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Unemployment Insurance Policy with Endogenous Labor Force Participation

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Abstract We construct a variant of the Mortensen-Pissarides matching model in which a worker's labor force participation decision is endogenous. The distinction between unemployment and nonparticipation, two non-working states, is due to a worker's job search behavior. A key feature of the model is that heterogeneity in productivity is introduced in order to characterize a worker's endogenous search intensity choice. A distinguishing result from the quantitative experiment of the unemployment insurance (UI) policy is that an increase in UI benefits has a significant impact on the labor force size as well as on the composition of the labor force, which crucially depends on the authority's ability to monitor the moral hazard. With perfect monitoring, more generous UI benefits increase both the ratios of employment and unemployment to population. In the absence of monitoring, we find the opposite results.

Keywords Heterogeneity, Labor Force Participation, Matching, Moral Hazard, Search, Unemployment Insurance, Worker Flows

JEL Classification E24, E61, J21, J65

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1. Introduction

Unemployment insurance (UI for short hereafter) policy has long been an important subject in macroeconomics and labor economics. The main concerns have been the unemployment rate, the duration of unemployment spells, welfare, and the design of an optimal UI scheme in the presence of the moral hazard associated with the provision of benefits.[1] A recent modeling strategy on the aggregate labor market focuses on the worker flows across establishments and through labor market states,[2] since the dynamics of the labor market can be better understood through the underlying labor market flows. The majority of previous research on the aggregate labor market and labor market policies has conducted analysis using models in which workers are either employed or unemployed, and transit between the two states. This practice, by construction, restricts the analysis of policies to changes in the composition of the labor force measured by the unemployment rate, and treats all new hires as worker transitions from unemployment. A novel feature of our analysis in this paper is that we consider a model in which the worker's labor force participation decision is endogenous. A major motivation for this approach is concern for the case where a policy has a major impact on the size of the labor force, rather than on the composition of the labor force, hence predictions about the policy effects based on a two state model may be misleading. An implication of the worker flows in a two state model is that the job finding rate for the nonemployed is too high to be consistent with the cyclical behavior of job creation and job destruction.[3] Moreover, the U.S.

1. Examples include Meyer (1990), Hansen and Imrohoroglu (1992), Millard and Mortensen (1997), Andolfatto and Gomme (1996), Wang and Williamson (1996), Hopenhayn and Nicolini (1997), Ljungqvist and Sargent (1998), Alvarez and Veracierto (1999), and Gomes, Greenwood and Rebelo (2001).
2. See, for example, Pissarides (1985), Blanchard and Diamond (1992), Mortensen and Pissarides (1994), Davis, Haltiwanger (1992), Davis, Haltiwanger and Schuh (1996), Merz (1999), den Haan, Ramey and Watson (2000).
3. Cole and Rogerson (1999) raise this point in their quantitative analysis of the reduced form implication of the Mortensen–Pissarides matching model. They suggest a need for incorporating the jobless workers with low search intensity in order to lower the job finding rate for the nonemployed.

labor market data confirms that there have always been as large worker flows in and out of the labor force as those within the labor force.[4] We develop a variant of the Mortensen and Pissarides (1994) matching model in which workers are either employed, unemployed, or out of the labor force (nonparticipant) in a period, and move across these three labor market states over time. The distinction between unemployment and nonparticipation, two non-working states, is due to the level of job search intensity exerted by workers in either state. Heterogeneity in workers' productivity is introduced in order to characterize the non-working individual's search intensity choice. The model is calibrated to replicate the labor market variables: the ratios of employment, unemployment and nonparticipation to population, and six transition rates across the three labor market states.

We then introduce a UI policy in the form of increasing benefits, and examine its effects on the agents' decision rules and the labor market aggregates. The results of the experiments crucially depend on the UI authority's ability to monitor the non-working individual's search effort, in other words, the severity of the moral hazard problem. With perfect monitoring, as benefits become more generous, the ratios of employment and unemployment to population increase, and the ratio of nonparticipation to population decreases. In the absence of monitoring ability, the changes in the labor market variables are completely opposite: the ratios of employment and unemployment to population decrease, and the ratio of nonparticipation to population decreases. Our findings from the experiments confirm that a UI policy has a significant impact on the size of the labor force as well as the relative composition of the labor force, which must be carefully taken into account when the authority designs a UI scheme.

Pries (2002) also argues that the high job finding rate for the unemployed is not consistent with the high persistence of the unemployment rate.

4. Clark and Summers (1979) report that 60% of unemployed workers completed their unemployment spells within a month and the average duration of unemployment was 1.94 month in 1974. They also note that 45% of unemployment spells were ended by exiting the labor force. Blanchard and Diamond (1990a) extensively document the empirical regularities of worker flows. Recently, Abraham and Shimer (2002) address similar patterns of worker flows as found by Blanchard and Diamond.

The experiments with various degrees of the severity of the moral hazard shed some light on the design of a UI scheme: the level of benefits in order for the authority to accomplish its target levels of the labor market variables, given the monitoring ability.

Similar works to ours are Andolfatto and Gomme (1996) and Garibaldi and Wasmer (2005). Andolfatto and Gomme analyze the Canadian UI reform in 1972, which is characterized by an increase in generosity of benefits. In their simulation without monitoring, the reform increases the unemployment rate due to a sharp decrease in employment and a mild increase in unemployment. Garibaldi and Wasmer consider a three state labor market model in which labor force participation is endogenous. They find that unemployment income has little effects on employment, and that taxation of market activity reduces the labor force participation rate and raises unemployment. The paper is organized as follows. In the next section, we describe the the model. In section 3, we define and discuss characteristics of the steady state equilibrium of the model. In section 4, we discuss our calibration strategy and the quantitative properties of the equilibrium. In section 5, we report our main findings about the effects of more generous UI benefits on the labor market variables, and discuss how the results vary according to the degree of the moral hazard. Section 6 concludes.

2. The Model

We develop a variant of the Mortensen and Pissarides (1994) matching model in which workers are either employed, unemployed, or out of the labor force in a period, and move across these three labor market states over time.

The model assumes that workers are heterogenous in their productivity, in order to characterize the worker's labor force participation decision and to account for the transitions of workers across the three labor market states. The distinction between unemployment and nonparticipation, two non-working states, is due to the level of job search intensity exerted by workers in either state: unemployed workers are defined as a group of jobless workers who search for jobs *actively*, while the remaining jobless workers are defined as nonparticipants. Presumably, a key element in an individual's decision to actively seek employment in the market sector is the relative productivity of their time in market and non-market activities. In general, one might imagine that both productivities in market and non-market activities are stochastic over time. To simplify the analysis, rather than incorporating two shocks, we will assume that individuals are subject to idiosyncratic shocks that affect their productivity when employed. We interpret this idiosyncratic productivity shock as a proxy for many events that occur in an individual worker's life, which can impact the health, desire, energy and focus that she brings to the workplace, hence affecting her current productivity. The detailed description of the model economy follows.

