UNEMPLOYMENT INSURANCE AND THE BUSINESS CYCLE: WHAT ADJUSTMENTS ARE NEEDED?

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Abstract: While the U.S. has a long history of increasing the generosity of unemployment insurance (UI) during recessions, the literature has yet to fully consider the question of whether these adjustments are optimal. In addition, the large differences in the magnitude of these changes, and the poor design of the U.S. automatic extension program, have resulted in an active policy debate on what revisions to UI benefit extension programs are needed. To address these issues I use a traditional labor search model to explore four areas the government should consider when adjusting benefits: (1) insuring the unemployed; (2) incentives to search for work; (3) UI's impact on wages; and (4) its influence on job creation. Numerical exercises, with a flexible benefit system, support the notion that more generous benefits should be provided to the long-term unemployed when jobs become harder to find. The finding is robust across three different wage setting mechanisms. In addition, a system that only adjusts the number of months UI is available during recessions, as is currently done in the U.S., implies an optimum extension of three months. However, policymakers could increase welfare considerably by adjusting benefit levels as well.

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1. INTRODUCTION

Using a dynamic labor search model, this paper shows that an optimal unemployment insurance system should provide more generous benefits for the long-term unemployed during recessions. High unemployment, low job finding rates, and longer unemployment spells typically characterize economic downturns. This suggests that losing a job during a recession is a greater hardship compared to during an expansion. The United States is one of just two OECD countries that have an unemployment insurance (UI) system that takes this into account by increasing the time period that recipients can draw upon UI benefits, also known as the potential duration.[1] In the U.S., potential duration has been extended in almost every recession in the past fifty years, through a series of both automatic and ad-hoc programs (Vroman, Wenger and Woodbury, 2003). These extensions have varied widely in their generosity, complexity and availability and the automatic program has "essentially repealed" (Nicholson and Needels, 2006: 65). As a result there is an active policy debate on how the UI system should adjust with changing labor market conditions. In addition, while there is a vast literature on the design of an optimal UI system, it has yet to fully address the question of how, or if, the system should adjust with the business cycle. This paper contributes to the literature, as well as the policy debate, by demonstrating that UI should become more generous for the longer-term unemployed during recessions and quantifies the magnitude of these adjustments.

I take the approach that the design of an unemployment insurance system that varies with the business cycle must not only consider the different degrees of insurance that should be provided, but also its macroeconomic effects on unemployment. In terms of insuring the unemployed, the current U.S. program replaces slightly less than 50 percent of earnings for approximately six months for individuals who involuntarily lose their jobs. In addition, while the automatic stabilizing feature of unemployment insurance is often discussed, benefits replace just 8 to 15 percent of lost earnings in U.S. recessions, even including benefit extension programs (Corson, Needles and Nicholson, 1999). The additional insurance that UI may provide during recessions needs to be balanced against the macroeconomic effects on the labor market. Nickell (1997) and Layard, Nickell and Jackman (1991) present empirical evidence of a positive relationship between higher unemployment insurance benefits and greater unemployment. Two theoretical mechanisms that may explain this relationship are often proposed. First, Mortensen (1977) shows that higher benefits create disincentives to search for employment, increasing the

[1] Canada is the other OECD country that takes economic conditions into account. Canada determines potential duration using the number of hours an individual has worked and the economic region's unemployment rate.

time it takes to find a job. Second, the standard Pissarides (1990) search model implies that more generous UI payments increase the opportunity costs to work and consequently puts upward pressure on wages. This in turn decreases firms' incentives to open vacancies. Further, as suggested by Blanchard and Wolfers (2000), unemployment in economies with more generous benefits may react more strongly to adverse productivity shocks. The choice of any adjustment to benefits during a recession consequently necessitates balancing the need for greater insurance against the costs of higher unemployment.

