average TUR. Unlike the FEU, no specific moments regarding the heterogeneity or dynamics of TUR are targeted. Figure A4 demonstrates that our model successfully captures two key features of the data. First, the model correctly predicts that unemployed individuals with lower self-insurance (starting unemployment with asset-to-income ratios below the median of the distribution) have a higher TUR than their wealthier counterparts (above median). Second, for both below- and above-median groups, the

TUR increases as the unemployment spell lengthens, reflecting the depletion of assets and the decision to claim UI. However, for individuals above the median, the model shows a faster rise in the take-up rate over the spell compared with the data. This discrepancy arises because self-insurance levels influence take-up decisions more strongly in the model, as discussed earlier.

Wealth holdings by employment and UI status. Next, Table A3 compares the model's asset-to-income ratio distributions by employment and UI status against the data. We emphasize two results that are relevant for quantifying the insurance-incentive trade-off of UI in our model.

First, as in the data, the model predicts that the unemployed have less of a buffer stock of savings to replace the monthly income than the employed, as in the data. When compared with the data, the model underestimates the level of available self insurance among the employed and the unemployed. This result is expected as the model is not designed to capture individuals with very high levels of wealth in the data. Second, the model also predicts that, among the UI-eligible unemployed, those who are wealth poor are more likely to take up UI, as in the data.

Job-finding dynamics. Finally, we compare the job-finding rate dynamics between the data and the model. Panel (a) in Figure A5 documents that the model largely captures the decline in the job-finding rate over the unemployment spell in the data, with a caveat that the decline in the model is smaller. Panel (b) compares the average change in the job-finding rate for UI exhaustees relative to non-exhaustees in the data and the model. In the model, we find that the level of available self insurance at the moment of exhaustion is critical for the response of the job-finding rate upon exhaustion. In particular, UI recipients with low levels of self insurance at exhaustion increase their efforts to find a job quickly as they have a limited savings buffer stock. On the other hand, the increase in the job-finding rate for wealth-rich recipients starts five months after the exhaustion. Only after they deplete their wealth and are unable to find reemployment do they raise their job-finding rates. As such, our model predicts that self insurance at the moment of the loss of UI benefits critically affects individual labor market responses.

Taking stock. Our model is broadly consistent with the data in terms of the (i) dynamics of eligibility and take-up rates over the unemployment duration, (ii) differences in how eligibility and take-up rates change over the unemployment spell by income and wealth groups, respectively, (iii) level of self insurance by employment and UI status, and (iv) dynamics of the job-finding rate over the unemployment spell, as well as how the job-finding rate changes upon UI exhaustion. We now use our model to solve for the optimal UI policy and discuss how matching these empirical moments are critical for optimal policy prescriptions.

6 Optimal UI Policy

In this section, we solve for the optimal UI policy in our model and analyze macro and micro effects of this policy relative to the calibrated UI policy.

We reemphasize that the optimal policy will not be a solution to a Ramsey problem, as that problem is computationally infeasible to solve with our model. Thus, we instead work with a restricted class of linear UI policies, as parameterized in Section 4, and solve for the combination of these instruments that maximizes a utilitarian welfare function. We detail our approach below.

We first discuss how we evaluate the welfare effects of various UI policies. As in Krusell, Mukoyama, and Şahin (2010), we compare steady states under different UI policy parameters. Following their approach, we refrain from comparing average utilities across steady states that would naturally have differing stationary distributions and equilibrium outcomes. Instead, we consider a number of different economies, each under a steady state with a different UI policy but identical in all other respects.[28] Rather than computing full transition dynamics in response to a UI policy change, we use an alternative welfare measure proposed by Krusell, Mukoyama, and Şahin (2010). The welfare experiment is as follows: We move each agent (along with their individual states) from the stationary distribution of the economy under the calibrated policy to alternate economies with different policies and compare utilities. A desirable feature of this "helicopter drop" of individuals from the baseline model with the calibrated UI policy to another economy with a different UI policy is that it captures the short- and long-term effects of the change in UI policy on an individual's welfare.[29] For example, if we move an unemployed individual with low previous earnings making her UI-ineligible under the calibrated policy to another economy that makes her eligible, she may benefit in the short run from collecting UI, but she might suffer in the future if this economy also features less vacancies or higher taxes.

We calculate the economy-wide welfare gain/loss π using the following equation:

$$\int E_0 \left[\sum_{t=0}^{\infty} \beta^t U \left(c_t^o \left(1+\pi\right), s_t^o, d_t^o \right) \right] d\mu = \int E_0 \left[\sum_{t=0}^{\infty} \beta^t U \left(c_t^n, s_t^n, d_t^n \right) \right] d\mu, \tag{9}$$

where $\{c_t^o, s_t^o, d_t^o\}$ refer to allocations under the old (calibrated or current) policy, while $\{c_t^n, s_t^n, d_t^n\}$ refer to those under the new (proposed) policy. Here, the distribution of the individual states μ is taken from the steady-state distribution under the calibrated policy. Then, the optimal policy is a combination of values for UI policy instruments $\left\{m_0^b, m_w^b, m_0^g, m_w^g, e\right\}$ and the tax rate τ that maximize the utilitarian welfare, i.e., the right-hand side of Equation (9), and thus π.[30]

6.1 Properties of optimal UI policy

Table 2 provides a comparison of outcomes under the optimal UI policy (second column) and the current UI policy (first column) as well as the welfare effects of the optimal policy.

[28] We assume that changes in UI policy do not affect the total asset supply A by foreigners but alter the real rate r. This assumption implies that the change in the equilibrium level of r upon a policy change will be limited. We believe that this is a plausible assumption given that changes in UI policy—which is a small fraction of total government budget—are unlikely to have a significant impact on the economy-wide interest rate.

[29] A separate advantage of using this welfare measure for our purposes is that it makes the comparison of our results later in Section 7 with those in Krusell, Mukoyama, and Şahin (2010) meaningful.

[30] It is important to reiterate that all economies satisfy all equilibrium conditions including Equation (8).

Table 2: Optimal UI policy in baseline model

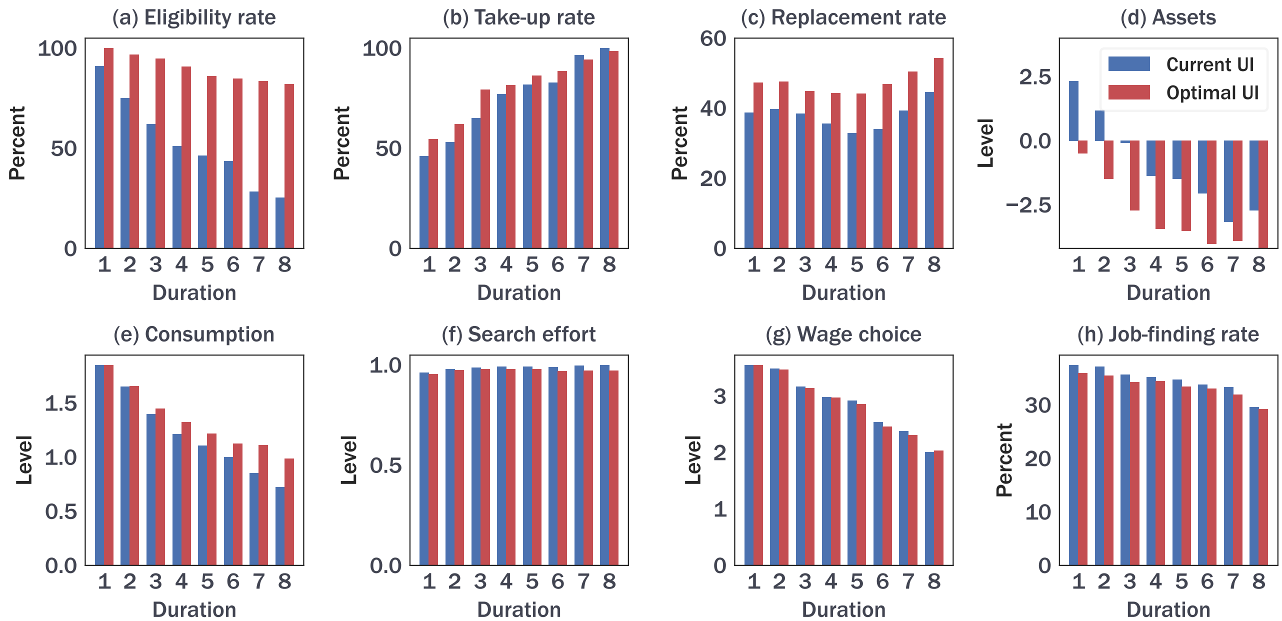
Panel A: Optimal UI policy parameters and welfare effects		
UI policy instrument	Current UI	Joint optimal UI
Level of UI replacement rate m_0^b	0.670	0.900
Het. of UI replacement rate m_w^b	-0.058	-0.093
Level of UI ineligibility rate m_0^g	1.107	0.200
Het. of UI ineligibility rate m_w^g	-0.448	-1.500
UI expiration rate e	0.154	0.038
Tax rate τ	0.313	0.314
Average welfare gains (%)		1.31
Fraction with positive gain (%)		67.1
Panel B: Implied UI replacement and eligibility rates, and expected benefit duration		
Replacement rate		
Average	0.52	0.68
Q1	0.58	0.76
Q2	0.55	0.72
Q3	0.52	0.66
Q4	0.48	0.59
Q5	0.28	0.36
Eligibility rate		
Average	0.68	0.93
Q1	0.42	0.92
Q2	0.56	0.93
Q3	0.78	0.94
Q4	0.83	0.95
Q5	0.79	0.94
Expected UI duration (months)	6.5	26.0

Note: This table summarizes optimal UI policy results in the baseline model. Panel A presents values of UI policy instruments and the equilibrium tax rate under the optimal (second column) and current (calibrated) (first column) UI policies as well as the average consumption-equivalent welfare gains and the fraction of population with positive welfare gains under the optimal policy relative to the current policy. Panel B provides implied UI replacement and eligibility rates both on average and across the quintiles of the wage distribution, and the expected UI payment duration in months.

The second column in Panel A shows that the following parameter values for the UI policy are optimal: $m_0^b = 0.9$, $m_w^b = -0.093$, $m_0^g = 0.2$, $m_w^g = -1.5$, $e = 0.034$, with an equilibrium tax rate $\tau = 0.314$. As shown in Panel B, these values imply that, relative to the current UI policy, the optimal UI policy features (i) more generous average UI replacement and eligibility rates, (ii) much larger increases in replacement and eligibility rates at the bottom quintiles of the wage distribution, (iii) a much longer expected payment duration, and (iv) only a slightly higher tax rate.[31] In particular, the average replacement and eligibility rate under the optimal policy are 68 percent and 93 percent, which are higher than their respective counterparts of 52 percent and 68 percent under the current policy. In addition, the replacement rate and the eligibility rate at the first quintile is 76 percent and 92 percent under the optimal policy, while they are 58 percent

[31] There are two reasons the tax rate rises by a small amount. First, UI expenses comprise a small fraction of total government spending in this model as we also incorporate other government expenditures G. As a result, changes in UI do not translate to large changes in total government expenses. Second, as we will show in Figure 7, the optimal policy does not cause job-finding rates to decline. Thus, because recipients collect UI for a similar duration under optimal and current policies and UI benefits are also taxed, the increase in the tax rate under the optimal policy relative to the current policy is limited.

Figure 7: Aggregate labor market effects of optimal UI policy in baseline model



Note: This figure plots how several moments in the baseline model change over unemployment duration under the current (calibrated) UI policy and the optimal UI policy. Panel (a) plots the average UI eligibility rate; Panel (b) plots the average UI take-up rate; Panel (c) plots the average replacement rate among UI recipients; Panels (d) and (e) plot average levels of assets and consumption among the unemployed, respectively; and Panels (f) to (h) plot average levels of job-search effort, re-employment wage choice, and job-finding rate among the unemployed, respectively.

and 42 percent under the current policy. Finally, the expected UI duration is 26 months under the optimal policy, while it is 6.5 months under the current policy. Overall, the optimal policy yields a 1.31 percent average consumption-equivalent welfare gain, and around two-thirds of the population receive positive welfare gains relative to the current policy.[32]

6.2 Aggregate and heterogeneous effects of optimal UI policy

We now analyze the aggregate and heterogeneous effects of the optimal UI policy. Results in this section help us quantify changes in labor market outcomes under the optimal policy and analyze its heterogeneous welfare effects across various groups in the population.