There is a continuum of infinitely-lived workers who are *ex ante* heterogeneous in productivity. The total mass of workers is equal to one. Each worker has preferences defined by

$$E_0 \sum_{t=0}^{\infty} \beta^t (c_t - d_t),$$

where $0 < \beta < 1$ is a discount factor, and $c_t \geq 0$ is consumption. A worker is endowed with one unit of time in each period. In choosing how to use her time, we assume the worker faces a discrete choice problem: either she works, engages in active job search, or enjoys leisure.[5] The variable d_t reflects the utility cost associated with this choice, and it is assumed that

$$d_t = \begin{cases} a & \text{if the individual works} \\ g & \text{if the individual engages in active job search} \\ 0 & \text{if the individual enjoys leisure,} \end{cases}$$

where $a > g > 0$.[6] Setting the utility cost of enjoying leisure to zero is purely a normalization.

5. Implicitly, we are assuming indivisible labor as in Rogerson (1988) and Hansen (1985), as well as indivisible search.

6. The search cost g can also be measured in units of consumption, though this entails worrying about maintaining nonnegative consumption, which we prefer to avoid.

There is also a continuum of identical, infinitely-lived entrepreneurs, whose preferences are defined by

$$E_0 \sum_{t=0}^{\infty} \beta^t c_t.$$

Each entrepreneur is endowed with $\bar{c}$ units of the consumption good in each period, which can be used for her own consumption, and for creating jobs. Job creation requires time and resources: an entrepreneur must pay k units of the consumption good each period to post a vacant position until it is filled with a worker. We assume that all jobs which entrepreneurs bring into the market are identical in quality. However, once a job is created, its quality follows a simple stochastic process with two states: either productive or unproductive.

The basic unit of production is a worker-entrepreneur pair that agrees to form a job match in period t. Matched workers are called *employed*. Due to the assumptions on worker and job productivity, the output of a job match solely depends on the worker's productivity y_t. We assume that y_t is a stochastic variable that evolves over time according to a transition function F on a measurable space $(Y, \mathcal{Y})$ with the interpretation $F(y, Y_0) = \text{prob}\,(y_{t+1} \in Y_0 | y_t = y)$ for all $Y_0 \in \mathcal{Y}$. In order to make the model tractable, we further assume (i) $F(y, \cdot)$ exhibits the Feller property, (ii) $F(y_1, \cdot)$ first-order stochastically dominates $F(y_2, \cdot)$ if $y_1 > y_2$, (iii) the evolution of productivity is independent across workers and their labor market state.

In addition to the idiosyncratic shock to worker's intrinsic productivity, each ongoing matched pair faces another idiosyncratic shock due to stochastic changes in job quality. At the beginning of each period, a job becomes unproductive with probability λ. Once a job becomes unproductive, it remains in this state forever. Hence, this shock effectively destroys a match. The realization of this shock is independent of worker's productivity, so a match termination due to this shock is exogenous from the worker's point of view.

We assume that job search is discrete. *Unemployed* workers' are those who engage in high intensity (or active) job search with utility cost g. High search intensity is denoted by $\overline{\eta}$.[7] *Nonparticipants* are those who do not search for a job actively. U.S. data show that there has been as large a transition from nonparticipation into employment as from unemployment. In order to accommodate this fact in our framework, we assume that nonparticipants engage in so-called low intensity (or passive) job search with zero utility cost, and hence may also come in contact with job openings. Low search intensity is denoted by $\underline{\eta}$.[8] We assume that an employed worker is not allowed to search for another job, i.e., there is no on-the-job search.[9]

The number of new contacts (or meetings) between unmatched workers and entrepreneurs posting vacancies is determined through an aggregate meeting function $M(v, s)$, where v denotes the number of vacancies that entrepreneurs post, and s denotes the total search intensity by unemployed workers (u) and nonparticipants (n), i.e., $s = \overline{\eta}u + \underline{\eta}n$. As is common in the literature, we assume that the aggregate meeting function is nonnegative, strictly increasing in both arguments, and homogeneous of degree one. The rate at which a unit search intensity results in a meeting with a vacant position is $M(v, s)/s = M(v/s, 1) = m(\theta)$, where $\theta = v/s$ is the labor market tightness. The probabilities that an unemployed worker and a nonparticipant meet a vacant position are $p^u(\theta) = \overline{\eta}m(\theta)$ and $p^n(\theta) = \underline{\eta}m(\theta)$, respectively. The rate at which an entrepreneur positing a vacant position meets an unmatched worker is $q(\theta) = M(v, s)/v = m(\theta)/\theta$.

Since workers are assumed to be *ex ante* heterogeneous in their productivity, which solely

7. According to the Bureau of Labor Statistics (1994), active job search consists of any of the following activities: (*i*) Contacting an employer directly or having a job interview, contacting a public or private employment agency, a school or university employment center; (*ii*) Sending out resumes or filling out applications; (*iii*) Placing or answering advertisements; (*iv*) Checking union or professional registers.

8. Passive job search includes the following activities: attending a job training program or course, reading help-wanted ads, or asking friends and relatives about potential job openings.

9. Since the productivity of a match that she may find with another entrepreneur will be the same as her current one, an employed worker doesn't have an incentive to engage in high-intensity search. However, this assumption is adopted to exclude the case where an employed worker meets another entrepreneur as a result of low-intensity search which is costless in the model.

determines the quality of a potential match, not all meetings made between workers and entrepreneurs turn into job matches. Instead, when a worker and an entrepreneur meet, they have to make decision whether to form a job match, or to reject it and search again.[10] This match process is different from that of Mortensen and Pissarides (1994). In these papers, workers and entrepreneurs are *ex ante* homogeneous and a new match starts off with the highest productivity, thus there is non match formation decision for new worker-entrepreneur pairs. Pissarides (1985) and Merz (1999) consider similar match processes to ours.

As is usual in heterogeneous models, the distribution of worker productivity becomes part of the state variables for agents' optimization problem, which complicates the analysis of the model considerably. Two measures, denoted by ψ and φ, are introduced to capture the distribution of workers. The former (ψ) represents the measure of workers who have a contact with an entrepreneur, while the latter (φ) represents the measure of workers who do not have a contact with an entrepreneur. By construction, $\psi(Y) + \varphi(Y) = 1$.

We assume that wages are determined by the generalized Nash bargaining, in which the worker's threat point is equal to the value of being unmatched (that is, either the value of unemployment or nonparticipation), and the threat point of an entrepreneur is the value of having an unfilled position. The worker's share of total match surplus is denoted by γ.

Timing of events in each period is as follows. At the beginning of a period, idiosyncratic shocks occur: A λ fraction of existing matches break up and workers receive new productivity for the period. At this point, the measures of worker productivity, ψ and φ, are observed. Upon observing the distribution of worker productivity, agents make decisions: Worker-entrepreneur pairs decide whether to continue or terminate their matches. Unmatched workers choose their search intensity, and unmatched entrepreneurs decide how many vacant jobs

10. Analogously, a worker who was matched in the previous period maintains the contact with an entrepreneur until the current period match formation decision which is exactly the same as that of a worker in a new contact.

to post. At the end of the period, matched worker-entrepreneur pairs split output according to the bargaining rule, and unmatched workers and entrepreneurs meet according to appropriate meeting probabilities. Time then moves on to the next period.

