# How much did Bonus Unemployment Insurance Payments During the COVID Pandemic Depress Aggregate Employment?

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November 2023

**Abstract**

During the COVID-19 pandemic, the number of Unemployment Insurance (UI) benefit recipients rose to unprecedented levels. This spike in benefits was especially dramatic for the number of recipients collecting partial benefits--UI benefits earned while working part time—which doubled from around 8% of total UI recipients pre-pandemic to 16% in early 2021. This rise coincided with some key temporary changes to the UI program, most prominently the Federal Pandemic Unemployment Compensation (FPUC), which paid a fixed $600 bonus to all workers collecting any amount of UI benefits. The FPUC induced a substantial cliff in disposable income for many workers, such that returning to full-time or near-full-time work would result in a loss of hundreds of dollars of weekly income, compared to working part-time just under the threshold required to collect benefits. This paper seeks to understand the effect this program had on aggregate employment and underemployment. To that end, I construct a job search model with moral hazard in which workers have the option to work part-time (even when they have full time job offers) and collect partial UI benefits. I calibrate this model to the pre-pandemic and then study the effects during the pandemic, using it to quantify the extent to which this newly introduced incentive discouraged workers from returning to full-time work.

**Keywords:** Unemployment insurance, pandemic, part-time work.

*This paper is based on Chapter 1 of my PhD thesis at the University of Minnesota. For valuable advice and suggestions, I thank Fatih Guvenen, Kjetil Storesletten, and the workshop participants at the University of Minnesota.

# 1 Introduction

This paper seeks to understand and quantify the effect of pandemic-era supplemental unemployment insurance bonus payments on the delayed return to full-time employment. To do this, I construct a model of unemployment insurance (UI) with partial employment and moral hazard. In the model, workers receive one of three discrete levels of employment opportunity each period. They can have a full-time job opportunity, a part-time job opportunity, or no job opportunity. A worker cannot to work full-time unless they have a full-time employment opportunity, but worker with a full-time opportunity may choose to work part-time or not at all. And similarly a worker with a part-time job opportunity may choose not to work. Workers receive unemployment insurance benefits if they work less than full-time hours due to lack of opportunity. However, workers who shirk by choosing a level of employment below their opportunity level also have a chance of successfully collecting benefits. Thus the UI program may incentivize workers with a full-time employment opportunity to work part-time or not at all, and may similarly incentivize a worker with a part-time job opportunity not to work.

It is partial unemployment in particular that I am interested in modeling. In the United States, workers can collect partial UI benefits when working reduced hours through no fault of their own. Figure 1 illustrates that the number of regular UI recipients spike upwards during the pandemic for both receipt of total unemployment insurance by those were fully unemployed and for receipt of partial unemployment insurance by those who were working part-time. The level of partial UI recipients returned more slowly to pre-pandemic levels, and consequently, the portion of regular UI recipients who were collecting only partial UI doubled by the end of 2020. As far as I am aware, this paper is the first to document this fact.

After setting up my model with partial unemployment insurance, I perform some experiments within the model. Firstly, I fit the model to parameters representing the pre-pandemic economy, and then compare equilibria with various different government policies. A large lump-sum bonus payment of the type seen with the FPUC induces low-earning workers in the model to shirk by reducing their employment to part-time work, but doesn't induce workers not to work. An elevated replacement rate doesn't provide a strong enough incentive to discourage full-time employment. A lump sum transfer distributed to all members of the work force can result in higher welfare when spending the same total amount of money as a lump-sum bonus to UI benefits.

Secondly, I simulate the dynamics of the COVID-19 recession within the model. The model starts in a stationary equilibrium representing the pre-pandemic economy. The direct effects of the pandemic are represented by a sharp single-period unemployment shock. Thereafter, each period in the model represents one month, and changes to the UI benefits are made each period to correspond to the timeline of the FPUC program.

I choose to model the pandemic as a short temporary shock to reflect the rapid recovery of labor market conditions from this recession. According to the Job Openings and Labor Turnover Survey (JOLTS), the layoffs and discharges rate spiked up in March and April of 2020, but thereafter quickly returns to below 2%, and 2021 experienced record low rates for layoffs and discharges (Penn and Nezamis, 2022). JOLTS similarly documents that the number of monthly hires dipped sharply down in March and April of 2020, before spiking upwards in May and June, before returning to more or less regular levels. Along similar lines, Chetty et al. (2023) finds that the COVID-19 recession was "v-shaped" for high-wage workers, lasting only a few weeks, and that although the loss of employment for low-wage workers was much more persistent, this persistence of low-wage employment was driven by labor supply rather than reduced demand for low-skill labor.[1] And in contrast to the Great Recession, in which some social groups took many years to recover, all social groups were able to recover their pre-COVID pre-tax income levels by the end of 2021 (Blanchet et al., 2022).

The COVID-19 pandemic was accompanied by unique changes in labor market dynamics, alongside massive expansions to unemployment insurance (UI) policy in the United States. In particular, alongside extensions to the duration of UI benefits, the Federal Pandemic Unemployment Compensation (FPUC) program provided a flat 600 dollar per week bonus, and later a 300 dollar per week bonus, to anyone collecting unemployment insurance. For lower income recipients, the additional payments from the FPUC meant that UI benefits could easily exceed the worker's pre-pandemic earnings, and among unemployed workers eligible for UI benefits in mid-2020, the majority did indeed have comprehensive replacement rates above 100% (Ganong et al., 2020).

The large size of FPUC benefit payments resulted in concerns that the expanded UI programs would disincentivize workers from returning to employment. However, there is a body of literature which analyzes the effect of the arrival or cessation of FPUC payments on job search and the rate of job finding, and these studies find relatively muted effects

[1] Note, however, that this paper also attributes only a very small portion of this low-wage labor supply reduction to extended UI coverage.

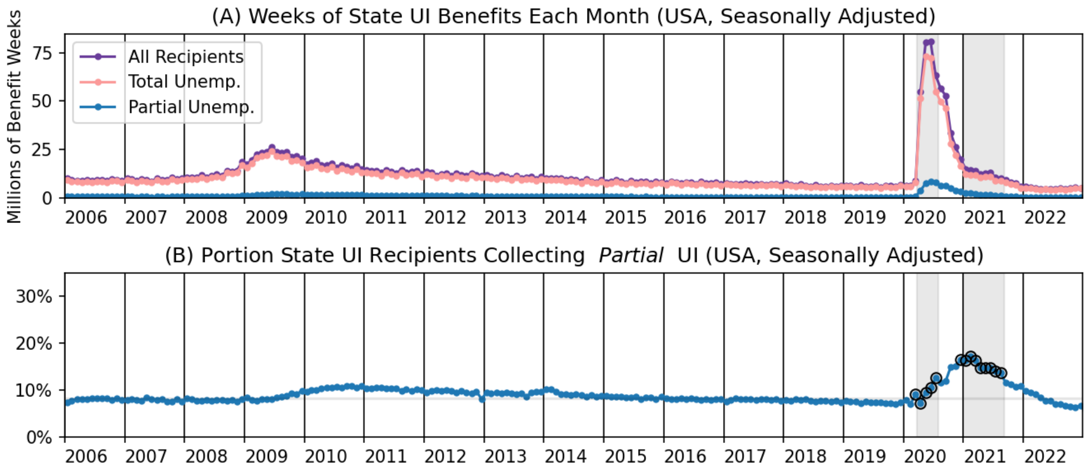


FIGURE 1
Regular UI Recipients

*Note.* Data from the Department of Labor is monthly, but the unit is benefit-weeks. If a single recipient collects benefits for multiple weeks during a month, the add that many weeks to the total for that month. Recipients of "total" unemployment insurance are collecting their full weekly benefit amount, while recipients of partial unemployment are collecting a reduced benefit amount because they are working part-time while collecting benefits. The bottom panel illustrates the portion of regular UI recipients who are collecting partial benefits.

(for example, Ganong et al. (2022) and Dube (2021)). Coombs et al. (2022) provides a particularly striking negative result by isolating the cessation of pandemic-era UI extensions from the loss of just the FPUC bonus. They estimate that job finding rates increased by 23% for those workers subject to the exhaustion of all UI benefits, but for workers who continued to collect benefits and simply lost the 300 dollar FPUC bonus, their estimates on job-finding impact are insignificant, with some point estimates being negative. From this evidence, it seems that these large lump-sum payments provided surprisingly little discouragement from returning to work.

However, an underappreciated fact about the US unemployment insurance system is that workers do not necessarily lose access to benefits when they regain employment, as long as their weekly earnings or hours remain low. Implementation varies by state, but benefits typically taper off as weekly earnings increase, up to some threshold, where they cease entirely. During the pandemic, workers were eligible to receive the full FPUC bonus payment if they collected even a single dollar of unemployment insurance, and the FPUC bonus payments didn't taper off with income. If a worker can freely choose to work reduced hours below the eligibility threshold, then it would not be a surprise to find that the FPUC payments had little effect on their decision to return to work per se. The FPUC bonus payments wouldn't alter such a worker's extensive margin incentives about *whether* to work, and would instead alter their decisions about *how much* to work. And indeed, the portion of regular UI recipients who were collecting only partial unemployment insurance doubled during the pandemic, as seen in Figure 1, which is suggestive of some possible effect at the intensive margin.

A primary motivation of this paper then is to use this understanding about partial unemployment insurance in the US to explore the effects of expanded pandemic-era UI programs of the intensive margin for labor. Did FPUC bonus payments discourage workers from returning to full-time work? And if so, how much of an impact did this have on the aggregate economy? Even if the results are small or nonexistent, this has important implications for government policy and for understanding labor market dynamics. If labor responses on the intensive margin to unemployment benefits programs are large, then such programs could encourage underemployment, a negative consequence that wouldn't be seen in statistics like aggregate employment and the job-finding rate. And if workers choose not to keep their working hours below the threshold for eligibility for partial UI benefits, even in the presence of massive pandemic-era incentives to do so, that suggests the existence of substantial frictions which prevent workers from freely choosing their weekly working hours.

There are many papers which model and analyze the effects of the pandemic-era UI extensions – on both labor market outcomes, and on other outcomes like consumption and welfare. Carroll et al. (2020) models the pandemic as a singular unemployment shock in conjunction with a shock to the marginal propensity to consume. Their model features income risk and a consumption-savings decision, but doesn't explicitly model the decision about whether to work or represent moral hazard, focusing instead on the program's impact on consumption and savings. Ganong et al. (2022) includes a model of job search intensity in response to UI benefits, but focuses on the rate of new job finding and doesn't include part-time work nor the opportunity to turn down job offers. That paper's main result is that the pandemic-era UI supplements were large enough to significantly increased the spending of recipients, which stands in contrast to the typical pre-pandemic situation where UI recipients have lower amounts of spending than usual (Ganong and Noel, 2019). Mitman and Rabinovich (2020) also uses a model with job search intensity, and models the pandemic as a destruction of job matches followed by a sequence of shocks reducing search efficiency. Although that paper does not give workers the ability to turn down a job, workers can reduce their search intensity, and the authors suggest counteracting this source of moral hazard by allowing newly hired workers to continue collecting the lump-sum bonus payment for some time. That paper doesn't feature partial unemployment insurance, but I want if partial unemployment insurance may, in the presence of a UI bonus which doesn't decline with income, act as a similar mechanism.

On the empirical side, Holzer et al. (2021) and Coombs et al. (2022) each use cross-state variation in the end-date of the pandemic-era UI programs to estimate the labor market impacts of a counterfactual where every state ended the program early, and Dube (2021) uses cross-state variation in the effective replacement rate to estimate the job-finding impacts of the expiration of the 600 dollar per week bonus payments, but these studies focus only on job finding, and don't include an analysis of workers who return to part-time work. Marinescu et al. (2021) uses data from an online jobs-finding platform to estimate that the 600 dollar UI bonus reduced job applications but not job vacancy creation, and so may have had little effect on aggregate employment because it decreased competition for jobs in a time when jobs were scarce. Bartik et al. (2020) finds that during the first few months of the pandemic, states with higher UI replacement rates didn't seem to have sharper or more persistent reductions in employment.