Labor market effects of optimal policy. We start with analyzing the aggregate labor market effects of the optimal policy. To do so, we compare outcomes between two steady states with different UI policies: an economy under the current policy and an economy under the optimal policy. We analyze how several important moments of interest change over the unemployment spell in these two economies. Results from this exercise are summarized in Figure 7.

We find that the optimal policy provides a more-generous UI system relative to the current policy along three dimensions. First, the eligibility rate remains substantially higher even as the unemployment duration lengthens (Panel (a)). Second, the UI take-up rate increases especially

[32] Table A4 in Appendix E provides results when we optimize over one instrument at a time to discuss how joint optimization of all UI policy instruments vs one parameter at at time changes optimal policy prescriptions.

during the early months of the spell (Panel (b)). We show in Figure A6 that this rise in the take-up rate is mainly driven by the rise in the take-up rate among agents with low wealth. Third, the optimal policy provides between 6.3 and 12.9 pp higher average replacement rates across the months of the unemployment spell (Panel (c)). As a result, the optimal policy provides more generous insurance relative to the current policy by offering greater eligibility especially among the long-term unemployed, generating higher take-up upon job loss especially among eligible individuals with low wealth, and providing higher replacement rates.

How does the optimal policy affect savings decisions of individuals? We find that the optimal policy changes both the precautionary saving motives while employed and the dynamics of assets over the unemployment spell. Panel (d) plots the average asset level among the unemployed and shows that it is much lower under the optimal policy than under the current policy at the start of the unemployment spell. This is because the precautionary savings motives are dampened among the employed who are offered a more-generous UI policy in the event of job loss under the optimal policy. Panel (d) also shows that levels of average assets of the unemployed under the two policies eventually become similar as the unemployment spell prolongs. This is because of the reduced need to deplete savings under the optimal policy, which offers sufficient coverage and income during unemployment. However, under the current policy, because replacement rates are less generous and eligibility and take-up rates are lower, the unemployed rely more on their own savings to cope with the income loss during longer unemployment spells. Overall, as shown by Panel (e) that plots the average consumption level among the unemployed, the optimal policy improves consumption especially for the long-term unemployed.

UI policy design also cares about the extent to which more-generous insurance negatively affects incentives for seeking re-employment. The final three panels (Panels (f) to (h)) illustrate how much the optimal policy impacts job search outcomes relative to the current policy. Overall, we find that the average search effort, re-employment wage choice, and the resulting job-finding rate of the unemployed barely differ between the two policies, indicating that the incentive costs of shifting to the optimal policy are small. The reason these incentive costs are small in the baseline model is discussed in detail in our earlier work (Birinci and See, 2023): When disciplined by the data carefully, the pool of UI recipients in the model comprises individuals with high marginal utility of consumption who are close to the borrowing constraint. Hence, their expected surplus from employment is large. Even in the face of a more-generous UI policy, this large surplus motivates them to pursue re-employment. In this sense, the borrowing constraint self-disciplines the job-search behavior of wealth-poor UI recipients.

Heterogeneous welfare effects of optimal policy. We evaluate welfare gains from the optimal policy for various groups. To do so, we calculate group-specific average consumption-equivalent welfare gains using Equation (9) where the distribution of individuals is taken from the steady state under the current policy. Table 3 shows welfare gains and the fractions of the

Table 3: Heterogeneous welfare effects of optimal policy in baseline model

	Wage					Asset-to-income ratio				
	Q1	Q2	Q3	Q4	Q5	Q1	Q2	Q3	Q4	Q5
All										
Average welfare gains (%)	2.88	0.98	0.19	0.05	-0.04	1.99	1.30	1.03	0.97	0.74
Fraction with positive gain (%)	100.0	100.0	100.0	32.3	3.6	99.4	93.2	80.0	30.1	32.5
Employed										
Average welfare gains (%)	2.78	0.92	0.18	0.03	-0.11	1.88	1.25	1.00	0.92	0.71
Fraction with positive gain (%)	100.0	100.0	100.0	28.4	2.0	99.5	92.8	79.2	27.1	31.9
Unemployed										
Average welfare gains (%)	3.88	3.00	1.86	0.83	0.97	3.39	2.36	2.14	2.23	1.80
Fraction with positive gain (%)	99.0	100.0	99.3	97.9	70.8	99.3	98.0	94.9	90.1	84.6

Note: This table presents average consumption-equivalent welfare gains and fractions of populations with positive welfare gains under the optimal policy in the baseline model relative to the current (calibrated) policy across quintiles of wage and asset-to-income ratio distributions for all individuals, employed individuals, and unemployed individuals. Cutoffs for quintiles of both distributions and employment status of individuals are based on the economy under the current policy.

population with positive gains from the optimal policy across quintiles of wage and asset-to-income ratio distributions, separately for all individuals as well as employed and unemployed individuals.[33] We find much larger welfare gains and fractions with positive gains in bottom quintiles when compared with top quintiles. In particular, average welfare gains are 2.88 percent and 1.99 percent in bottom quintiles of the wage and asset-to-income ratio distributions, while they are -0.04 percent and 0.74 percent in top quintiles. The optimal policy yields much larger gains for those with low wages and levels of self insurance, as insurance benefits are largest while incentive costs are relatively weak for them. The insurance value of UI is larger for them as they have the highest marginal utility of consumption. On the other hand, incentive costs are small for them given that the borrowing constraint disciplines their job search, as discussed above.[34]

Table 3 also shows that welfare gains and fractions with positive gains are much larger for the unemployed than for the employed. Clearly, the unemployed enjoy a more generous UI system under the optimal policy, while the employed with higher wages and low unemployment risk have much less to gain from this policy but suffer from higher taxes.

Taking stock. To summarize, we have shown that the optimal policy features much more generous eligibility and replacement rates especially for those in the bottom quintile of the wage distribution and a much longer expected UI duration than the current policy. Under the optimal policy, the increase in consumption is especially observed for the long-term unemployed, while the incentive costs of the optimal policy are limited. Overall, the optimal policy yields a sizable increase in average welfare, with even larger gains for those in bottom quintiles of wage and asset-to-income ratio distributions and for the unemployed. On the other hand, most of the employed in top quintiles experience welfare losses from the optimal policy.

In the next section, we will focus on the role of accounting for heterogeneity within the

[33] Table A5 repeats this exercise for quintiles of productivity and asset distributions and finds similar results.

[34] We explain this point more in Section 7.1 when discussing the role of heterogeneity on the optimal policy.

unemployed on optimal UI policy prescriptions and associated welfare effects.

7 Role of Heterogeneity within the Unemployed

Alternative model. To analyze the role of the heterogeneity within the unemployed on optimal policy, we now consider an alternative (nested) model that misses the link between the heterogeneity in income and wealth and the heterogeneity in unemployment risk and UI eligibility, take-up, and replacement rates. In particular, the alternative model assumes (i) full take up (i.e., $\alpha_d = 0$ such that $d = 1$ for all eligible unemployed), (ii) homogeneous job-separation and job-finding probabilities (i.e., $\eta_y^\gamma = 0$ such that $\gamma(y) = \overline{\gamma}$ and $\eta_y^\lambda = 0$ such that $\lambda(y) = \overline{\lambda}$), (iii) homogeneous eligibility rates (i.e., $m_w^g = 0$ such that $g(w) = m_0^g$), and (iv) homogeneous replacement rates (i.e., $m_w^b = 0$ such that $b(w) = m_0^b$). We calibrate the alternative model to match *the same* heterogeneity in income and wealth but only average job-finding and job-separation rates and average eligibility, take-up, and replacement rates. Thus, the alternative model is unable to capture how income and wealth heterogeneity determines the heterogeneity in unemployment risk as well as eligibility, take-up, and replacement rates. In this section, we solve for the optimal policy in the alternative model and evaluate its aggregate and heterogeneous effects. Comparison of optimal policies in the baseline and alternative models allows us to illustrate the role of heterogeneity within the unemployed on optimal policy prescriptions.

7.1 Properties of optimal UI policy

Optimal UI policy when all instruments are jointly optimized. The second column of Table 4 presents the optimal policy and associated outcomes in the alternative model. When all UI policy parameters in the alternative model (i.e., m_0^b, m_0^g, and e) are jointly optimized, we find that the optimal policy (Table 4 column 2) is much less generous than the optimal policy in the baseline model (Table 2 column 2), especially in terms of replacement rates: Average replacement and eligibility rates are 15 and 89 percent under the optimal policy in the alternative model, while they are 68 and 93 percent in the baseline model. On the other hand, the expected UI duration is the same under optimal policies in these models.

Why does the government find it optimal to provide much less generous benefits in the alternative model? This is precisely because this model misses the key dimensions of heterogeneity within the unemployed. In particular, the alternative model cannot capture the characteristics of UI recipients in the data in terms of which type of individuals become unemployed, UI eligible, and eventually UI recipients. For example, in the alternative model, individuals with high income and wealth are equally likely to become unemployed and receive UI as those with low income and wealth, which is at odds with the data. This critically affects the optimal UI generosity because the insurance-incentive trade-off changes depending on the level of self insurance. In our previous work (Birinci and See, 2023) that studies the positive implications of UI policy

Table 4: Optimal UI policy in alternative model

Panel A: Optimal UI policy parameters and welfare effects					
UI policy instrument	Current UI	Joint optimal UI	Only optimal m_0^b	Only optimal m_0^g	Only optimal e
Level of UI replacement rate m_0^b	0.517	0.150	0.183	0.517	0.517
Het. of UI replacement rate m_w^b	0	0	0	0	0
Level of UI ineligibility rate m_0^g	0.131	0.05	0.131	0.95	0.131
Het. of UI ineligibility rate m_w^g	0	0	0	0	0
UI expiration rate e	0.154	0.038	0.154	0.154	0.503
Tax rate τ	0.300	0.290	0.288	0.285	0.292
Average welfare gains (%)		0.37	0.30	0.25	0.15
Fraction with positive gain (%)		96.9	96.8	97.2	93.4
Panel B: Implied UI replacement and eligibility rates, and expected benefit duration					
Replacement rate					
Average	0.52	0.15	0.18	0.52	0.52
Q1	0.52	0.15	0.18	0.52	0.52
Q2	0.52	0.15	0.18	0.52	0.52
Q3	0.52	0.15	0.18	0.52	0.52
Q4	0.52	0.15	0.18	0.52	0.52
Q5	0.52	0.15	0.18	0.52	0.52
Eligibility rate					
Average	0.68	0.89	0.68	0.04	0.44
Q1	0.65	0.88	0.65	0.04	0.40
Q2	0.64	0.87	0.63	0.04	0.38
Q3	0.72	0.91	0.72	0.05	0.51
Q4	0.72	0.91	0.73	0.05	0.51
Q5	0.62	0.86	0.66	0.05	0.39
Expected UI duration (months)	6.5	26.0	6.5	6.5	1.99

Note: This table summarizes optimal UI policy results in the alternative model. Panel A presents values of UI policy instruments and the equilibrium tax rate under different UI policies. The first column (current UI) represents the current policy; the second column (joint optimal UI) represents the optimal policy when all policy parameters are jointly optimized (i.e., m_0^b, m_0^g, and e at the same time); and the third to fifth columns represent cases where we optimize only over one parameter (i.e., m_0^b, m_0^g, and e one at a time), respectively. Panel B provides implied UI replacement and eligibility rates both on average and across the quintiles of the wage distribution, and the expected UI payment duration in months under each UI policy.

changes, we show that while the insurance value of UI declines with the level of self insurance, incentive costs of UI—measured by the change in the job-finding rate upon a change in UI—have an inverse-U-shaped pattern in the level of self insurance. Here, we briefly summarize this result.

First, individuals with low levels of self insurance exert close to maximal search effort $s = 1$ under the current UI policy because the value of employment relative to unemployment (i.e., the surplus from employment) is very large for them.[35] Importantly, for these individuals, the surplus from employment remains high for a wide range of generous UI configurations, leaving incentive costs from rises in UI generosity small for them. Second, individuals with high levels of self insurance exert lower search effort because the surplus from employment is small for them. The incentive costs of UI are also small for them but for a different reason: They are less affected by changes in UI given that they are sufficiently self-insured and enjoy low unemployment risk. Finally, individuals in the middle of the two groups exhibit higher elasticities: A more generous

[35]This can be seen in Panel (f) of Figure 7. Because the baseline model captures the fact that the majority of UI recipients are wealth poor, the average job-search effort is close to maximal search effort.