3. Steady State Equilibrium

In this section we define and characterize an equilibrium of the model. In this paper, we focus on a steady state of the model economy in which the distribution of worker productivity is invariant over time. As a result, levels of employment, unemployment and nonparticipation are constant. Even without aggregate shocks, there exist worker transitions across the three labor market states due to the idiosyncratic shocks to the workers' productivity, which are also constant in the steady state.

It is common in the literature to define a recursive equilibrium. We start by describing the agents' value functions and their optimal decision rules. Let $W(y)$, $U(y)$ and $N(y)$ respectively denote the values to a worker whose productivity equals y when she is employed, unemployed, and out of the labor force. For future references, we define the value to an unmatched worker as $O(y) = \max\big\{U(y), N(y)\big\}$, where the max operator reflects an unmatched worker's decision on search intensity that will be discussed shortly. Let $J(y)$ and V respectively denote the value to an entrepreneur when she is matched with a worker of productivity y, and when posts a vacant position. In principle, all value functions depend on the two measures of workers, ψ and φ, and the evolution of these measures which is described by a transition function $\mathbf{T}$, i.e., $(\psi', \varphi') = \mathbf{T}(\psi, \varphi)$. We will omit these elements from specifications of the value functions for notational convenience.

The value to an employed worker satisfies the following functional equation:

$$W(y) = w(y) - a + \beta\Big\{(1-\lambda)E\big[\max\big\{W(y'), O(y')\big\}|y\big] + \lambda E\big[O(y')|y\big]\Big\}, \tag{1}$$

where $w(y) - a$ is the wage net of disutility from working, and the remaining terms represent the discounted expected value in the subsequent period. Expectations are taken with respect to $F(y, \cdot)$ and λ. If the match survives the exogenous separation with probability $1 - \lambda$, the worker will have to decide whether to continue or terminate the match. If the match is dissolved exogenously with probability λ, the worker will become unmatched and will have to choose her search intensity.

The values to an unemployed worker and a nonparticipant satisfy the following functional equations, respectively:

$$U(y) = -g + \beta\Big\{p^u(\theta)E\big[\max\left\{W(y'), O(y')\right\}|y\big] + \big(1 - p^u(\theta)\big)E\big[O(y')|y\big]\Big\} \qquad (2)$$

and

$$N(y) = \beta\Big\{p^n(\theta)E\big[\max\left\{W(y'), O(y')\right\}|y\big] + \big(1 - p^n(\theta)\big)E\big[O(y')|y\big]\Big\} \qquad (3)$$

These value functions consist of (i) the utility costs of job search in the period: g for an unemployed worker and zero for a nonparticipant, (ii) the discounted expected value in the subsequent period where expectations are taken with respect to $F(y, \cdot)$ and the meeting probability ($p^u(\theta)$ for an unemployed worker and $p^n(\theta)$ for a nonparticipant).

The worker's decision is to choose the labor market state that gives the highest value. In other words, a worker who has a contact with an entrepreneur decides whether or not to form a job match, and an unmatched worker chooses her search intensity. The worker's optimal decision rule for match formation is denoted by a simple function $\chi^w(y)$, which takes on one if $W(y) \geq O(y)$ and zero otherwise. The interpretation is that $\chi^w(y) = 1$ indicates to form the match, and $\chi^w(y) = 0$ indicates to discard the contact. Analogously, an unmatched worker's search intensity decision is denoted by another simple function $\chi^s(y)$, which takes on $\overline{\eta}$ if $U(y) \geq N(y)$ and $\underline{\eta}$ otherwise. The interpretation is that $\chi^s(y) = \overline{\eta}$ indicates to engage in high intensity search, and $\chi^s(y) = \underline{\eta}$ indicates to engage in low intensity search.

The value to an entrepreneur, when she is matched with a worker whose productivity is equal to y, solves the following functional equation:

$$J(y) = y - w(y) + \beta(1-\lambda)E\big[\max\big\{J(y'), V\big\}|y\big], \tag{4}$$

where $y - w(y)$ is the flow profit, and the remaining terms are the discounted expected values of the match, if the job is still productive with probability $1-\lambda$ in the subsequent period.

The value to an entrepreneur who posts a vacant job, V, solves

$$V = -k + \beta\Big\{q(\theta)E_{\widetilde{\varphi}}\big[\max\big\{J(y'), V\big\}\big] + \big(1-q(\theta)\big)V\Big\}, \tag{5}$$

where $E_{\widetilde{\varphi}}\big[\max\big\{J(y'), V\big\}\big]$ is the expected value of making a contact with an unmatched worker. This expectation is taken with respect to a measure $\widetilde{\varphi}$, where $\widetilde{\varphi}(Y_0)$, for any $Y_0 \in \mathcal{Y}$, denotes the measure of workers who are unmatched in period t and whose productivity will be $y_{t+1} \in Y_0$, i.e. $\widetilde{\varphi}(Y_0) = \int_Y F(y, Y_0)\varphi(dy) + \int_Y (1-\chi^w(y))F(y, Y_0)\psi(dy)$. The reason is that an entrepreneur posts a vacancy after observing the measures ψ and φ at the beginning of t, while she meets an unmatched worker with probability $q(\theta)$ at the end of t, and then the worker's productivity evolves according to $F(y, \cdot)$ in $t+1$. Hence an entrepreneur must take into account both the distribution of unmatched workers and their transition. The measure $\widetilde{\varphi}$ reflects these events. An entrepreneur who has a contact with a worker decides whether or not to form a job match. Given the wage being determined by a generalized Nash bargaining solution, this decision is the same as the worker's match formation decision stated above, i.e. match formation is a mutual outcome for both the worker and the entrepreneur in contact. Since entrepreneurs are allowed to post as many vacant positions as they want, entrepreneurs keep posting vacancies until rents from doing so exhaust. Hence the total number of vacancies that entrepreneurs post, denoted by v, is determined by this free entry condition, $V = 0$ in equilibrium. Wages are determined by a generalized Nash bargaining, in which the worker's share of the total surplus from a match equals γ, the worker's threat point is $O(y)$, and the entrepreneur's threat point is V. Equilibrium wages are determined such that the following condition holds:

$$(1-\gamma)\big(W(y)-O(y)\big)=\gamma\big(J(y)-V\big). \tag{6}$$

Having stated agents' value functions and decision rules as above, it is now straightforward to define a steady state equilibrium of the model.