This paper is also more generally part of the large body of literature looking at the effects of the COVID-19 Pandemic and about the policy responses to the pandemic. Cox et al. (2020) finds a decrease in consumption across all four quintiles of pre-pandemic income, and argues that the decline was driven primarily by the direct effects of the pandemic discouraging consumption, rather than by labor market disruptions. Casado et al. (2020) finds that pandemic-era fiscal policies - the FPUC UI supplements and others - were successful in their goal of increasing consumer spending. Cajner et al. (2020) documents how reduced employment was more common among low-income workers. Baker et al. (2020) documents how, compared to the great recession, stimulus payments during the pandemic seem to have involved less spending on durable goods and more paying down of debts.

The effects of partial unemployment insurance for recipients who are working at the time are less studied than other aspects of unemployment insurance, but there is a body of research about partial unemployment insurance in pre-pandemic contexts. Kyyrä (2010) finds that in Finland, the presence of partial unemployment insurance benefits for part-time or temporary work also facilitates the return to regular full-time work, and Godøy and Røed (2016) finds similar results for partial UI in Norway and Cockx et al. (2013) in Belgium. Kyyrä et al. (2013) finds mixed effects of supplementary unemployment benefits for part-time workers in Denmark. Caliendo et al. (2016) finds that in Germany, having access to "mini-jobs" while collecting unemployment benefits reduces the rate of full job finding at the beginning of an unemployment spell but increases job finding for long-term unemployed. Le Barbanchon (2016) documents income bunching around the disregard[2] of a state UI programs in the US, suggesting that at least some employed workers may be choosing to reduce their hours in response to partial UI benefits. From older literature, McCall (1996) finds that increasing the disregard results in a higher rate of return to part-time work, and to work overall. As far as I am aware, this paper is the first to study partial UI in the era of pandemic-related expansions to unemployment insurance.

The rest of the paper is as follows. In Section 2, I describe my model of job search with moral hazard. In Section 3, I fit the model's parameters to the pre-pandemic economy. In Section 4, I perform several computational experiments using the model.

# 2 Model

This section presents a dynamic equilibrium model of job search and Unemployment Insurance in an environment with partial benefits and moral hazard. In brief, workers stochastically receive full or partial job opportunities, but may choose not to take full advantage of them. When a worker is unemployed or underemployed, they receive UI benefits. Imperfect monitoring of UI eligibility means that workers can choose a lower level of employment, and have some chance of collecting benefits they are not entitled to. Workers can choose to save, but there is otherwise no private insurance.

## 2.1 Individuals

Time is discrete and indexed by $t$. There is a continuum of infinitely-lived workers, whose type is indexed by $i$.[3] Within each type, workers are ex-ante identical. Each worker discounts the future at rate $\beta$ and seeks to maximize

$$\mathbb{E}\sum_{t}\beta^{t}U(c_t, l_t) \tag{1}$$

where $c_t$ is consumption at time $t$ for that worker, $l_t$ is leisure at time $t$, and $U(...)$ is the flow of utility.

[2]"Disregard" is the amount of weekly earnings allowed before UI benefits begin to taper off.

[3]For much of the following description, the type index $i$ is dropped for ease of reading. This index will be reintroduced in the subsection on equilibrium.

Workers enter period $t$ with some amount of non-interest-bearing assets $a_t$, and choose how to divide disposable income between consumption and savings, subject to the budget constraint $a_{t+1} + c_t = a_t + y_t^d$, where $y_t^d$ is the worker's disposable income that period. The workers may only save, not borrow, meaning assets are subject to a non-negativity constraint $a_{t+1} \geq 0$.

#### 2.1.1 Employment Opportunities

Each worker is endowed with one unit of time, which is split between labor and leisure. Rather than having this variable be continuously divisible, there are three distinct levels of labor which can be chosen. $\eta_t \in \{E, P, U\}$ represents the level of employment chosen by the worker, with $E$ representing full-time employment, $P$ representing part-time employment, or underemployment, and $U$ representing no employment at all. If $\eta_t = E$, the worker spends some fixed amount $\hat{h}_e$ of their time on labor, and if $\eta_t = P$, the worker spends a lesser amount $\hat{h}_p$ of their time on labor, where $\hat{h}_e > \hat{h}_p > 0$. Finally, if the person is not employed, then $\eta_t = U$ and no time is spent on labor. In all three cases, all time not spent on labor is instead spent on leisure:

$$l_t(\eta_t) = \begin{cases} 1 - \hat{h}_e & \text{if } \eta = E \\ 1 - \hat{h}_p & \text{if } \eta = P \\ 1 & \text{if } \eta = U \end{cases} \tag{2}$$

The choice of employment level is constrained by employment opportunity. Each period, the worker faces a stochastic employment opportunity $s_t \in \{E, P, U\}$, which represents the maximum amount they can choose to work. If $s_t = U$, then the worker doesn't have an employment opportunity this period, and so must choose not to work, with $\eta_t = U$. If $s_t = P$, then the worker has a partial job opportunity, which they can choose to accept (with $\eta_t = P$) or reject (with $\eta_t = U$). Finally, if $s_t = E$, then the worker has a full job opportunity, and can choose any of the three employment levels, $E$,$P$, or $U$. Implicit here is the assumption that a full-time job opportunity comes with the option to accept the job but work part time. The worker's idiosyncratic employment opportunity $s_t$ evolves over time according to a first-order Markov process with transition matrix $\chi(s_t, s_{t+1})$

$$\chi = \begin{bmatrix} \chi(E,E) & \chi(E,P) & \chi(E,U) \\ \chi(P,E) & \chi(P,P) & \chi(P,U) \\ \chi(U,E) & \chi(U,P) & \chi(U,U) \end{bmatrix} \tag{3}$$

### 2.1.2 Income and Unemployment Benefits

The worker has two sources of disposable income: labor income, and UI benefits. Both sources of income of taxed at rate $\tau$. If a worker is employed full time, with $\eta_t = E$, they generate $w$ units of consumption goods as pre-tax earnings, where $w$ represents the worker's exogenous productivity.[4] The value of $w$ does not evolve over time. A full-time worker pays taxes, and collects no unemployment benefits, and so such a worker's disposable income is given by $y^d = (1-\tau)w$.

In the absence of Unemployment Insurance benefits, a worker who is not employed collects no disposable income, with $y^d = 0$. Meanwhile, a worker who is partly employed without UI benefits collects a proportionally reduced share of their full time earnings $(1-\tau)w\frac{\hat{h}_e}{\hat{h}_p}$.

To summarize ,the worker's gross income before taxes and UI transfers is

$$y^g(\eta) = \begin{cases} w & \text{if } \eta = E \\ w\frac{\hat{h}_p}{\hat{h}_e} & \text{if } \eta = P \\ 0 & \text{if } \eta = U \end{cases} \tag{4}$$

This amount $y^g(\eta)$ also represents the amount of units of consumption goods being produced by the worker. There are no firms or capital in this model. In addition to income from labor, people who are either partly employed or not employed may also collect UI benefits. There are two components to these benefits. The first component consists of regular benefits, with which the worker's earnings are raised to match some fraction of their typical earnings. This fraction is called the replacement rate. The replacement rate for underemployed part-time workers is denoted $\theta_p$, and the replacement rate for full time workers is denoted $\theta_u$. Note that the part-time worker is still earning labor income $w\frac{\hat{h}_e}{\hat{h}_p}$, and so the pre-tax regular benefits paid to a part-time worker will be $w\theta_p - w\frac{\hat{h}_e}{\hat{h}_p}$, the amount ensured by UI minus the amount the worker earns from working. Meanwhile, the regular benefits paid to a fully unemployed worker are simply $w\theta_u$.

The second component of UI benefits is a lump-sum amount $b$ paid on top of the regular benefits. Unlike the regular benefits, the lump sum benefits are not proportional to the worker's regular full-time earnings level $y$. The lump sum amount is also the same for the underemployed and unemployed. Anyone who collects UI benefits earns the same lump

[4] You may also think of $w$ as their skill level or their real wage for full-time work.

sum bonus, regardless of their regular or current earnings. This reflects the nature of the payments implemented by the FPUC during the pandemic.

To summarize disposable income, let $\mu_t \in \{0,1\}$ be a binary variable which indicates whether a worker is collecting UI benefits this period. $\mu_t = 1$ if they are collecting benefits, and $\mu_t = 0$ if they are not. The worker's disposable income is given by the following.

$$
\begin{aligned}
y^d(\eta,\mu) &= \begin{cases} (1-\tau)w & \text{if } (\eta,\mu) = (E,0) \\ (1-\tau)w\frac{\hat{h}_p}{\hat{h}_e} & \text{if } (\eta,\mu) = (P,0) \\ 0 & \text{if } (\eta,\mu) = (U,0) \\ (1-\tau)(w\theta_p + b) & \text{if } (\eta,\mu) = (P,1) \\ (1-\tau)(w\theta_u + b) & \text{if } (\eta,\mu) = (U,1) \end{cases} \\
&= \begin{cases} (1-\tau)y^g(\eta) & \text{if } \mu = 0 \\ (1-\tau)(w\theta_p + b) & \text{if } (\eta,\mu) = (P,1) \\ (1-\tau)(w\theta_u + b) & \text{if } (\eta,\mu) = (U,1) \end{cases}
\end{aligned}
\tag{5}
$$

What determines whether a person collects UI benefits? If a person is underemployed or unemployed because they lack a job opportunity, then they are guaranteed to collect benefits. That is, if either $s_t = \eta_t = P$ or $s_t = \eta_t = U$, then the person receives benefits as intended, and $\mu_t = 1$.

Unemployment Insurance requires that a worker accept a suitable job offer and return to work. However, monitoring is imperfect, and so a worker may continue to collect benefits instead of returning to work or full-time work when the opportunity arises. In the model, this possibility is represented by the parameter $\pi$, which represents the probability that a person collects benefits when choosing an employment level below their employment opportunity. That is, if $(s_t,\eta_t) = (E,P)$, $(s_t,\eta_t) = (E,U)$, or $(s_t,\eta_t) = (P,U)$, then there is a chance $\pi$ that the worker collects UI benefits (with $\mu_t = 1$), and a chance $(1-\pi)$ that they do not collect benefits (with $\mu_t = 0$). In the model, this probability $\pi$ is independent and identically distributed each period.

$$
Pr_\mu(s,\eta) \equiv \Pr(\mu = 1|s,\eta) = \begin{cases} 0 & \text{if } \eta = E \\ 1 & \text{if } s \in \{P,U\} \text{ and } \eta = s \\ \pi & \text{if } s \in \{P,U\} \text{ and } \eta \neq s \end{cases}
\tag{6}
$$

Note that if $\eta_t = E$, no benefits are ever received. There is no row for $(\eta_t, \mu_t) = (E, 1)$ in the equation for $y^d$, because workers who are employed full-time do not collect benefits.[5]

### 2.1.3 Individual's Dynamic Programming Problem

A worker enters the period with some level of assets $a$. At the beginning of the period, their employment opportunity $s$ is stochastically realized, based on their previous employment opportunity.

Given their asset level and realized employment opportunity, $(a, s)$, the worker then chooses the level of actual employment $\eta$, subject to the restriction that $\eta \in \omega(s)$, where $\omega(s)$ expresses the set of potential employment levels given employment opportunity $s$.

$$\omega(s) = \begin{cases} \{E, P, U\} & \text{if } s = E \\ \{P, U\} & \text{if } s = P \\ \{U\} & \text{if } s = U \end{cases} \tag{7}$$

Next, the value of $\mu$ is determined, indicating whether the person collects benefits. Depending on the values of $s$ and $\eta$, this determination process may or may not be random.

