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Unemployment Insurance Take-up Rates in an Equilibrium Search Model *

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Abstract

In the US unemployment insurance (UI) system, only a fraction of those eligible for benefits actually collect them. We estimate this fraction using CPS data and detailed state-level eligibility criteria. It averaged 77% from $1989-2012$ and is negatively correlated with the unemployment rate. These empirical facts are explained in an equilibrium search model where firms finance UI benefits and are heterogeneous with respect to their specific tax rate, which is experience rated. In equilibrium, low tax firms effectively offer workers an alternative UI scheme featuring a faster job arrival rate and a higher wage offer. Some eligible workers prefer the "market" scheme and thus do not collect UI. The model captures the negative correlation between the take-up and unemployment rate. If all eligible unemployed collect, benefit expenditures increase by 16% and welfare increases. Average search effort decreases, but the unemployment rate and duration decrease as vacancy creation increases.

Keywords: unemployment insurance, take-up, matching frictions, search
JEL classification: E61, J32, J64, J65

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1 Introduction

The unemployed *not* collecting benefits they are eligible for may represent the most important issue in the U.S. unemployment insurance system. The existing literature on UI has focused primarily on incentive problems, such as moral hazard, and recently on the effects of UI benefit extension programs (e.g. Nakajima (2012)). In the U.S., from 1989 – 2011, UI fraud and benefit extensions amounted to 2.4% and 13% of total benefit expenditures on average, respectively.[1] According to our analysis, the "unclaimed" benefits from eligible unemployed not collecting benefits amounts to more than the *combined* expenditures on UI fraud and benefit extensions. Our contribution includes a calculation of the fraction of eligible unemployed collecting UI (hereafter "take-up rate"), an equilibrium theory to explain the take-up decision, and an exploration of the implications of unclaimed benefits.

Traditional theories of the take-up decision assume an explicit application cost. It could be the specifics of the administrative procedures, or lack of anonymity, i.e. a "stigma" attached to collecting benefits. For example, the quantitative analyses of U.S. take-up rates in Blank and Card (1991) and Anderson and Meyer (1997) propose such costs, as well as Blasco and Fontaine (2009) who examine the take-up issue in the French UI system.

Our calculation of the take-up rate uses Current Population Survey (CPS) data along with detailed, state-level eligibility criteria. From 1989 – 2012, the take-up rate averaged 77%. These calculations also yield the following two facts. First, the take-up rate has remained relatively constant since 1989, actually decreasing from 2006 – 2012. Second, it is *negatively* correlated with the unemployment rate. While the traditional theories certainly account for some aspects of the

[1] UI fraud includes issues such as concealed earnings, insufficient job search, job offer refusals, and quits, among others. See Fuller, Ravikumar, and Zhang (2013) for further details on the issue of UI fraud.

take-up decision, they are inconsistent with the data on two dimensions.

First, application costs in the U.S. have decreased over time, with no noticeable changes in benefit generosity. For example, in 1988, 94% of initial unemployment insurance claims were filed in person, while in 2011, 85% were filed via phone and internet (see Figures 1(a)-1(b) for details). According to the traditional theory, one expects to observe a corresponding increase in the take-up rate, which has instead remained relatively constant. Second, the traditional theory (with a fixed utility cost of collecting UI) predicts a positive correlation between the take-up and unemployment rate.

We develop an alternative theory based on the equilibrium interaction between workers and firms. In equilibrium, the market effectively offers the worker two possible unemployment insurance schemes. The first is determined by the government, but financed by firms. It offers relatively high consumption smoothing during the unemployment spell. The second scheme is offered by certain firms in equilibrium. This scheme does not directly provide consumption insurance while unemployed, but offers a faster job arrival rate and a higher wage offer when one arrives.

The take-up decision is captured using a search model with matching frictions, in the class considered by Pissarides (2000). Workers are risk averse, heterogenous in productivity, and exert variable search effort looking for a job. Firms post vacancies and search/advertise for workers to fill them. Incorporating heterogenous firms paying different taxes to finance unemployment benefits is a key feature of the model. This feature captures the "experience rating" in the U.S. system, where a firms' tax rate depends on the "experience" it has sending workers to collect unemployment benefits. Since firms finance the benefits of their workers, their costs are reduced when fewer workers collect benefits.

In our model, the cost of collecting unemployment benefits is endogenously determined by firm and worker decisions. The economy is segmented into two markets, one for workers who collect benefits and one for those who do not. If separated, workers decide whether or not to collect benefits. Firms in the market with collectors have a higher tax rate, and as a result open fewer vacancies. In equilibrium, workers choosing to search in the non-collecting market receive job offers more frequently relative to those in the collecting market. Wages are determined by Nash Bargaining, and given the experience rated taxes, workers collecting benefits receive lower wage offers relative to an equivalent worker who does not collect.

The unemployment benefits in our model represent a stylized version of the US system. Workers receive a constant fraction of their previous wage, up to a maximum benefit amount. We also allow for a "two-tiered" benefit system, similar to Fredriksson and Holmund (2001) and Albrecht and Vroman (2005), where with a Poisson arrival rate a worker collecting benefits may lose them.

The quantitative analysis presents two counterfactual experiments. The first examines the correlation between the take-up and unemployment rate. Specifically, it examines the effects of an increase in productivity that reduces the steady state unemployment rate. The experiment takes place in two economies: the baseline model and an alternative model with a fixed flow utility cost of collecting UI benefits. In the baseline model, when the unemployment rate decreases from 6.0% to 5.0%, the take-up rate increases from 77% to 79%. In contrast, the standard theory model (i.e. fixed cost of collecting) predicts a positive correlation; the take-up rate decreases from 77% to 68%.

Since the costs of collecting benefits in the baseline model are endogenously determined in equilibrium, they change when productivity changes. The increase in productivity reduces the gap in arrival rates for collectors relative to non-collectors. Moreover, the wage gain for non-collectors decreases. Thus, the costs of collecting benefits decrease, inducing more workers to collect UI.

The second counterfactual experiment asks the question: "What happens if all eligible unemployed collect benefits?" To answer it, suppose that there exists only one market for all workers and that firm taxes are no longer experience rated. In this model the take-up rate goes to 100% as the market UI scheme is no longer offered. The move to 100% take-up has several interesting implications.

First, total benefit expenditures increase by 16%. Second, there is also an impact on key equilibrium variables. The unemployment rate decreases from 6.0% in the baseline model (the average unemployment rate during the 1989−2012 period) to 5.47%. Moreover the average duration of unemployment decreases from 18 to 15 weeks. The existing literature analyzing the effects of unemployment benefits on these moments predicts a much different result. More unemployed workers collecting benefits implies reduced search effort, a higher unemployment rate, and a higher average duration of unemployment.

While indeed search effort decreases on average, there is more variation in search effort across the higher levels of productivity. This changes the endogenous distribution of agents, and firms are more frequently match with relatively high productivity workers. The expected value of a vacancy increases, and free-entry implies that vacancy creation increases, decreasing the unemployment rate.

Finally, the move to a 100% take-up rate increases welfare by around 0.40% in consumption equivalent terms. Overall, our results suggest that including an endogenously determined take-up rate represents an essential aspect of understanding the implications of UI in labor market models.

The remainder of the paper proceeds as follows. In Section 2 we present the data, our procedure for estimating the take-up rate, and provide a discussion of how the data supports our modeling choices. Section 3 describes the model, and Section 4 presents the calibration. Section 5 presents the counterfactual experiments. Finally, we conclude in Section 6.

"I did not want to do this as I did not want the negative impression of the VEC (Virginia Employment Commission) checking with employers while they were considering my application. I did not want the risk of seeming like a bad candidate and hurting my chances of being accepted."

Matthew Egerton on why he did not collect UI benefits, Huffington Post, December 2012

2 Evidence on take-up rates

This section has three objectives. First, a description of key features of the U.S. unemployment insurance system relevant for our analysis. Second, a presentation of data that support our attempt to model alternative costs of collecting unemployment benefits. Third, a description of our take-up rate estimation and exploration of its key features.

2.1 Unemployment Insurance System in the U.S.

The costs imposed on firms by workers who collect benefits represents the key element of our theory. The specifics of the U.S. unemployment insurance system help illuminate these costs, which arise from the administrative procedures related to a worker who files a claim for benefits, and the tax rates imposed on firms to finance the benefits.

When a worker files a claim for unemployment benefits, the UI authority in that U.S. state contacts the worker's previous employer(s) to verify the relevant information. For example, they verify the worker's wages to determine eligibility and calculate the proper benefit amount. They also have to verify that the nature of the separation is proper, since certain separations render the worker ineligible for benefits (we discuss these criteria below in Section 2.3.1). When disagreements between the worker and the firm arise, the case may move to the legal system to resolve the dispute. Thus, even before paying taxes, the administrative costs related to a worker filing a claim for benefits may be substantial.

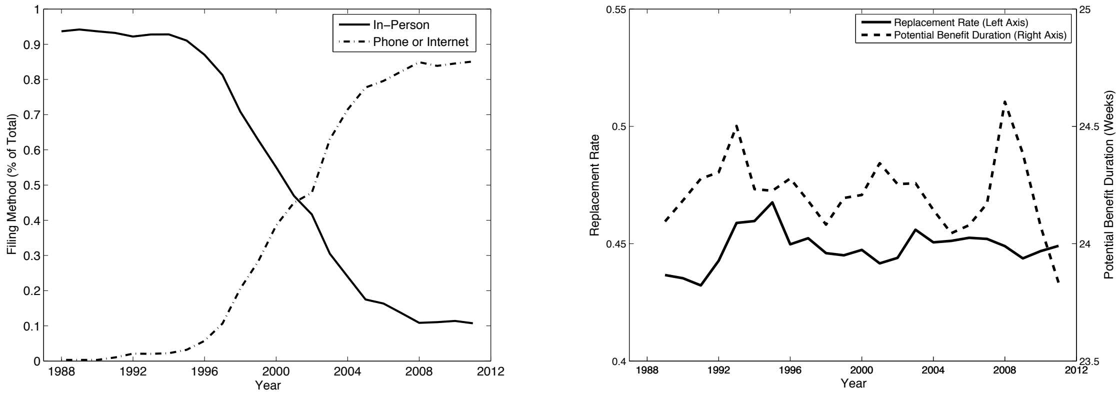
The tax levied on firms to finance benefits is experienced rated. Firms pay a tax rate that is positively correlated with their contribution to *insured* unemployment in their particular U.S. state. For example, a firm that has never separated from a worker who collects benefits pays a lower tax rate than a firm that has frequent layoffs collecting benefits. Note, for the firm's tax rate, it does not matter how frequently they separate from workers, but how frequently they separate from workers who collect benefits.