Definition: A *steady state equilibrium* consists of value functions $\{W(y)$, $U(y)$, $N(y)$, $J(y)$, $V\}$, functions for agent's decision rules $\{\chi^w(y),\ \chi^s(y)\}$, the number of vacancies v, a wage function $w(y)$, and measures of workers, $\{\psi,\varphi\}$, and a transition function for measures $\mathbf{T}$ that satisfy:

1. Value functions: Given $\chi^w(y)$, $\chi^s(y)$, v, $w(y)$, ψ, φ and $\mathbf{T}$, $W(y)$, $U(y)$, $N(y)$, $J(y)$ and V solve the Bellman equations in (1), (2), (3), (4) and (5), respectively.[11]
2. Decision rule for match formation: Given $\chi^s(y)$, v, $w(y)$, ψ, φ, $W(y)$, $U(y)$ and $N(y)$, $\chi^w(y)$ is the optimal decision rule for a worker-entrepreneur pair's match formation.
3. Decision rule for search intensity: Given $\chi^w(y)$, v, $w(y)$, ψ, φ, $W(y)$, $U(y)$ and $N(y)$, $\chi^s(y)$ is the optimal decision rule for an unmatched worker's search intensity choice.
4. Free entry: Given $\chi^w(y)$, $\chi^s(y)$, $w(y)$, ψ, φ, $J(y)$ and V, $V=0$ holds and determines v.
5. Wage bargaining: Given $\chi^w(y)$, $\chi^s(y)$, v, ψ, φ and $W(y)$, $U(y)$, $N(y)$, $J(y)$ and V, $w(y)$ is determined by generalized the Nash bargaining rule in (6).
6. Consistency of individual and aggregate behavior: Given $\chi^w(y)$, $\chi^s(y)$ and v, $(\psi',\varphi')=$

11. Note that given $\chi^w(y)$, $\chi^s(y)$, v, ψ and φ, $\theta=v/s$, where $s=\int_Y \chi^s(y)\varphi(dy)+\int_Y(1-\chi^w(y))\chi^s(y)\psi(dy)$.

$\mathbf{T}(\psi, \varphi)$ is described as

$$\begin{aligned}\psi'(Y_0) = &\int_Y \Big[\chi^w(y)(1-\lambda) + \big(1-\chi^w(y)\big)\chi^s(y)m(\theta)\Big] F(y, Y_0)\, \psi(dy) \\ &+ \int_Y \chi^s(y)m(\theta)F(y, Y_0)\, \varphi(dy)\end{aligned} \tag{7}$$

and

$$\begin{aligned}\varphi'(Y_0) = &\int_Y \Big[\chi^w(y)\lambda + \big(1-\chi^w(y)\big)\big(1-\chi^s(y)m(\theta)\big)\Big] F(y, Y_0)\, \psi(dy) \\ &+ \int_Y \big(1-\chi^s(y)m(\theta)\big) F(y, Y_0)\, \varphi(dy)\end{aligned} \tag{8}$$

for all $Y_0 \in \mathcal{Y}$.

7. Steady state: ψ and φ are invariant over time, i.e., $\psi' = \psi$ and $\varphi' = \varphi$.

3.1. Discussion

Working with the match surplus function, instead of five value functions for agents, is common in the literature, and makes it easy to characterize the optimal decision rules. Define the surplus function by $S(y) = W(y) - O(y) + J(y) - V$. Substituting (1) through (6), and the free entry condition ($V = 0$) into this equation yields:

$$\begin{aligned}S(y) = y - a + \min \Big\{ &g + \beta\big(1-\lambda-\gamma p^u(\theta)\big)E\big[\max\big\{S(y'), 0\big\}|y\big], \\ &\beta\big(1-\lambda-\gamma p^n(\theta)\big)E\big[\max\big\{S(y'), 0\big\}|y\big]\Big\},\end{aligned} \tag{9}$$

where the min operator appears due to $O(y) = \max\big\{U(y), N(y)\big\}$. It is easy to show that the right-hand side of (9) defines a contraction mapping given θ. Moreover, since $F(y, \cdot)$ is assumed to satisfy the Feller property and the first order stochastic dominance, $S(y)$ is unique, bounded, continuous and strictly increasing in y.

Thanks to these properties of $S(y)$, the worker's optimal decision rules can be characterized by two reservation productivities, y_w and y_s. The decision rule for match formation is that $\chi^w(y) = 1$ if $y \geq y_w$ and $\chi^w(y) = 0$ otherwise, where y_w is the solution to $S(y_w) = 0$. A worker who has contact with an entrepreneur forms a match (*employed*) if her productivity is higher than y_w, or discards the contact otherwise. The decision rule for search intensity choice is that $\chi^s(y) = \overline{\eta}$ if $y \geq y_s$ and $\chi^s(y) = \underline{\eta}$ otherwise, where y_s is the solution to $g = \beta\gamma(\overline{\eta} - \underline{\eta})m(\theta)E\big[\max\big\{S(y'), 0\big\}|y_s\big]$. An unmatched worker engages in high intensity search (*unemployed*) if her productivity is higher than y_s, or engages in low intensity search (*nonparticipant*) otherwise. The number of vacancies, v, solves $k = \beta(1-\gamma)q(\theta)E_{\widetilde{\varphi}}\big[\max\big\{S(y'), 0\big\}\big]$, where $\theta = v/s$.

The equilibrium may display two different cases in the relative magnitudes of y_w and y_s depending on the parameter values and the nature of the stochastic process of the idiosyncratic productivity. In the case with $y_w < y_s$, all workers who decide to terminate their matches go out of the labor force. In the opposite case ($y_w > y_s$), workers whose productivities are between y_s and y_w terminate current matches and actively search for another one. We focus on the case with $y_w < y_s$ in our quantitative analysis. The reason for this choice is as follows. The individual wages from the PSID exhibit a very high persistence which suggests that the underlying stochastic process of the idiosyncratic productivity is strongly persistent. Workers are assumed to be heterogeneous while jobs are identical so that the match quality is determined by the worker's productivity. Given the strong persistence of the productivity, if a worker terminates her match due to low productivity, then any job that the worker may find elsewhere will not increase her value of working above that of the current job. There is no incentive for the worker to search actively.

3.2. Labor Market Variables in the Steady State

Define $Y_W = \{y \in Y | y \geq y_w\}$ and $Y_S = \{y \in Y | y \geq y_s\}$. With these additional notations, measuring the labor market variables in the steady state equilibrium is straightforward. Three labor market stock variables, employment (e), unemployment (u) and nonparticipation (n), are written as follows:

$$e = \int_{Y_W} \psi(dy),$$

$$u = \int_{Y_S} \varphi(dy),$$

$$n = \int_{Y_W^C} \varphi(dy) + \int_{Y_S^C} \psi(dy) = 1 - e - u,$$

where Y_W^C and Y_S^C are complements of Y_W and Y_S respectively.

Six gross worker flows across the three states can be expressed in a similar way. They involve workers' decisions in two consecutive periods. Below, eu denotes the worker transition from employment to unemployment and other flows are interpreted analogously.

$$eu = \int_{Y_W} \lambda F(y, Y_S)\, \psi(dy),$$

$$en = \int_{Y_W} \Big[\lambda F(y, Y_S^C) + (1-\lambda) F(y, Y_W^C)\Big]\, \psi(dy),$$

$$ue = \int_{Y_S} p^u(\theta) F(y, Y_W)\, \varphi(dy),$$

$$un = \int_{Y_S} \Big[p^u(\theta) F(y, Y_W^C) + \big(1 - p^u(\theta)\big) F(y, Y_S^C)\Big]\, \varphi(dy),$$

$$ne = p^n(\theta) \left\{ \int_{Y_S^C} F(y, Y_W)\, \varphi(dy) + \int_{Y_W^C} F(y, Y_W)\, \psi(dy) \right\},$$

$$nu = \big(1 - p^n(\theta)\big) \left\{ \int_{Y_S^C} F(y, Y_S)\, \varphi(dy) + \int_{Y_W^C} F(y, Y_S)\, \psi(dy) \right\}.$$

The worker transition rates are calculated by the ratios of the worker flows to the source stocks. For example, the transition rate from employment to unemployment is $h_{eu} = eu/e$.