UI allows them to reduce search effort and look for high-wage jobs that are difficult to find.

As a result, a model's ability to accurately capture the patterns of heterogeneity among the unemployed is crucial in assessing the insurance-incentive trade-off of UI. The baseline model predicts that the pool of UI recipients comprises income- and wealth-poor individuals who assign higher insurance value to UI and exhibit smaller changes in their job-finding rates when UI generosity rises. Therefore, the optimal UI policy features a more-generous UI system. On the other hand, in the alternative model, because the pool of UI recipients comprises more individuals who assign lower insurance value to UI and exhibit larger incentive costs, the optimal policy in this model becomes substantially less generous than that in the baseline model.[36]

Overall, we find that the optimal policy in the alternative model yields 0.37 percent average consumption-equivalent welfare gains and that almost all individuals experience positive welfare gains. As such, welfare gains from the optimal policy in the alternative model is only around a third of the welfare gains from the optimal policy in the baseline model.

Welfare-improving policies when only one UI instrument is optimized. Next, we solve for welfare-improving UI policies in the alternative model when the government optimizes over only a single UI parameter. This analysis is useful as comparable studies in the literature typically (i) solve for the optimal policy in a model without taking into account the heterogeneity within the unemployed and (ii) optimize over a more limited set of UI instruments than in the baseline model. As such, solving for welfare-improving UI policies in the alternative model when optimizing only over a single parameter allows us to benchmark both the optimal policy prescriptions and associated magnitude of welfare gains against existing studies.

Columns three to five in Table 4 summarize the welfare-improving policies and their associated outcomes in the alternative model when we optimize only over one parameter (i.e., m_0^b, m_0^g, and e one at a time), respectively. We find that welfare-improving policies over a single instrument yield a much less generous UI system—especially along eligibility and duration dimensions—when compared with the optimal policy when all parameters are jointly optimized. This is because, when the government cannot optimize over all parameters jointly, in order to temper large incentive costs in this model, it must choose a less generous UI policy for the single parameter over which it can optimize. For instance, when the replacement rate and expected duration are set to their current (relatively more generous) levels of $m_0^b = 0.517$ and 6.5 months, optimizing over m_0^g alone leads to a welfare-improving policy with $m_0^g = 0.95$ (fourth column), implying that only 5 percent of job losers are eligible. Similarly, under calibrated levels of $m_0^b = 0.517$ and $m_0^g = 0.131$, optimizing over e alone leads to a welfare-improving policy with

[36]The optimal policy in the alternative model features much lower replacement rates when compared with the current policy. However, the optimal policy also provides a higher eligibility rate and a longer payment duration. This is because as the optimal policy offers much lower replacement rates relative to the current policy to begin with, incentive costs of providing insurance through the remaining two policy instruments are lower.

$e = 0.503$ (fifth column), implying that the expected UI duration is only around two months.[37]

In a series of exercises in the alternative model (not presented in Table 4), we find that the only way to refrain from such low levels of eligibility rates and UI payment duration in the alternative model is to equip the government with more instruments. For example, when we start from a less-generous replacement rate $m_0^b = 0.183$ (welfare-improving policy in the third column of Table 4), the welfare-improving level of UI ineligibility becomes $m_0^g = 0.292$ (instead of $m_0^g = 0.95$ in the fourth column of Table 4), implying that raising the eligibility rate improves welfare once a low replacement rate is implemented. Further, when we implement these two instruments (i.e., $m_0^b = 0.183$ and $m_0^g = 0.292$), the welfare-improving UI expiration probability becomes $e = 0.077$ (instead of $m_0^g = 0.503$ in the fifth column of Table 4), implying that offering a much longer payment duration improves welfare once replacement and eligibility rates are optimized to account for large incentive costs in the alternative model.

Comparison with Krusell, Mukoyama, and Şahin (2010). Overall, Table 4 provides important results for comparing the optimal policy prescriptions and their welfare effects in the alternative model with those from existing studies. We believe that our analysis is the most comparable to Krusell, Mukoyama, and Şahin (2010) who develop an incomplete markets model combined with a random search and matching framework in general equilibrium and use it to solve for the optimal UI benefit level.[38] In their model, however, they do not account for the heterogeneity within the unemployed because (i) unemployment risk is homogeneous across workers, (ii) all unemployed workers are eligible and take up UI, and (iii) UI benefit amount is the same for all unemployed. Using this model, they find that the optimal replacement rate is 12 percent with associated average welfare gains of around 0.12 percent.[39]

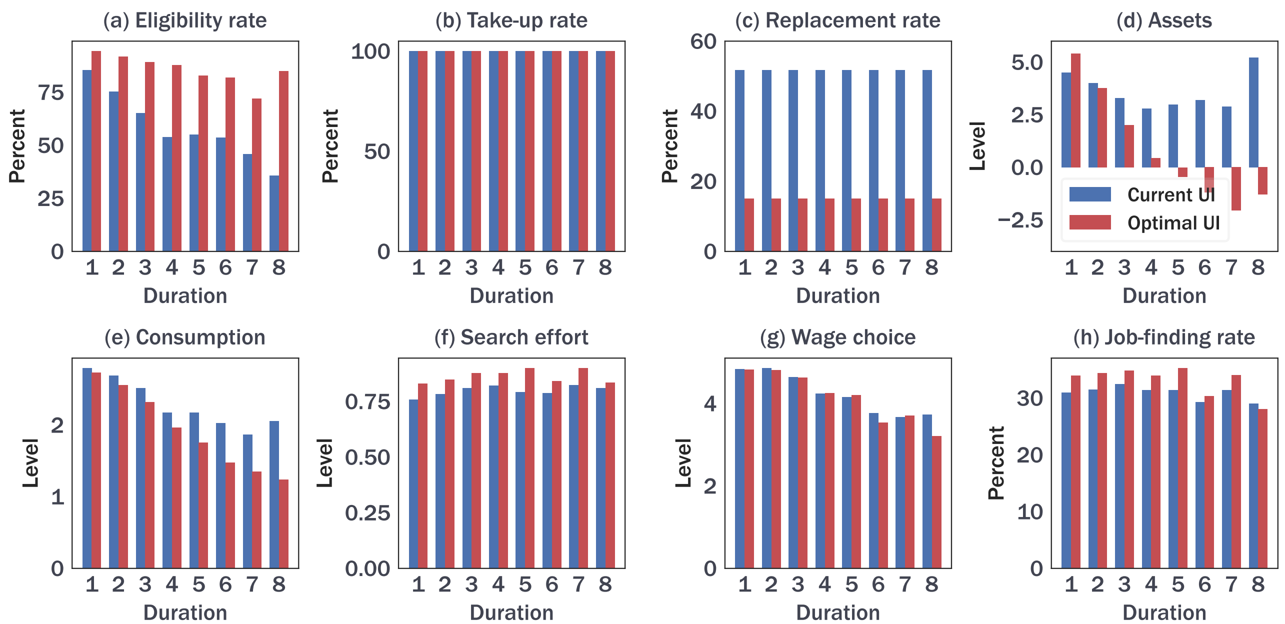
Recall that the alternative model already eliminates the heterogeneity within the unemployed in the baseline model, making our model much closer to their model. Then, among our optimal policy exercises using the alternative model, the third column in Table 4 is our most comparable exercise to that in Krusell, Mukoyama, and Şahin (2010), as it presents the case where we optimize only over the replacement rate level. We find that the welfare-improving replacement rate in this case is 18 percent and that this policy yields an average of 0.30 percent consumption-equivalent welfare gains. These findings turn out to be within the neighborhood of those in Krusell, Mukoyama, and Şahin (2010), as mentioned above.

[37] In the third column of Table 4, when we only change m_0^b and keep m_0^g and e at their calibrated levels, eligibility rates also slightly change relative to those under the current (calibrated) policy. This is because, individuals change their job-search effort and re-employment wage choices, affecting their job-finding rates and leading to slightly different UI exhaustion probabilities. Similarly, in the fifth column, when we only change e, eligibility rates also change given that UI exhaustion probability affects average eligibility rates.

[38] Importantly, as we explained in Section 6, we also use the same welfare criteria as in their paper.

[39] Krusell, Mukoyama, and Şahin (2010) find that the optimal value of h in their model is 0.30. This corresponds to a 12 percent average replacement rate given that the average wage is around 2.5 as reported in their Table 1. Moreover, Table 2 reports that average welfare gains at $h = 0.25$ are 0.12 percent. We take this number to approximate average welfare gains at $h = 0.30$ as they do not mention average welfare gains at this value of h.

Figure 8: Aggregate labor market effects of optimal UI policy in alternative model



Note: This figure plots how several moments in the alternative model change over unemployment duration under the current (calibrated) UI policy and the optimal UI policy. Panel (a) plots the average UI eligibility rate; Panel (b) plots the average UI take-up rate; Panel (c) plots the average replacement rate among UI recipients; Panels (d) and (e) plot average levels of assets and consumption among the unemployed, respectively; and Panels (f) to (h) plot average levels of job-search effort, re-employment wage choice, and job-finding rate among the unemployed, respectively.

Our main point is *not* to literally compare the welfare-improving replacement rate and associated welfare gains to those in Krusell, Mukoyama, and Şahin (2010), as there are other differences between the two models. The crucial takeaway from our analysis is that accounting for the heterogeneity within the unemployed *and* jointly optimizing over a richer set of UI instruments—both level and heterogeneity parameters—drastically change the optimal policy and welfare gains from it. First, in our baseline model, the optimal policy features much more generous replacement and eligibility rates as well as payment duration (second column in Table 2) than the welfare-improving replacement rate in the alternative model (third column in Table 4) or the optimal replacement rate in Krusell, Mukoyama, and Şahin (2010). Second, welfare gains from the joint optimal policy in our baseline model are also much larger than welfare gains from the welfare-improving $m_0^b = 0.183$ in the alternative model in this paper and from the optimal replacement rate in Krusell, Mukoyama, and Şahin (2010).

7.2 Aggregate and heterogeneous effects of optimal UI policy

Next, we summarize the aggregate labor market and heterogeneous welfare effects of the joint optimal policy (second column in Table 4) in the alternative model. In doing so, we compare outcomes between a steady state under the optimal policy and the current policy.

Labor market effects of optimal policy. Figure 8 summarizes the aggregate labor market effects of the optimal policy. Recall from Section 7.1 that, relative to the current policy, the optimal policy in the alternative model prescribes a higher eligibility rate and a much longer payment duration, but a much lower replacement rate. As a result, under the optimal policy, the eligibility rate over the unemployment spell is larger (Panel (a)), while the replacement rate is much lower (Panel (c)).[40] Panel (d) shows that the average asset level upon job loss is already quite high under the current policy. Because unemployment risk is homogeneous across the income distribution, individuals with high income and wealth are subject to the same job-separation risk as income- and wealth-poor individuals. Because the alternative model also assumes full UI take up, these income- and wealth-rich individuals who assign lower insurance value to UI end up receiving UI. As a result, for the government, the insurance value of raising UI payments is much lower in the alternative model. The lower insurance value of UI benefits is the reason the optimal policy in this model features a much less generous replacement rate. Under this optimal policy, the unemployed deplete wealth rapidly as the unemployment spell lengthens due to the low replacement rate, leading to lower consumption for the long-term unemployed (Panel (e)). Less-generous UI payments under the optimal policy lead to around an 8 to 12 percent (or 2.4 and 3.9 pp) increase in the average job-finding rate relative to that under the current policy during the earlier months of unemployment (Panel (h)). We find that the optimal policy induces a higher job-search effort (Panel (f)) and job-finding rate without worsening the equilibrium wage distribution of the employed (Panel (g)).

Heterogeneous welfare effects of optimal policy. Table 5 presents heterogeneous welfare effects of the optimal policy across quintiles of the wage and asset-to-income ratio distributions.[41] Table 5 demonstrates two important differences between this model and the baseline model (Table 3). First, welfare gains are lower and more homogeneous across the wage and asset-to-income ratio distributions in the alternative model. Second, welfare gains and the fractions with positive welfare gains are much lower for the unemployed than for the employed in the alternative model. Since the pool of unemployed comprises more individuals with higher levels of self insurance in the alternative model, the optimal policy that features a lower tax rate, a higher eligibility rate, and a longer UI payment duration is preferable by almost all individuals, despite a lower replacement rate. In addition, the government's inability to use slope parameters m_w^b and m_w^g as well as the absence of heterogeneity within the unemployed in this model make it more difficult to target groups within the unemployed who assign higher insurance value to UI. As a result, the optimal policy is much less redistributive in the alternative model.