Finally, given assets, potential and actual employment level, and benefits status $(a, s, \eta, \mu)$, the worker now knows their disposable income $y^d$ and leisure $l$. Given all this information, the worker chooses how many assets $a'$ to set aside for the next period, and consumes the remainder of their resources, such that $c = y^d + a - a'$.

After the employment opportunity has been realized at the start of the period, the worker's maximization problem can be expressed by the following dynamic programming problem.

$$\begin{aligned} V(a, s) = \max_{\eta} & \left\{ \mathbb{E}\left[ \max_{m'} \left\{ U\left(y^d(\eta, \mu) + a - a', l(\eta)\right) + cont(s, m) \right\} \right] \right\} \\ \text{s.t. } & \eta \in \omega(\eta) \\ & 0 \le a' \le a + y^d(\eta, \mu) \end{aligned} \tag{8}$$

where $cont(\ldots)$ is shorthand for the continuation value below.

[5]This paper is concerned only with people declining the opportunity to increase their hours worked in response to the incentives of a UI program. In the real world, there is also the separate issue of people returning to work while claiming to be still unemployed, but this latter issue is a more serious criminal matter, and is outside the scope of this model. Here, only the employment opportunity is imperfectly monitored, not the actual level of employment.

$$cont(s,a') \equiv \beta \sum_{s'} \chi(s,s') V(a',s') \tag{9}$$

To be more explicit about each case, let $V_2(a,s,\eta,\mu)$ be shorthand for the inner maximization problem:

$$\begin{aligned} V_2(a,s,\eta,\mu) \equiv \max_{m} &\left\{ U\left(y^d(\eta,\mu) + a - a', l(\eta)\right) + cont(s,a') \right\} \\ \text{s.t. } & 0 \leq a \leq a' + y^d(\eta,\mu) \end{aligned} \tag{10}$$

Then the the value function for the three different possible values of $\eta$ is as follows.

$$\begin{aligned} V(a,E) &= \max \left\{ \begin{array}{c} V_2(a,E,E,0), \\ \pi \cdot V_2(a,E,P,1) + (1-\pi) \cdot V_2(a,E,P,0), \\ \pi \cdot V_2(a,E,U,1) + (1-\pi) \cdot V_2(a,E,U,0) \end{array} \right\} \\ V(a,P) &= \max \left\{ \begin{array}{c} V_2(a,P,P,1), \\ \pi \cdot V_2(a,P,U,1) + (1-\pi) \cdot V_2(a,P,U,0) \end{array} \right\} \\ V(a,U) &= V_2(a,U,U,1) \end{aligned} \tag{11}$$

## 2.2 Stationary Equilibrium

Let state $x \equiv (a,s,\eta,\mu)$ be shorthand for a state consisting of asset holdings, employment opportunity, employment choice, and status of employment benefits. These variables together represent states that a worker can be in immediately before making their decision about how much to save and consume.

If all workers are ex-ante identical, then the *stationary competitive equilibrium* for this economy consists of a tax rate $\tau$, a time-invariant measure $\lambda(x)$ of workers in state $x$, and decision rules $c(x)$, $a'(x)$, $\eta'(a,s)$, such that:

1. Given the tax rate, the decision rules solve the worker's maximization problem in equation 8.

2. The goods market clears, with the total amount of goods being produced equal to the amount being consumed.

$$\sum_x \lambda(x) c(x) = \sum_x \lambda(x) y^g(x) = \sum_{x \text{ s.t. } \eta=E} \lambda(x) w + \sum_{x \text{ s.t. } \eta=P} \lambda(x) w \frac{\hat{h}_p}{\hat{h}_e} \tag{12}$$

3. The government's budget constraint is balanced each period.

$$\sum_x \lambda(x)\big(y^g(x) - y^d(x)\big) = 0 \tag{13}$$

4. The invariant measure $\lambda(x)$solves the following functional equation.

$$\lambda(x') = \begin{cases} \sum_x \left[\lambda(x) \cdot \mathbb{I}_{m'}(x) \cdot \chi(s, s') \cdot \mathbb{I}_{\eta'}(a', s') \cdot Pr_\mu(s', \eta')\right] & \text{if } \mu' = 1 \\ \sum_x \left[\lambda(x) \cdot \mathbb{I}_{m'}(x) \cdot \chi(s, s') \cdot \mathbb{I}_{\eta'}(a', s') \cdot (1 - Pr_\mu(s', \eta'))\right] & \text{if } \mu' = 0 \end{cases} \tag{14}$$

where $\mathbb{I}_{m'}(x)$ is an indicator function equal to 1 when $a'(x) = a'$, indicating that the decision rule selects that particular value of $a'$ in response to state $x$, and $\mathbb{I}_{\eta'}(a', s')$ is an indicator function equal to 1 when $\eta'(a', s') = \eta'$. $Pr_\mu$ is shorthand for $\Pr(\mu = 1|s, \eta)$ as defined in equation 6.

For an individual worker to move from being in state $x = (a, s, \eta, \mu)$ one period, to being in state $x' = (a', s', \eta', \mu')$ the next period, it must be that they chose to carry $a'$ units of assets into the next period, that their new job opportunity happens to be $s'$, which happens with probability $\chi(s, s')$, that their choice of employment level next period is $\eta'$, and that their receipt of employment benefits is correctly indicated by $\mu'$, which may or may not happen randomly.

Thus the term in the summation in equation 14 adds up the probability of transitioning to new state $x'$, across all possible previous states $x$. If $\lambda(x)$, together with the tax rate and decision rules, satisfies this functional equation, then the distribution is stable across time.

### 2.2.1 Equilibrium with Multiple Types of Workers

Additional ex-ante heterogeneity is now introduced. There are multiple types of worker. Types are indexed by $i$. Within each type, there is a continuum of workers with population mass given by $p_i$. And within each type, workers are ex-ante identical. Government tax and transfer policy is applied the same across types. That is, the value of the tax rate $\tau$, the UI replacement rates $\theta_p, \theta_u$, and the lump-sum UI payment $b$ are the same for all workers.[6]

Each worker solves a problem of the form described in Section 2.1, but the

[6] In the real world, states have limits on the weekly benefit amount, and as such the upper end of the income distribution has a lower effective replacement rate. That feature of the UI system isn't modeled here. The fact that the lump sum $b$ are independent of income is, however, reflective of reality.

parameterization of this problem may differ between types along several dimensions including preferences, job-finding rates, and productivity. It is this last dimension in particular, variation in productivity $w_i$, that I wish to exploit. Note that even facing the same UI policy, the UI benefits payments will differ between types if their productivity levels $w_i$ differ. This is due to the regular UI benefits which proportionally replace regular earnings. Differing disposable income functions will also induce differing value functions and optimal decision rules.

With multiple types of worker, the stationary competitive equilibrium for this economy now consists of a tax rate $\tau$, time-invariant measures $\lambda_i(x)$ for workers of each type $i$ in state $x$, and decision rules $c_i(x)$, $a'_i(x)$, $\eta'_i(a,s)$ for each type, such that:

1. Given the tax rate, the decision rules for each type solve the worker's maximization problem in equation 8.

2. The goods market clears.

$$\sum_i \sum_x p_i \lambda_i(x) c_i(x) = \sum_i \sum_x p_i \lambda_i(x) y_i^g(x) \tag{15}$$

3. The government's budget constraint is balanced each period.

$$\sum_i \sum_x p \lambda_i(x) \big( y_i^g(x) - y_i^d(x) \big) = 0 \tag{16}$$

4. For each type, the invariant measure $\lambda_i(x)$ solves the following functional equation.

$$\lambda_i(x') = \begin{cases} \sum_x \left[ \lambda_i(x) \cdot \mathbb{I}_{m'_i}(x) \cdot \chi(s,s') \cdot \mathbb{I}_{\eta'_i}(a',s') \cdot Pr_\mu(s',\eta') \right] & \text{if } \mu' = 1 \\ \sum_x \left[ \lambda_i(x) \cdot \mathbb{I}_{m'_i}(x) \cdot \chi(s,s') \cdot \mathbb{I}_{\eta'_i}(a',s') \cdot (1 - Pr_\mu(s',\eta')) \right] & \text{if } \mu' = 0 \end{cases} \tag{17}$$

Note that the market clearing condition and government budget sum across all types, whereas the decision rules and time-invariant measures have simply been indexed by type, but are otherwise unchanged.

# 3 Parameterization

The utility function takes the following Constant Relative Risk Aversion form.

Table 1
Parameter Values.

| Variable | Parameterization |
|---|---|
| **Preference Parameters** | |
| Discount factor | $\beta = 0.9966$ |
| Leisure exponent | $\sigma = 0.5$ |
| Degree of risk aversion | $\rho = 2$ |
| **Population and Work Parameters** | |
| Time spent on full employment | $\hat{h_e} = 0.45$ |
| Time spent on partial employment | $\hat{h_p} = 0.15$ |
| Population of each type | $p_i = 1$ for each quintile. |
| Productivity of each type | $w_i = \left\{\frac{372}{886}, \frac{592}{886}, \frac{886}{886}, \frac{1280}{886}, \frac{2323}{886}\right\}$ |
| Job opportunity transition matrix $\chi$ | See text. |
| **UI Policy Parameters** | |
| Replacement rate for unemployed | $\theta_u = 0.5$ |
| Replacement rate for underemployed | $\theta_p = 0.\bar{6}$ |
| Pandemic bonus | $b = 0$, $b = \frac{600}{886}$, or $b = \frac{300}{886}$ |
| Chance of receiving benefits when $s \neq \eta$ | $\pi = 0.12$ |

$$\mathbb{E} \sum_t \beta^t \frac{(c_t^{1-\sigma} l_t^{\sigma})^{1-\rho} - 1}{1-\rho} \tag{18}$$

Each time period in the model represents a period of one month, and the discount factor is set to $\beta = 0.9966$. This monthly value for $\beta$ corresponds to a yearly discount rate of 4%. The other utility parameters are set to $\sigma = 0.5$ and $\rho = 2$.

Suppose that a worker has around 100 hours per week which they can split between leisure and labor, after subtracting the time spent on mandatory activities like sleeping and eating. Normalize the total available time that could be spent on work to 1. Then a value of $\hat{h_e} = 0.45$ corresponds to spending 45 hours per week on full-time work. This is much longer than the average work week, but a reasonable approximation when looking only at workers who work at least full-time. Similarly, I set the time spent for part-time work to $\hat{h_p} = 0.15$, corresponding to 15 hours of work per week, which is a typical amount when conditioning on those who work no more than half-time.

To introduce ex-ante heterogeneity, I split workers into five types of equal population mass, each representing a quintile of workers, based on pre-pandemic earnings. I take estimates of these earnings by quintile from Ganong et al. (2022), normalize the productivity of the median worker quintile to 1, and scale the productivity of each other quintile accordingly. For example, the median quintile has an income of \$886 dollars per week, and their productivity in the model is scaled to $y_3 = 1$, and the lowest quintile has a weekly income of \$372 with a productivity of $y_1 = \frac{372}{886} \approx 0.42$. Note that although each period in the model represents one month, and the figures for income levels are expressed weekly, I am only using these income numbers to scale the relative size of income across quintiles. Normalization removes the mismatch between period lengths.