The precise nature of this experience rating depends on the U.S. state, with both the tax rates and the taxable wage base varying across states. In 2010 for example, the smallest taxable wage base was \$7000 (several states) and the maximum was $\$37,300$ in Washington. The experience rated tax rates are also subject to maximum and minimum amounts. In 2010 the lowest minimum tax rate was 0% (several states) and the highest maximum rate was 13.5576% in Pennsylvania.[2]

2.2 Filing methods for initial claims

If there do exist explicit costs to applying for unemployment benefits, these should manifest themselves in the specifics of the application process. Examining data on the initial filing method represents one way to determine how the costs to applying may have changed over time. Such data is available from a program called BAM (Benefit Accuracy Measurement) run by the U.S. Department of Labor. BAM selects a random sample of UI recipients/applicants and audits each case to examine the accuracy of paid claims, as well as the appropriateness of any benefit denials.

[2] Given the maximum and minimum tax rates, the experience rating is "partial." That is, there exists some cross subsidization across certain firms/industries. Topel (1983) and Wang and Williamson (2002) examine some of the effects of this "partial" experience rating.



(a) Filing Methods (b) Benefit Generosity

Figure 1: UI Filing Methods and Benefit Generosity

The 2.4% fraud rate cited in the introduction is calculated from this data set. It represents the total dollar amount of fraudulent benefits collected as a fraction of total benefit expenditures.

In Figure 1(a), we present the data on the initial filing method, from $1988-2011$ (the only years for which the BAM data is available). There exist five possible initial filing methods. These include, in person, mail (including e-mail), telephone, employer filed claim, and internet claim. Figure 1(a) plots the fraction of agents who file in person, compared to the fraction filing by phone and/or internet.[3] The graph indicates that there has been a large shift in how unemployment benefit applications are filed in the U.S.; since 2000, in person claims and phone and internet claims have switched as the dominant method.

This change has almost certainly had an effect on the explicit application costs of applying for UI. First, since an in person application is typically no longer required, at a minimum, the time associated with filing a claim has been dramatically reduced. Second, applying via phone or internet makes the process more anonymous, which reduces any negative stigma associated with

[3]The other filing methods account for a small fraction of the total. Moreover, prior to 2002, there were no internet claims observed, so this represents a recent phenomenon.

applying for benefits.

One could also argue that although application costs have decreased, benefits may be less generous. In Figure 1(b) we plot the average replacement ratio (left axis) and the average potential benefit duration (right axis) over time. We calculate the replacement rate and potential benefit duration from observations in the BAM sample. For the replacement rate, we take the weekly benefit amount divided by weekly wages. Note, since these are observed replacement rates, they often differ from the traditional 50% replacement rate. This occurs given various deductions available, and the maximum benefit amount, which binds for high income recipients. In addition, each state has unique rules for determining the replacement rate. We calculate the potential benefit duration using the weekly benefit amount and the total dollar amount of benefits the worker is entitled to. Note, this data refers to regular program benefits, and thus the potential duration excludes any extended benefits. There is some cyclical behavior, but otherwise it appears the generosity of the US system has been relatively constant from $1988-2011$.[4]

Overall, it appears that the administrative costs of the UI system fall primarily on the firm, not the worker. Given these facts, if indeed explicit application costs explain the majority of the take-up decision, we should observe an increase in the take-up rate as these costs have clearly decreased, with no change in benefit generosity. We argue that outside of cyclical variations, the take-up rate has remained relatively constant, and below we present the details of our calculations.

[4]Our estimates of the replacement rate do not include the taxation of benefits. Since 1979, UI benefits are considered taxable income. Anderson and Meyer (1997) show that this taxation reduces the after-tax replacement rate, and they further show this change may have had an impact on the take-up rate at this time. To the best of our knowledge, there have not been any significant changes in the taxation of UI benefits during the $1988-2011$ period we plot.

2.3 Take-up rate estimates

While many statistics and data on the labor market are readily available for public use, there exists little information on take-up rates of unemployment insurance. There is data on the characteristics of the insured unemployed (those collecting benefits), as well as data on the ratio of insured unemployed to total unemployed (hereafter IUR). While this provides some characterization of the take-up rate, the IUR does not control for eligibility. That is, many of the unemployed are not eligible to collect benefits. To calculate the *take-up rate*, we first find the fraction of unemployed agents who are currently eligible to collect, and then take the ratio to insured unemployed to *eligible* unemployed.

We follow a method similar to Blank and Card (1991). Specifically, we start with IUR data, which refers to those collecting "Regular Program" benefits. These are the 26 weeks of benefits primarily financed by each state, and exclude any extended benefit programs financed by the state or federal government. We use the IUR series tabulated by the U.S. Department of Labor, which can be found at: `http://workforcesecurity.doleta.gov/unemploy/chartbook.asp`. For 2012, since the IUR is not yet available from this source, we use the weekly claims data series from the U.S. Department of Labor, which contains the total number of regular program insured unemployed (including new and continued claims). We divide this number of regular program insured by the total unemployed to obtain the IUR for 2012.

To determine the fraction of unemployed eligible for regular program benefits, we use data from the March Supplement of the CPS, along with the specific eligibility criteria of each state, for each year from 1989 – 2012.[5] The take-up rate is calculated as the ratio of the IUR to the Fraction of Unemployed Eligible. Figure 2 displays the IUR, our estimate of the take-up rate, and

[5] Blank and Card (1991) and Anderson and Meyer (1997) provide estimates of the take-up rate prior to 1989.

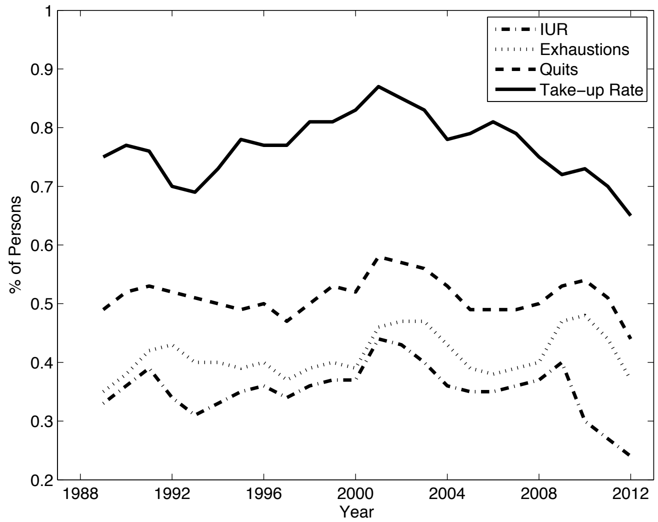


Figure 2: Take-up Rates by Eligibility Criteria Over Time

The bottom line labeled "IUR" is the ratio of insured unemployed to total unemployed. As the lines progress, unemployed individuals are eliminated from the denominator based on different eligibility criteria. "Exhaustions" removes to those ineligible because they exhausted their benefits and "Quits" removes those who are ineligible because they quit the job. The jump from the "Quits" line to the "Take-up Rate" line occurs when those unemployed who are ineligible because they do not meet the monetary requirements are removed. Thus, the "Take-up Rate" line plots the fraction of eligible unemployed collecting benefits.

a decomposition of the different eligibility criteria.

2.3.1 Eligibility Criteria

Eligibility depends primarily on three factors, all of which are determined at the state level. First, as mentioned above, there is a fixed duration that an individual may collect benefits for. In the majority of states, regular program benefits have a potential duration of 26 weeks. In all of the years studied, Massachusetts and Washington have a maximum potential benefit duration of 30 weeks. Beginning in 2004, Montana has a maximum potential benefit duration of 28 weeks. Again, these potential durations refer to the *Regular Program* benefits, and thus exclude any extended benefit programs. Of course, being unemployed for longer than 26 weeks does not necessarily make an individual ineligible. The key issue is whether or not the individual exhausted their regular program benefits.

To control for this eligibility criteria, we use the information in the March CPS about whether an individual collected benefits in the previous year or not. If an individual is unemployed in March of a given year and has expired regular program benefits, then they have been unemployed for longer than 26 weeks (accounting for differences in Massachusetts, Washington, and Montana where applicable) and must have collected benefits in the previous year.[6] We eliminate such individuals as ineligible. In addition to the maximum length of benefits, many states also have a minimum waiting period, typically 1 week, and we control for this criteria where applicable.

In Figure 2 we plot the take-up rate along with a decomposition of the three eligibility criteria. The line labeled "IUR" is the ratio of insured unemployed to total unemployed. As the lines progress, we remove some unemployed individuals from the denominator (total unemployed) until we reach the number of unemployed eligible for benefits.

The line labeled "Exhaustions" removes from the total unemployed those who have exhausted their benefits. On average, over the period from 1989 – 2012, 11% of those ineligible for benefits were deemed to have exhausted benefits.[7] As expected, this criteria has a cyclical contribution, with more individuals exhausting benefits during periods of high unemployment. For example, in 2010, 31% of those ineligible were due to exhausted benefits.

The nature of the separation leading to the spell of unemployment represents the second element of eligibility criteria. Specifically, in most states, agents who quit their previous job, or were fired for cause, are not eligible to collect benefits. Georgia is an exception, and does allow job leavers (quits) to collect benefits, but they face an increased waiting period before eligible. This criteria

[6]In some states, certain individuals may have potential benefit durations less than 26 weeks, depending on their particular circumstances. The most common potential duration, however, is 26 weeks.

[7]Note, this fraction will not match with the BLS series calculating the fraction of collectors who exhaust benefits, but is strongly correlated with it. What we measure are those individuals who exhaust benefits *and* are still unemployed as of March in that year. This fraction is necessarily below the fraction that exhaust benefits.

is intended to limit benefits to only those individuals who have lost their job through no fault of their own. In the CPS data, we can eliminate quits; however, we cannot determine whether or not the agent was fired for cause. We also use information on an individual's industry to focus only on covered employment. As in Blank and Card (1991), we eliminate postal workers, federal public administration workers, and ex-service persons. In Figure 2, the line labeled "Quits" shows the contribution of this eligibility criteria. On average, 19% were ineligible because they quit their previous job.

Finally, there exist monetary eligibility requirements. These require an agent to have accumulated a sufficient amount of earnings in a specified "base-period," or worked a minimum number of weeks.[8] To estimate monetary eligibility, we use the earnings information contained in the March CPS, along with the state-level monetary eligibility requirements. Such monetary requirements vary significantly across states.

There are several different varieties of monetary eligibility. Perhaps the most standard is to require base period wages that exceed some multiple of the weekly benefit amount. The weekly benefit amount (WBA) is the benefit the worker would be entitled to, which is based on these previous earnings. For example, in 1989, Colorado required base period wages to exceed 40 times the WBA. Determining eligibility with this type of criteria also requires estimating the WBA for the individual; each state also has specific rules determining the WBA given earnings. As another example, in 1989, California required base period earnings of at least $1,200.