I assess these competing interests using a dynamic search model to determine how benefits should change with the business cycle. In order to accomplish this, I subject the economy to stochastic productivity shocks. While in reality perfect information about the current state of the economy is not available, the model I present in this paper assumes the government can observe current labor market conditions. In a companion paper I describe how, on a practical level, the government could infer the state of the economy using a Markov Switching model when only imperfect information is available. In addition, unlike prior work that examines adjustments to UI during economic downturns, the search model employed in this paper endogenizes wages and job creation. Another important aspect of the model is the division of the unemployment spell into several periods, which allows for an accurate reflection of an individual's search behavior and the possibility of a non-monotonic optimal sequence of benefits during an unemployment spell. These aspects of the model unify two strands of the literature to address the specific question of how benefits should change during economic downturns.

While this paper considers the macro influences of unemployment insurance on wages, vacancies, and unemployment, the first strand of literature analyzes only the moral hazard problem and holds wages and labor market conditions fixed. In Shavell and Weiss's (1979) seminal work, the authors determine the utility maximizing sequence of benefits given a fixed budget constraint and moral hazard, when efforts to find work cannot be observed. When agents do not have access to credit markets, a declining sequence of benefits provides the appropriate incentives to search for employment. Hopenhayn and Nicolini (1997) use a recursive contract framework with moral hazard, where the government's objective is to provide a promised level of utility at minimum cost. Workers exert effort, which is not observable by the government, to find a job that has an infinite duration. Again, a declining sequence of benefits is optimal. Wang and Williamson (2002) provide an example where a monotonically declining sequence of benefits is not preferred. They allow for precautionary savings and multiple unemployment spells within a Hopenhayn and Nicolini (1997) type model. After an initial period, benefits fall substantially to give incentives to search. However, as duration continues and assets are exhausted, benefits increase to provide insurance for the long-term unemployed. Kiley (2003) uses the Hopenhayn and Nicolini (1997) model to demonstrate that when jobs become harder to find, in order to reach the same promised level of utility, the government must increase the level of benefits provided throughout the unemployment spell and have them fall at a slower rate. In a similar setting to Wang and Williamson (2002), but without personal savings, Sanchez (2008) shows that the benefit scheme should become more generous as the job finding rate worsens.[2]

The search model I develop in this paper differs with the dynamic recursive contract literature by recognizing that UI has consequences for the broader economy. Cahuc and Lehmann (2000), citing the work of Holmlund (1998), state "it is well known that the level of unemployment benefits influences wages, labor cost and labor demand as well as search intensity," (137). The authors' assertion is supported by several empirical studies. Using British data, Layard and Nickell (1985) established a link between UI benefits and unemployment via real wages. In the U.S., Feldstein and Poterba (1984) use a survey of individuals' reported reservation wages and find that unemployment insurance puts upward pressure on wage expectations. As a result, it is important to consider UI's positive relationship with wages and negative relationship with job creation that results from higher labor costs. During recessions, governments are typically interested in giving incentives to create jobs and may be wary about policies that work against this goal. Therefore, these factors have the potential to mitigate or even reverse the conclusions from Kiley (2003) and Sanchez (2008). It is critical that they be considered when analyzing how UI benefits should change in recessions.

This paper explores a dynamic search model that allows UI to adjust to the business cycle. The model is based on the second strand of the optimal unemployment insurance literature which uses a Pissarides (1990) type search model to endogenize wages and job creation. In Davidson and Woodbury (1998), the authors consider the effect of UI on wages in a model where the government maximizes the sum of agents' discounted utility by varying the replacement rate and potential duration. After UI benefits are exhausted, no further government benefit is provided. Davidson and Woodbury's (1998) numerical results with endogenous wages indicate an optimal potential duration of between 20 and 104 weeks and a replacement rate between 0.50 and 0.68, depending on various factors, including risk aversion. However, Davidson and Woodbury (1998) illustrate that their model implies that UI should be provided indefinitely when wages are exogenous. Contrary to much of the literature, the authors suggest that it is not

[2] In Sanchez (2006), the UI contract should be more generous with worsening labor market conditions if the elasticity of the probability of staying unemployed, with respect to effort, decreases as the probability of staying unemployed increases.

necessary to provide incentives for individuals to vary their search effort during an unemployment spell and changes in current unemployment benefits are only needed to influence wages and job creation. This finding likely comes from two sources. First, the result is derived assuming a fixed tax rate. However, providing UI benefits for a fixed duration will increase search effort, lowering unemployment, and may improve the welfare of the employed by allowing for a lower tax rate. Second, Davidson and Woodbury (1998) assume that no additional government benefits are provided after UI is exhausted, which is a fairly severe punishment. As a result, a large welfare improvement can be achieved by ensuring that individuals face a very small or zero probability of exhausting benefits.