The transition matrix for job opportunity is calibrated as follows.

$$\chi = \begin{bmatrix} \chi(E,E) & \chi(E,P) & \chi(E,U) \\ \chi(P,E) & \chi(P,P) & \chi(P,U) \\ \chi(U,E) & \chi(U,P) & \chi(U,U) \end{bmatrix} = \begin{bmatrix} 0.965 & 0.017 & 0.018 \\ 0.598 & 0.343 & 0.059 \\ 0.339 & 0.057 & 0.604 \end{bmatrix}$$

This matrix is meant to represent the pre-pandemic economy of 2019 and early 2020. These transition rates are based on the average monthly transition rates between employment states in the twelve months leading up to the pandemic. This matrix gives a stationary distribution for E, P, and U of approximately $92.6\%, 2.8\%, 4.6\%$, which is close to the actual distribution of $92.6\%, 2.9\%, 4.5\%$ calculated from Current Population Survey data. See the appendix for how I map workers in real-world data to these three employment levels, and for other details about the derivation of $\chi$.

In the model, UI benefits are set so that a fully unemployed worker has half of their typical earnings replaced, with $\theta_u = 0.5$, while a partially employed person has two thirds of their regular income replaced, with $\theta_p = 0.\bar{6}$. For the latter number, the worker earns $\frac{\hat{h_p}}{\hat{h_e}} = \frac{1}{3}$ of their typical full time earnings as labor income. The regular UI benefits then provide the equivalent of an extra third of that typical income. This parameterization corresponds to a state UI system in which the benefits paid out decrease by 50 cents for every dollar of pre-tax labor income, as happens in, for example, Minnesota.

Finally, $\pi = 0.12$, meaning that when a worker doesn't take full advantage of their job opportunity, they nonetheless have 12% chance of collecting UI benefits. This value is calibrated to invoke a similar level of response to the program as seen during the actual pandemic.

In the following section, I will look at examples with and without the weekly 600 dollar FPUC bonus. When this supplemental payment is in place in the model, it is normalized to

$b = \frac{600}{886} \approx 0.677$. As with the productivity levels, a weekly dollar amount is here being using to establish a parameter in a model with monthly periods. The important thing is that the relative value of the bonus is normalized with respect to earnings. Multiplying both the dollar bonus and dollar median income by four to put them in monthly terms would result in the same parameter value for $b$.

# 4 Policy Experiments

I use this model to conduct several simulations of the economy during the pandemic. I start by calculating the baseline stationary equilibrium with the parameters described in the previous section. For the first batch of experiments, I look at equilibria with supplemental UI policies in place. I add the 600 dollar bonus to the pre-pandemic economy and compare the resulting equilibria. I then do the same by imposing counterfactual policies of increasing the replacement rate or transferring money in a lump sum fashion to all members of the labor force, regardless of employment status. After that, I start with a stationary pre-pandemic equilibrium, and simulate the month-by-month effects of the pandemic shock in conjunction with the FPUC bonus payments.

## 4.1 Wealth Levels of Baseline Stationary Distribution

Using the parameterization above, all workers fully accept every job opportunity in equilibrium. The resulting distribution of employment levels matches the stationary distribution for $\chi$, and the equilibrium tax level is $\tau = 3.35\%$.

Within each quintile, the distribution of wealth is mostly is mostly concentrated around a single level of $a$. Employed workers tend to increase their holding of assets by saving, up until the point where it is no longer beneficial in expectation to hold more assets. Unemployed or underemployed workers then deplete those savings as their spell of reduced employment continues. This reflects how savings acts as a mechanism for privately insuring against the risk of reduced employment activity.

Workers spend most of their time fully-employed, and the expected duration of unemployment spells is much shorter than that of full-time employment spells. As such, workers are often able to remain employed long enough to increase their asset holdings up to the maximum level they wish to hold, and in the stationary equilibrium, the majority of workers are in such a high-asset-holding state.

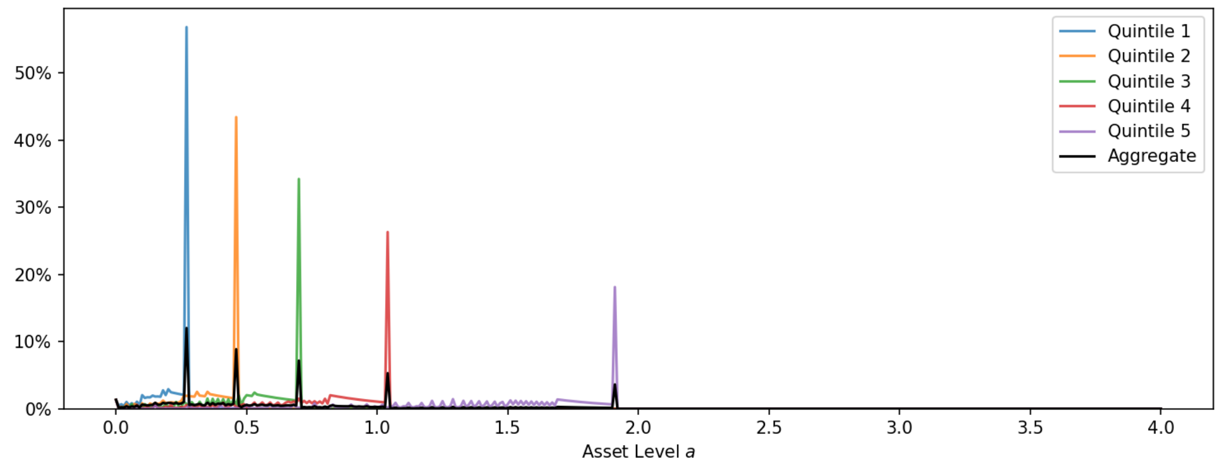


FIGURE 2
Wealth Distribution in the Baseline Stationary Equilibrium.

*Note.* Asset level $a$ is a worker's savings. The distribution of asset levels is displayed for each quintile, and for the economy as a whole, in the stationary equilibrium calibrated to pre-pandemic conditions. Quintiles are ordered from lowest productivity to highest.

## 4.2 Comparison of Equilibria With and Without Bonus.

To study the effects of the pandemic UI program, I next conduct two policy experiments within the model. First, I introduce the 600 dollar weekly bonus payment on top of regular UI benefits, and re-solve for the optimal decision rules and invariant measures. Within this experiment I look at two sub-possibilities. In the first, the tax rate is left at pre-pandemic levels. Decision rules and measures are updated while ignoring government budget constraints and market clearing. In the second, the tax rate is adjusted to find a new equilibrium with the program in place. Table 2 summarizes these results.

Employment falls in response to the 600 dollar per week bonus, as many of those with full-time job jobs instead choose to work only part time. Note that with this parameterization, the bonus does not induce worker's to switch to unemployment when they have a job offer. To fund the program without raising taxes, the government must run a deficit of 5% of the median income, which corresponds to approximately 45 dollars per week.

Alternatively, the bonus payments can be funded by increasing taxes by 4.2%. When taxes are increased to fund the program, only a relatively small number of additional workers choose to work part-time despite having full-time job opportunities. This is because the higher taxes aren't enough to encourage the higher-earning quintiles to reduce the level of

Table 2
Effects of *Bonus* on Aggregates During Pandemic

| | Tax Rate | Deficit | Cons. Equiv. | Full-Time | Part-Time | Unemployed |
|---|---|---|---|---|---|---|
| Pre-pandemic Baseline | 3.35% | -0.0 | +0.0% | 92.58% | 2.8% | 4.62% |
| Pandemic Bonus, Unbalanced Budget | 3.35% | 0.052 | +5.8% | 88.91% | 6.46% | 4.62% |
| Pandemic Bonus, Balanced Budget | 7.6% | -0.0 | +1.5% | 88.88% | 6.49% | 4.62% |

*Note.* Summary statistics for three different cases. The baseline case is the budget-balanced stationary equilibrium calibrated to pre-pandemic levels. The other two cases represent equilibria with the lump-sum UI bonus elevated to the equivalent of 600 dollars per week, either without or with an increase in the tax rate to fund it. The deficit is the government's budget shortfall per worker. Deficits are scaled in the model such that a value of 1 corresponds to the median worker's productivity. The consumption equivalent ("Cons. Equiv.") is the average permanent percentage change in consumption each period which would make agents indifferent between the baseline and another case. Positive values represent a case which is better on average than the baseline.

work they choose, and so the overall picture looks very similar to that of the case where the bonus payments are funded via deficit spending.

As a metric for welfare changes, I numerically estimate the permanent percentage change in consumption which would make a worker indifferent between the baseline economy and each alternate case. This is presented in the "Cons. Equiv." column of the table, with positive values indicating that an alternative is better in expectation than the baseline economy. Compared to the pre-pandemic stationary equilibrium, adding the bonus does increase average welfare by this metric.. This is because the bonus payment is independent of earnings potential, and it is funded with proportional taxes on income. The combined effect amounts to form of redistributionary transfers.

Average asset holdings increases with the bonus in place, whether or not the budget is balanced. However, despite the increase in the mean asset holding, median assets actually fall. In fact, for the top 4 highest-earning quintiles, median assets are actually zero. Tables 3 and 4 show the response by quintile to each of these two cases.

As described above, in response to the bonus payment, many workers choose a level of employment which is lower than their employment opportunity. In particular, lower-wage workers in the first quintile with a full-time job offer often choose to work part-time instead. The second and third quintile could gain more income from working part-time and collecting UI benefits, but due to the low chance of collecting those benefits, in expectation, it is better for them to accept full-time work. Comparing the case where taxes are increased to fund

Table 3
Effects of *Bonus With Unbalanced Budget* on Aggregates During Pandemic: Heterogeneity

| Quintile | 1 | 2 | 3 | 4 | 5 | all |
|---|---|---|---|---|---|---|
| **Fully employed** | **74.2%** | **92.6%** | **92.6%** | **92.6%** | **92.6%** | **88.9%** |
| **Partly employed** | **21.1%** | **2.8%** | **2.8%** | **2.8%** | **2.8%** | **6.5%** |
| Offered E, chose P | 18.3% | 0.0% | 0.0% | 0.0% | 0.0% | 3.7% |
| Offered P, chose P | 2.8% | 2.8% | 2.8% | 2.8% | 2.8% | 2.8% |
| **Unemployed** | **4.6%** | **4.6%** | **4.6%** | **4.6%** | **4.6%** | **4.6%** |
| Offered E, chose U | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Offered P, chose U | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Offered U, chose U | 4.6% | 4.6% | 4.6% | 4.6% | 4.6% | 4.6% |

*Note.* The three potential employment levels are full employment E, part-time employment P, or unemployment U. Each column displays the percentage of workers, either in a given quintile or in the entire economy, who choose each employment level. The indented rows display the offers of workers who made that choice. Quintiles are ordered from lowest productivity to highest.

the program to the case where a deficit is used to fund the program, a slightly larger number of workers in the bottom-earning quintiles willingly choose to work part-time in response to the increased taxes. For the upper quintiles, the lump-sum bonus UI payments simply are not large enough to sway them from accepting a job offer, and there is no response to the program in either case.

These results make for a poor fit by themselves for the dynamics of employment resulting from the COVID-19 Recession. The major issue is that, although there is a large increase in the number of people working reduced hours, there is no increase at all in the number of unemployed. In fact, the shift from full-time to part-time employment is larger than the shock seen in the real world in response to the pandemic.