High Quarter Earnings (HQE) represents an important object for monetary eligibility in some states. This also represents a drawback to using the March CPS earnings information (Blank and Card (1991) also discuss these drawbacks). Since it only details earnings during the previous year, HQE

[8] The base-period differs across states. Many use a year, while others use two quarters. The base-period is used both to determine monetary eligibility and to calculate the specific benefit an agent is entitled to.

cannot be determined. In some states, eligibility is based on earnings outside of the HQE. For example, in 1989, Georgia required base period earnings greater than 1.5 times the HQE. In such cases, we are unable to determine monetary eligibility.[9]

In Figure 2, moving from the "Quits" line to the take-up rate displays the contribution of monetary requirements to the number of unemployed deemed ineligible for benefits. On average, 71% of those deemed ineligible failed to satisfy their state's monetary eligibility requirements.

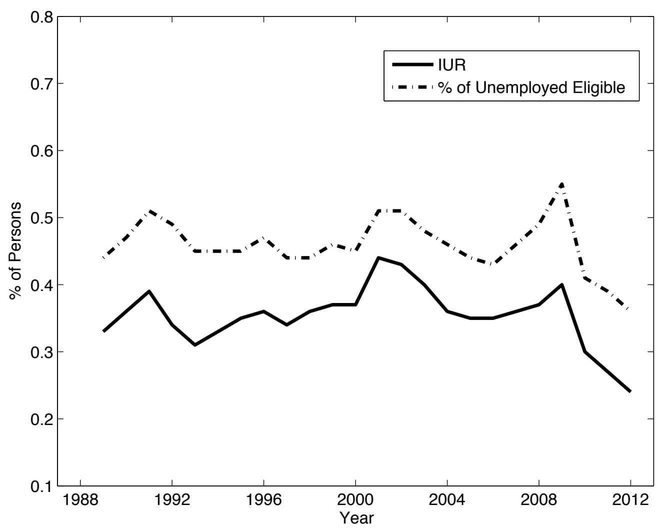


Figure 3: Insured Unemployed and Fraction of Unemployed Eligible

Figure 3 plots the IUR and the fraction of unemployed eligible for benefits. When the two lines move closer together, the take-up rate increases, and it decreases when the lines diverge. The Fraction of Unemployed Eligible for benefits displays a similar cyclical pattern to the IUR.

[9]Using weeks worked represents one possible way to proxy for this type of eligibility. For example, in the case of Georgia above, we could require total weeks worked in the previous year to exceed 19.5 ($1.5 * 13$). This assumes constant earnings over the year, and simply requires the individual to have worked more than one quarter. We have implemented this alternative and it has a negligible impact on the fraction of unemployed eligible for benefits.

2.3.2 Features of Take-up Rate

There are several interesting features of the take-up rate estimates displayed in Figure 2. First, the take-up rate is persistently below one. Second, it appears to be negatively correlated with the unemployment rate. Figure 4 plots the take-up rate (left axis) and the unemployment rate (right axis) from $1989-2012$. The take-up increases during the period from $1996-2002$, when the lowest unemployment rates during the period we study are observed. However, the take-up rate has declined since 2006, as the unemployment rate reached the highest levels in the period of study. Plotting the take-up rate and the average duration of unemployment produces a similar pattern.

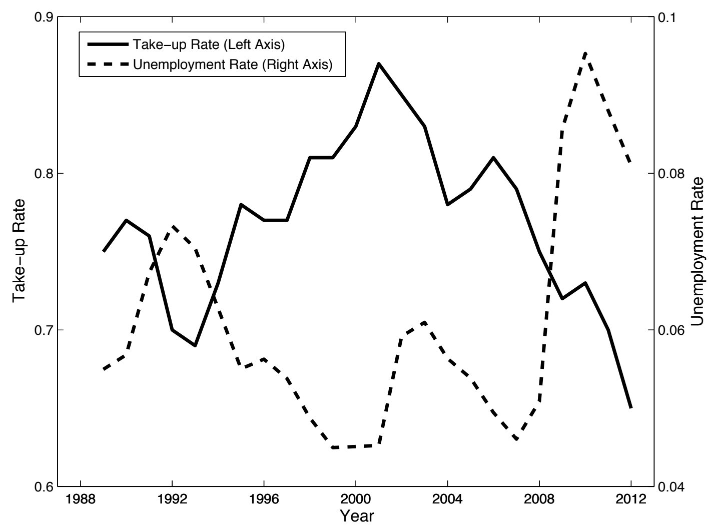


Figure 4: Take-up and Unemployment Rates

The take-up rate estimates in Blank and Card (1991) display the same cyclical pattern. For example, from $1989-2012$, we find a correlation between the take-up and unemployment rates of -0.73. The take-up rates in Blank and Card (1991), which cover $1977-1987$, imply a correlation of -0.36.

According to the standard theory of take-up rates, the take-up and unemployment rate should be positively correlated; periods of high unemployment and unemployment durations increase the expected benefits of collecting relative to the costs. In our equilibrium theory, however, this need not be the case. While in periods of high unemployment the expected benefits of collecting indeed increase, the costs to firms do as well. More workers collecting benefits (with a higher expected duration of collection) implies higher tax bills for firms, as well as changes in worker decisions. Such equilibrium interaction between workers and firms may in fact explain the cyclicality of the take-up rate observed in Figure 4. Indeed, our analysis in Section 5.1 predicts precisely this relationship between the take-up and unemployment rate.

The data presented in this section highlight the key features of the take-up rate from 1989−2012. Our estimates have several interesting features that highlight the need to analyze the take-up rate in a model where it is endogenously determined by *both* worker and firm decisions.

3 Model

3.1 Setup

The economy consists of a unit-measure of infinitely-lived, risk-averse agents, and a large measure of risk-neutral firms. Time is continuous and goes on forever, and both agents and firms discount the future at rate $r > 0$. Each agent has an endowment of one unit of time. Agents have preferences over consumption and leisure, with flow utility given by $h(c, \ell)$, where c represents consumption and ℓ is leisure. Let h_c and h_ℓ denote the partial derivatives of h with respect to its first and second arguments, respectively.

Agents are heterogenous with respect to their permanent productivity y. Let $\mathbf{Y}$ denote the set of all productivity levels, and F the distribution of agents over $\mathbf{Y}$. Firms are composed of a single job, either filled or vacant, and discount future profits at rate r. Vacant firms are free to enter and pay a flow cost, $\kappa > 0$, to advertise a vacancy. Vacant firms produce no output. The flow output of a firm with a filled job is given by productivity of its employee y.

Workers vary the intensity with which they search for a match. Specifically, an unemployed worker exerts search effort $s \in [0, 1]$ looking for a firm; therefore, leisure is $\ell = 1 - s$. While employed, a worker supplies labor inelastically, spending s_w hours of the time endowment working.

Unemployment benefits are financed by lump-sum taxes levied on firms. These taxes are experienced rated in the following manner. All firms contribute taxes, but firms that hire workers who collect benefits pay higher taxes relative to firms that hire agents who do not collect benefits. We model this feature by segmenting the labor market into two "types" of firms: firms that hire collectors and firms that do not. Since ultimately the decision to collect or not depends on the worker's permanent productivity, a collector works and searches in that sector for life.[10] Denote by $j \in \{1, 3\}$ the two sectors, where $j = 1$ refers to the market for collectors and $j = 3$ the market for non-collectors.

An alternative to assuming segmented markets is to assume homogenous firms and vacancies, but allow the firm to vary its advertising intensity searching for collectors vs. non-collectors. We used this approach in an earlier version of the paper. This does not affect the results, but assuming segmented markets allows the key mechanisms to be more transparent.

There exists a matching function describing the number of matches formed between the v vacancies and u unemployed workers in each of the two sectors of the economy. Denote the average search intensity of the unemployed in sector $j \in \{1, 3\}$ by $\bar{s}_j$. Further let $S_j \equiv \bar{s}_j u_j$ denote the

[10] Allowing for idiosyncratic productivity (i.e. match specific productivity) represents one alternative. In this case, however, the computational burden of the model increases significantly. Specifically, all firms hire some workers who eventually collect UI benefits. Calculating the firm's tax rate thus requires tracking which agents collect in specific periods, and which do not. To maintain a tractable environment, we use the assumption of permanent productivity.

"efficiency units" of the unemployed workers searching in sector j.

The matching function is given by $m(S, \mathrm{v})$, which gives the number of matches between the S efficiency units of unemployed searchers and v vacancies. We assume standard properties, i.e. m is continuous, strictly increasing, strictly concave (with respect to each of its arguments), and exhibits constant returns to scale. Furthermore, $m(0, \cdot) = m(\cdot, 0) = 0$ and $m(\infty, \cdot) = m(\cdot, \infty) = \infty$. Let $\theta_j = \dfrac{\mathrm{v}_j}{u_j}$ denote the vacancy to unemployment ratio in sector $j \in \{1, 3\}$.

Given this matching technology, a vacancy in market j is filled with Poisson arrival rate $m(S_j/\mathrm{v}_j, 1)$. Similarly, an unemployed worker in market j with search intensity $s_j(y)$ finds a job according to a Poisson process with arrival rate $s_j(y)m(1, \mathrm{v}_j/S_j)$. Let $q_j = m(S_j/\mathrm{v}_j, 1)$ and $p_j = m(1, \mathrm{v}_j/S_j)$ denote the vacancy filling and job finding rates, respectively. Filled jobs receive negative idiosyncratic productivity shocks rendering the match unprofitable with a Poisson arrival rate λ.

Given the aforementioned technology, matching is random. When a firm meets a worker and a vacancy is filled, it is filled by a worker drawn randomly from the population. The firm does not direct its search. Since search intensity is variable and endogenous, however, the population of unemployed agents across y is endogenous. Thus, the probability that upon meeting, a firm randomly matches with a worker of productivity y, is endogenously determined in equilibrium.

3.2 Value functions and wage determination

Unemployed agents can be in one of three possible states. The states are differentiated based on whether or not the agent collects unemployment benefits. First, upon being separated from an employer, the agent decides whether to enter unemployment state $i = 1$ or $i = 3$, where $i = 1$ denotes unemployed collecting benefits, while $i = 3$ denotes unemployed not collecting benefits.

That is, the worker decides which sector of the economy to search in. Finally, if collecting benefits, we assume that with Poisson arrival rate δ, benefit eligibility ends, and the agent enters state $i = 2$. This feature captures the empirical fact that in the U.S., unemployment benefits are paid for a fixed period of time, while maintaining a stationary environment. Let $u_i(y)$ denote the number of unemployed workers of productivity y in state $i \in \{1, 2, 3\}$, and $e_j(y)$ the total number of employed workers of productivity y working in market $j \in \{1, 3\}$.