By allowing the government to choose the benefit level at various points during the unemployment spell, including a social assistance benefit received after UI is exhausted, I avoid the extreme drop in consumption modeled by Davidson and Woodbury (1998). In addition, when analyzing the optimal potential duration, I do not assume a fixed tax rate. This approach is similar to that of Cahuc and Lehmann (2000) and Frederickson and Holmlund (2001). Cahuc and Lehmann (2000) develop a model where the unemployed are divided into two periods, the short-term unemployed, which receive unemployment insurance, and the long–term unemployed, which receive social assistance (potential duration is ignored). The authors show that with fixed wages, a downward profile of benefits, where UI is higher than social assistance, leads to a strong decrease in unemployment. This in part calls into question Davidson and Woodbury's (1998) result that UI should be provided indefinitely when wages are fixed. In Cahuc and Lehmann's (2000) full model, wages are determined by insiders with short-term unemployment, providing the opportunity costs in wage negotiations. As a result, increasing the value of being unemployed in the initial period increases wages and decreases job creation. It may be optimal instead to keep unemployment benefits low, even relative to social assistance, to encourage job creation. This is a possibility that the Davidson and Woodbury (1998) model cannot consider since only the unemployment insurance benefit is chosen by the government.

This paper, in contrast to Cahuc and Lehmann (2000) who use the Rawls (1971) welfare criterion and the level of unemployment to evaluate the benefit system, employs a utilitarian welfare function similar to Frederickson and Holmlund (2001). A utilitarian welfare function takes into account the effects on the employed, which must finance the UI system. Frederickson and Holmlund (2001) keep the two period structure of unemployment, yet assume a positive probability of losing UI benefits, which they interpret as the inverse of potential duration. For reasons similar to Cahuc and Lehmann (2000), the authors conclude that with positive discounting, it is analytically ambiguous as to whether or not UI benefits should be greater than social assistance. However, the general conclusion of their calibration exercise is that the unemployment benefit should be higher.

In addition to considering how benefits may vary with labor market conditions, the model in this paper has an advantage over Cahuc and Lehmann (2000), and Frederickson and Holmlund (2001) by considering variations in effort during an unemployment spell. This is a key feature of the unemployment experience and should be captured by models concerned with the duration of unemployment spells. Mortensen (1977) develops a search model that supports the notion that as an individual nears the point of exhausting benefits, she increases the level of effort exerted to search for work. Using administrative records from the United States, Meyer (1990) and Katz and Meyer (1990) find empirical evidence that escape rates do increase through an unemployment spell, particularly immediately before benefits are exhausted. However, in Cahuc and Lehmann (2000) there is just one effort level in the economy. This is because with only two periods of unemployment both the short-term and long-term unemployed will find themselves in a state of long-term unemployment if they do not find a job. As a result, they face the same problem with respect to their search decision and, contrary to the theoretical and empirical evidence, choose the same effort level. Frederickson and Holmlund's (2001) inclusion of a positive probability of exhausting benefits creates differences between the effort exerted by the short and long-term unemployed, but does not capture increases in search prior to benefit exhaustion. While both sets of authors show that many of their conclusions generalize to a model of multiple periods of unemployment, I find that these additional periods allow for a richer analysis. In particular, multiple periods of unemployment allow me to lift the restriction that the benefits sequence must be monotonic, which proves to be important early in an unemployment spell.