It is possible to use a different parameterization of the utility function such that this experiment induces workers with full-time employment opportunities to choose not to work in hopes of collecting UI benefits. However, any such parameterization that I have tried results in an even more dramatic reduction in full-time employment, along with workers choosing not to accept full-time job offers even in the pre-pandemic case without the FPUC bonus. Although it cannot be proven that this qualitative result is a general

TABLE 4
EFFECTS OF *Bonus With Balanced Budget* ON AGGREGATES DURING PANDEMIC: HETEROGENEITY

| Quintile | 1 | 2 | 3 | 4 | 5 | all |
|---|---|---|---|---|---|---|
| **Fully employed** | **74.1%** | **92.6%** | **92.6%** | **92.6%** | **92.6%** | **88.9%** |
| **Partly employed** | **21.3%** | **2.8%** | **2.8%** | **2.8%** | **2.8%** | **6.5%** |
| Offered E, chose P | 18.5% | 0.0% | 0.0% | 0.0% | 0.0% | 3.7% |
| Offered P, chose P | 2.8% | 2.8% | 2.8% | 2.8% | 2.8% | 2.8% |
| **Unemployed** | **4.6%** | **4.6%** | **4.6%** | **4.6%** | **4.6%** | **4.6%** |
| Offered E, chose U | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Offered P, chose U | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Offered U, chose U | 4.6% | 4.6% | 4.6% | 4.6% | 4.6% | 4.6% |

*Note.* The three potential employment levels are full employment E, part-time employment P, or unemployment U. Each column displays the percentage of workers, either in a given quintile or in the entire economy, who choose each employment level. The indented rows display the offers of workers who made that choice. Quintiles are ordered from lowest productivity to highest.

property of this model, I can provide some intuition. Even without the FPUC bonus, workers have the option to reduce their hours. The *marginal* change in income and hours between unemployment and part-time employment is the same without or without the lump-sum bonus. If the bonus induces a worker to choose unemployment over part-time employment, when they otherwise would not, it is because the bonus payment increases their expected disposable income and consumption, decreasing the marginal utility of consumption, and making additional leisure more attractive. If a parameter is adjusted to the point where the worker responds to a full-time employment offer by choosing not to work, there is likely to be a less extreme value of the parameter which results in them choosing to work part-time. So to 'crank up the dial' to the point where workers are offered E, but choose U, the dial first 'passes through' a region where workers are offered E but choose P.

My conclusion from this first experiment is that in this model, an increase in $b$ is unlikely to manifest a large increase in full unemployment unless there is either a larger increase in part-time employment, or if the pool of people who might switch to part-time is 'depleted'.

This stands in contrast to the dynamics of the pandemic, in which partial

Table 5

Effects of *Higher Replacement Rate* on Aggregates During Pandemic

| | Tax Rate | Deficit | Cons. Equiv. | Full-Time | Part-Time | Unemployed |
|---|---|---|---|---|---|---|
| Pre-pandemic Baseline | 3.35% | 0.0 | +0.0% | 92.58% | 2.8% | 4.62% |
| Higher RR, Unbalanced Budget | 3.35% | 0.018 | +1.7% | 92.58% | 2.8% | 4.62% |
| Higher RR, Balanced Budget | 4.81% | -0.0 | +0.2% | 92.58% | 2.8% | 4.62% |

*Note.* Summary statistics for three different cases. The baseline case is the budget-balanced stationary equilibrium calibrated to pre-pandemic levels. The other two cases represent equilibria with the baseline replacement rate elevated to 70%, either without or with an increase in the tax rate to fund it. The deficit is the government's budget shortfall per worker. Deficits are scaled in the model such that a value of 1 corresponds to the median worker's productivity. The consumption equivalent ("Cons. Equiv.") is the average permanent percentage change in consumption each period which would make agents indifferent between the baseline and another case. Positive values represent a case which is better on average than the baseline.

unemployment spiked up only in relative terms. In absolute terms a larger number of people became fully unemployed and collected full unemployment benefits. The results are however parsimonious with the finding of (Ganong et al. (2022)) that the FPUC program seems to have had only small effects on the exit rate from unemployment to employment.

## 4.3 Comparison to Equilibria With an Elevated Replacement Rate.

Next, I consider the results of a counterfactual policy. Instead of a lump-sum bonus being given to all UI recipients, the replacement rate is increased. The replacement rate for unemployed people is set to $\theta_u = 0.7$. The replacement rate for underemployment, in turn, is set to $\theta_p = 0.8\bar{6}$, such that the increase in disposable income when going from unemployment to partial employment is the same as it was in the baseline economy.

As before, I evaluate a case where the tax rate remains at its original level while allowing decision rules to adjust to the new program, and a case where the tax rates are adjusted to bring the economy back into an equilibrium with balanced budget. Table 5 summarizes the aggregate results.

With this counterfactual government policy, the incentives are not strong enough to encourage workers to turn down job offers, and so the distribution of employment states decisions as it was in the pre-pandemic economy. In neither case, with or without balanced budget, does any of the quintiles ever wish to shirk. Welfare is slightly increased because with this parameterization, the increased replacement rate is better able to insure worker's against unemployment risk without inducing workers not to take up job offers. Compared to the 600 dollar bonus, this counterfactual program has more moderate effects. The spending required to fund the program, the average consumption equivalent to the welfare change, and the incentive to reduce employment are all much lesser.

Another striking contrast with the lump-sum bonus plan is the effect on savings. Whereas the lump-sum bonus increased mean asset holdings in equilibrium, this higher replacement rate decreases the mean value of $m$. With a higher replacement rate, workers are more insured against risk, and so have less of a need to privately insure themselves with precautionary saving.

## 4.4 Comparison to Equilibria With Unconditional Transfers

Next, consider again the third case above, the static equilibrium where the 600 dollar per week bonus is imposed and taxes are raised to allow the budget to be balanced. Compared to the baseline case, taxes are much higher, and so more tax revenue is being raised to pay out benefits. Now suppose that the same amount of additional revenue is collected and then paid out as lump-sum benefits, but instead of being paid to those with reduced employment, it's paid out to everyone, regardless of employment status. As an additional alternative, suppose that the same amount were paid out specifically to the bottom two quintiles, those with the lowest wage level. Table 6 summarizes the equilibrium results in each of these cases.

Despite involving the same total amount of transfer payments being paid out, the programs with a lump-sum transfer which is unconditional on employment status require a lower tax rate to implement and result in improved welfare. Neither of these transfer programs are large enough to incentivize any additional reduced employment.

## 4.5 Further Comparisons by Quintile

Table 7 shows the consumption equivalent to the welfare change from the baseline economy by quintile in each of the cases evaluated above.

Without the balanced budget, all five quintiles would prefer the lump-sum bonus payment over the increased replacement rate. The lump-sum payment also results in a larger welfare increase for the lower-income quintiles, when compared to the baseline stationary equilibrium. This may be a desirable outcome if equability is a concern.

When budgets are balanced, the increased replacement rate increases welfare for all five quintiles, but the program with the lump sum bonus actually *reduces* average welfare

Table 6
Effects of *Transfers* on Aggregates During Pandemic

| | Tax Rate | Deficit | Cons. Equiv. | Full-Time | Part-Time | Unemployed |
|---|---|---|---|---|---|---|
| Pre-pandemic Baseline | 3.35% | 0.0 | -0.0% | 92.58% | 2.8% | 4.62% |
| Pandemic Bonus, Balanced Budget | 7.6% | -0.0 | +1.5% | 88.88% | 6.49% | 4.62% |
| Transfer to Everyone | 7.39% | -0.0 | +1.8% | 92.58% | 2.8% | 4.62% |
| Transfer to Bottom Two Quintiles | 7.39% | 0.0 | +4.2% | 92.58% | 2.8% | 4.62% |

*Note.* Summary statistics for three different cases. The baseline case is the budget-balanced stationary equilibrium calibrated to pre-pandemic levels. For the other three cases, taxes are raised to fund lump-sum transfers to some subset of the population - Either those with reduced employment, all members of the labor force, or anyone in the bottom two quintiles of labor productivity. The total amount of revenue spent on these transfers is the same in each case, and in all three cases, the government budget is balanced. The deficit is the government's budget shortfall per worker. Deficits are scaled in the model such that a value of 1 corresponds to the median worker's productivity. The consumption equivalent ("Cons. Equiv.") is the average permanent percentage change in consumption each period which would make agents indifferent between the baseline and another case. Positive values represent a case which is better on average than the baseline.

for the two quintiles with the highest earnings. The lump sum bonus is essentially a redistributionary transfer when budgets are balanced. The bonus does provide welfare to the higher-earning quintiles in the form of reduced income risk from the loss of employment, but such a boon is outweighed by the loss in full-employed income due to the increase in taxes. In contrast, while the higher replacement rate may provide more moderate improvements to welfare, the benefits are seen by all quintiles. The higher replacement rate provides additional insurance with less of an inter-quintile transfer effect.[7] An increased replacement rate, in conjunction with an increased tax rate, means that the costs and additional benefits from the program are proportional to each other within each quintile.

Compared to the budget balanced lump-sum UI bonus, the universal lump-sum transfer results is preferred by all five quintiles, which larger gains for the bottom three quintiles, and smaller losses for the top two quintiles. As one may expect, the transfer specifically to the bottom two quintiles results in the highest welfare gains among those two quintiles, but is the worst option for the other three quintiles. Nonetheless, the transfer to the bottom two quintiles results in the largest consumption equivalent welfare gains on average, due to redistributionary effects.

[7] In part, this is because with this parameterization, the higher replacement rate doesn't result in the

Table 7

Consumption Equivalent to Welfare Changes. Comparison of Cases.

| Quintile | Consumption Equivalent to Welfare Change | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | all |
| Pre-pandemic Baseline | +0.0% | +0.0% | +0.0% | +0.0% | +0.0% | +0.0% |
| Pandemic Bonus, Unbalanced Budget | +10.9% | +7.2% | +5.1% | +3.7% | +2.1% | +5.8% |
| Pandemic Bonus, Balanced Budget | +6.9% | +2.9% | +0.7% | -0.8% | -2.4% | +1.5% |
| Higher RR, Unbalanced Budget | +1.7% | +1.7% | +1.7% | +1.7% | +1.7% | +1.7% |
| Higher RR, Balanced Budget | +0.2% | +0.2% | +0.2% | +0.2% | +0.2% | +0.2% |
| Transfer to Everyone | +7.5% | +3.4% | +1.0% | -0.6% | -2.3% | +1.8% |
| Transfer to Bottom Two Quintiles | +21.0% | +13.2% | -4.4% | -4.4% | -4.4% | +4.2% |

*Note.* Percentage change in consumption for all time periods which would result in the same change in welfare as changing from the baseline economy to some other case. Each row corresponds to a different scenario, and each column to a different subset of workers. The "all" column presents the average across all workers, while the columns labeled 1-5 present the average only within a single quintile for productivity. Quintiles are ordered from lowest productivity to highest. The bottom two options represent transfers which are not dependent on employment status.

Table 8 shows the average asset holdings by quintile in each of the cases evaluated above. The higher replacement rate results in less savings on average for all quintiles, and with little difference between the cases with balanced or unbalanced budgets. The lump-sum bonus increases the mean level of savings for the bottom quintiles, while decreasing it for the top quintiles. For all quintiles, the mean goes down when taxes are raised to balanced the budget. For the middle quintile, the reduction in savings which is induced by higher taxes is large enough to 'flip' the result. Without a balanced budget, the lump-sum bonus induces a higher mean savings level for the middle quintile, but with a balanced budget, it reduces the mean instead. Compared to the baseline case, the transfers which are not dependent on employment status result in lower average savings level for all five quintiles. Compared to the case where the same amount of money is spent on a budget-balanced UI bonus, such transfers result in the top two quintiles instead increasing their average level of savings, and the bottom quintiles decreasing it.

lower income quintiles choosing not to accept job opportunities.