4. Quantitative Analysis: Benchmark

In this section, we calibrate the model to the U.S. labor market and present the quantitative properties of the steady state equilibrium assuming no UI benefits. We take this as a benchmark, and then analyze the effects of an unemployment insurance policy in the next section. Due to the specification of the stochastic process of the idiosyncratic productivity, the value functions are nonlinear in worker productivity. Moreover, it is a non-trivial task to characterize the distribution of workers over the productivity space. Because of these difficulties, the model does not allow an analytic solution, so the equilibrium of the model will be computed numerically.

4.1. Calibration

The time unit is one month: the frequency of worker flows data. The discount factor, β, is 0.9967, which is consistent with the annual interest rate being 4%. The worker's share of the total match surplus, γ, is set to 0.4, which is a commonly used value for this parameter in the literature. We assume that the meeting function takes a Cobb-Douglas form $m(v, s) = v^{\alpha} s^{1-\alpha}$, and set the elasticity of the number of meetings with respect to the number of vacancies, α, to 0.6 following Blanchard and Diamond (1990b).[12]

The idiosyncratic productivity assumed to follow an AR(1) process, $y' = (1-\rho)\mu + \rho y + \nu$, where ν is the normally distributed innovation to the productivity, i.e., $\nu \sim N(0, \sigma_{\nu}^2)$. The mean productivity, μ, is normalized to one, and the persistence, ρ, is estimated using individual wages from the Panel Study of Income Dynamics (PSID) for 1979-1992. We estimate the AR(1) process of the wage residual using Heckman's (1979) maximum-likelihood estimation procedure, correcting for a sample selection bias because productivities (wages) of workers who did not work are not reported. We also control for time effects by annual dummies and individual fixed effects by sex, age, schooling, age^2, schooling^2, and age $\times$ schooling. We then

12. It should be noted that their estimation procedure differs from our specification of the matching function. In their estimation, the number of new hires is assumed to be a Cobb-Douglas function of the number of vacancies and the number of unemployed workers. In our specification, the number of contacts (meetings) between workers and entrepreneurs is a Cobb-Douglas function of the number of vacancies and the total search intensity by both unemployed workers and nonparticipants.

convert the annual estimates to monthly value. The monthly value we obtain is $\rho = 0.97$. For computational purpose, we assume that the unconditional distribution of the idiosyncratic productivity lie on the range of $[0, 2]$. With this assumption, the corresponding value of the standard deviation of the innovation, σ_ν, is 0.081.[13]

We need to set the parameter values for $\overline{\eta}$, $\underline{\eta}$, λ, a, g and k, for which no empirical estimates are available. Moreover, the model does not allow for a one-to-one mapping between these parameters and a set of relevant statistics. In other words, a statistic depends on more than one parameters, at the same time, a parameter affects the equilibrium values of more than one statistics. Therefore, we choose these parameter values simultaneously in order for the model-generated labor market aggregates to mimic the data counterparts, i.e., we want to replicate eight statistics (e, u, h_{eu}, h_{en}, h_{ue}, h_{un}, h_{ne}, and h_{nu}) by assigning some numbers to the above six parameters. The following two equations must hold in the steady state:

$$(h_{eu} + h_{en} + h_{ne})e - (h_{ue} - h_{ne})u = h_{ne},$$

$$(h_{eu} - h_{nu})e - (h_{ue} + h_{un} + h_{nu})u = -h_{nu}.$$

Two of the eight labor market statistics are redundant and the system is exactly identified. We calibrate the six parameters to match the statistics of e, u, h_{eu}, h_{en}, h_{ue} and h_{ne} as closely as possible, given other parameter values already chosen.

The first column of Table 1 presents the averages of labor market variables as percentages of the noninstitutionalized civilians of age 16 and over from the the Current Population Survey

13. This value for σ_ν is on the low side comparing with values used in other works. For example, Chang and Kim (2007) estimated ρ and σ_ν simultaneously using the same precoedure to get $\rho = 0.975$ and $\sigma_\nu = 0.14$ at the monthly frequency. Bils, Chang and Kim (2008) also set $\rho = 0.97$ and $\sigma_\nu = 0.13$ for the steady state of their model to generate the wage dispersion comparable to the one estimated by Woodcock (2007). As σ_ν increases given the value of ρ, the model tends to generate more frequent transitions of workers across the three labor market states. However, simulation show that the increments of worker transitions even with $\sigma_\nu = 0.14$ are not large enough to alter the main results.

(CPS) for the period from June 1967 to December 2001. The worker transitions are adjusted by Abraham and Shimer (2002).[14]

The employment to population ratio is 60.23%, and the unemployment to population ratio is 3.91%. The values for the utility costs associated with working and active job search, a and g, are chosen so that the model replicates the observed employment and unemployment ratios: $a = 0.886$ and $g = 0.231$.

The worker transition rate from unemployment to employment ($h_{ue} = 27.74\%$) is about six times greater than that from nonparticipation to employment ($h_{ne} = 4.66\%$). Among unmatched workers, those who meet entrepreneurs and whose productivities are higher than y_w make transition to employment. Conditional on having contacts with entrepreneurs of which probabilities are p^u for the unemployed and p^n for nonparticipants, the unemployed are more likely to make transition to employment than nonparticipants because the former's productivities are much higher than the latter. It follows that $\dfrac{h_{ue}}{h_{ne}} > \dfrac{p^u}{p^n} = \dfrac{\overline{\eta}}{\underline{\eta}}$. The vacancy posting cost, k, affects the meeting probabilities, which in turn affects the transition rates into employment. The high and low search intensities and the vacancy posting cost are chosen to match the absolute and relative transition rates into employment described above: $\overline{\eta} = 0.12$, $\underline{\eta} = 0.035$, $k = 0.3$.

The transition rate from employment to nonparticipation ($h_{en} = 3.13\%$) is about twice as large as that to unemployment ($h_{eu} = 1.47\%$). Among employed workers, those whose matches are hit by the exogenous match separation shock and whose productivities are higher than y_s become unemployed. Among employed workers, the following types of workers go out of the labor force: (i) those whose matches are hit by the exogenous match separation shock and whose productivities are lower than y_s, (ii) those whose productivities fall below

14. Blanchard and Diamond (1990a) report similar patterns of worker transitions using the CPS data adjusted by Abowd and Zellner (1985).

y_w and voluntarily break up their matches, despite avoiding the exogenous shock. It follows that $h_{eu} < \lambda < h_{en}$. We set λ to 0.025.