Taking stock. Overall, we have shown that an alternative model that abstracts from the heterogeneity within the unemployed prescribes a substantially different optimal policy than

[40] We note that because the alternative model features no UI take-up cost and replacement rates are independent of previous wages, both UI policies in this model yield full take-up and a constant average replacement rate over the unemployment spell, as shown in Panels (b) and (c), respectively.

[41] Table A6 repeats this exercise for quintiles of the productivity and asset distributions and finds similar results.

Table 5: Heterogeneous welfare effects of optimal policy in alternative model

	Wage					Asset-to-income ratio				
	Q1	Q2	Q3	Q4	Q5	Q1	Q2	Q3	Q4	Q5
All										
Average welfare gains (%)	0.39	0.37	0.45	0.38	0.16	0.38	0.39	0.39	0.37	0.32
Fraction with positive gain (%)	97.6	97.4	97.5	97.0	94.7	96.6	96.5	97.2	97.8	96.2
Employed										
Average welfare gains (%)	0.42	0.40	0.47	0.42	0.30	0.43	0.44	0.43	0.40	0.35
Fraction with positive gain (%)	100.0	100.0	99.7	99.6	99.3	100.0	100.0	100.0	100.0	98.5
Unemployed										
Average welfare gains (%)	-0.35	-0.28	-0.28	-0.76	-0.87	-0.43	-0.58	-0.61	-0.55	-0.16
Fraction with positive gain (%)	38.1	34.3	29.7	24.2	38.6	45.5	33.8	28.1	23.4	34.2

Note: This table presents average consumption-equivalent welfare gains and fractions of populations with positive welfare gains under the optimal policy in the alternative model relative to the current (calibrated) policy across quintiles of wage and asset-to-income ratio distributions for all individuals, employed individuals, and unemployed individuals. Cutoffs for quintiles of both distributions and employment status of individuals are based on the economy under the current policy.

that in our baseline model. When the government optimizes only over the replacement rate in the alternative model, the welfare-improving UI policy and its welfare effects approach earlier results in a comparable study (Krusell, Mukoyama, and Şahin, 2010). The welfare-improving policy in this case features a much less generous replacement rate and yields much lower average welfare gains. However, once we account for the heterogeneity within the unemployed and jointly optimize over a richer set of UI instruments, as in the baseline model, results change drastically. In this case, the optimal policy prescribes much more generous eligibility and replacement rates and a much longer payment duration, and welfare gains from the optimal policy become much larger, especially for individuals with low levels of wages and self insurance.

8 Optimal UI Policy under Different Specifications

The previous section has shown that the optimal policy prescribed by a model that does not discipline the pool of UI recipients with the data is substantially different from the optimal policy in a baseline model that disciplines it by linking the heterogeneity in income and wealth with the heterogeneity in eligibility and take up rates and unemployment risk. In this section, we evaluate whether other features of our baseline model matter for the optimal policy design. This way, we are able to identify which model elements—beyond the heterogeneity within the unemployed—that vary across studies in this literature are pivotal for optimal policy conclusions. In the following discussion, we will focus on four of these features and solve for the optimal policy when different assumptions are made regarding these features. We briefly discuss our results in this section, which are summarized in Table 6, and relegate further explanations to Appendix F.

Partial equilibrium in asset market. We start with testing whether the general equilibrium change in the interest rate r upon changes in UI affects our optimal policy conclusions. To do so, we fix the interest rate to its value under the calibrated policy and solve for the optimal

Table 6: Optimal UI policy under different specifications

UI policy instrument	Baseline	Alternative	Partial equilibrium	Progressive tax	No borrowing	High unemployment value
Panel A: Optimal UI policy parameters and welfare effects						
Level of UI replacement rate m_0^b	0.900	0.150	0.900	0.500	0.900	0.900
Het. of UI replacement rate m_w^b	-0.093	0	-0.079	-0.079	-0.107	-0.079
Level of UI ineligibility rate m_0^g	0.200	0.05	0.200	0.200	0.200	0.200
Het. of UI ineligibility rate m_w^g	-1.500	0	-1.500	-1.500	-1.200	-0.200
UI expiration rate e	0.038	0.038	0.038	0.038	0.038	0.279
Tax rate τ	0.314	0.290	0.313	0.114	0.318	0.314
Average welfare gains (%)	1.31	0.37	1.37	0.43	0.88	0.34
Fraction with positive gain (%)	67.1	96.9	66.5	99.4	38.2	35.8
Panel B: Implied UI replacement and eligibility rates, and expected benefit duration						
Replacement rate						
Average	0.68	0.15	0.70	0.35	0.65	0.71
Q1	0.76	0.15	0.78	0.38	0.73	0.78
Q2	0.72	0.15	0.75	0.36	0.69	0.77
Q3	0.66	0.15	0.70	0.30	0.62	0.70
Q4	0.59	0.15	0.63	0.24	0.56	0.67
Q5	0.36	0.15	0.39	0.13	0.31	0.45
Eligibility rate						
Average	0.93	0.89	0.93	0.94	0.94	0.50
Q1	0.92	0.88	0.92	0.92	0.92	0.37
Q2	0.93	0.87	0.93	0.93	0.93	0.38
Q3	0.94	0.91	0.94	0.94	0.94	0.55
Q4	0.95	0.91	0.95	0.95	0.95	0.62
Q5	0.94	0.86	0.94	0.94	0.94	0.59
Expected UI duration (months)	26.0	26.0	26.0	26.0	26.0	3.6

Note: This table summarizes the optimal policy results under different model specifications. The first two columns refer to the optimal policy in baseline and alternative models. The third to sixth columns refer to the optimal policy in a version of our baseline model with exogenous interest rate r, with progressive income taxation, where individuals cannot borrow in the asset market, and where the monetary value of nonmarket activity h is set to 0.9 such that the value of unemployment becomes larger, respectively. In all models except the alternative model, the current (calibrated) UI policy instruments are the same UI policy as in the baseline model, which is presented in Panel A of Table 2. Finally, in all models except the progressive tax model, τ refers to tax rate in the linear income taxation system, while in the progressive tax model, τ refers to the level parameter of the progressive tax function.

policy in this partial equilibrium version of the baseline model. The optimal policy in this case (third column) features (i) the same eligibility and expiration rate parameters as in the optimal UI policy when the interest rate is endogenous (first column) and (ii) the same level parameter of UI replacement rate m_0^b with a slightly lower (in absolute terms) slope parameter m_w^b. As a result, the optimal policy in the partial equilibrium case is identical to that in the baseline model except that the former prescribes slightly higher replacement rates.[42]

Progressive income taxation. In our baseline model, UI payments and other government expenses are funded by a constant tax rate on wages and benefits. We now consider a progressive labor income tax system using the progressive tax function proposed by Benabou (2002) and Heathcote et al. (2014). We find that the optimal policy in this case (fourth column) features very similar eligibility rates and payment duration as in the optimal policy in the baseline model. However, the optimal policy now features lower replacement rates.[43] The reason behind

[42] This result is also expected because our general equilibrium model assumes that changes in UI policy do not alter the total asset supply A by foreigners, leading to a small change in the equilibrium level of real rate.

[43] We note that the optimal UI policy under progressive taxation also prescribes a more-generous UI system when compared with the calibrated UI policy, driven by much higher eligibility rates and payment duration.

this result is that, under progressive taxation, there already exists redistribution from the tax system because the tax rate is now lower for low-income and -wealth individuals, lowering the need to provide higher replacement rates for them.

No borrowing. Our model assumes that individuals are allowed to borrow up to a limit in the asset market. When they are able to borrow, this may dampen the government's incentives to provide a more-generous policy. On the other hand, if a majority of UI recipients are indebted, providing a more-generous policy may be welfare improving if it helps them pay interest on their loans. To understand whether the ability to borrow affects the optimal policy, we now eliminate borrowing by setting the borrowing limit $a_l = 0$ and solve for the optimal policy. The optimal policy in this case (fifth column) features (i) the same eligibility rates and payment duration as in the optimal policy when individuals can borrow and (ii) the same level parameter of replacement rate m_0^b with a slightly higher (in absolute terms) slope parameter m_w^b.[44] Hence, we conclude that allowing individuals to borrow is not at all pivotal for the optimal policy.

High value of unemployment. In our model, the value of unemployment is affected by UI generosity and the monetary value of nonmarket activity h. We calibrate the set of parameters controlling UI generosity to target the generosity of eligibility and replacement rates and payment duration in our data. On the other hand, we calibrate the value of h to match the drop in consumption upon job loss. According to this strategy, the value of h is small. We now explore how an alternative value of $h = 0.9$—which increases the value of unemployment substantially and yields a calibration closer to that proposed by Hagedorn and Manovskii (2008)—affects the optimal policy. The optimal policy in this case (sixth column) features (i) the same level parameter of replacement rate m_0^b with a slightly lower (in absolute terms) slope parameter m_w^b, (ii) the same level parameter of ineligibility rate m_0^g with a substantially lower (in absolute terms) slope parameter m_w^g, and (iii) much higher expiration rate e. The optimal policy is now much less generous in terms of payment duration because the surplus from employment is now much smaller. However, because a high value of h also lowers precautionary saving motives among the employed, the average wealth of the unemployed declines. Thus, the optimal policy in this case still offers high replacement rates, but only does so for a much shorter duration.

9 Conclusion

We digitize state-level and time-varying UI laws on initial eligibility, payment amount, and payment duration and combine them with microdata from SIPP between 1996 and 2016. We document how levels of income and wealth affect unemployment risk as well as UI eligibility, take-up, and replacement rates both upon job loss and over unemployment spell. We show that the

[44] Note that the heterogeneity parameter of UI ineligibility rate m_w^g is also different between the optimal policies in this model and the baseline model. However, this difference does not create almost any difference in eligibility rates, as shown in Panel B of Table 6, because almost all job losers are eligible under both values of m_w^g.

eligibility rate increases in previous earnings but declines over unemployment duration, while the take-up rate declines in wealth but increases over unemployment duration. To evaluate whether these empirical findings are important in shaping the UI policy design, we build a general-equilibrium, heterogeneous-agent, directed-search model with incomplete markets that matches these empirical moments. Our main finding is that matching these empirical moments critically affects optimal UI policy prescription. An alternative model that fails to match them yields a substantially less-generous optimal policy than the optimal policy in the baseline model.

We believe that our data work is relevant for a large and active empirical literature estimating the effects of UI policy changes on job-finding and unemployment rates by utilizing state-level changes on maximum UI payment duration. This is because our findings reveal that a longer extension of UI payment duration in one state relative to another state may not immediately translate into an overall more-generous UI policy in the former state if these states implement different eligibility rules and replacement rates. We hope that our data will be useful for researchers when estimating the effects of changes in UI generosity on labor market outcomes.

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Online Appendix

A Data

In this section, we provide details about our data sources and our calculations of the empirical moments described in Section 2. We also present additional results to supplement our discussion.

A.1 SIPP data

In the SIPP, individuals are followed longitudinally for a period of up to five years. Until the 2014 panel, interviews were held at four-month intervals called waves. The respondents were then divided into four rotation groups. Rotation groups determined in which month a respondent was interviewed within a wave. Interviews covered information about the four months (reference months) preceding the interview month. When a new SIPP panel launched and Wave 1 (the first four months of the new panel) began, the first rotation group was interviewed in the first month, the second rotation group in the second month, etc. The second interview of the first rotation group was conducted after all four rotation groups had been interviewed by the end of the fourth month of Wave 1. This way, all four rotation groups would have been interviewed at the end of each wave. The SIPP changed the interview structure starting with the 2014 panel. While the four-wave structure was maintained, the frequency of interviews was reduced to once a year (as opposed to thrice) and the reference period was extended to 12 months. Thus, each interview collected information for 12 months in the preceding calendar year. Overall, the SIPP provides monthly data on demographics, earnings, and unemployment benefits, as well as weekly data on employment status. Importantly, the SIPP also provides data on asset holdings. In each panel, respondents provide information about different assets in two to three waves, usually every year. In the 2014 panel, this information was collected once every year.

Our sample is restricted to individuals between the ages of 25 and 65 who are not business owners. If a respondent has missing information on a variable of interest, we drop observations after the first missing observation.[1] Our discussions in the next section supplement the analysis in the main text on our findings from the SIPP data merged with UI laws across states.