This paper presents results from several numerical experiments that explore how UI benefits should change during recessions using an adaptation of the Cahuc and Lehmann (2000) and Frederickson and Holumnd (2001) models that allow for stochastic productivity shocks to the economy and multiple periods of unemployment. The first set of exercises focuses on how an optimal UI system, where benefits vary throughout an unemployment spell and with the business cycle, should be designed. The model indicates that in a recession optimal UI is more generous for the longer-term unemployed than in expansions. However, contrary to the recursive contract literature, benefits for the short-term employed should become less generous. The next set of experiments analyzes the question of how long benefits should be extended during economic downturns within the step-function type structure of the current system. The results indicate that benefits should be extended for an additional three months, consistent with the current U.S.

automatic extension program. Finally, I analyze what portion of the improvement in welfare relates to extending potential duration. While benefit extensions improve social welfare, this analysis shows a much larger increase can be obtained by adjusting benefit levels as well. In addition, such a program is likely to be more politically viable than a program focusing solely on potential duration. In the future, when revising or implementing extended benefit programs, policymakers should consider adjustments to benefit levels, in addition to increasing potential duration.

The remaining sections of this paper are organized as follows. Section 2 provides some context by describing the U.S. unemployment insurance system and how it changes in recessions. Next, Section 3 outlines the search model I use in the analysis and Section 4 discusses a version of the model with two unemployment periods to highlight the changing returns to effort in recessions compared to expansions. Section 5 describes the calibration of the model and computational strategy and Section 6 presents the results. Finally, Section 7 concludes.

2. U.S. Unemployment Insurance System

The U.S. unemployment insurance system has a long history of taking varying labor market conditions into account, within what Woodbury (1995) describe as three tiers of benefits. The first is the regular UI system, the second is an automatic standby extended benefit (SEB) program that requires no congressional action, and the third is the emergency extended benefit (EEB) programs passed individually by Congress during various recessions. When considering the varying rules across states for the regular UI program, as well as the changing policies across time, particularly for EEB programs, the system can be quite complex.

The regular unemployment insurance system in the U.S. is a state administered program within federally mandated guidelines. The program is funded through the Federal Unemployment Tax Act (FUTA), which authorizes the IRS to collect taxes for administrative purposes and state workforce agencies to collect taxes to fund benefits (U.S. Department of Labor, 2004). For states that have UI programs that conform to federal requirements, a substantial portion of the administrative tax is refunded to employers. States may differ in their maximum allowable potential duration of benefits[3], the method used to determine potential duration on an individual basis[4], and the benefit calculation[5]. However, the standard benefit is

[3] For example, the maximum duration in Massachusetts is 30 weeks and in Montana is 28. The remaining states offer a maximum duration of 26 weeks (U.S. Department of Labor, 2004b)
[4] In a small number of states, the same duration is provided to all individuals. However, for a majority of states, the maximum number of weeks available is a function of a person's earnings or employment history. (Woodbury, 1995: 12).

about fifty percent of wages paid for a maximum of six months. It is also important to note that within the regular UI program, there may be changes in benefits and duration depending on labor market conditions. For instance, when wages rise, more workers may hit the maximum allowable benefit. As a result, the average replacement rate, which is the ratio of the benefit to wages, may fall. The differences across states and time can result in significant variations in benefits.

In 1970, the Federal-State Extended Unemployment Compensation Act was passed, establishing the second tier of UI benefits, the stand-by extended benefit program (SEB). Half of the program's funding is derived from FUTA taxes, while the remaining half is funded by the states. An individual becomes eligible for the SEB program if the following conditions are met: unemployment has risen above a certain threshold level; regular, and sometimes an EEB program's benefits, are exhausted; and the individual has worked 20 or more weeks in their base period. If a person meets these requirements, he/she is eligible for an extension equal to fifty percent of their potential duration under the regular UI program, up to a maximum of 13 weeks (Woodbury, 1995: 5). However, primarily due to the stringent requirements for a state triggering on benefits, as well as the secular decline in the unemployment rate for which these triggers are based, fewer individuals are meeting these criteria.[6] For instance, from 1981 to 1982, residents in 32 states had access to the SEB program, while between 2003 and 2004 access was restricted to just five states. While it is commonly thought that the recession of the early 2000s was fairly mild, in fact the peak average duration of an unemployment spell was just 0.3 weeks lower than its peak in the recession of the 1980s. Consequently, it is not clear that the SEB program should be more widely available in the 1980s than it is today. The lack of availability of benefit extensions under the SEB program, which has rendered it virtually irrelevant, has sparked several papers that have proposed revisions to make the program viable again (see Vroman and Woodbury, 2004; and Wenger and Walters, 2006).