4.2. Results

The steady state equilibrium is numerically computed for the benchmark calibration. The match surplus function in (9) and the measures of workers in (7) and (8) are approximated on sufficiently many grids over the range of productivity. The conditional expectations in (9) are computed using the transition probabilities approximated by Tauchen's (1986) algorithm. The steady state is found by iterating these procedures until ψ and φ do not vary over iterations. Then, the labor market aggregates are calculated using the artificial data generated by simulating 100,000 workers.

Figure 1 shows the measures of workers (ψ and φ) and the reservation productivities for match formation (y_w) and high intensity search (y_s). Table 1 compares the labor market statistics in the data with those from the simulation of the model under the benchmark calibration. The measure of workers who have contacts with entrepreneurs (ψ) has relatively a greater mass on high productivities than the measure of workers who do not have contacts with entrepreneurs (φ). These shapes of the measures of workers are a natural consequence of the evolution of idiosyncratic productivities and past match breakups. Given the high persistence of the idiosyncratic productivity, workers who are not currently attached to entrepreneurs are likely to be those who broke up matches due to their low productivity in the past.

Since the model parameters are calibrated in order to replicate the target variables in the data, the model replicates the labor market variables very closely. Especially, the labor market stock variables are very close to their targets. The total mass of psi is 0.6313 (not shown in Figure 1), and 4.5% (2.85% of the population) of these workers have lower productivities than the reservation productivity for match formation ($y_w = 0.7116$) and thus break up. Therefore, the employment to population ratio is 60.28%. The total mass of φ is 0.3687 (not shown in Figure 1), and 89.45% (32.97% of the population) of these workers fall below the reservation productivity for high intensity search ($y_w = 1.1245$), hence the unemployment to population ratio is 3.9%. The labor force participation rate is 64.18% and the unemployment rate is 6.08%.

The worker flows from employment to unemployment and nonparticipation are 0.78% and 1.79% of the population (1.29% and 2.97% of employed workers), respectively. The worker flows from unemployment to employment and nonparticipation are 1.11% and 0.39% of the population (28.59% and 10.0% of unemployed workers), respectively. The worker flows from nonparticipation to employment and unemployment are 1.46% and 0.72% of the population (4.08% and 2.02% of nonparticipants), respectively. The model accounts for only 44% of the worker transition from unemployment to nonparticipation in the data. This is due to the high persistence of the idiosyncratic productivity and the absences of other kind of shocks (e.g. a home productivity shock), which would attract jobless workers with high productivity out of the labor force. Since all unemployed workers who meet entrepreneurs form matches, while only about half of nonparticipants do, the ratio of the hazard rate into employment from unemployment to that from nonparticipation (h_{ue}/h_{ne}) is approximately seven, which slightly overshoots the target.

5. Unemployment Insurance Policy

The majority of previous research on UI policy has focused on changes in the composition of the labor force (measured by the unemployment rate), while the size of the labor force is fixed. Not only the composition of the labor force but also do we pay attention to the effect of a UI policy on the size of the labor force through the changes in worker's labor force participation decision.

We introduce an unemployment insurance (UI) policy in the simplest form: unemployed workers receive a fixed amount of UI benefits denoted by b each period, regardless of their previous employment states and wages received in the previous jobs. The government finances the UI benefits by a lump-sum tax τ on the endowments of entrepreneurs. We adopt this simple tax scheme to focus on the distortions on agents' decisions induced by the payment of UI benefits, rather than one by financing them. effectiveness of UI benefits as subsidies to active job search in the presence of imperfect monitoring ability of the UI authority.

It is well known that UI benefits provide unemployed workers with an incentive to shirk when their search effort is a hidden action, this is so called the moral hazard problem.[15] Since the distinction between the unemployed and nonparticipants is due to their search intensities, the moral hazard in our model occurs in the way that both the unemployed and nonparticipants have a chance to receive UI benefits. Therefore, the effects of UI policy on agents' decision rules, and in turn, the labor market, depends on the UI authority's ability to monitor the non-working individual's search effort, as well as the amount of benefits. Below we examine the UI policy with different degrees of monitoring ability. In the following quantitative experiments, this ability is captured by a parameter p^b, which denotes the successful 'shirking' probability that a nonparticipant can collect UI benefits without getting caught by the authority.

15. Wang and Williamson (1996) and Hopenhayn and Nicolini (1997) consider the optimal UI policies that reduce the negative effect of UI benefits on worker's search effort, while providing consumption smoothing with risk-averse workers. The common feature of their optimal UI policy schemes is that UI benefits decrease with unemployment duration. They reach the same conclusion that the unemployment rate under an optimal UI policy is lower compared to that under the current U.S. system.

5.1. Perfect Monitoring

First, we consider the case that the authority can observe the non-working individual's search intensity so that only unemployed workers can collect the UI benefits, i.e., $p^b = 0$. The moral hazard is abstracted away and the UI benefits serve as a subsidy to high intensity job search by reducing its effective utility cost to $g - b$,

We examine changes in the agents' decision rules and the labor market variables according to increases in UI benefits starting from no benefit ($b = 0$) up to the maximum benefits ($b = 0.23$), which virtually removes the utility cost of active job search. Table 2 presents the results of these experiments for selected values of UI benefits: $b = 0$, $b = 0.04$, $b = 0.08$, $b = 0.12$, $b = 0.16$, and $b = 0.2$. The value $b = 0.04$ corresponds to a reduction in search cost by 17%, $b = 0.08$ by 34%, and so on.

As UI benefits increase, the reservation productivity for high intensity search (y_s) decreases, while the reservation productivity for match formation (y_w) increases, and the number of vacancies (v) decreases. These changes can be easily understood from the value functions in (1) through (5). An increase in UI benefits increases the value $U(y)$ relative to $N(y)$, which induces more non-working individuals search with high intensity. Hence y_s falls with higher benefits. The worker's option value outside employment ($O(y) = \max\{U(y), N(y)\}$) becomes higher, which makes workers more selective in match formation. Hence, y_w rises with higher benefits. Since $O(y)$ is the worker's threat point in wage bargaining, the equilibrium wage becomes higher, which reduces the entrepreneur's flow profits, which, in turn, discourages their vacancy posting.

The labor market variables change as the agents' decision rules change, although the exact effects depend on changes in the measures of workers. The increase in the unemployment to population ratio is a natural consequence of the decrease in y_s, which also increases the hazard rates of worker flows to unemployment from both employment and nonparticipation (h_{eu} and h_{nu}). The decrease in v lowers the meeting probabilities of the unemployed and nonparticipants, so it reduces the hazard rates h_{ue} and h_{ne}, but the effects are proportional. In addition to the effect of the decrease in v, the increase in y_w causes h_{ne} to decrease more than h_{ue}.

The changes in worker's decision rules have offsetting effects on the nonparticipation to population ratio. The increase in y_w induces more workers to discard contacts, if any, with entrepreneurs, and leave the labor force, hence increasing nonparticipation. Among the workers who do not have contacts with entrepreneurs, the decrease in y_s reduces the number of those who exit the labor force. The quantitative results in Table 2 show that falls in y_s (3.8% when $b = 0.04$, 7.9% when $b = 0.08$ and so on) are larger than rises in y_w (0.1% when $b = 0.04$, 0.4% when $b = 0.08$ and so on), which causes the nonparticipation to population ratio to fall and the labor force participation rate to rise.