A.2 Details on measurement

UI eligibility, take-up, and replacement rates. Once we digitize all state-level and time-varying UI policy rules and merge this information with the SIPP data, we use information on employment, earnings, reason for unemployment, and state of residence from the SIPP to estimate one's UI eligibility status upon unemployment, maximum UI payment duration, and UI replacement rate. We also use information on UI receipt in the SIPP to identify whether an eligible unemployed individual takes up UI. Here, we provide details on our measurement of UI eligibility, take-up, and replacement rates to supplement the discussions in Section 2.

[1] This is because, for example, labor market flows of these individuals cannot be accurately identified.

In our sample, we require positive previous labor earnings in order to focus on individuals with sufficient labor market attachment. For observations that do not cover the entire base period but do contain information for at least one quarter prior to unemployment, we estimate base period earnings using the information available. Moreover, if earnings in the base period do not allow eligibility, some states also check earnings during the alternative base period, which is typically defined as the four completed quarters before the applicant's claim for benefits. We implement the same rule for these states in our program. In addition, our program rarely classifies an unemployed individual as ineligible based on UI state laws when the respondent reports receiving UI benefits. In these rare instances, we consider the self-reported UI receipt as an indication of eligibility. Results remain similar when we consider these individuals ineligible.

When calculating the heterogeneity in take-up rates across the asset-to-income ratio distribution, because the SIPP data usually provide yearly information on asset holdings of the respondent, we approximate the respondent's asset holdings (described below) in each month using the SIPP wave with asset information closest to that month.

Assets and asset-to-income ratio distribution. We now discuss our measure of asset holdings and the asset-to-income ratio in our data. We focus on the net liquid asset holdings of individuals. The SIPP contains information on liquid financial assets at the individual level, including interest-earning financial assets in banks and other institutions, checking account balances, stocks and mutual funds, and savings bonds. Moreover, for married individuals, the survey asks about the amounts of these assets in joint accounts. The joint accounts question is given to only one spouse; the response is divided by two and copied to both spouses' records. Likewise, the SIPP contains information about revolving debt on credit card balances at the individual level for both single and joint accounts. The summation of the amounts in liquid asset accounts net of revolving debt gives us the net financial asset holdings of the individual. Finally, the SIPP provides data on equity in cars at the household level. That amount is divided among the members of the household and recorded as equity in cars for each member. Adding this value to the net financial asset holdings of the individual gives us the measure of net liquid asset holdings for each SIPP wave with information on assets. Finally, dividing the net liquid asset holdings measure by monthly labor income yields the ratio of net liquid assets to monthly income. Here, if the individual is unemployed during the interview month, we use the individual's previous labor income associated with the last employment in earlier waves. The asset-to-income ratio provides a useful metric of self insurance in that it measures how many months of labor earnings net liquid assets can replace.

Job-finding and job-separation rates. Next, we provide details on how we obtain the job-finding and job-separation rates both on average and across the income distribution. In the SIPP, we calculate the monthly job-finding (UE) and job-separation (EU) rates as follows. We first classify an individual as employed (E) if he/she reports having a job and is either working or not on layoff, but is absent without pay during the first week of the month. We classify the individual as unemployed (U) if he/she reports either having no job and actively looking for work or having a job but is currently laid off in the first week of the month. For each month, we calculate the average job-separation rate as the ratio of total EU transitions from that month to the next, divided by the total number of employed individuals in the current month. Similarly, we compute the average job-finding rate as the ratio of total UE transitions from that month to the next, relative to the total number of unemployed individuals in the current month.[2] Once we obtain the monthly transition probabilities over time, we account for seasonality by removing monthly fixed effects.[3]

To calculate the heterogeneity of job-finding and job-separation rates across the income distribution, which are reported in Section 4, we use monthly labor earnings data to measure the current labor earnings of employed workers as well as the previous labor earnings of unemployed workers, which is calculated as the average labor earnings three months before a job loss.[4] We require positive labor earnings for the employed and positive previous labor earnings for the unemployed in order to focus on individuals who have sufficient attachment to the labor market.

Unemployment spell duration. Finally, we provide details on how we measure the duration of each unemployment spell. Again, we require positive previous labor earnings in order to focus on individuals with sufficient labor market attachment. Spells that are left-truncated and spells with missing information for which we cannot ascertain respondents' employment status are dropped. We define spells as uninterrupted months of unemployment and thus do not consider time spent out of the labor force, since we do not model the non-participation margin.

A.3 Additional results

Controlling for observable characteristics. In Sections 2.2 and 2.3, we present how eligibility, take-up, and job-finding rates change over unemployment duration. Those results do not control for observable characteristics of individuals in our estimation. We now present the same results with controls in Figure A1. In particular, for the eligibility rate dynamics in Panel (a), we restrict our panel data to unemployed individuals and first regress a dummy of being UI eligible on dummies of unemployment duration (in months), control variables, and time dummies, using individual weights. The control variables are the following: gender, a fifth-degree polynomial in age, four race dummies (white, black, Asian, and other), four education category dummies (less than high school, high school graduate, some college, and college graduate and above), and

[2]Even if this EU rate measure captures both voluntary and involuntary separations, our UI program is able to filter out those who quit their jobs from being eligible for UI, as we observe the reason of unemployment.

[3]For our calibration exercise in Section 4, we calculate the job-finding and job-separation probabilities from the CPS between 2004 and 2007 using the same methodology.

[4]The result for the heterogeneity in job-finding rates across income groups is similar if we take previous employment income as the labor earnings from the month prior to job loss.

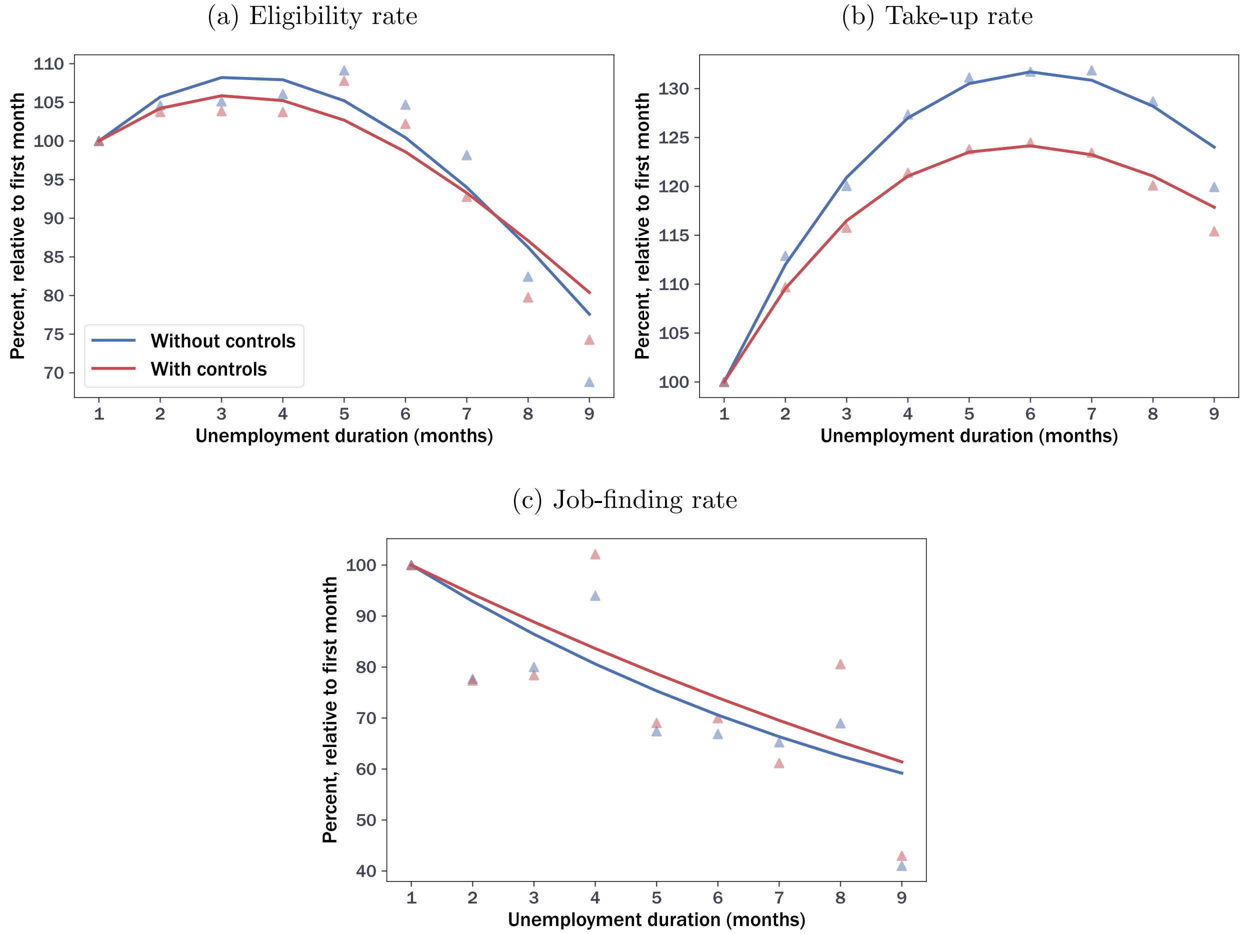
gender interactions for all of the age, race, and education variables. This specification closely follows that in Kroft, Lange, Notowidigdo, and Katz (2016). Once we obtain the coefficients on how the eligibility rate changes for each month of unemployment relative to the first month, we then fit a cubic polynomial (red-solid line) to the resulting coefficients of duration dummies (red triangles). We compare this result to the result in the main text, which does not control for observables (blue-solid line and triangles). We also repeat this process separately for take-up rate and job-finding rate dynamics in Panel (b) and Panel (c), respectively. For Panel (b), we use the same data but restrict the sample to those who are UI eligible and change the dependant variable to a dummy of receiving UI instead, while for Panel (c) we use the same data as in Panel (a) and change the dependant variable to a dummy of finding a job next month.

Overall, results in Figure A1 reveal that controlling for observable individual characteristics does not lead to substantial changes especially in eligibility and job-finding rate dynamics. In terms of take-up rate dynamics, we find that controlling for observables slightly dampens the rise in the take-up rate as the unemployment spell becomes longer, signaling some role of composition effects.

Eligibility and take-up dynamics during a downturn. In Section 2.2, we present results using the SIPP 2004 panel, covering the period between 2004 and 2007. This is because we calibrate our model to the same period and want to ensure comparability between the data and the model when we calibrate and validate our model against our empirical findings. In this section, we now present results using data from the SIPP 2008 panel, covering the period between 2008 and 2013, to understand how dynamics of eligibility and take-up rates change during an episode with a large economic downturn. Figure A2 provides the results.

We find that results obtained using data between 2008 and 2013 are different from our baseline results in two ways. First, while the UI eligibility rate at the onset of the unemployment spell is very similar to our baseline estimate, the UI eligibility rate does not decline as the unemployment duration becomes longer. This result is expected, as the period between 2008 and 2013 covers the Great Recession and the subsequent recovery episode when the UI payment duration was extended from about six months to as high as two years. Second, the increase in the take-up rate over duration is now larger and the take-up rate remains higher as the unemployment duration lengthens during this episode. This result is also intuitive as UI-eligible unemployed individuals should be more motivated to take up UI in an economy where jobs are more difficult to find. Overall, we view these differences between the results from our baseline period and from the Great Recession as a validation of our own UI program that estimates UI eligibility and take-up rates. Because our model abstracts from aggregate fluctuations, it is natural that we use empirical results from an episode without a large economic downturn.