The third tier of benefits consists of a fairly diverse group of Emergency Extended Benefit programs that differ in terms of generosity and complexity. For instance, the Federal Supplemental Benefits (FSB) program passed within three years of the SEB program going into effect in all states, provided some with benefits for as long as 65 weeks. In contrast, the first

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[5] The benefit calculation is a percentage of a defined period's wage, given that the resulting benefit amount falls within state minimum and maximums (U.S. Department of Labor, 2004b).

[6] Prior to 1981, an un-seasonally adjusted 13 week average insured unemployment rate (IUR) greater than 4.0% at the state level and 20% higher than the prior two years was required to turn on the trigger. Alternatively, at the national level a 13 week average IUR greater than 4.0% would also trigger the SEB program. After 1981, the national trigger was eliminated and the state trigger was increased to a 13 week average IUR greater than 5% (Vroman and Woodbury, 2004). In 1992, a total unemployment rate trigger greater than 6.5%, and exceeding the same rate in the previous two years by 10%, was added (Nicholson and Needels, 2004).

phase of the Federal Supplemental Compensation (FSC) program extended benefits just six weeks in the early period of the 1981 – 1982 recession (U.S. Department of Labor, 2007). There are also large variations within a given EEB Program. For instance, the FSC went through four phases and the Emergency Unemployment Compensation (EUC) of the early 1990s went through five with varying degrees of benefit duration, depending on congressional action or labor market conditions (Woodbury, 1995: 7). The EUC was so complex that some states, such as Pennsylvania and Michigan, had more than a half a dozen changes in potential duration from 1990 to 1995 (Vroman and Woodbury, 2004; 67 , analysis of Bureau of Labor Statistics trigger notice data, 2007). Despite this long, and somewhat complicated history of adjusting the UI system in recessions, there appears to be little consensus among policymakers on the appropriate level of extensions. The remaining sections of this paper establish the need for such adjustments in recessions and their magnitude.

3. Search Model of Optimal UI over the Business Cycle

TABLE 1: MODEL VARIABLES AND DEFINITIONS

Variable	*Description*	*Variable*	*Description*
z	Productivity	θ	Labor market thickness
w	Wage	e^d	Search effort
$p(\theta, e^d)$	Job finding probability	$a(e^d)$	Application production function
A	Aggregate number of applications	υ	Vacancies
n	Employment	u	Aggregate unemployment
u^d	Unemployment in the *dth* period	$M(A, \upsilon)$	Total number of matches
$q(\theta)$	Job filling rate	s	Probability of match being destroyed
k	Cost of maintaining a vacancy	τ	Tax rate
$v(c)$	Utility over consumption	$h(e^d,w)$	Disutility of search
Φ^d	Difference in utility between unemployed *d* and *d+1* periods, excluding effort	ψ^d	Difference in utility between employed and unemployed in state *d*
$V^e(w_t)$	Discounted utility of the employed	$V^{u^d}(w_t)$	Discounted utility of agent in state *d* of unemployment
J^e	Discounted utility of matched firms	J^v	Discounted utility of firms with a vacancy
SW	Social welfare, sum of agents' utility	$\beta=1/(1+r)$	Discount rate
T	Termination costs	ϕ	Nash bargaining parameter
Y	Costs or benefit received by firm while negotiations are on-going (applies to strategic bargaining only)	Δ	Time between offer and counter offer (applies to strategic bargaining only)
X	Costs or benefit received by worker while negotiations are on-going (applies to strategic bargaining only)		

This section describes the search model that is used to analyze how UI should adjust with the business cycle and assess the adequacy of the current U.S. programs used to extend benefits.