A distinguishing result of these experiments compared to the traditional two state models is that the employment to population ratio increases with UI benefits, although the increment is small. This change can be understood by examining the changes in the levels of worker flows in and out of employment. It is apparent that ne decreases. One can easily notice that ue increases despite the decreasing hazard rate. This is due to the larger stock of unemployment. The increase in h_{eu} and the decrease in h_{en} imply that more workers search for another job when they are displaced, rather than exiting the labor force. Since unemployment is the more advantageous state to meet entrepreneurs, and the unemployed tend to be more productive, the distribution of workers who have contacts with entrepreneurs moves to the right, hence the lower tail of the distribution gets thinner as UI benefits increase. The mass of workers who terminate their matches decreases, despite the slight increase in y_w. Since the increment of unemployment is larger than that of employment, the unemployment rate becomes higher as UI benefits increase, which is consistent with the findings of most models in the literature with more generous UI benefits.

5.2. No Monitoring

We now consider the effects of the same UI policy when the authority can not observe the individual's search effort. This is the case with $p^b = 1.0$, so that all non-working individuals can collect UI benefits, regardless of their job search behavior. Therefore, the role of UI benefits is an income support to all non-working individuals. Table 3 reports the results of the experiments with more generous UI benefits, and shows a sharp contrast to the results in Table 2.

The absence of monitoring ability has a large impact on the reservation productivity for high intensity search (y_s), which increases with more generous UI benefits, as opposed to the case of perfect monitoring. Since all non-working individuals are equally eligible for benefits, unemployment is not as an attractive state relative to nonparticipation, as is the case with perfect monitoring. Therefore, only high productivity workers would search actively in order to exploit the opportunity of high wages when employed, which raises y_s. As y_s gets higher, the unemployment to population ratio gets smaller. Workers go out of labor force when displaced rather than search for another job actively, which decreases h_{eu} but increases h_{en}. Non-working individuals are more likely to go out of labor force rather than stay in the labor force as unemployed workers, which increases h_{un} and decreases h_{nu}.

The reservation productivity for match formation (y_w) increases by larger increments than with perfect monitoring. The number of vacancies (v) decreases by similar magnitudes as those with perfect monitoring, which lowers the meeting probabilities ($p^u(\theta)$ and $p^n(\theta)$), which, in conjunction with the decrease in y_w, results in lower h_{ue} and h_{ne}. As a result of the increases in y_s and y_w, and the corresponding changes in hazard rates, the nonparticipation to population ratios soars with UI benefits. The employment to population ratio declines rapidly, although h_{ue} and h_{ne} decline similarly as with perfect monitoring. This is attributed to the rapid decline in the total mass of workers who have contacts with entrepreneurs (not shown in Table 3), which is a mirror image of the soar in the nonparticipation to population ratio. Since the meeting probability of a nonparticipant is only 30% of that for an unemployed worker ($p^u(\theta)/p^n(\theta) = \overline{\eta}/\underline{\eta} = 0.12/0.035$ in our calibration), the number of new meetings decreases as unemployment decreases and nonparticipation increases.

The increase in nonparticipation and decrease in unemployment, in response to more generous UI benefits in the presence of the moral hazard, are distinguished. In two state models, the moral hazard typically increases unemployment by lengthening the duration of unemployment spells. A related feature of the experiments is that the unemployment rate decreases with UI benefits, which is opposite to the prediction from two state models. However, our model and two state models produce the common result that employment decreases with UI benefits. Since the measurement of unemployment by the data collecting bureau is based on the non-working individual's search behavior, rather than the receipt of UI benefits, the shirkers should be counted as nonparticipants. In this sense, the model reflects reality better than the two state model.

Andolfatto and Gomme (1996) analyze the effects of the Canadian UI reform in 1972, with a detailed UI policy specification. They also assume that the authority can not monitor the non-working individual's search intensity. In their simulation of the Canadian UI reform characterized by an increase in generosity of benefits, the unemployment rate increases, which is a result of a sharp decrease in employment and a mild increase in unemployment.

5.3. Partial Monitoring

In the previous two subsections, we considered the effects of more generous UI benefits in two extreme environments. However, it is rare for the UI authority to be able to perfectly monitor the individual's search effort. On the other hand, given that the size of nonparticipation is 36% of the population, it is not an acceptable assumption that all non-working individuals are eligible for UI benefits either. In this subsection, we do the same analysis as that of the previous subsections, but with various degrees of the moral hazard. Figure 2 shows how the labor market stock variables vary with more generous UI benefits as p^b increases from 0.1 to 0.9. These experiments shed some light on the design of a UI scheme, the level of UI benefits in order for the authority to accomplish its target levels of the labor market variables, given the monitoring ability.

The employment to population ratio rises with UI benefits when the moral hazard problem is not severe, i.e., a small shirking probability. Roughly speaking, UI benefits have similar effects on the labor market variables which are addressed in Table 2 up to about 5% of the shirking probability (not shown in Figure 2). As the moral hazard gets more problematic (as p^b increases), more generous benefits reduce the employment ratio. The increasing pattern of the unemployment to population ratio with UI benefits is maintained with a significant degree of the moral hazard (up to about 70% of the shirking probability). Up to 20% of the shirking probability, the nonparticipation to population ratio decreases with UI benefits. As the moral hazard becomes severe (the shirking probability higher than 20%) the nonparticipation ratio tends to increase with UI benefits.

It seems obvious that the main purpose of the provision of UI benefits is, in most occasions, to provide the non-working individuals with some income supports in order to mitigate the burden while they search for jobs. It is also seem to be inevitable that the unemployment rate increases as a byproduct of UI benefits. According to the experiments above, however, a well designed UI policy may counterbalance the increase in the unemployment rate. If the UI authority wants to increase the employment to population ratio regardless of the accompanying unemployment rate, it must be able to keep the shirking probability under 5%. On the other hand, if the authority intends to maintain the size of the labor force regardless of the unemployment, it should be able to keep the shirking probability under 20% for any level of UI benefits.

6. Conclusions

We have constructed a variant of the Mortensen–Pissarides matching model in which the worker's labor force participation decision is endogenous. Heterogeneity in workers' productivity has been introduced in order to characterize the non-working individual's search intensity choice, which distinguishes unemployment from nonparticipation. We have introduced a UI policy in the form of increasing benefits and examined its effects on the labor market variables. The results of the experiments crucially depend on the UI authority's ability to monitor the non-working individual's search effort. With perfect monitoring, as the benefits become more generous, the ratios of employment and unemployment to population increase, and the ratio of nonparticipation to population decreases. In the absence of monitoring ability, the changes in the labor market variables are completely opposite. Our findings from the experiments confirm that a UI policy has a significant impact on the size of the labor force as well as the relative composition of the labor force, which must be carefully taken into account when the authority designs a UI scheme. The experiments with various degrees of the severity of the moral hazard shed some light on the design of a UI scheme: the level of benefits in order for the authority to accomplish its target levels of the labor market variables, given the monitoring ability.