Figure A1: Eligibility, take-up, and job-finding dynamics: With and without controls



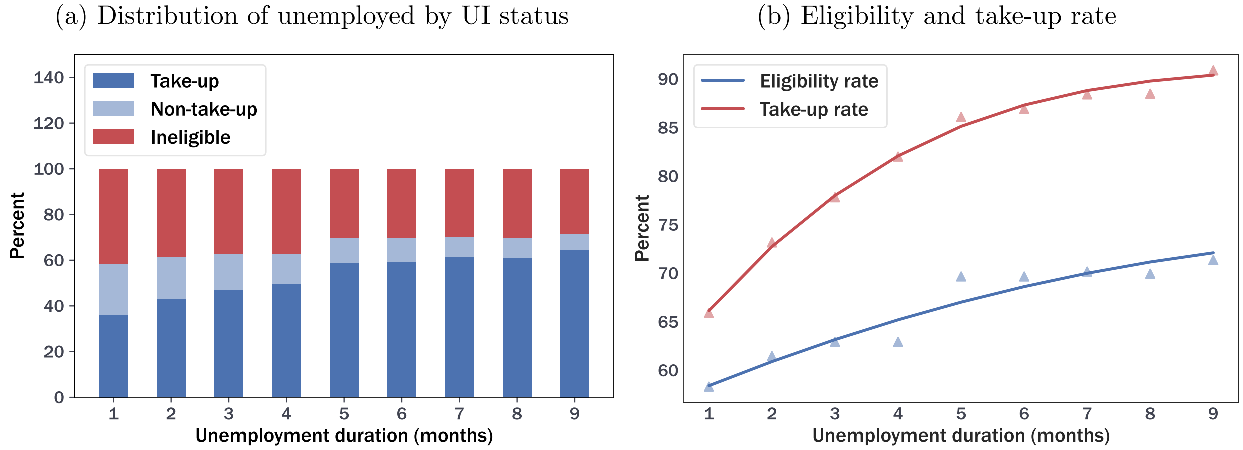
Note: This figure presents how eligibility (Panel (a)), take-up (Panel (b)), and job-finding (Panel (c)) rates change over unemployment duration relative to the first month of unemployment, with and without controlling for observable characteristics of individuals. For the eligibility rate dynamics in Panel (a), we restrict our panel data to unemployed individuals and first regress a dummy of being UI eligible on dummies of unemployment duration (in months), control variables, and time dummies, using individual weights. Once we obtain the coefficients on how the eligibility rate changes for each month of unemployment relative to the first month, we then fit a cubic polynomial (red-solid line) to the resulting coefficients of duration dummies (red triangles). We compare this result to our result in the main text which does not control for observables (blue-solid line and blue triangles). We also repeat this process separately for take-up rate and job-finding rate dynamics in Panel (b) and Panel (c), respectively. For Panel (b), we use the same data but restrict the sample to those who are UI eligible and change the dependant variable to a dummy of receiving UI instead. For Panel (c), we use the same data as in Panel (a) and change the dependant variable to a dummy of finding a job next month. Please refer to the text for a list of control variables.

Wealth holdings by employment and UI status. Finally, we conclude this section by showing that the level of self insurance is lower among the unemployed relative to the employed, and, within the eligible unemployed, it is lower among those who take up UI relative to those who do not, as mentioned in Section 2.2 in the main text.

To measure the distribution of self insurance for each group, we calculate the mean and various percentiles of the asset-to-income ratio distribution separately for the employed, unemployed, take-up, and non-take-up groups for each month. Then, we average the monthly outcomes across all months of the SIPP 2004 panel. Table A1 presents the results.

We highlight two main takeaways from this table. First, unemployed individuals have sub-

Figure A2: Eligibility and take-up dynamics over unemployment duration: 2008-2013



Note: This figure repeats our results in Figure 3 using data between 2008 and 2013. Panel (a) shows how the shares of UI ineligible, UI eligible who take up UI, and UI eligible who do not take up UI within the unemployed change over months of unemployment. Panel (b) documents how eligibility rate (FEU) and take-up rate (TUR) change over months of unemployment. To generate the dynamics of average FEU in Panel (b), we restrict our panel data to unemployed individuals and first regress a dummy of being UI eligible on dummies of unemployment duration (in months) using individual weights and then fit a cubic polynomial (solid-blue line) to the resulting coefficients of duration dummies (blue triangles). We repeat the same process to obtain the average TUR dynamics where we use the same data but restrict the sample to those who are eligible and change the dependant variable to a dummy of receiving UI instead.

Table A1: Distribution of asset-to-income ratio by employment and UI status

	p10	p20	p25	p30	p40	p50	p60	p70	p75	p80	p90	Mean
Employed	-1.76	-0.44	-0.08	0.02	0.37	0.79	1.38	2.33	3.08	4.18	9.59	2.58
Unemployed	-2.24	-0.53	-0.15	0.00	0.12	0.44	0.88	1.59	2.09	2.83	7.82	1.37
Take up	-1.97	-0.60	-0.22	0.00	0.11	0.39	0.76	1.29	1.61	2.12	4.99	1.15
Non-take up	-2.58	-0.62	-0.25	0.00	0.21	0.53	1.08	1.77	2.35	3.09	7.77	2.17

Note: This table documents the distributions of asset-to-income ratio by employment and UI status from the SIPP 2004 panel.

stantially lower levels of self insurance than employed individuals. This result is in line with the previous findings in Krusell, Mukoyama, Rogerson, and Şahin (2017) and Birinci and See (2023) that show that the job-separation rate is higher at the lower end of the wealth distribution. Second, those who take up UI have lower levels of self insurance than those who are eligible but do not take up, reinforcing our findings in Figure 4. For instance, we find that the mean asset-to-income ratio is 1.15 for the former group, while it is 2.17 for the latter group.

B Model

In this section, we provide the definition of equilibrium for our model as well as the computational algorithm used to solve it.

Equilibrium. A recursive stationary equilibrium for this economy is a list of value functions of individuals and of firms; a list of policy functions of individuals for assets, wage choice, search effort, and UI take-up decision, and capital choice policy function of firms; a labor market tightness function $\theta(w, y)$; and the distribution of agents across individual states μ such that:

1. Given government policy $\{b(\cdot), g(\cdot), e, G, \tau\}$, market tightness θ, and interest rate r, value functions of individuals solve problems given by Equations (2), (3), (4), the problem of UI-eligible who do not take up benefits that is similar to (4), and (5) with associated policy functions.

2. Given interest rate r, value functions of firms solve Equation (6) with associated capital choice policy function and Equation (7).

3. The number of vacancies posted in each submarket v satisfies the free-entry condition $V = 0$, which yields the equilibrium labor market tightness θ.

4. The government budget constraint given by Equation (8) holds.

5. The interest rate r clears the asset market such that $\int a d\mu + A = \int k \times 1_{\{l=W\}} d\mu$, where the left-hand side is the net asset supply of individuals and foreigners and the right-hand side is the sum of total capital demand of firms.

6. The stationary distribution of individuals across states μ is consistent with individuals' policy functions and job-finding and job-separation rates.

Computational algorithm. The computational algorithm for solving the model under any UI policy change from the current policy is given as follows:

1. Guess the tax rate τ and the interest rate r.

2. Solve for the value function of the matched firm $J(w, y)$.

3. Using the free-entry condition $0 = -\kappa + q(\theta(w, y)) J(w, y)$ and the functional form of $q(\theta)$, we can solve for market tightness for any given submarket (w, y):

$$\theta(w, y) = q^{-1}\left(\frac{\kappa}{J(w, y)}\right),$$

   where we set $\theta(w, y) = 0$ when the market is inactive.

4. Given the function θ, we can then solve for individuals' value functions V^W, V^B, and V^{NB} using standard value function iteration.

5. Once policy functions are obtained, we simulate the model to obtain moments of interest.

6. Check whether the government budget constraint and asset market clearing conditions are satisfied. If not, go back to Step 1 and iterate until convergence.

We note that the solution algorithm for the model's steady state imposes $r - \delta = 0.0033$ so that the net annual return is 4 percent in equilibrium. Then, we back out the total asset supply by foreigners A in equilibrium, which is kept constant for any other UI policy. This eliminates the loop over r in the above algorithm when solving for the steady state.

C Calibration

External parameters. Table A2 provides a list of externally calibrated parameters discussed in Section 4.

Table A2: Externally calibrated parameters

Parameter	Explanation	Value	Reason
ω	Death probability	0.0021	40 years of working life
σ	Curvature in utility function	2	Standard
α_s	Level of utility cost of search	1	Normalization
δ	Capital depreciation rate	0.0051	6 percent annual depreciation rate
ρ^y	Persistence of labor productivity	0.9867	40 years of expected duration
e	UI expiration rate	4/26	Expected UI payment duration of 26 weeks
κ	Vacancy creation cost	0.58	Hagedorn and Manovskii (2008)
ζ	Exponent to capital in production function	1/3	Standard
ξ	Matching function parameter	0.5	Set
Υ	Tax progressivity	0	Set

Note: This table summarizes externally calibrated parameters. See the main text for a detailed discussion.

Consumption drop upon job loss. In Section 4, we target the magnitude of the consumption drop upon unemployment. Here, we detail how we measure this moment in the data.

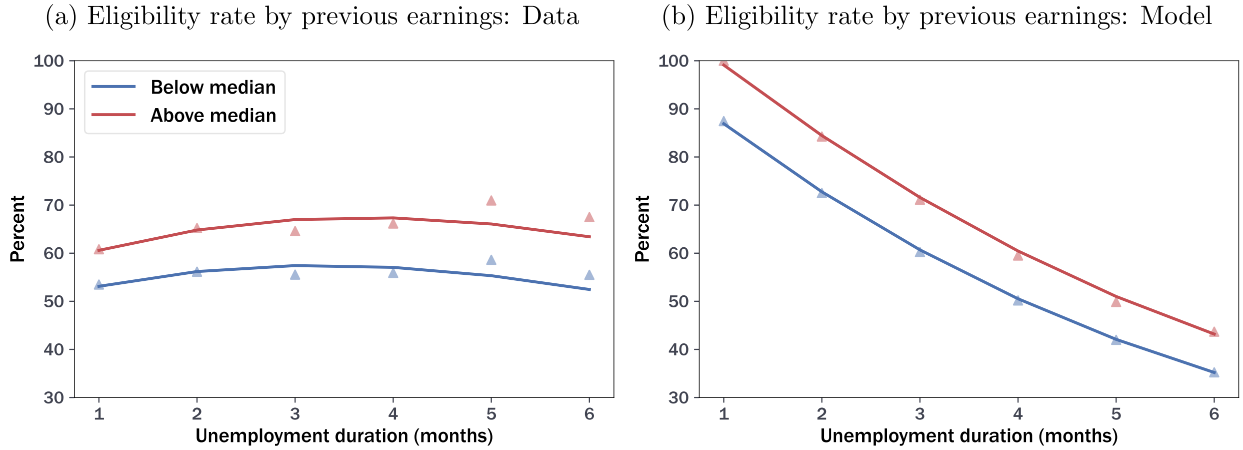
We use data from the PSID between 1999 and 2019 to estimate the consumption drop upon job loss. The PSID is available annually between 1968 and 1997 and biannually since 1997. It provides information on labor earnings, consumption expenditures, and demographics. Consumption expenditures include expenditures on food consumed inside and outside the home, health expenditures, housing expenditures (utilities, taxes, maintenance, etc.), transportation, education, and childcare.[5] Prior to 1999, expenditure information was only available for the food category, while the other categories were added after 1999. For this reason, we estimate the dynamics of consumption upon job loss based on biannual data between 1999 and 2019.

We construct variables for job loss using a question that asks individuals who are either jobless or have been employed in their current job for less than a year about the reason for the loss of their previous job. Since our model does not distinguish between reasons for unemployment, our definition of a job loss in the data incorporates unemployment arising from any reason (for example, voluntary/expected separations like quits, firings, and the end of temporary/seasonal employment, as well as involuntary/unexpected separations like layoffs and business closures).

Our sample consists of household heads between the ages of 25 and 65. We drop families observed for only one year and those with labor earnings or consumption expenditures that exceed

[5] Since 2005, additional categories have been included (clothing, recreation, alcohol, and tobacco). These categories are not included in the consumption expenditure measure to maintain consistency over time.

Figure A3: Heterogeneity in eligibility rates over unemployment duration: Data vs model



Note: Panel (a) plots the eligibility rate—measured as the fraction of UI eligible within the unemployed—over unemployment duration separately for spells originating from below or above the median of the earnings distribution of the employed in the data. Panel (b) repeats the same calculations in the model.

the 99th percentile. Using this sample, we estimate the following distributed lag regression:

$$\log(c_{it}) = \beta X_{it} + \sum_{k=-2}^{10} \psi_k D_{it}^k + \iota_i + \xi_t + \epsilon_{it},$$

where the outcome variable is the logarithm of real annual consumption expenditures c_{it} of household i in year t; the variable X_{it} is a vector of time-varying household characteristics, including a quadratic term of the head's age and the head's marital status; the variable ι_i captures a time-invariant unobserved error component associated with household i; and ξ_t is an error component common to all individuals in the sample at year t. The indicator variables D_{it}^k identify all household heads k periods prior to or after a job loss, where $k = 0$ is the period in which the job loss occurs. For instance, $D_{it}^2 = 1$ for a household head i who experiences job loss in year $t-2$, and it equals zero otherwise. Thus, ψ_k captures the effect of job loss on the outcome variable k years prior to or after household heads separate from a job (treatment group) relative to household heads with no job separation (control group).