3.2.1 Workers

Let $U_i(y)$ denote the expected value of searching for a job to an unemployed worker of productivity y, in state $i \in \{1, 2, 3\}$. Let $W(y)$ denote the expected lifetime utility of employment to a worker of productivity y. Below, $z_i(y)$ denotes the flow income/consumption of an unemployed worker in state $i \in \{1, 2, 3\}$, and $w(y)$ denotes the wage. Wages are determined via Nash Bargaining between the worker and firm. In equilibrium there exists a one-to-one mapping of productivity to wages. Given this, the value functions are given by:

$$rU_1(y) = \max_s \{h(z_1(y), 1 - s) + p_1 s (W(y) - U_1(y)) + \delta (U_2(y) - U_1(y))\}, \tag{1}$$

$$rU_2(y) = \max_s \{h(z_2(y), 1 - s) + p_1 s (W(y) - U_2(y))\}, \tag{2}$$

$$rU_3(y) = \max_s \{h(z_3(y), 1 - s) + p_3 s (W(y) - U_3(y))\}, \tag{3}$$

$$rW(y) = h(w(y), 1 - s_w) + \lambda (\max\{U_1(y), U_3(y)\} - W(y)). \tag{4}$$

Equation (1) says that an unemployed agent collecting benefits receives instantaneous flow utility $h(z_1(y), 1 - s)$ from unemployment compensation and the utility cost of search effort s. With arrival rate $p_1 s$ the worker matches with a firm and transitions to employment, while at rate δ unemployment benefits expire, and the agent transitions to state $i = 2$. Equations (2) and (3) have similar interpretations for an agent who has exhausted benefits and one who does not collect, respectively. Finally, equation (4) states that, given the productivity-specific wage $w(y)$, an employed agent receives instantaneous flow utility $h(w(y), 1 - s_w)$. With Poisson arrival rate λ, the job dissolves and the agent then decides whether or not to collect unemployment benefits. Notice, since productivity is permanent, in the steady state, if a worker prefers to enter sector $j \in \{1, 3\}$ he always prefers this sector. Thus, there are effectively two employed value functions, each with a distinct wage function, $w_j(y)$:

$$rW_1(y) = h(w_1(y), 1 - s_w) + \lambda \left(U_1(y) - W_1(y)\right), \tag{5}$$

$$rW_3(y) = h(w_3(y), 1 - s_w) + \lambda \left(U_3(y) - W_3(y)\right). \tag{6}$$

Indeed, in equilibrium, workers in sector $j = 3$ (i.e. non-collectors) receive higher wages for a given y than workers in sector $j = 1$ (collectors). This represents one aspect of the market UI scheme.

The flow income of an unemployed worker collecting benefits is modelled using the key features of the U.S. system. This system involves payments that are a constant fraction of the previous wage, for a fixed length of time. An agent's unemployment benefit is given by $bw_1(y)$, where b is the replacement rate. We also restrict benefits to a maximum amount denoted by B, another feature of the U.S. system. Thus, the actual unemployment benefit of the agent is given by $\min\{bw_1(y), B\}$. All unemployed workers, regardless of collection status, earn a base level of income, given by $gw_i(y), i \in \{1, 3\}$, where $g < b$.[11] The consumption of an unemployed agent is summarized by the

[11] There are several possible ways to interpret this value. A natural interpretation of non-market income is home

following function:

$$
z_i(y) = \begin{cases} gw_1(y) + \min\{bw_1(y), B\} & \text{if } i = 1, \\ gw_i(y) & \text{if } i \in \{2, 3\}. \end{cases} \tag{7}
$$

3.2.2 Firms

Denote by V_j the value of a vacancy, and by J_j the value of a matched firm in sector $j \in \{1, 3\}$. Further, let $\mathbf{Y}_1 \subset \mathbf{Y}$ denote the subset of productivity levels where workers collect benefits and $\mathbf{Y}_3 \subset \mathbf{Y}$ ($\mathbf{Y}_3 = \mathbf{Y} \setminus \mathbf{Y}_1$) the subset of productivity levels where workers do not collect benefits. Then, a firm's vacancy creation is captured by

$$
rV_j = -\kappa_j + q_j \int_{\mathbf{Y}_j} (J_j(y) - V_j)\, d\psi_j(y)\}, \tag{8}
$$

where $\psi_j(y)$ is the endogenous distribution across y of the unemployed population in sector j. Notice, since workers exert search effort $s_i(y)$, and this depends on y, in equilibrium the job finding rate for an unemployed worker may differ by productivity and collection status.

We also allow for market-specific vacancy creation costs, κ_j. In our quantitative analysis, we find the best results when $\kappa_1 > \kappa_3$; vacancy creation costs remain higher in the market for collectors. There are several alternatives to this assumption (which we have tried and discuss further in Section 4) that produce similar results.

The firm pays per-period lump sum taxes τ_j that are experience rated; therefore, $\tau_1 > \tau_3$. Specifically, we assume that τ_3 is fixed at some level. Then, τ_1 is determined based on the total

production. Another possibility is that g serves as a proxy for other assets or savings. The main idea is that for positive g, an agent's total consumption while unemployed is not equal to only UI benefits if collecting.

UI expenditures in equilibrium. The Bellman equations describing the value of a matched firm in sector j are:

$$rJ_j(y) = y - w - \tau_j + \lambda \left(V_j - J_j(y)\right). \tag{9}$$

3.2.3 Wages

Upon meeting and deciding to form a match, wages are determined by the generalized Nash Bargaining solution between workers and firms. Letting $\beta \in (0,1)$ denote the worker's bargaining power, the wage for an agent of productivity $y \in \mathbf{Y}_j$, $j \in \{1,3\}$, is determined by:

$$\max_{w_j} \left(W_j(y) - U_j(y)\right)^{\beta} \left(J_j(y) - V_j\right)^{1-\beta}. \tag{10}$$

As in Fredriksson and Holmund (2001), we also assume that wages can be re-negotiated at any time, so that the threat value of an agent who collects benefits is $U_1(y)$, regardless of whether or not benefits have expired.

3.3 Behavior of workers and firms

In the remainder of the section, we characterize the equilibrium of the model economy. First, using the free-entry condition for firms, $V_j = 0$, (9) to solve for J_j, and plugging into (8) gives

$$\frac{\kappa_j}{q_j} = \int_{\mathbf{Y}_j} \frac{y - w_j(y) - \tau_j}{r + \lambda} d\psi_j(y). \tag{11}$$

Next, to determine wages, the F.O.C. of equation (10) is given by,

$$W_j(y) - U_i(y) = \frac{\beta}{1-\beta} \left(J_j(y) - V_j\right) h_c(w_j(y), 1 - s_w). \tag{12}$$

Let $s_i(y)$ be the optimal choice of search effort for an unemployed worker with productivity y. Using the F.O.C. in the agent's problem with respect to s,

$$p_i\left(W_j(y) - U_i(y)\right) = h_\ell(z_i(y), 1 - s_i(y)). \tag{13}$$

Given the decision rules for effort in (13), the Bellman equations for unemployed workers are simplified as:

$$\begin{aligned}
rU_1(y) &= h(z_1(y), 1 - s_1(y)) + s_1(y)h_\ell(z_1(y), 1 - s_1(y)) + \delta\left(U_2(y) - U_1(y)\right), && (14)\\
rU_2(y) &= h(z_2(y), 1 - s_2(y)) + s_2(y)h_\ell(z_2(y), 1 - s_2(y)), && (15)\\
rU_3(y) &= h(z_3(y), 1 - s_3(y)) + s_3(y)h_\ell(z_3(y), 1 - s_3(y)). && (16)
\end{aligned}$$

Using these equations, the following must hold for an unemployed agent who is currently collecting benefits:

$$\begin{aligned}
W_1(y) - U_1(y) &= \frac{1}{r+\lambda}\Big\{h(w_1(y), 1 - s_w) - \\
&\quad \frac{r}{r+\delta}\Big(h(z_1(y), 1 - s_1(y)) + s(y)h_\ell(z_1(y), 1 - s_1(y))\Big) - \\
&\quad \frac{\delta}{r+\delta}\Big(h(z_2(y), 1 - s_2(y)) + s_2(y)h_\ell(z_2(y), 1 - s_2(y))\Big)\Big\}. && (17)
\end{aligned}$$

Combining (4), (15), and (17), for an agent who has exhausted benefits,

$$\begin{aligned}
(r+\lambda)(W_1(y) - U_2(y)) &= h(w_1(y), 1 - s_w) + \frac{\lambda}{r+\delta}\Big(h(z_1(y), 1 - s_1(y)) + \\
&\quad s_1(y)h_\ell(z_1(y), 1 - s(y))\Big) - \frac{r+\lambda+\delta}{r+\delta} \times \\
&\quad \Big(h(z_2(y), 1 - s_2(y)) + s_2(y)h_\ell(z_2(y), 1 - s_2(y))\Big). && (18)
\end{aligned}$$

Finally, for a non-collector, using (4) and (16) we have

$$(r+\lambda)(W_3(y)-U_3(y)) = h(w_3(y), 1-s_w) - h(z_3(y), 1-s_3(y)) - s(y)h_\ell(z_3(y), 1-s_3(y)). \quad (19)$$

Combining (9), (17), and (19) with the Nash F.O.C. in (12) determines $w_j(y)$, and combining (17)-(19) with (13) determines the optimal search intensity $s_i(y)$ for each i.

3.3.1 Endogenous segmentation by productivity

To determine equilibrium, we also need to determine the set $\mathbf{Y}_1$. This can be characterized by $U_1(y)$ and $U_3(y)$ crossing either once or twice (of course they need not cross for every parametrization). Figure 5 plots the difference $U_3(y)-U_1(y)$ across y for our baseline calibration. The difference $U_3(y)-U_1(y)$ initially decreases, and then starts increasing at the value of y where the maximum benefit level begins to bind. Once the maximum benefit binds, as y (and thus $w(y)$) increases, the replacement rate is decreasing, and eventually becomes low enough that the benefits of not collecting (higher job arrival rate and higher wage) outweigh the benefits of collecting. In this case, the section where $U_3(y)-U_1(y)$ decreases lies below zero, implying only relatively high productivity (wage) workers prefer not to collect benefits. Let y_1 denote this crossing point, i.e. $U_1(y_1) = U_3(y_1)$. Thus, $\mathbf{Y}_1 = \{y \in \mathbf{Y} | y < y_1\}$. Given the sets $\mathbf{Y}_1$ and $\mathbf{Y}_3$, we define the take-up rate as the ratio of unemployed in the collecting market, to total eligible unemployed:

$$TUR = \frac{u_1}{u_1 + u_3},$$

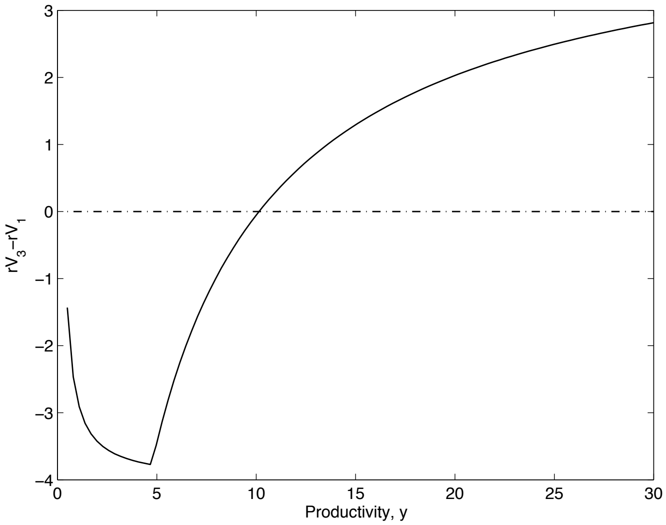


Figure 5: Determination of $\mathbf{Y}_1$

This figure plots the difference in value functions for unemployed collectors and non-collectors, $U_3 - U_1$. When the difference is positive the worker prefers not to collect, when negative they prefer to collect. The difference is initially negative and decreases with y. Once the maximum benefit amount binds the difference begins to increase, eventually becoming positive.

where u_i is the measure of unemployed workers in each state i.[12]

3.3.2 Labor market flows and stocks

Our description of equilibrium also requires the flow equations associated with the measures $\{u_1, u_2, u_3, e_1, e_3\}$. In the market for collectors, we have the following flow equations.

$$\lambda e_1(y) = p_1 s_1(y) u_1(y) + p_1 s_2(y) u_2(y), \tag{20}$$

$$\delta u_1(y) = p_1 s_2(y) u_2(y), \tag{21}$$

$$e_1(y) + u_1(y) + u_2(y) = f(y),, \tag{22}$$

[12]Note, in our model, we do not model monetary eligibility, nor do we have quits. We could introduce monetary eligibility (and maintain stationarity) by assuming a Poisson arrival rate of eligibility among the employed. This additional feature, however, adds an additional state without a commensurate increase in our understanding of the decision of whether or not to collect UI.