Table 8

Average asset holdings of each quintile. Comparison of Cases.

| | Average Asset Holdings | | | | | |
|---|---|---|---|---|---|---|
| Quintile | 1 | 2 | 3 | 4 | 5 | all |
| Pre-pandemic Baseline | 0.223 | 0.363 | 0.539 | 0.785 | 1.422 | 0.666 |
| Pandemic Bonus, Unbalanced Budget | 0.378 | 0.431 | 0.265 | 0.124 | 0.014 | 0.242 |
| Pandemic Bonus, Balanced Budget | 0.369 | 0.416 | 0.254 | 0.118 | 0.015 | 0.234 |
| Higher RR, Unbalanced Budget | 0.01 | 0.019 | 0.026 | 0.042 | 0.076 | 0.034 |
| Higher RR, Balanced Budget | 0.01 | 0.019 | 0.023 | 0.042 | 0.072 | 0.033 |
| Transfer to Everyone | 0.158 | 0.286 | 0.451 | 0.688 | 1.3 | 0.577 |
| Transfer to Bottom Two Quintiles | 0.093 | 0.216 | 0.517 | 0.745 | 1.359 | 0.586 |

*Note.* The "all" column presents the average across all workers, while the columns labeled 1-5 present the average only within a single quintile for productivity. Quintiles are ordered from lowest productivity to highest. The bottom two options represent transfers which are not dependent on employment status. Both of these cases have balanced budgets with the same amount of additional tax revenue collected as in the case with the UI bonus with a balanced budget.

### 4.6 Simulation of Dynamics During the Pandemic

For this policy experiment, I simulate the effects of the FPUC program in conjunction with a shock to employment levels caused by the pandemic. I start by finding the pre-pandemic stationary equilibrium, as in experiment 1. Starting from that stationary equilibrium, I advance the model one period at a time. For each period, I impose some level of lump-sum bonus $b$, and solve for the worker's policy functions. I do not, however, solve for the stationary distribution or equilibrium tax rate. I keep the tax rate at the pre-pandemic level, and use the updated policy functions and transition probabilities to advance the distribution across states by one period.

There are 24 periods in this simulation, representing the 24 months of 2020 and 2021. The first three months have their distributions set to the pre-pandemic stationary equilibrium. In the fourth month, two things occur. The first thing that occurs is that a shock to employment levels is imposed to match that seen at the start of the pandemic. That is, instead of the usual transition probabilities, the transition occurs according to the following.

$$\chi_{shock} = \begin{bmatrix} 0.783 & 0.065 & 0.152 \\ 0.360 & 0.252 & 0.388 \\ 0.268 & 0.053 & 0.679 \end{bmatrix}$$

This transition matrix is chosen to match the transition between employment states between March and April of 2020, and is applied for only the transition from period 3 to period 4. In all subsequent periods, the values for $\chi$ are returned to their pre-pandemic values. This simplification reflects the fact that the COVID-19 recession was characterized by a singular spike in job loss in the last week of march and the first week of April, followed by a quick return to more ordinary levels of transition between employment states.

The second thing that occurs in the fourth month is that the FPUC payments begin. The value of the lump-sum UI bonus $b$ is raised from 0 to a level representing 600 dollars per week,[8] and this level of bonus is imposed for 4 months. Starting in month 8, and continuing to month 12, the bonus is set back to $b = 0$. This corresponds to September to December of 2020. For months 13 through 20, January to August of 2021, a 300 dollar per week bonus[9] is imposed. After this, the bonus is again set back to $b = 0$. Results are shown in Figure 3.

The results here need some additional work to better quantitatively match the actual employment dynamics of the pandemic. Qualitatively, these results match some of the properties seen in the pandemic, with part-time work spiking upwards and then decaying with a plateau. But in other respects, the model generates qualities that don't match what is seen in the real pandemic.

In particular, when the bonus payments are not in effect, the path of the simulation with the bonus payments immediately reverts to the same level as that of the simulation without the bonus payments. As seen in Figure **??**, the number of recipients of partial UI remained elevated in between the two periods in which the FPUC was active. This discrepancy comes from the model's assumption that a worker's job opportunity today depends on their job opportunity last period, rather than their actual employment level last period. That is, the distribution of $s'$ depends on $s$ rather than $\eta$.[10] This means that the worker's decisions don't affect the trajectory of employment opportunity, and so the distribution of states can quickly revert after the incentive to choose a lower level of employment disappears. The

[8] Recall that corresponds to a value of 0.677 in the model.

[9] $b = 0.339$ in the model.

[10] Hansen and Imrohoroğlu (1992) conceptualizes this process as an environment with something like a gig economy, where the worker chooses a job each period, and the Markov process for employment opportunity represents shocks to the demand for that occupation. Carpentry is the example used therein.

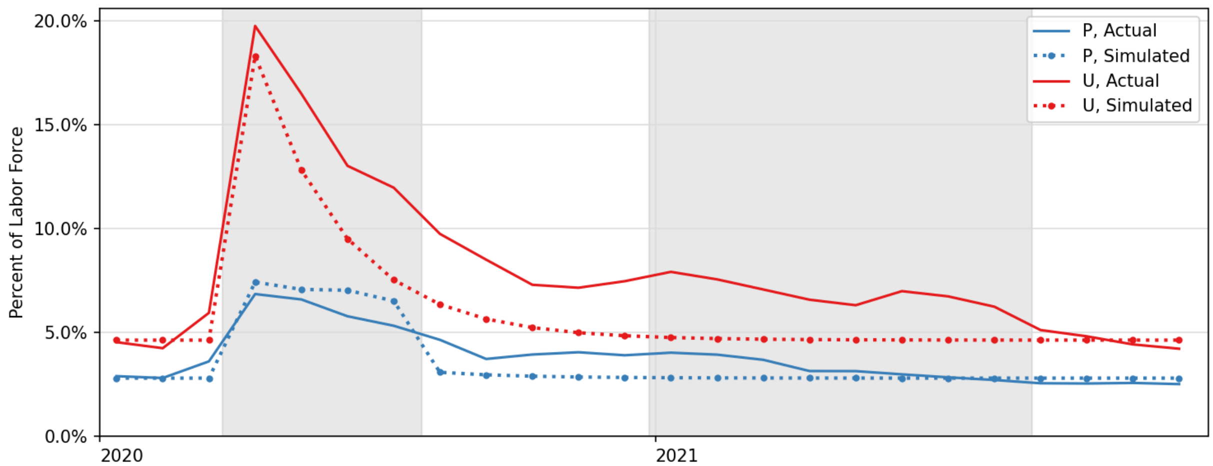


FIGURE 3
Simulated Response to Pandemic with UI bonuses.

*Note.* The solid lines depicts data from IPUMS CPS about the composition of the labor force. The dotted lines shows the simulated response to a one-period unemployment shock, followed by a sequence of elevated lump-sum bonus UI payments. The first shaded region corresponds to the time period in which there was a 600 dollar per week bonus, and the second shaded region a 300 dollar per week bonus. For this simulation, both the arrival and cessation of the bonus programs is a surprise.

persistence of UI during the interim between FPUC periods may be better simulated by a model in which employment opportunity depends on the level of employment *chosen* in the previous period.

There is no elevated response to the 300 dollar bonus. (And including a 300 dollar bonus in August or September results in no change to the path of the simulated response.) The chance of collecting those benefits simply isn't worth the risk of having lowered income without benefits, even for the lowest-productivity quintile. Increasing the chance of collecting benefits $\pi$ would increase the expected reward, potentially inducing workers to shirk during the 300 dollar bonus phase, but would also induce the response during the 600 dollar phase to be incredibly exaggerated. The appendix contains a robustness check with a slightly higher value for $\pi$ which induces a much stronger response.

## 4.7 Simulation of Dynamics with Expectations About the Program Ending.

In the previous simulation, both the arrival and cessation of the program was a surprise each time. However when the FPUC program and its extension were put into place, people were aware that it would end in a few months. The initial 600 dollar bonus lasted for four months, and the subsequent 300 dollar bonus was initially scheduled to last for three months, before being extended in March of 2021 to last until the beginning of September.

To represent worker's anticipation that the program will soon end, I modify the model to have each worker believe that there is a some fixed chance each month that the program will revert and that the bonus $b$ will return to zero. The arrival of each bonus is still a surprise. When there isn't a bonus in place, the worker's value functions are as described in Section 2.1. Let $V_0$ represent the value worker's value function when there isn't a bonus in place, and let $\delta$ be the worker's belief about the arrival rate of the return to zero bonus payments. When there is a bonus in place, then the value function is as described in Equation 8, save that the continuation value is now given by

$$cont(s, a') = \sum_{s'} \left[\chi(s, s') \cdot ((1-\delta)V(a', s') + \delta V_0(a', s'))\right] \tag{19}$$

I rerun the simulation. This time, when the 600 dollar bonus is added in the fourth month of the simulation, I set it so that workers believe that the program has a 1/4 chance of ending each period. This belief persists until the program actually does end after month seven. When the 300 dollar bonus is added in month thirteen, which corresponds to January of 2021, I initially set the belief about arrival rate of the program's end to $\delta = 1/3$, to represent the face that the bonus was initially scheduled to last into March. In month fifteen, the belief about the arrival rate of the program's end is updated to $\delta = 1/6$. The results of this simulation are depicted in Figure 4.

The response of partial employment is greatly moderated compared to the case where workers expect the bonus to last indefinitely.

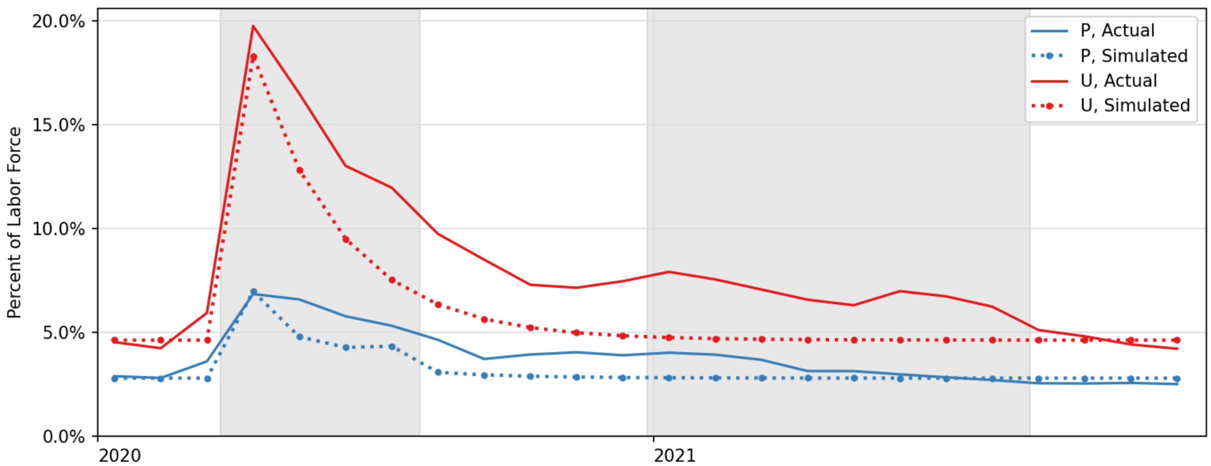


FIGURE 4
Simulated Response to Pandemic and with UI bonuses. Program End is Anticipated.

*Note.* The solid lines depicts data from IPUMS CPS about the composition of the labor force. The dotted lines shows the simulated response to a one-period unemployment shock, followed by a sequence of elevated lump-sum bonus UI payments. The first shaded region corresponds to the time period in which there was a 600 dollar per week bonus, and the second shaded region a 300 dollar per week bonus. As Figure 3, but with workers expecting the program to end. For this version of the simulation, the arrival of the bonus payments is a surprise each time, but the cessation of the benefits is anticipated.

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# Appendix

## Additional Details About Pandemic-Era Changes to the UI System

The CARES Act was a comprehensive bill which authorized a number of different fiscal programs to counteract the effects of the COVID-19 recession. The included policies ranging from large one-time lump-sum payments to individuals, to small business loans through the Paycheck Protection Program and similar, to suspension of student loan payments. Regarding the Unemployment Insurance system in particular, there are three main programs of note: Pandemic Unemployment Assistance (PUA) extended the UI system to cover additional categories of workers, such as the self-employed and gig workers, the Pandemic Emergency Unemployment Compensation (PEUC) extended the duration of eligibility for unemployment insurance benefits, and the Federal Pandemic Unemployment Compensation (FPUC), which provided lump-sum bonus payments of 600 and then later 300 dollars to all UI recipients.