D Model validation

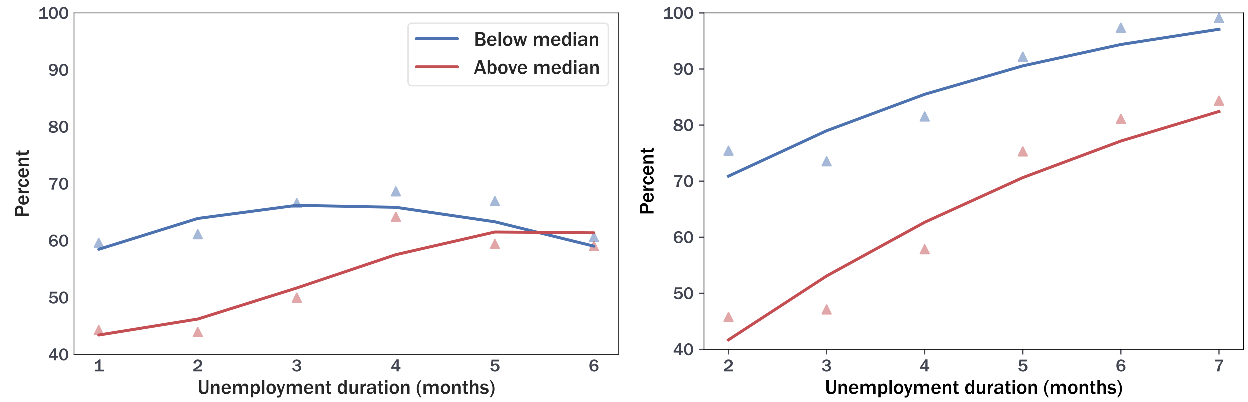
In this section, we provide results to supplement our discussions in Section 5.

Heterogeneity in eligibility and take-up rates. Figure A3 presents the eligibility rate for spells originating from below or above the median of the earnings distribution over the months of unemployment both in the data and in the model.

Similarly, Figure A4 plots the take-up rate among UI-eligible spells originating from below or above the median of the asset-to-income ratio distribution over the months of unemployment both in the data and in the model.

Figure A4: Heterogeneity in take-up rates over unemployment duration: Data vs model

(a) Take-up rate by asset-to-income ratio: Data (b) Take-up rate by asset-to-income ratio: Model



Note: Panel (a) plots the take-up rate—measured as the fraction of UI eligible who take up UI—over unemployment duration separately for spells originating from below or above the median of the asset-to-income ratio distribution in the data. Panel (b) repeats the same calculations in the model.

Table A3: Distribution of asset-to-income ratio by employment and UI status: Data vs model

Data	p10	p20	p25	p30	p40	p50	p60	p70	p75	p80	p90	Mean
Employed	-1.76	-0.44	-0.08	0.02	0.37	0.79	1.38	2.33	3.08	4.18	9.59	2.58
Unemployed	-2.24	-0.53	-0.15	0.00	0.12	0.44	0.88	1.59	2.09	2.83	7.82	1.37
Take up	-1.97	-0.60	-0.22	0.00	0.11	0.39	0.76	1.29	1.61	2.12	4.99	1.15
Non-take up	-2.58	-0.62	-0.25	0.00	0.21	0.53	1.08	1.77	2.35	3.09	7.77	2.17

Model	p10	p20	p25	p30	p40	p50	p60	p70	p75	p80	p90	Mean
Employed	-0.83	-0.36	-0.17	-0.01	0.22	0.39	0.60	0.93	1.02	1.08	1.25	0.43
Unemployed	-2.17	-1.29	-1.05	-0.83	-0.51	-0.23	0.00	0.23	0.37	0.55	1.39	-0.35
Take up	-1.76	-1.22	-1.04	-0.87	-0.58	-0.39	-0.24	-0.08	0.00	0.09	0.40	-0.45
Non-take up	-0.36	-0.13	-0.05	0.02	0.20	0.41	0.58	0.91	1.02	1.20	2.45	0.30

Note: This table shows asset-to-income ratio distributions by employment and UI status from the SIPP 2004 panel and our model.

Wealth holdings by employment and UI status. Table A3 presents distributions of the asset-to-income ratio by employment and UI status in the data and the model.

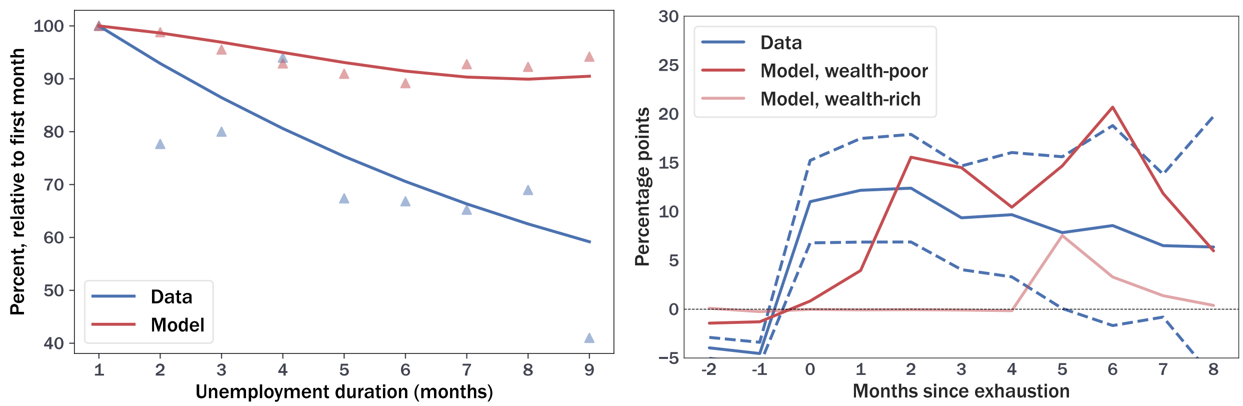
Job-finding dynamics. Panel (a) in Figure A5 documents that the model largely captures the decline in the job-finding rate over the unemployment spell in the data, with a caveat that the decline in the model is slower.[6]

Panel (b) compares the average change in the job-finding rate for UI exhaustees relative to non-exhaustees in the data and the model. We obtain the model values here by estimating the model-counterpart of the regression specification in Equation (1). Moreover, in the model,

[6]We note that we do not compare the levels of the job-finding rate between the SIPP data and the model here because the level of the job-finding rate in the model is calibrated to match the level of the job-finding rate in the CPS data due to the discrepancy between the monthly job-finding rates between the CPS and the SIPP as mentioned in Section 4.

Figure A5: Job-finding rate over duration and upon UI exhaustion: Data vs model

(a) Change in job-finding rate over duration (b) Change in job-finding rate upon UI exhaustion



Note: Panel (a) presents the average job-finding rate over unemployment duration relative to the first month of unemployment in the data and the model. Panel (b) plots the percentage-point change in the average job-finding rate of UI recipients around UI exhaustion (i.e., from two months prior to eight months after UI exhaustion) relative to the average job-finding rate of UI recipients who do not experience UI exhaustion in the data and the model. In the model, we present results separately for wealth-poor and wealth-rich individuals based on their levels of asset-to-income ratio at the moment of UI exhaustion. The wealth-poor (rich) are defined as those with an asset-to-income ratio upon exhaustion that is less than or equal to the 10th percentile (greater than the median) of the asset-to-income ratio distribution of UI exhaustees. Dashed lines represent 90 percent confidence intervals in the data.

we classify individuals based on their levels of the asset-to-income ratio at the moment of UI exhaustion.[7]

In addition to the results discussed in the main text, we note that while the average increase of the job-finding rate upon UI exhaustion in the model is very similar to that in the data, the timing of this increase is later in the model than in the data. In particular, instead of the immediate increase in the job-finding rate observed in the data, a significant increase in the job-finding rate starts two months after the UI exhaustion in the model. This is because, UI expiration probability e is exogenous and the same for all UI recipients. As a result, individuals experience the same probability of UI expiration regardless of their self-insurance levels (e.g. expiration can occur even during early months for a well-insured agent). However, the UI-exhaustee group in the data potentially comprises UI recipients who stay unemployed longer and deplete their wealth already. This leads the increase in the job-finding rate to occur earlier on average.

E Optimal UI policy

In this appendix, we provide results to complement our discussions in Sections 6 and 7.

Welfare-improving policies when only limited UI instruments are optimized in the baseline model. Section 6 presents optimal UI policy in the baseline model when all UI policy instruments are optimized jointly. In Table A4, we now provide results when we optimize over

[7]Here, wealth-poor individuals are those with an asset-to-income ratio less than or equal to the 10th percentile of the asset-to-income ratio distribution, while wealth-rich individuals are those with an asset-to-income ratio above the median of the distribution.

Table A4: Optimal UI policy in baseline model: Joint optimal vs one instrument at a time

Panel A: Optimal UI policy parameters and welfare effects					
UI policy instrument	Current UI	Joint optimal UI	Only optimal m_0^b	Only optimal m_0^g	Only optimal e
Level of UI replacement rate m_0^b	0.670	0.900	0.928	0.670	0.670
Het. of UI replacement rate m_w^b	-0.058	-0.093	-0.058	-0.058	-0.058
Level of UI ineligibility rate m_0^g	1.107	0.200	1.107	0.474	1.107
Het. of UI ineligibility rate m_w^g	-0.448	-1.500	-0.448	-0.448	-0.448
UI expiration rate e	0.154	0.038	0.154	0.154	0.051
Tax rate τ	0.313	0.314	0.314	0.311	0.311
Average welfare gains (%)		1.31	0.48	0.61	0.41
Fraction with positive gain (%)		67.1	68.5	100.0	100.0
Panel B: Implied UI replacement and eligibility rates, and expected benefit duration					
Replacement rate					
Average	0.52	0.68	0.75	0.53	0.52
Q1	0.58	0.76	0.84	0.58	0.58
Q2	0.55	0.72	0.80	0.56	0.55
Q3	0.52	0.66	0.78	0.52	0.52
Q4	0.48	0.59	0.72	0.49	0.48
Q5	0.28	0.36	0.46	0.28	0.28
Eligibility rate					
Average	0.68	0.93	0.67	0.77	0.79
Q1	0.42	0.92	0.42	0.71	0.52
Q2	0.56	0.93	0.56	0.74	0.68
Q3	0.78	0.94	0.77	0.78	0.91
Q4	0.83	0.95	0.83	0.83	0.94
Q5	0.79	0.94	0.77	0.79	0.92
Expected UI duration (months)	6.5	26.0	6.5	6.5	19.4

Note: This table summarizes optimal UI policy results in the baseline model model. Panel A presents values of UI policy instruments and the equilibrium tax rate under different UI policies. The first column (current UI) represents the current policy; the second column (joint optimal UI) represents the optimal policy when all policy parameters are jointly optimized (i.e., m_0^b, m_w^b, m_0^g, m_w^g, and e at the same time); the third to fifth columns represent cases where we optimize only optimize the level parameters (i.e., m_0^b, m_0^g, and e) one at a time, respectively, while keeping heterogeneity parameters (i.e., m_w^b and m_w^g) at their calibrated values in each of these cases. Panel B provides implied UI replacement and eligibility rates both on average and across the quintiles of the wage distribution, and the expected UI payment duration in months under each UI policy.

one instrument at a time in the baseline model, as we did in the alternative model in Table 4 in Section 7.

In the third to fifth columns in Table A4, we present welfare-improving UI policy parameters and corresponding outcomes when we optimize only the level parameters (i.e., m_0^b, m_0^g, and e) one at a time, respectively, while keeping heterogeneity parameters (i.e., m_w^b and m_w^g) at their calibrated values in each of these cases. As expected, the welfare gain from optimizing over a single instrument relative to the calibrated UI policy is much lower when compared with the welfare gain when all parameters are jointly optimized. Specifically, we find that welfare gains now drop to between one-third and one-half of gains under the joint optimal policy.

What are the differences in UI policy prescriptions between these welfare-improving policies when only one parameter is optimized and the joint optimal policy? Overall, we find that UI policy prescriptions differ significantly between the joint optimal policy and these welfare-improving policies that are found with a more limited set of UI policy instruments.