$\forall y \in \mathbf{Y_1}$, where f denotes the p.d.f of F.

Equation (20) states that the flows into and out of insured employment remain equal. The flows of agents who have exhausted benefits is governed by equation (21), and equation (22) ensures the total number of agents searching in this market is $\int_{\mathbf{Y_1}} dF(y)$.

Given these flows, we now determine the endogenous distribution of unemployed agents over productivity, $\psi_1(y)$. The density function for this distribution is given by:

$$\psi_1(y) = \frac{u_1(y) + u_2(y)}{u_1 + u_2}, \tag{23}$$

where $u_i = \int_{Y_1} u_i(y) dF(y), i = 1, 2$.

We also have flow equations in the market for non-collectors. Under our specification of preferences and flow income/consumption, since agents in this market do not collect UI benefits, the difference $W_3(y) - U_3(y)$ remains constant across y. From equation (13), this implies that search effort for agents in this market remains constant across y. Thus, the flows in and out of employment are also constant across y, and we only need to determine e_e and u_3.

$$\lambda e_3 = p_3 s_3 u_3, \tag{24}$$

$$e_3 + u_3 = \int_{\mathbf{Y_3}} dF(y). \tag{25}$$

Equation (24) equalizes the flows into and out of employment in this market, and (25) ensures consistency of the fraction of agents searching in this market. Since the measure of agents is constant across y, the corresponding distribution of agents in this market is simply given by $F(y)$; i.e. $\psi_3(y) = F(y), \forall y \in \mathbf{Y_3}$.

3.3.3 Equilibrium

The following definition summarizes the equilibrium conditions.

Definition 1 *An equilibrium consists of functions* $\{w_1(y), w_3(y), s_1(y), s_2(y), s_3(y)\}$*, measures of workers* $\{u_1, u_2, u_3, e_1, e_3\}$*, quantities* $\{q_1, q_3, S_1, S_3, \tau_1, \tau_3\}$ *and subsets* $\{\mathbf{Y}_1, \mathbf{Y}_3\}$ *such that*

1. *Given equations (17)-(19),*

   (a) q_j *satisfies (11),*

   (b) the function w_j *satisfies (12) for* $j \in \{1, 3\}$*, and*

   (c) the function $s_i(y)$*, satisfies (13) for each* i*;*

2. $\{u_1, u_2, u_3, e_1, e_3\}$ *satisfy (20)-(25);*

3. *Subsets* $\{\mathbf{Y}_1, \mathbf{Y}_3\}$ *and total search intensities* $\{S_1, S_3\}$ *are consistent with individuals' behavior:*

$$S_1 = \frac{1}{u_1 + u_2} \int_{\mathbf{Y}_1} (u_1(y)s_1(y) + u_2(y)s_2(y))dy, \tag{26}$$

$$S_3 = \int_{\mathbf{Y}_3} s_3(y)dy = s_3, \tag{27}$$

   and,

4. τ_1 *and* τ_3 *satisfy the government's budget constraint:*

$$\int_{\mathbf{Y}_1} \min\{bw_1(y), B\} u_1(y)dy = \tau_1 \int_{\mathbf{Y}_1} e_1(y)dy + \tau_3 e_3, \tag{28}$$

   where the L.H.S. gives total benefits paid, the R.H.S. total revenue collected from firms.

3.3.4 Firm Knowledge of Collection Status

One may ask the following question: how does a firm know whether or not a worker it hires is a collector or a non-collector? That is, how do markets segment? The definition of equilibrium represents the key to understanding how the segmented markets work in this model.

The firm does not explicitly need to know the collection status of a worker. Instead, the firm knows the productivity of a worker. In this sense, it is appropriate to imagine markets segmented by productivity as opposed to collectors and non-collectors. According to the definition of equilibrium, the firm forms beliefs about the sets $\mathbf{Y}_1$ and $\mathbf{Y}_3$. Given these beliefs, the firm makes vacancy creation decisions. Similarly, given their beliefs about firms, workers make decisions to collect benefits or not. In equilibrium beliefs are consistent.

Consider the following example. Imagine two different vacancies. One is for an entry-level telemarketing position, the other for a CFO (Chief Financial Officer). Now imagine a worker collecting benefits, who in the model is a relatively low productivity worker. This worker is searching for a job in the category of the telemarketing position.

A firm that advertises a vacancy for the telemarketing position knows the unemployed workers searching for such a job collect UI benefits. They know this not because they search a database of UI benefit recipients (which does not exist) or because they ask the worker's previous firm if they filed a UI claim (although they could). Rather, this is based on their equilibrium beliefs about $\mathbf{Y}_1$. Moreover, the firm with the CFO position expects it to be filled with a non-collector, again based on their equilibrium $\mathbf{Y}_3$ beliefs.

If individual productivity is private information, or only imperfectly observed by the firm, the problem is more complicated. In general, the segmented markets approach may not work in this case. Market segmentation based on gender, i.e. males and females, represents an analogous situation used in the search literature. In such models, gender is observable and permanent, and markets segment on that margin. We assume the same for productivity.

Next, it is important to recognize that given Nash Bargaining, it is efficient for workers to reveal whether or not they collect UI benefits. That is, to achieve the pair-wise efficient surplus split, workers and firms reveal their disagreement values. Since these values differ for a worker who collects relative to one who does not (ceteris paribus), this information is revealed implicitly. Even if all workers search in the same market, the firm learns whether or not the agent collects through the bargaining process (e.g. see the alternative model in Appendix A).

It may also appear that there exists a commitment problem: a worker could search in the non-collecting market, but upon a future separation "renege" and collect benefits. Indeed such a scenario remains possible. Nothing explicitly prevents a worker from deciding to collect or not-collect upon separation, regardless of their past history. Since productivity is permanent and the environment is stationary, however, if a worker decides once not to collect, they always make the same choice.

Finally, the firm must have consistent beliefs about $\mathbf{Y}_1$ to correctly forecast the endogenous distribution $\psi_1(y)$, which depends on search effort. Without these beliefs, the firm can not calculate the expected value of a vacancy. Given this and the experience rating feature, it is logical that the firm utilizes strategies to increase the likelihood of matching with a non-collector, ceteris paribus. In Appendix A we present an alternative model where all workers search in the same market. The firm value functions in this model reinforce the aforementioned points.

4 Empirical analysis

In this section, we present a quantitative analysis of the aforementioned model and equilibrium. Our calibration focuses on the time period from 1989 – 2012.

4.1 Calibration

The model described in Section 3 leaves the following parameters to be determined: β, r, b, B, g, λ, δ, κ_j, s_w, $F(y)$, τ_1/τ_3 (ratio of taxes in collecting and non-collecting sectors), and functional forms for the matching function, m, and the utility function, h.

4.1.1 Preferences

The time period is set to one quarter, so a per-annum risk-free interest rate of 4% implies $r = 0.01$. The utility function is given by

$$h(c, \ell) = \frac{(c\ell^{\gamma})^{1-\phi} - 1}{1 - \phi}. \tag{29}$$

For the coefficient of relative risk aversion, ϕ, we use a value of 1.0, which falls within the range considered in Hansen and Imrohoroglu (1992) and the existing RBC literature.

4.1.2 Matching technology, separation, and search costs

For the matching function, m, we use the standard constant returns to scale form given by $m(S_j, \mathrm{v}_j) = S_j^{\eta}\mathrm{v}_j^{1-\eta}$ where $j \in \{1, 3\}$.[13] As in Fredriksson and Holmund (2001), we use a value of 0.5 for β, and set $\eta = \beta$. The job separation rate is set to $\lambda = 0.031$, consistent with Shimer

[13] An equivalent alternative, used by others including Shimer (2005), is $m(S, \mathrm{v}) = m_0 S^{\eta}\mathrm{v}^{1-\eta}$ where S/v is normalized to 1, and m_0 is chosen to target the number of matches.

Table 1: Parameters

r	0.01	Discount rate
ϕ	1.0	Coefficient of relative risk aversion
β	0.5	Bargaining parameter
η	0.5	Elasticity of matching function
λ	0.031	Job separation rate
b	0.48	Replacement rate, UI, non-binding
B	2.15	Maximum UI benefit
g	0.4	Minimum consumption rate
δ	0.2	Length of unemployment benefits
κ_1	4.68	Marginal vacancy cost, collecting market
ξ	0.67	Ratio of marginal vacancy costs, κ_3/κ_1
γ	0.32	Utility parameter
s_w	0.357	Hours worked
σ	1/5.46	Scale parameter of $F(y)$
$\frac{\tau_1}{\tau_3}$	1.25	Experience rating

(2005). We then set the utility parameter on leisure, γ to match the average unemployment rate during the $1989-2012$ period, 6.0%. This implies a value of $\gamma = 0.489$. Further, we set work hours, s_w, to match data from the American Time Use Survey (ATUS). We calculate $s_w = 0.357$, within the range typically considered (e.g. Hansen and Imrohoroglu (1992)). We set the marginal cost of vacancy creation in the collecting market to match the average unemployment duration of 18.1 weeks (or 1.39 quarters), from $1989-2012$. This implies $\kappa_1 = 5.34$. We then set $\kappa_3 = \xi\kappa_1$, for $\xi > 0$, and describe the calibration of ξ below.