Of the pandemic-era supplemental UI programs, only the FPUC is addressed in this paper. I neglect to try modeling the PUA, and the data on UI recipients in Figure 1 does not include PUA recipients. In my model of unemployment insurance, I don't model the duration and expiry of UI benefit eligibility, although doing so is a potential extension of this work.

These programs were initially authorized by the CARES Act in March of 2020, before being either renewed or extended by a number of later acts and executive actions. For the FPUC, the CARES Act authorized a 600 dollars per week UI bonus from March 20 to July 31st of 2020. An executive order authorized the payment of a 300 dollar per week bonus from August to December of that year, but those payments were inconsistently implemented, and the program ran out of funding several months early. In December of 2020, the FPUC was reinstated by law at a 300 dollar level as part of the Consolidated Appropriations Act, with the payments set to be in place from December 28th of 2020 to March 14, 2021. In early march, the American Rescue Plan Act extended the FPUC to September 6th. The time-frames for the legislatively implemented FPUC bonuses are represent by darkened backgrounds in graphs throughout this paper, and it is these dates that I use to simulate the program.

However these precise start and cutoff dates belie the consistency of the program implementation. Firstly, there were substantial delays in the implementation of the program and in the timely payment of benefits. In the year following the passing of the

CARES Act, only 5 states were able to timely pay benefits, and 6 million people waited a month or more before receiving CARES Act UI benefits (U.S. Department of Labor, 2023). I don't attempt to model these delays in benefit implementation and receipt, but they may be important to take into account in a more precise empirical analysis of the program. Secondly, 26 states opted to end the second batch of pandemic-era UI before September, with some states exiting the program as early as June 12. Once again, I don't attempt to model this aspect of the program. Coombs et al. (2022), mentioned in the introduction, exploits the cross-state variance in program cessation to estimate that the 300 dollar bonus itself had approximately zero effect on job finding rate.

## Parameterizing Transition Rates

### CPS Data

In order to get a coarse visualization of the transitions between states $E$,$P$, and $U$, I reclassified survey responses from the current population survey (CPS),[11] and calculated the probability of appearing in some employment state in a month, conditional on appearing in some other state the previous month.

I categorized workers into employment states $E, P, U$, and $NILF$ as follows. Those not in the labor force were categorized straightforwardly as $NILF$. Likewise, people classified as unemployed by the CPS' Work Status variable were categorized as U, but some nominally employed people – those who were absent from work for "other" reasons not enumerated by the CPS – were also re-categorized as $U$. As explained by the BLS,[12] a large number of CPS respondents who *should* have been classified as unemployed on layoff were instead miscategorized as employed but absent from work. This miscategorization was especially large during the first few months of the pandemic, with millions of workers on layoff being improperly categorized as employed. Note, however, the classification of employed but absent from work for unspecified reasons *is* appropriate for some workers, and so my decision to classify *all* such workers as unemployed will result in an overestimate of the unemployment rate. Cortes and Forsythe (2023) calculates a similar modified unemployment level with the additional caveat that anyone absent for "other" reasons, but who still received pay that week remains classified as employed. Although there are CPS supplements which ask absent workers whether they were paid during their

[11]CPS data was accessed via IPUMS CPS, University of Minnesota (Flood et al., 2023).

[12]See items 10-15 in the BLS article Effects of COVID-19 Pandemic on the Employment Situation News Release and Data.

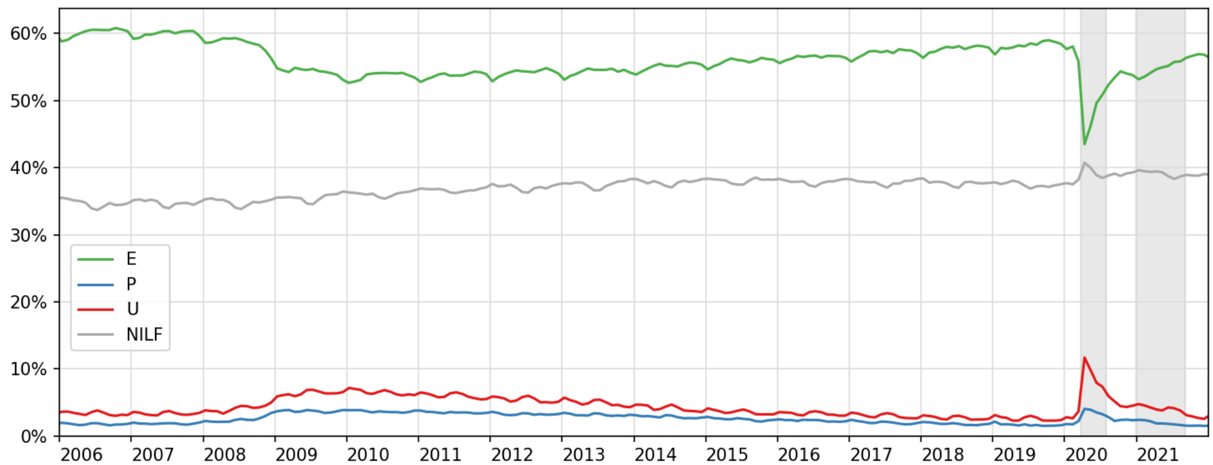


FIGURE 5
Composition of Civilian Working-age Population

*Note.* Author's calculations from CPS, not seasonally adjusted. NILF is "not in the labor force", as per usual definitions. E,P and U represent measures of the fully employed, partially employed, and unemployed, respectively. See text for details.

absence, this information isn't available in the monthly data I am using, hence the zealous reclassification.

For the $P$ category , I include only workers who are classified as working part-time for "economic reasons" according to the CPS. This means that the worker worked fewer than 35 hours during the reference week, and indicated that they want to work part-time and are available for full-time work, but had to work reduced hours due to slack work, unfavorable business conditions, etc.[13]

All other individuals were categorized as $E$. This includes people working 35 hours or more during the reference week, part-time workers who are working reduced hours because of non-economic reasons like illness or family obligations, and those with a job but who were absent from work in the reference week due to a reason enumerated by the CPS questionnaire (which likewise include reasons like illness and family obligations). Figure 5 displays the composition of the Civilian population aged 15+, once re-categorized into $E, P, U$, and $NILF$ as described above. Employment dips sharply downward in 2020, and the other categories all rise upwards.

To estimate the transition rates between these categories for each month, I restricted the sample to those individuals who appeared in both that month's and the subsequent

[13]See here for further explanation: https://www.bls.gov/cps/definitions.htm#pter


FIGURE 6
Transitions Between Employment States

*Note.* Author's calculations from CPS, not seasonally adjusted. NILF is "not in the labor force", as per usual definitions. E,P and U represent measures of the fully employed, partially employed, and unemployed, respectively. See text for details. Here, the probability of transition from X to Y in a given month is the probability that a person finds themselves in state Y the following month, conditional on being in state X this month. Each subfigure depicts the monthly transition rates out of a particular state.

month's CPS samples. This results in a sample size of between sixty thousand and one hundred thousand people each month. Using statistical weights from the earlier month, I calculated the weighted probability that the worker in one state finds themselves in each other state in the following month. Figure 6 displays these transition rates.

Looking at these monthly transition rates, the great recession is visible as a small but persistent swell in the exit rate from full employment $E$, and a similarly persistent dip in the transition rate from unemployment back to full time employment. In contrast, the pandemic results in a massive but very temporary increase in the exit rate from employment, and a decrease in the transition rate from $U$ to $E$ which is muted in both intensity and duration. Or to put it another way: the great recession made it much more difficult to find a job, while the pandemic made a lot of people lose their jobs at the same time.

Note that during both recessions, the exit rate from full employment $E$ to partial employment $P$ increased quite dramatically, but the exit rate from unemployment $U$ to partial employment $P$ seems to have changed comparatively little. There is a small momentary increase in the $U$ to $P$ transition rate from May to June of 2020, but it's difficult at a glance to distinguish this from the noise in the time series. This also seems to contradict my expectation that workers collecting expanded UI benefits might be accepting part-time jobs to continue collecting the full lump-sum bonus payments. Instead, the elevated levels of partial employment during these two recessions was driven by inflows from full-time employment. (But in the context of my model this distinction is moot. Anyone shirking to collect partial UI benefits in the model is simply someone who has a full-time employment opportunity which they turn down.)

Another thing I notice about these transitions is that the transition rate from being unemployed to being not in the labor force decreases during both recessions. The transition from being not in the labor force back to being unemployed likewise increases. There is an especially notable spike in the latter series early in the pandemic. This may be directly due to the pandemic if a large number of workers choose not to search for work in response to the risk of disease, and then began to re-enter the labor market and needed to find new jobs. But I also wonder if expanded UI benefits may encourage otherwise non-labor force workers to search for a job in order to claim benefits. Krueger and Mueller (2010) finds that the time UI recipients spend on job search is lower where UI benefits are higher. Suppose that higher UI benefits also encourage the only marginally motivated worker to enter the labor force in the first place. In that case, generous benefits would still result in lower average search effort, but with ambiguous effects on the inflows to employment. That, perhaps is a topic for future research.

Moving on, I wish to use these calculated transition rates to parameterize my model. But one obstacle I run into is that my model lacks a state for those not in the labor force. I could simply normalize each row of the transition matrix after restricting the states to $E, P$, and $U$. As demonstrated in Figure 7, this causes a distortion in the levels of unemployment traced out by following the re-normalized transition rates, compared to the levels directly calculated from the data. The simplest ad hoc solution I've found which seems to make the re-normalized matrix follow the levels more closely is to reduce the value of $\chi(s, E)$ by 0.005 and increase the value of $\chi(s, U)$ by 0.005 for each $s$.

To have a cleaner simulation in Section 4.6, I choose to represent the economy as just a single period shock instead of changing the transition rates each period. To construct the simplified simulation in Section 4.6, I need two different transition matrices – one matrix representing the baseline condition of the pre-pandemic economy and the other representing the direct effects of the pandemic itself. For the former, I take the average transition rates

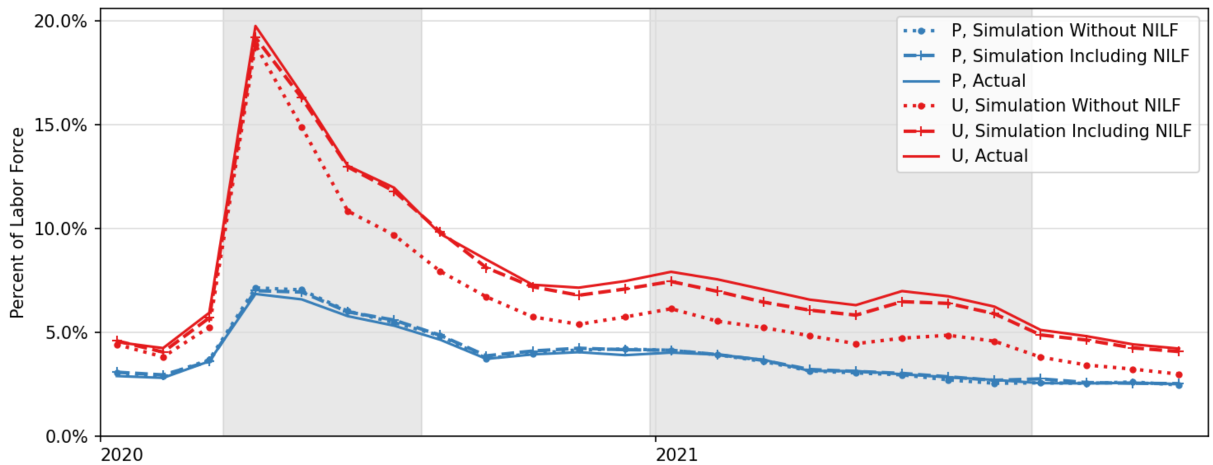


FIGURE 7
Transitions Don't Quite Match Data Without NILF

*Note.* Labor market composition and transitions are calculated from CPS data. My model is not being used for this simulation. Each period, the composition of the labor market is evolved according to the calculated transitions. The dashed lines apply the calculated transitions and then plot the resulting partial employment and unemployment levels as a percentage of the labor force. The dotted line begins at the same levels, but remove transitions to and from $NILF$ (not in the labor force).