We start with the scenario when the government optimizes only over the level of UI replacement rate m_0^b and keeps all other UI policy parameters at their calibrated values. In this case, the welfare-improving $m_0^b = 0.928$ becomes higher than its value under the joint optimal policy 0.9 and its calibrated value 0.67. This is because, given that the slope parameter of UI replacement rate m_w^b is fixed to a less-steep calibrated value, the government can only provide larger insurance to individuals with lower previous wages—those who assign a higher insurance value to UI benefits and have smaller incentive costs—by choosing a higher m_0^b level. As such, this yields an even more-generous replacement rate schedule both on average and across the distribution than that under the joint optimal policy.

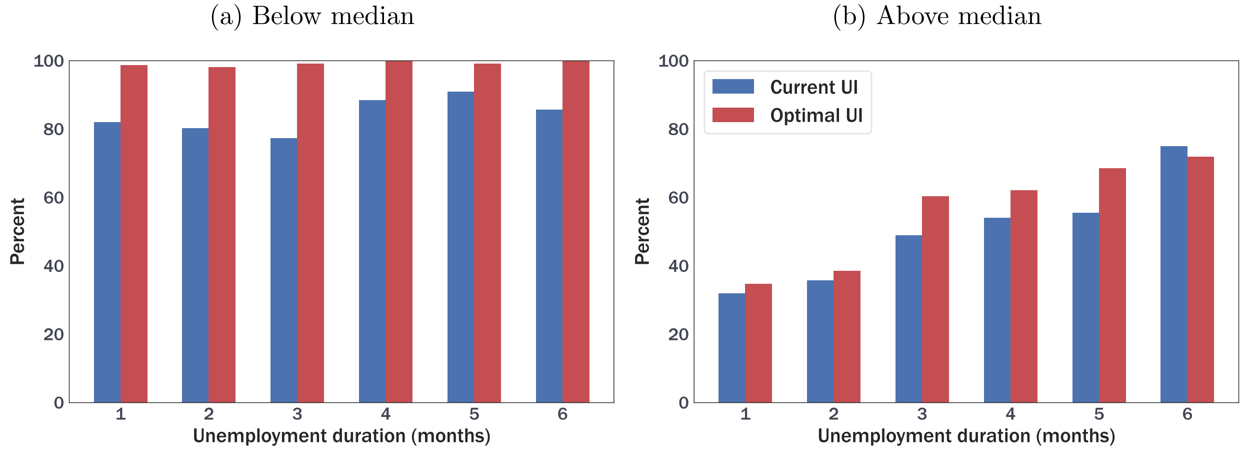
Next, we consider the scenario when the government optimizes only over the level of UI *ineligibility* probability m_0^g while keeping all other UI policy parameters at their calibrated values. Here, the welfare-improving $m_0^g = 0.474$ is still much lower than its calibrated value of 1.107 but higher than its value of 0.2 when all parameters are jointly optimized. The implied UI eligibility rates (inversely related to m_0^g) are much lower under the welfare-improving m_0^g than the joint optimal policy not only because of a higher value for the level of UI ineligibility probability m_0^g but also because of a smaller (in magnitude) slope parameter m_w^g and shorter expected UI payment duration.

Finally, if the government optimizes only over the UI expiration rate e, the implied welfare-improving expected UI payment duration in this case is around 19.4 months, which is still much larger than the calibrated duration of 6.5 months but less generous than 26 months under the joint optimal policy. When the government optimizes only over the expected duration of UI payments, it is less enthusiastic about extending the duration of payments to even longer months because it cannot expand coverage to low-wage individuals and raise replacement rates for them as it does under the joint optimal policy. However, relative to the calibrated UI benefit duration, the welfare-improving UI duration in this case is still substantially longer.

Heterogeneous take-up dynamics under the optimal policy in the baseline model. In Figure 7, we show that the average take-up rate increases under the optimal policy relative to calibrated policy, especially during the early months of the unemployment spell. Figure A6 documents that this rise in the average take-up rate is largely driven by the increase in the take-up rate among the unemployed with lower self-insurance abilities (i.e., those with an asset-to-income ratio below the median of the asset-to-income ratio distribution of the unemployed).

Heterogeneous welfare effects of the optimal policy in the baseline model. In Table 3, we document the heterogeneous welfare effects of the optimal policy in the baseline model across quintiles of the wage and asset-to-income ratio distributions. Here, in Table A5, we present the same results across quintiles of labor productivity and asset distributions. We find the same conclusions. Specifically, welfare gains and fractions of individuals with positive gains

Figure A6: Heterogeneous effects of optimal UI policy on take up dynamics: Baseline model



Note: This figures presents take-up rates (TUR)—measured as the fraction of UI eligible who take up UI within the UI eligible—over unemployment duration in our baseline model both under the calibrated (current) UI policy and under the optimal UI policy. Panel (a) plots the TUR over unemployment duration for spells originating from below the median of the asset-to-income ratio distribution of the unemployed. Panel (b) repeats the same for spells originating from above the median of this distribution.

Table A5: Heterogeneous welfare effects of optimal policy in baseline model

	Labor productivity					Asset				
	Q1	Q2	Q3	Q4	Q5	Q1	Q2	Q3	Q4	Q5
All										
Average welfare gains (%)	2.89	0.96	0.20	0.05	-0.08	1.74	1.77	1.33	0.46	0.27
Fraction with positive gain (%)	100.0	99.1	95.7	32.3	8.2	98.1	97.2	88.7	32.5	18.8
Employed										
Average welfare gains (%)	2.77	0.90	0.19	0.04	-0.07	1.64	1.72	1.25	0.44	0.25
Fraction with positive gain (%)	100.0	98.7	95.8	28.2	7.7	98.1	97.2	87.9	29.1	18.1
Unemployed										
Average welfare gains (%)	4.15	3.07	1.35	0.80	0.09	2.79	2.65	2.65	2.54	1.31
Fraction with positive gain (%)	100.0	100.0	100.0	100.0	67.2	95.6	98.1	98.2	94.9	80.0

Note: This table presents average consumption-equivalent welfare gains and fractions of populations with positive welfare gains under the optimal policy in the baseline model relative to the current (calibrated) policy across quintiles of labor productivity and asset distributions for all individuals, employed individuals, and unemployed individuals. Cutoffs for quintiles of both distributions and employment status of individuals are based on the economy under the current policy.

are heterogeneous in a way that they are both larger in the bottom quintiles of both of these distributions. Further, welfare gains are larger for the unemployed than for the employed.

Heterogeneous welfare effects of the optimal policy in the alternative model. In Table A6, we also present the heterogeneous welfare effects of the optimal policy in the alternative model across quintiles of labor productivity and asset distributions. We find the same conclusions as in Table 5 in the main text. In particular, welfare gains are smaller than those under the baseline model and almost equal across the quintiles of these distributions, and almost all individuals at each quintile experience positive gains among the employed. Moreover, the majority of the unemployed experience welfare losses from the optimal policy in the alternative model.

Table A6: Heterogeneous welfare effects of optimal policy in alternative model

	Labor productivity					Asset				
	Q1	Q2	Q3	Q4	Q5	Q1	Q2	Q3	Q4	Q5
All										
Average welfare gains (%)	0.37	0.32	0.45	0.41	0.31	0.37	0.41	0.40	0.38	0.26
Fraction with positive gain (%)	96.5	96.3	97.0	97.2	97.2	96.5	97.3	97.7	97.5	95.3
Employed										
Average welfare gains (%)	0.41	0.37	0.48	0.44	0.34	0.43	0.44	0.43	0.42	0.31
Fraction with positive gain (%)	99.4	99.5	99.7	99.9	100.0	100.0	100.0	100.0	100.0	98.5
Unemployed										
Average welfare gains (%)	-0.45	-0.54	-0.41	-0.37	-0.44	-0.52	-0.38	-0.48	-0.57	-0.33
Fraction with positive gain (%)	38.1	41.8	30.8	27.8	26.3	47.6	30.8	26.1	27.0	33.5

Note: This table presents average consumption-equivalent welfare gains and fractions of populations with positive welfare gains under the optimal policy in the alternative model relative to the current (calibrated) policy across quintiles of labor productivity and asset distributions for all individuals, employed individuals, and unemployed individuals. Cutoffs for quintiles of both distributions and employment status of individuals are based on the economy under the current policy.

F Discussion

Finally, in this section, we provide additional explanations to supplement our brief discussion of results in Section 8.

Partial equilibrium in asset market. We mentioned in Section 8 that the optimal policy in the partial equilibrium case is identical to that in the baseline model except that the former prescribes slightly higher replacement rates. We now discuss the reasons behind this result. In the baseline model, the optimal policy, which features more-generous UI payments relative to the calibrated UI policy, leads to a decline in precautionary savings (as discussed in Section 6.2) and capital and to a rise in the equilibrium level of net annual return on savings $r - \delta$ from 4.02 to 4.06 percent. The decline in equilibrium capital leads to a slightly lower output and consumption. The small change in equilibrium r is expected because our general equilibrium model assumes that changes in UI policy do not impact the total asset supply A by foreigners. When this small change in real interest rate r is not allowed, the small negative effect of optimal UI policy on consumption is not present. As a result, the government is encouraged to provide slightly higher replacement rates in the partial equilibrium case. This generates slightly larger average welfare gains from the optimal policy in the partial equilibrium model than welfare gains from the optimal policy in the baseline model. Overall, we conclude that the endogeneity of the real interest rate is not at all pivotal for the optimal UI policy prescription.

Progressive income taxation. We also considered a progressive income taxation case in the main text. Here, we first provide additional details on this exercise. Following Benabou (2002) and Heathcote, Storesletten, and Violante (2014), the after-tax labor income of the individual is given by $\widetilde{x} = (1-\tau)\, x^{1-\Upsilon}$, where $x = w$ for an employed and $x = b(w)\, w$ for a UI recipient, τ determines the level of taxation, and $\Upsilon \geq 0$ determines the rate of progressivity built into the tax system. We set $\Upsilon = 0.151$, as in Heathcote, Storesletten, and Violante (2014). In this case, we find that the equilibrium value of the level parameter of this tax system under the calibrated UI policy is $\tau = 0.116$.

The reason behind less-generous replacement rates prescribed by the optimal policy under progressive income taxation relative to the optimal policy under linear income taxation is that, under progressive taxation, there already exists redistribution coming from the tax system. When individuals lose employment and receive UI, their benefits are also taxed at a lower tax rate compared with the case under linear taxation, dampening the government's incentives to offer as high a replacement rate under linear taxation. As a result, the welfare gains from the optimal policy in a model with fewer redistributive motives are also smaller. Overall, we conclude that the taxation system plays a quantitatively important role in shaping optimal UI policy. However, its impact is not significant enough to substantially reduce the generosity of the optimal UI or overturn the baseline policy prescription. Even under progressive taxation, the optimal policy still offers significantly higher eligibility rates and longer payment durations compared with the current UI system.

No borrowing. We stated in Section 8 that the optimal policy when we do not allow individuals to borrow in the asset market is very similar to that under the baseline model. We also find that welfare gains from the optimal policy in the model without borrowing are also relatively lower. This could potentially be because given that this model does not feature individuals who have negative wealth holdings and relatively higher marginal utility of consumption, insurance gains from the optimal policy is also smaller. Overall, we conclude that allowing individuals to borrow is not at all pivotal for the optimal UI policy prescription.

High value of unemployment. Finally, we provide additional details on our experiment when we set the monetary value of nonmarket activity $h = 0.9$ in the model so that the value of unemployment increases and the surplus from employment relative to unemployment shrinks (Hagedorn and Manovskii, 2008).

In this scenario, the average consumption drop upon job loss becomes 5.5 percent instead of 8.4 percent under the baseline calibration. The reason the decline in consumption is still not close to zero is because when the value of h becomes much larger, the decline in precautionary saving motives leads to lower wealth holdings among the employed, generating a decline in consumption upon job loss.

We mentioned in Section 8 that the optimal policy in this case still offers high replacement rates but pays UI for a much shorter duration due to a higher expiration rate. In particular, the expected UI duration is only 3.6 months under this scenario's optimal policy. The reason the optimal policy now offers a much shorter payment duration, rather than lowering replacement rates as seen under progressive taxation, is that there are still welfare gains from redistribution through higher replacement rates for those with low previous wages. Note that unlike in the progressive taxation case, which explicitly redistributes toward low-income (low-wealth) workers, the high level of h is enjoyed by *all* workers, and, as a result, low-wealth workers are still relatively worse-off. However, because of the lower surplus from employment, these payments are only made for a shorter duration as the long-term unemployed are not in as dire a situation as their counterparts in the low h economy.