4.1.3 U.S. unemployment insurance system

Our model in Section 3 specifies a stylized, but relatively detailed version of the U.S. unemployment insurance system. The next step in our calibration is to determine the relevant parameters describing this system. To do so, we need to find three values: b, the basic replacement rate; B, the maximum benefit level; and δ, the arrival rate of benefit expiry. While the March CPS Supplement does contain some information about the actual amount of benefits collected, we use the BAM data to directly calculate the replacement rate. Since the data are from careful audits of unemployment claims, the earnings and benefit information is more complete, and this data also allows for more information regarding those collecting the maximum benefit amount.

For the U.S. overall, we calculate an average replacement rate of 0.45 (see Section 2.2 for the details of these calculations). This is similar to the commonly used replacement rate of 0.50. For those agents receiving below the maximum benefit, the average replacement rate is $b = 0.48$, and we set b accordingly. To set δ, we target the "exhaustion rate" for regular program benefits. In the data this is the fraction of initial claims that collect the full potential duration of benefits. In the model, it is $\frac{U2}{U1}$. From 1988 to 2012 the average exhaustion rate was 38%. This implies $\delta = 0.2$.

Further, we find that, on average, 23% of those collecting UI benefits are receiving the maximum benefit level in their respective state. Among those collecting the maximum benefit level, the average replacement rate is 0.36. We target these two moments with the maximum benefit level, B, and the ratio of firm vacancy creation costs, ξ. These targets imply values of $B = 2.15$ and $\xi = 0.67$.

To calibrate the distribution of productivity $F(y)$, we assume an exponential distribution, so that $F(y) = 1 - \exp(-y/\sigma)$, where $\sigma > 0$. We set σ to match the observed standard deviation of log wages. From the March CPS data we calculate the corresponding moment to be 0.76.[14] This implies $\sigma = 1/5.46 = 0.18$. As discussed in Section 3.2.2, an alternative calibration strategy is to set $\xi = 1$ (i.e. $\kappa_1 = \kappa_3$). We then set σ and B to match the fraction collecting the maximum benefit amount and the corresponding replacement rate. Both strategies produce similar results. In general, given the other moments, the alternative implies a standard deviation of log wages slightly

[14] We calculate this using the log of hourly wages from $1980-2009$, for a sample including white males, ages $18-64$. When controlling for age and education, we find a standard deviation of 0.63.

different from the data value.

To calibrate the fraction g, which is the fraction of previous wages an unemployed worker consumes when not receiving unemployment benefits, we set $g = 0.4$. This implies an unemployed worker collecting benefits consumes 88% of their employed consumption. This is in the range of estimates in Gruber (1997).

Finally, we set the experience rating of firm taxes to match the average take-up rate of 77% (from 1989 − 2012). This implies $\frac{\tau_1}{\tau_3} = 1.25$. After fixing the ratio, τ_1 is set to balance the government's budget constraint. We only target the ratio as firms in the non-collecting sector never send workers to insured unemployment; in the US system, these firms pay the minimum tax rate. Table 1 lists the parameters and their values.

4.2 Results

Table 2: Calibration Results

Moment	Model	Data
Unemployment rate	6.0%	6.0%
Unemployment duration	1.39	1.39
Take-up rate	0.77	0.77
Replacement rate, binding benefit	0.36	0.36
Fraction with binding benefit	0.24	0.23
Standard deviation of log wages	0.76	0.76
Benefit exhaustion rate	38%	38%

The first column lists the moment, the second column the model's predictions, and the third column the value of the moment in the data. "Replacement rate, binding benefit" is the average replacement rate among collectors for whom the maximum benefit amount is binding. "Fraction with binding benefit" is the fraction of collectors with a binding maximum benefit amount. "Benefit exhaustion rate" is the ratio U_2/U_1.

Table 2 presents the results from our calibration. There are several interesting features of the results that we now explore in more detail. First, the model performs well matching the observed moments of the U.S. economy, capturing the targeted moments using parameter values all within reasonable ranges.

Second, Table 3 summarizes the differences between the government provided UI scheme (77% of the unemployed in the model are collecting such benefits) and the "market" scheme (i.e. what non-collectors encounter). A faster job arrival rate represents the essential feature of the market provided UI scheme. Indeed, in the non-collecting market, the vacancy to unemployment ratio is $\theta_3 = 1.08$, compared to $\theta_1 = 0.69$ in the collecting market. In the non-collecting market, this implies an average job arrival rate of 0.92, or an average unemployment duration of 1.08 quarters. Similarly, for the collecting market, the job arrival rate is 0.67, for an average unemployment duration of 1.49 quarters.

Table 3: Government Scheme vs. Market Scheme

Variable	Government Scheme	Market Scheme
Market Tightness	0.69	1.08
Unemployment duration	1.49	1.08
Average wage gain	–	4.41%

The "Government Scheme" refers to workers in market $j = 1$; i.e. collectors. The "Market Scheme" refers to non-collectors in market $j = 3$. The average wage gain in the last row is the average percentage wage gain for non-collectors relative to an otherwise identical worker who does collect.

In general, firms that never send workers to insured unemployment (because the workers do not collect benefits upon separation) have higher profits in a given match. This occurs because of the lower tax rate, and that this market employs relatively high productivity workers. In response to the higher profits, firms create more vacancies, resulting in a faster job arrival rate for unemployed workers.

The market UI scheme also features higher wages for non-collectors. On average, workers in the non-collecting market receive a 4.41% wage increase relative to a comparable worker in the collecting market. Here we compute the percent increase in wages for a worker in the non-collecting market, relative to an identical worker in the collecting market.

There are several forces contributing here. First, the aforementioned lower tax rate increases the wage. Second, by definition of being a non-collector, their threat value is higher than in the collecting market. This effect increases the worker's bargaining power, further increasing the wage.

5 Counterfactual Experiments

Determining the implications of a take-up rate below 100% represents the next step in our analysis. This is accomplished with two counterfactual experiments. The first counterfactual analyzes the model's predictions for the correlation between the take-up and unemployment rate. A second counterfactual experiment imposes a one market structure by removing firm experience rating. This increases the take-up rate to 100%, allowing for an analysis of the implications of the unclaimed UI benefits.

5.1 Productivity Increase

In this section, we examine the correlation between the take-up and unemployment rates.[15] Specifically, consider the following experiment. The economy experiences a steady state increase in productivity that decreases the unemployment rate from the baseline value of 6.0% to 5.0%. We examine the effects of this change on the key steady state variables. The analysis features two different models: the baseline model presented above, and an alternative model.

The alternative model features a fixed flow utility cost to collecting UI benefits. This model

[15] Davidson and Woodbury (1998) and Wang and Williamson (2002) are two examples where unemployment insurance policies are considered in models with take-up rates less than 1, but in these papers the take-up rate is exogenous.

closely follows the traditional theories of take-up rates described in Section 1. That is, there exists a flow cost, denoted by $\zeta \geq 0$, to collecting benefits. As a result, $h(z_1, s_1) - \zeta$ represents the flow utility of a worker who collects benefits, while $h(z_3, s_3)$ represents flow utility for a non-collector (z_i defined as in equation (7)).

In Appendix A we describe the corresponding value functions for workers and firms. Collectors and non-collectors in a combined market with identical job arrival rates (given search effort) represents the key difference between the two models. Hereafter, we refer to the Baseline Model as "BM" and the Utility Cost Model as "UC."

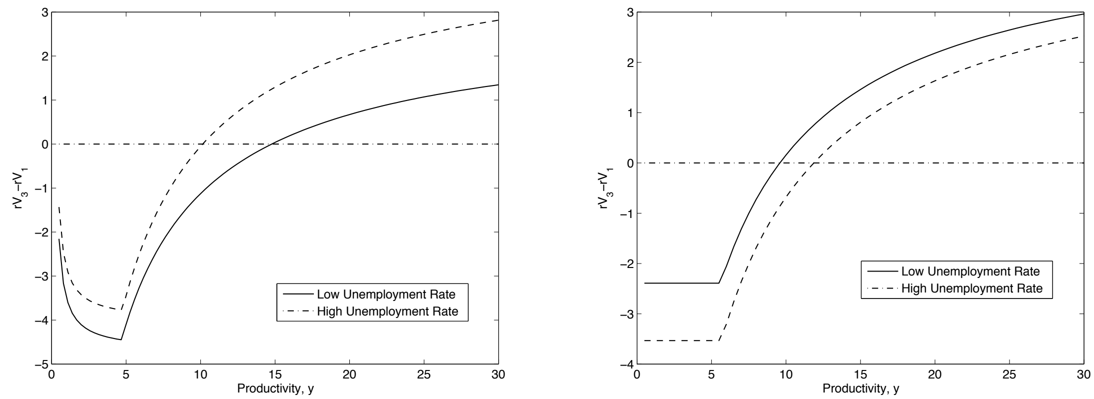
Table 4: Results: Steady State Productivity Increase

Moment/Parameter	Baseline(BM)	BM	UC	Baseline(UC)
% increase in mean of $F(y)$	–	50%	28%	–
Unemployment rate	6.0%	5.0%	5.0%	6.0%
Unemployment duration	1.39	1.15	1.18	1.39
Take-up rate	0.77	0.79	0.68	0.77
% change in average search intensity	–	−0.084%	1.91%	–

The first column describes the moment/parameter. The second through fifth columns describe the particular model. "Baseline (BM)" refers to the baseline model under the parametrization in Section 4.1. "BM" refers to the baseline model (with segmented markets) and the increase in productivity, and "UC" to the utility cost model with the increase in productivity. Finally, "Baseline (UC)" is the baseline parametrization of the utility cost model, detailed in Appendix A.

Table 4 displays the results from this experiment. The first row shows the % increase in the mean of the productivity distribution. In each case (BM and UC) we increase the mean until the equilibrium unemployment rate reaches 5.0%. For comparison, the second and last columns of Table 4 present the baseline parameterization of the BM and UC model, respectively.

The correlation of the take-up rate with the unemployment rate represents the main result from Table 4. In the case of the BM, the decrease in the unemployment rate *increases* the take-up rate from 77% to 79%. In the UC model, however, the correlation is positive, as the take-up rate



(a) Baseline Model

(b) Utility Cost Model

Figure 6: Take-up Rate Determination in High and Low Unemployment Rate Economies

This figure plots the change in y_1 from the high to the low unemployment rate economy. For $y > y_1$, workers prefer to forgo collecting UI benefits. In the Baseline Model, y_1 increases when the unemployment rate decreases, increasing the take-up rate. In the Utility Cost Model, y_1 decreases along with the take-up rate.

decreases from 77% to 68%. In Section 2.3.2 we demonstrate a correlation of -0.73 between the take-up and unemployment rate. Why does the UC model fail to capture this feature while the BM does?

Figures 6(a) and 6(b) plot the change in the determination of y_1 for the BM and UC model, respectively. In the BM, y_1 increases, which increases the take-up rate. In contrast, y_1 and the take-up rate decrease in the UC model. The endogenous cost of collecting benefits in the BM model represents the reason this model matches the negative correlation in the data.