of the 12 months leading up to the pandemic, and apply the ad hoc adjustment mentioned above. This results in the following transition matrix, used for the parameterization of my model in Section 3, which approximates the average transition rates in 2019 and early 2020.

$$\chi_{2019} = \begin{bmatrix} \chi(E,E) & \chi(E,P) & \chi(E,U) \\ \chi(P,E) & \chi(P,P) & \chi(P,U) \\ \chi(U,E) & \chi(U,P) & \chi(U,U) \end{bmatrix} = \begin{bmatrix} 0.965 & 0.017 & 0.018 \\ 0.598 & 0.343 & 0.059 \\ 0.339 & 0.057 & 0.604 \end{bmatrix}$$

The above is used for the baseline calibration. Then for the one period shock applied in my simulation, I use the transitions between March and April of 2020:

$$\chi_{shock} = \begin{bmatrix} \chi(E,E) & \chi(E,P) & \chi(E,U) \\ \chi(P,E) & \chi(P,P) & \chi(P,U) \\ \chi(U,E) & \chi(U,P) & \chi(U,U) \end{bmatrix} = \begin{bmatrix} 0.783 & 0.065 & 0.152 \\ 0.360 & 0.252 & 0.388 \\ 0.268 & 0.053 & 0.679 \end{bmatrix}$$

### Other Measures of Transition Rates

The following are some alternate metrics which are compared to the transition rates calculated above. Firstly, the Bureau of Labor Statistics publishes the rate of separations

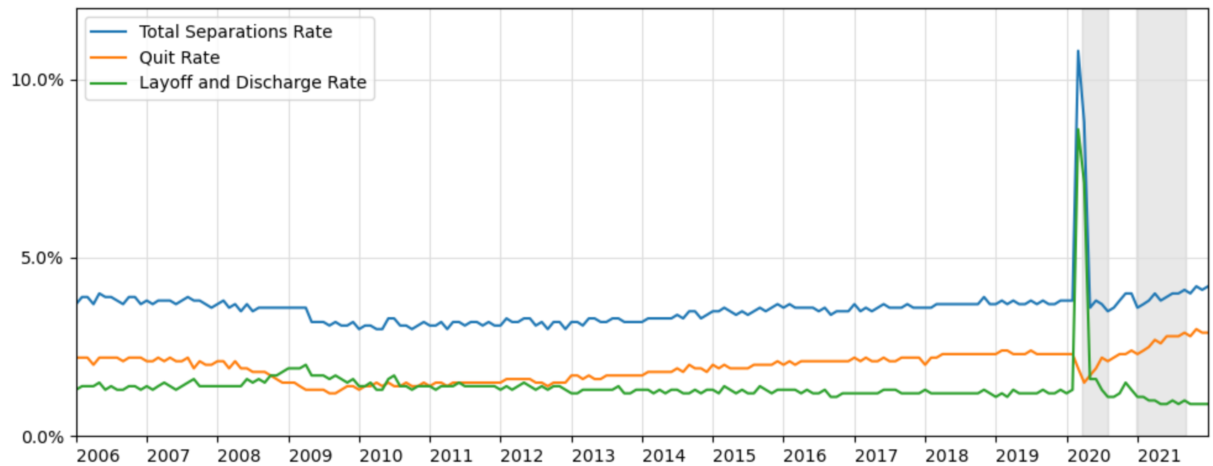


FIGURE 8
Monthly Rate of Job Separation from JOLTS.

*Note.* Data from the BLS' Job Openings and Labor Turnover Survey. Seasonally Adjusted. The denominator for these rates is the "the number of employees who worked during or received pay for the pay period that includes the 12th of the month."

from employment in the Job Openings and Labor Turnover Survey (JOLTS). These are plotted in Figure 8. In JOLTS data, the total separations rate from employment is around 4% in typical times. The monthly rate of transition between $E$ or $P$ to $U$ in the transitions calculated above is around 2%. The quit rate by itself in JOLTS is closer to the transition rate calculated above, but still a bit higher than the monthly transition rates I calculated. One potential explanation for the discrepancy is that if a worker quickly moves between two jobs – e.g. by quitting when another job is already lined up, then there would be a separation, but the worker would be employed in both months and so not be measured as transitioning. As for the spike during the pandemic, my numbers above suggest around 15% of people losing their jobs in a sharp one month peak, while the JOLTS figures have a 2-month peak for quit rates of 11% and 9% in March and April of 2020. Due to the singular nature of the event, and the potential for timing differences in data collection, this latter discrepancy is not too surprising.

Another way to measure the outflow from unemployment is described in Shimer (2012). Let $u_t$ be the level of unemployment at time $t$, and $u_t^s$ to be the level of short term unemployment. The CPS asks unemployed workers how long they have been unemployed and any with an unemployment duration of 4 or fewer weeks are termed short-term unemployed. The calculated job finding rate according to this method is then as follows,

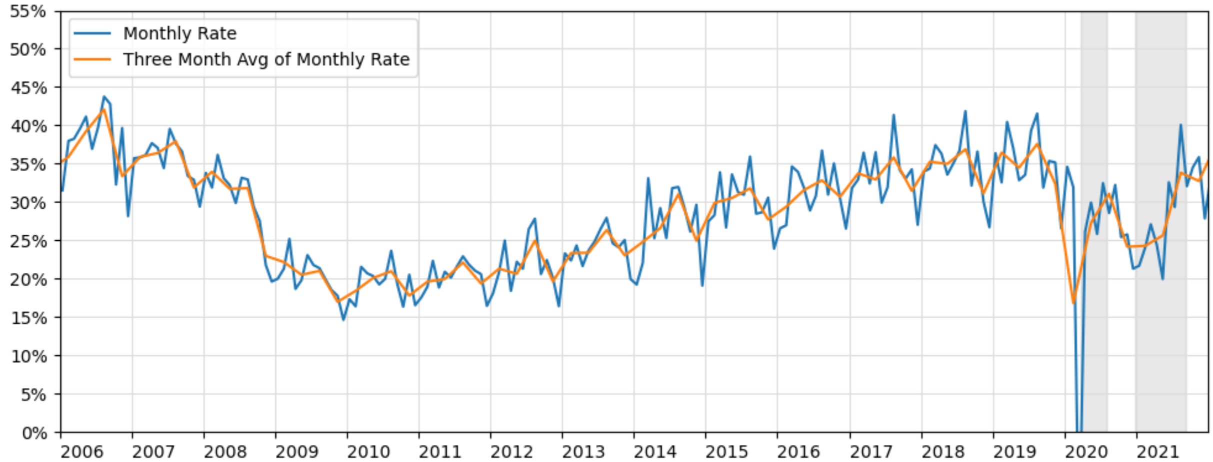


FIGURE 9
Alternate Monthly Outflow Rate from Unemployment

*Note.* Author's own calculations from IPUMS CPS Data. Using a method based on Shimer (2012).

and this value is plotted in 9.

$$F_t = 1 - \frac{u_{t+1} - u^s_{t+1}}{u_t}$$

Due to the 4-week window not perfectly matching the duration between measurement periods and to the rapid change in the labor market near the end of March, this measure as calculated has an error where the outflow between March and April of 2020 actually goes negative. Aside from this issue, this measure of outflow from employment and the one calculated above seem to follow similar trends, though at slightly different levels. If the sample were restricted to those people with back-to-back responses in the data, if the short term unemployment $u^s_t$ were redefined to be any unemployed person who was not unemployed last month, and if the absentee adjustment were made to the definition of unemployed, then this measure would become equivalent to one minus the transition rate from $U$ to $U$ which I calculated above.

## Robustness: Alternate Parameterizations

### Higher Value of $\pi$

In Section 4.6, I had $\pi$ calibrated to 0.12. This resulted in an induced response in the level of partially employed workers which was slightly too high during the period with 600 dollar bonuses, but completely flat during the period with 300 dollar bonuses.

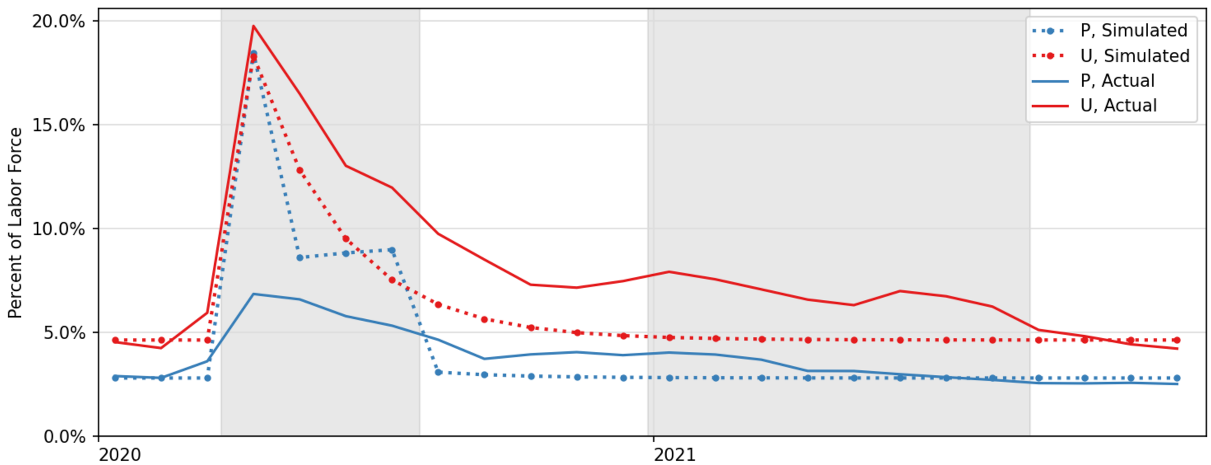


FIGURE 10
Simulated Response to Pandemic with UI bonuses with $\pi = 0.13$.

*Note.* The solid lines depicts data from IPUMS CPS about the composition of the labor force. The dotted lines shows the simulated response to a one-period unemployment shock, followed by a sequence of elevated lump-sum bonus UI payments. The first shaded region corresponds to the time period in which there was a 600 dollar per week bonus, and the second shaded region a 300 dollar per week bonus. For this simulation, both the arrival and cessation of the bonus programs is a surprise.

Raise the chance of collecting bonuses when shirking just a small amount to $\pi = 0.13$, and the simulated response, depicted in Figure 10, has a drastically different behavioral response. Now nearly 20% of the population chooses partial employment during the period with a 600 dollar bonus. This is because the entire first quintile, save for those who have no employment opportunity, choose partial employment. Thereafter, the response plateaus at a lower level for the remainder of the 600 dollar bonus period.

The underlying issue has to do with my implementation of the worker heterogeneity. There are five discrete types of workers, and in static equilibrium, as discussed in Section 4.1, most of the workers within each quintile concentrate at a single level of asset holdings. The simulation begins already in a stationary equilibrium, and so when the initial shock hits, there are large singleton masses of individuals who will have the same behavioral response. The results in the threshold effect seen when raising $\pi$ from 0.12 to 0.13. At the lower level of $\pi$, that mass of workers in the same state doesn't wish to shirk, and then at the slightly higher level, they do, and so nearly a fifth of the population responds in the same way. A modification to the model to represent income heterogeneity in a more continuous manner may be able to induce a smoother gradation of behavioral responses.