The model can be extended to incorporate more a realistic UI system. which may include strict eligibility conditions, a finite benefit duration, duration-dependent benefits, a proportional tax to finance benefits, etc. These extensions enrich the analysis of UI policy and the labor market, and provide more accurate predictions of the policy. The model can also be applied to the analysis of other policies or institutional arrangements, of which main effects may be on the labor force size, for example, minimum wage regulation, welfare payments, labor unions, and various employment protection programs such as firing taxes and severance payments. We defer these analyses to future research.

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Table 1: Labor Market Steady States

	U.S. Data	Model
e	60.23	60.28
u	3.91	3.90
n	35.86	35.82
$u/(e+u)$	6.09	6.08
eu (h_{eu})	0.88 (1.47)	0.78 (1.29)
en (h_{en})	1.88 (3.13)	1.79 (2.97)
ue (h_{ue})	1.05 (27.74)	1.11 (28.59)
un (h_{un})	0.86 (22.80)	0.39 (10.00)
ne (h_{ne})	1.67 (4.66)	1.46 (4.08)
nu (h_{nu})	0.87 (2.45)	0.72 (2.02)

Table 2: Effects of Unemployment Insurance Policy with Perfect Monitoring

Variable	$b = 0.0$	$b = 0.04$	$b = 0.08$	$b = 0.12$	$b = 0.16$	$b = 0.20$
y_s	1.1245	1.0821	1.0356	0.9835	0.9218	0.8370
y_w	0.7116	0.7124	0.7146	0.7176	0.7228	0.7334
v	0.0719	0.0680	0.0665	0.0632	0.0589	0.0556
e	60.28	60.42	60.64	61.07	61.25	61.50
u	3.90	4.68	5.60	6.83	8.61	11.72
n	35.92	34.89	33.76	32.10	30.14	26.78
$u/(e+u)$	6.08	7.19	8.45	10.06	12.32	16.01
h_{eu}	1.29	1.46	1.63	1.82	2.03	2.27
h_{en}	2.97	2.79	2.62	2.42	2.26	2.22
h_{ue}	28.59	26.97	25.63	24.14	22.25	20.06
h_{un}	10.00	9.52	9.17	8.60	8.14	7.83
h_{ne}	4.08	3.74	3.38	2.93	2.37	1.54
h_{nu}	2.02	2.37	2.84	3.51	4.56	6.99

Table 3: Effects of Unemployment Insurance Policy with No Monitoring

Variable	$b = 0.0$	$b = 0.04$	$b = 0.08$	$b = 0.12$	$b = 0.16$	$b = 0.20$
y_s	1.1245	1.1862	1.2510	1.3197	1.3935	1.4718
y_w	0.7116	0.7537	0.7963	0.8393	0.8827	0.9269
v	0.0719	0.0698	0.0667	0.0625	0.0573	0.0523
e	60.28	54.57	48.51	42.49	36.25	30.35
u	3.90	3.56	3.13	2.64	2.12	1.61
n	35.92	41.88	48.36	54.87	61.62	68.04
$u/(e+u)$	6.08	6.12	6.05	5.85	5.54	5.05
h_{eu}	1.29	1.15	0.98	0.83	0.66	0.50
h_{en}	2.97	3.38	3.87	4.32	4.84	5.40
h_{ue}	28.59	26.26	24.24	22.31	20.24	18.41
h_{un}	10.00	11.31	12.92	14.43	16.04	18.18
h_{ne}	4.08	3.68	3.29	2.91	2.54	2.20
h_{nu}	2.02	1.69	1.42	1.13	0.86	0.64

Figure 1: Distribution of Workers and Reservation Productivities

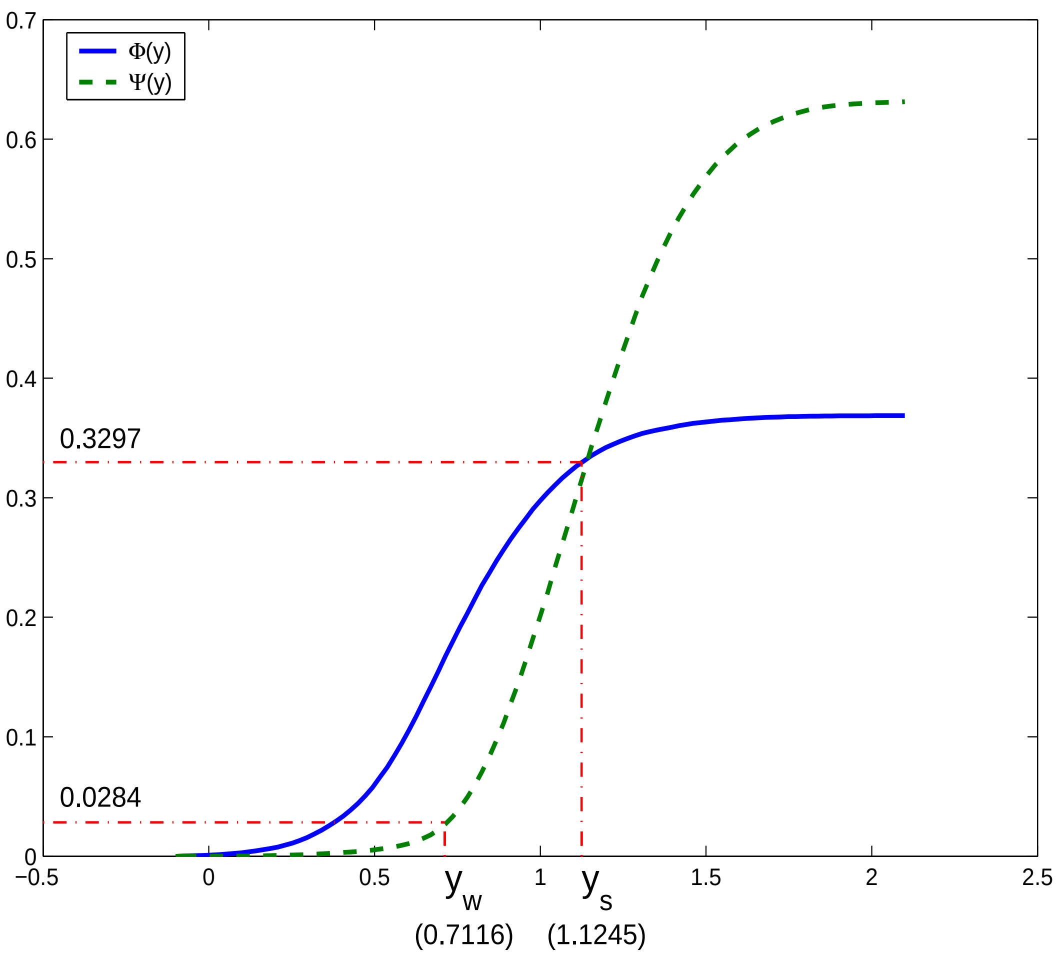

Figure 2: Effects of UI Benefits on Labor Market Variables: Partial Monitoring