In the UC model, the cost of collecting benefits is fixed. When productivity increases (on average), the unemployment rate and average duration of unemployment decrease. In the UC model, this decreases the expected gains from collecting UI benefits; a shorter expected duration of unemployment implies a reduced opportunity cost to forgoing benefits. Since the cost of collecting benefits remains fixed at ζ, the take-up rate decreases.

The BM, however, features an endogenous cost of collecting benefits. Recall that job arrival rates represents the primary difference between the government and market UI schemes. When average productivity changes (exogenously), this impacts the specifics of the market scheme. In the baseline parameterization of the BM, the ratio of job arrival rates in the two markets, $\frac{p_3}{p_1}$, is 1.38. When productivity increases, this ratio becomes 1.26. On this dimension, the cost of collecting benefits decreases: workers do not receive as large a "penalty" in the job arrival rate. Moreover, the average wage gain among non-collectors decreases from 4.41% to 1.45%.

Notice in the last row of Table 4 average search effort is countercyclical in the BM: it decreases when productivity increases. This result is driven by the change in the take-up rate. For a given y, the increase in productivity increases search effort, as in the standard Pissarides (2000) model. The take-up rate also increases, however, which moves more unemployed workers to a lower level of search effort. On average, this decreases search effort. In the UC model average search effort increases (last row third column) because the take-up rate decreases, moving more unemployed workers to a higher level of search effort. This result highlights the need to include an endogenously determined take-up rate in an analysis of search models (i.e. in the class of Pissarides (2000)).

A negative correlation between the take-up and unemployment rate represents an interesting feature of the data. In this section, we show that a fixed utility cost of collecting benefits delivers the opposite prediction. Our model captures the negative correlation because the cost of collecting benefits is endogenously determined, and decreases when productivity (unemployment rate) increases (decreases).

5.2 100% Take-up Economy

This section analyzes the implications of a take-up rate below 100%. To determine the impact, we perform the following counterfactual experiment. Suppose we remove the firm experience rating;

Table 5: Counterfactual: 100% Take-up Economy

Moment	Baseline Model	100% Take-up Model
Unemployment rate	6.0%	5.47%
Unemployment duration	1.39	1.22
Take-up rate	0.77	1
Vacancies, v	4.51%	5.55%

thus, all firms pay the same taxes. This implies a single sector economy, and the take-up rate becomes 100%, as the market UI scheme is no longer available. There are several implications of this change.[16]

5.2.1 Results

First, total UI expenditures increase by 16.4%. With a take-up rate of 77%, one expects an increase in benefit expenditures of around 23%. Notice, however, the unemployment rate in the 100% take-up economy decreases. From 1989 – 2012, UI expenditures averaged \$39 billion per year (in 2012 dollars), implying an additional \$6.4 billion per year in unemployment benefits in the 100% take-up economy. Over the entire period, this amounts to an additional \$154 billion in benefit expenditures.[17]

Second, equilibrium is affected. Table 5 compares the key features of equilibrium in each of the two economies. Despite the increase in benefit expenditures, the equilibrium unemployment rate decreases from 6.0% to 5.47%, and the average duration of unemployment decreases from 1.39 to 1.22 quarters. How do these moments decrease when *more* unemployed workers collect benefits?

[16] Our analysis only applies to the implications regarding the take-up rate. Of course changes to experience rating will have other impacts, specifically on job separation decisions by firms. Topel (1983) (among others) argues that these effects may be large, although Wang and Williamson (2002) argue they may be relatively small.

[17] The dollar amounts for benefits are based on total benefit expenditures, including any extended benefits. We use benefit expenditure data from the U.S. Department of Labor, available at `http://workforcesecurity.doleta.gov/unemploy/chartbook.asp`. This data is also used to compute that 13% of total benefit expenditures are from extended benefits (on average), a figure quoted in the introduction.

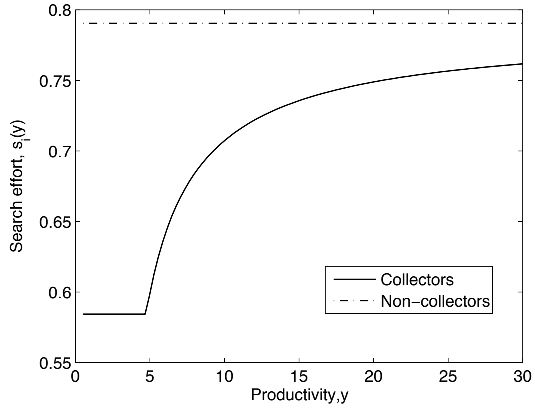
Standard theory predicts that an increase in unemployment benefits increases both the unemployment rate and the average duration of unemployment, as unemployed workers exert less search effort looking for employment. Indeed, in our model, the move to a 100% take-up rate decreases average search effort by 3.9%. The composition of employment changes, however, affecting the vacancy creation decisions of firms.

Specifically, in the 100% take-up rate economy, vacancy creation increases by 23%. Recall, equilibrium vacancy creation is determined by the free-entry condition in equation (11). If the expected value of a filled vacancy (the RHS of (11)) increases, then vacancy creation increases. In the 100% take-up economy, the distribution of unemployed agents across y, i.e. the distribution $\psi(y)$, changes relative to the baseline economy. When everyone collects, average search effort decreases, but higher productivity workers arrive faster for the firm (relative to lower productivity workers). Since firm profits increase with productivity, this has the aforementioned effect on the expected value of a filled vacancy, and thus on vacancy creation.[18]

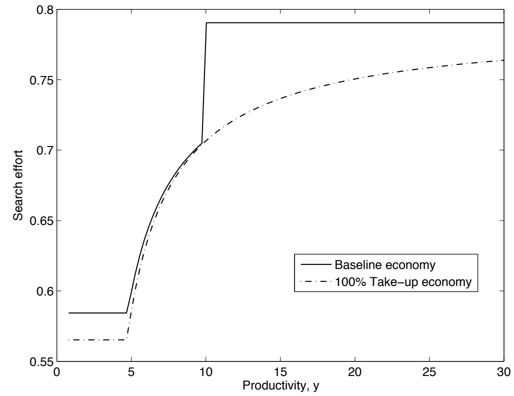
To understand this effect, consider how search effort differs in the two economies. For the baseline economy, Figure 7(a) plots search effort of unemployed collectors and non-collectors. For collectors, when receiving the basic replacement rate, search effort remains constant across y, since the difference between employed and unemployed consumption is constant. Once the maximum benefit amount binds, search effort begins to increase with y, as the value of employment increases faster than the value of unemployment.

For non-collectors, unemployed consumption is a constant fraction of employed consumption, implying constant search effort across y. Since search effort remains constant across y in the non-collecting market, the distribution of the unemployed across y is identical to the population

[18] Pries (2008) also analyzes the effects of worker heterogeneity on vacancy creation. Specifically, Pries (2008) examines how these firms effects can increase the volatility of vacancies in response to a productivity shock.



(a) Baseline Economy



(b) Baseline vs. 100% take-up economy

Figure 7: Search Effort Comparison

The left figure plots search effort for collectors and non-collectors in the baseline economy. Search effort for collectors increases with y once the maximum benefit amount binds. It is constant for non-collectors across y. The right figure plots a comparison of search effort in the two economies. The solid line plots the composite search effort function in the baseline economy; i.e. a combination of search effort for collectors. The dotted line plots the same search effort function for the 100% take-up economy. Search effort is lower for each y. This is noticeably true for relatively high productivity workers, who previously were non-collectors. Although their search effort is lower, it now increases with y.

distribution $F(y)$ (over the relevant range of y). In the collecting market, however, search effort increases with y for higher productivity workers. As a result, the distribution of the unemployed across y, $\psi_1(y)$, differs from the population distribution, as unemployed workers exit to employment at different rates across y.

Figure 7(b) displays the change in search effort moving from the baseline economy (solid line) to the 100% take-up rate version (dashed line). In the baseline economy, for low values of productivity, search effort coincides with that in Figure 7(a); i.e. $s_1(y)$. Once the critical value of y is reached (above which the unemployed prefer not to collect), search effort jumps to the higher level, s_3, and remains constant as y increases. Moving to the 100% take-up economy, search effort is lower for each y, relative to the baseline economy. Notice, however, that it is strictly increasing, even in the range of y where the unemployed were previously not collecting benefits. The latter fact explains why vacancy creation increases in the counterfactual economy. Now, firms are more likely to match with a higher productivity worker, relative to a lower productivity worker. This increases the expected value of a filled vacancy, and free-entry implies vacancies must increase.

5.2.2 Welfare

To further understand the implications of the counterfactual move to a 100% take-up economy, we also analyze how it affects welfare. In this comparison, we use the following welfare function:

$$
\begin{aligned}
W \quad = \quad & \int_{\mathbf{Y}} \Big\{ u_1(y)h(z_1(y), l_1(y)) + u_2(y)h(z_2(y), l_2(y)) + u_3(y)h(z_3(y), 1 - l_3(y)) + \\
& e_1(y)[y - w_1(y) - \tau_1 + h(w_1(y), l_w)] + e_3(y)[y - w_3(y) - \tau_3 + h(w_3(y), l_w)] \Big\} dy - \\
& (u_1 + u_2)\theta_1\kappa_1 - u_3\theta_3\kappa_3. \qquad (30)
\end{aligned}
$$

Total welfare is the sum of flow utility among the unemployed and the net flow value of employment at each y, net of total vacancy creation costs. Table 6 presents total welfare for each economy, along with a decomposition of each component.

Table 6: Welfare Comparison

Welfare component	Baseline Model	100% Take-up Model
Unemployed flow utility	0.0144	0.0241
Employed flow value	0.6475	1.091
Vacancy creation costs	0.1879	0.2424
Total Welfare	0.4740	0.8727

To measure the welfare gain in consumption equivalent terms, we use

$$\exp\left[r(W_C - W_B)\right] - 1,$$

where W_C denotes the total welfare from equation (30) for the 100% take-up economy, and W_B for the baseline economy. The numbers in Table 6 imply a welfare gain of 0.40% in consumption equivalent terms. While there exists some gain in the flow utility of the unemployed in a 100% take-up economy, these are relatively small. Table 6 indicates that the majority of the welfare gains occur in the flow value of employment. Again, this occurs via two channels. First, the employment rate is higher in the 100% take-up economy. Second, the change in the composition of employment implies more employment at higher levels of productivity (and thus higher wages).

Based on these welfare calculations, the experience rating feature of UI finance in our baseline economy implies an "externality" relative to the 100% take-up economy. These taxes create incentives for relatively high productivity workers to forgo the government UI scheme in favor of the market scheme. Removing the experience rating feature changes these incentives and all unemployed workers collect benefits. Then, the maximum benefit feature in the current U.S. system "corrects" the externality. It adds a constant amount of consumption to the relatively high productivity unemployed. This implies an increasing marginal gain to employment, causing search effort to increase faster with productivity. Since the distribution of employed workers across y is endogenously determined, this increase in the slope of s with respect to y increases the rate at which firms match with high productivity workers. In the baseline economy, workers do not internalize this equilibrium effect when deciding whether or not to collect UI benefits.

These results are driven by the fact that higher wage (productivity) workers are the ones not collecting benefits they are eligible for, and that they are bound by a maximum benefit amount when they do collect (a feature of the current U.S. system). Having unemployed consumption a constant fraction of employed consumption (for non-collectors) represents the other key assumption for these results. It does not particularly matter what the fraction is, only that it remains constant as the wage increases. When these workers start collecting benefits, this constant fraction no longer obtains, since the maximum benefit adds a fixed amount of consumption.

6 Conclusion

We estimate the UI take-up rate for the U.S. economy from 1989 – 2012. The take-up rate is negatively correlated with the unemployment rate, and has remained relatively low despite apparent reductions in the costs to applying for benefits. We develop a search model with matching frictions to reconcile these empirical facts. In our model, the costs of collecting benefits are endogenously determined by worker and firm decisions in equilibrium. Modelling the experience rating of firm UI taxes represents a key feature, and leads the market to offer workers an alternative UI scheme, featuring a faster job arrival rate and higher wages.

After calibrating the model, we find that it matches key features of the data. The model delivers the observed negative correlation between the take-up and unemployment rate. We also find that a counterfactual move to a 100% take-up rate economy increases benefit expenditures and welfare. Average search effort decreases, but vacancy creation increases, decreasing the unemployment rate and the average duration of unemployment.

We examine how experience rating of firm UI taxes affects the hiring decisions of firms. It remains possible, however, that such experience rating also affects firm layoff decisions. Feldstein (1976) and Topel (1983) both examine how the partial experience rating in the U.S. affects firm separation decisions. For example, to economize on unemployment insurance taxes, a firm may find it beneficial to reduce hours worked rather than layoff a worker. While in our model we assume separations are exogenous, incorporating this dimension into the analysis of take-up rates represents an interesting direction for future research.

Finally, including a decision to collect benefits or not is important for determining wages. We assume no informational problems related to a worker's productivity, or their previous history of collecting benefits. Incorporating such informational asymmetries into the Nash Bargaining problem represents an interesting direction for future research. That is, one could assume that productivity and/or disagreement values are private information for the worker. Another possibility is to incorporate a competitive search environment, where firms post wage contracts subject to an additional incentive compatibility constraint that workers prefer to truthfully reveal their true productivity.

References

Albrecht, J., and S. Vroman (2005): "Equilibrium Search with Time-Varying Unemployment Benefits," *The Economic Journal*, 115, 631–648.

Anderson, P., and B. Meyer (1997): "Unemployment Insurance Takeup Rates and the After-Tax Value of Benefits," *The Quarterly Journal of Economics*, 112, 913–937.

Blank, R., and D. Card (1991): "Recent Trends in Insured and Uninsured Unemployment: Is There an Explanation?," *The Quarterly Journal of Economics*, 106, 1157–1189.

Blasco, S., and F. Fontaine (2009): "A Structural Model of the Unemployment Insurance Take-up," Working paper.

Davidson, C., and S. Woodbury (1998): "The optimal dole with risk aversion and job destruction," Working paper, Michigan State University.

Feldstein, M. (1976): "Temporary Layoffs in the Theory of Unemployment," *Journal of Political Economy*, 84, 937–958.

Fredriksson, P., and B. Holmund (2001): "Optimal Unemployment Insurance in Search Equilibrium," *Journal of Labor Economics*, 19, 370–399.

Fuller, D. L., B. Ravikumar, and Y. Zhang (2013): "Unemployment Insurance Fraud and Optimal Monitoring," Working paper, Federal Reserve Bank of St. Louis.

Gruber, J. (1997): "The Consumption Smoothing Benefits of Unemployment Insurance," *The American Economic Review*, 87, 192–205.

Hansen, G., and A. Imrohoroglu (1992): "The role of unemployment insurance in an economy with liquidity constraints and moral hazard," *Journal of Political Economy*, 100, 118–142.

Nakajima, M. (2012): "A Quantitative Analysis of Unemployment Benefit Extensions," *Journal of Monetary Economics*, 59, 686–702.

Pissarides, C. A. (2000): *Equilibrium Unemployment Theory*. MIT Press, Cambridge, MA.

Pries, M. J. (2008): "Worker Heterogeneity and Labor Market Volatility in Matching Models," *Review of Economic Dynamics*, 11, 664–678.

Shimer, R. (2005): "The Cyclical Behavior of Equilibrium Unemployment and Vacancies," *American Economic Review*, 95, 25–49.

Topel, R. H. (1983): "On Layoffs and Unemployment Insurance," *American Economic Review*, 83, 541–559.

Wang, C., and S. Williamson (2002): "Moral hazard, optimal unemployment insurance, and experience rating," *Journal of Monetary Economics*, 49, 1337–1371.

A Utility Cost Model

This section describes the version of the model with a fixed utility cost of collecting benefits. The model follows that in Section 3 except for the following two dimensions. First, there is only one sector in the economy (i.e. markets are not segmented). Given this, similarly to the segmented case above, let p denote the arrival rate of job offers for workers and q the vacancy filling rate for firms. All firms pay the same tax; that is, there is no experience rating. Note, in this model, the arrival rate of jobs, for workers and firms, is the same regardless of whether the worker collects benefits or not, given search effort. Second, if a worker decides to collect unemployment benefits upon separation, there exists a flow cost to collecting benefits, denoted by ζ.

A.1 Value Functions

This section details the value functions for workers and firms. For workers, the value functions in this case are given by:

$$
\begin{aligned}
rU_1(y) &= \max_s \left\{h(z_1(y), 1-s) - \zeta + ps\left(W(y) - U_1(y)\right) + \delta\left(U_2(y) - U_1(y)\right)\right\}, && (31)\\
rU_2(y) &= \max_s \left\{h(z_2(y), 1-s) + ps\left(W(y) - U_2(y)\right)\right\}, && (32)\\
rU_3(y) &= \max_s \left\{h(z_3(y), 1-s) + ps\left(W(y) - U_3(y)\right)\right\}, && (33)\\
rW(y) &= h(w(y), 1-s_w) + \lambda\left(\max\{U_1(y), U_3(y)\} - W(y)\right), && (34)
\end{aligned}
$$

where again,

$$rW_1(y) = h(w_1(y), 1-s_w) + \lambda\left(U_1(y) - W_1(y)\right), \tag{35}$$

$$rW_3(y) = h(w_3(y), 1-s_w) + \lambda\left(U_3(y) - W_3(y)\right). \tag{36}$$

Wages differ for collectors and non-collectors. This occurs because of the Nash Bargaining process. The wage depends (among other considerations) on the disagreement value for the worker, which depends on whether or not the worker collects benefits.

Given this, the value functions for the firm depend on the "type" of worker encountered. For the value of a filled vacancy,

$$rV = -\kappa_j + q\left[\int_{\mathbf{Y}_1} (J_1(y) - V)\, d\psi_1(y) + \int_{\mathbf{Y}_3} (J_3(y) - V)\, d\psi_3(y)\right], \tag{37}$$

where $\psi_j(y)$ is the endogenous distribution across y of the unemployed population with collection status j. Notice, since workers exert search effort $s_i(y)$, and this depends on y, in equilibrium the job finding rate for an unemployed worker may differ by productivity and collection status. This is true because the value of a filled vacancy depends on whether or not the worker collects benefits, based on the Nash Bargaining process. Thus, the value of a filled vacancy for a worker with collection status $j \in \{1, 3\}$ is given by:

$$rJ_j(y) = y - w_j - \tau + \lambda\,(V - J_j(y))\,. \tag{38}$$

In Section 3.3.4 we discuss how segmented markets operate in equilibrium. Firms know a worker's productivity. They form expectations about who collects benefits by productivity. Firms must know if a worker collects benefits or not in order to determine wages in the Nash bargaining process, and to correctly calculate the expected value of a vacancy and filled job. The same is true in this model, even though there exists only one market. In equation (37), the expected value of a vacancy depends on the sets $\mathbf{Y}_1$ and $\mathbf{Y}_3$. This is true for two reasons.

First, the value of a filled job in equation (38) depends on the wage, which depends on whether or not the worker collects UI benefits via the Nash bargaining game. Second, the endogenous distribution of workers across y, $\psi_j(y)$, depends on search effort for each y. As in Figure 7(b) for the baseline model, in this UC model search effort as a function of y depends on collection status.

Looking at equation (37), if UI taxes are experience rated, it appears natural to assume the firm would take actions to increase the likelihood of meeting a non-collector. One example is to allow the firm to exert some variable advertising intensity, a_1, towards collectors and a_3 towards non-collectors. This is similar to the segmented markets approach we take for our baseline model. In an earlier version of the paper we used the variable search intensity version. Both models produce similar results, but the segmented markets approach allows for more transparent and intuitive results.

A.2 Calibration

The calibration of this one-sector version with a flow utility cost to collecting benefits follows similarly to the case in Section 4.1. The only difference is in the calibration of σ and B. In the baseline two-sector version, we can match three moments: standard deviation of log wages, the average replacement rate for those with a binding maximum benefit amount, and the fraction of collectors with a binding maximum benefit amount. In that case, the additional parameter ξ allows us to match all three moments. Since the one-sector model has one less parameter, we set σ and B to minimize the squared distance of these three moments with their model counterparts. Finally, in the baseline model, the ratio of taxes in the two sectors was calibrated to match the take-up rate; in this alternative version, we set the utility cost of collecting, ζ, to match the take-up rate. Table 7 lists the parameters and their values and Table 8 describes the results of the calibration.

Table 7: Parameters: Utility Cost Model

r	0.01	Discount rate
ϕ	1.0	Coefficient of relative risk aversion
β	0.5	Bargaining parameter
η	0.5	Elasticity of matching function
λ	0.031	Job separation rate
b	0.48	Replacement rate, UI, non-binding
B	2.50	Maximum UI benefit
g	0.4	Minimum consumption rate
δ	0.195	Length of unemployment benefits
κ	9.03	Marginal vacancy cost
γ	0.49	Utility parameter
s_w	0.357	Hours worked
σ	1/4.18	Scale parameter of $F(y)$
ζ	0.32	Flow utility cost of collecting benefits

Table 8: Calibration Results: Utility Cost Model

Moment	Model	Data
Unemployment rate	6.0%	6.0%
Unemployment duration	1.39	1.39
Take-up rate	0.77	0.77
Replacement rate, binding benefit	0.33	0.36
Fraction with binding benefit	0.24	0.23
Standard deviation of log wages	0.73	0.76
Benefit Exhaustion Rate	38%	38%

This table presents only the calibration results. Additional analysis of the UC model is contained in Table 4, which examines a steady state decrease in the unemployment rate.