There are four important considerations in determining an optimal UI system that are captured by the model: (1) insuring the unemployed, (2) providing appropriate incentives for the unemployed to search for work, (3) the effect of the UI system on wages and (4) its influence on job creation. These four aspects of choosing a UI system change with the business cycle and consequently, a benefit system that is independent of labor market conditions, is likely to be sub-optimal. While, Kiley (2003) and Sanchez (2008) consider the first two of these issues the dynamic model presented in this section allows wages and job creation to be endogenous. If increasing benefits puts upward pressure on wages resulting in lower job creation it may not be optimal to increase benefits during recession when job creation is already low.

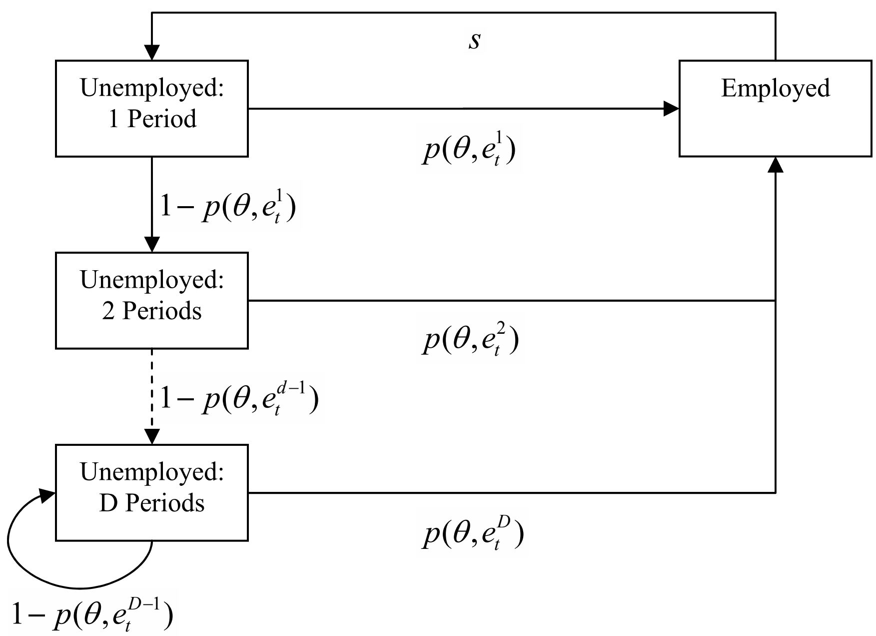
3.1 Matching Technology and Worker Flows

The model is a discrete time analog to the Pissarides (1990) matching model, similar to Cahuc and Lehmann (2000) and Frederickson and Holmlund (2001). I adopt the notation that a variable x at time t, applied to those in their d^{th} period of unemployment, is denoted x_t^d and for much of the discussion, I drop the time index for ease of reading. A full list of the variables and definitions can be found in Table 1.

The economy consists of a finite measure of infinitely lived workers normalized to unity, and an endogenously determined continuum of firms. Workers are the sole input in the production process and can be either matched with a firm (employed) or unmatched and searching for work. When matched they produce a numeraire good of which the firm pays a portion to the worker. The worker in turn provides a share to the government to fund the unemployment insurance system. The productivity of the match is constant across matches but varies stochastically through time, where high levels of productivity can be thought of as expansions and low levels as recessions. Productivity is also observable by workers, firms and the government. The unemployed receive a benefit from the government based on being in one of D states. States $d=1,\ldots,D-1$ correspond to those in their d^{th} period of unemployment. State D is an absorbing state that holds all workers unemployed more than $D-1$ periods. The good is non-storable, thus firms and workers consume their entire share of the periods' production and the government redistributes all tax revenue collected.

The unemployed can influence their probability of finding a job by exerting effort, e^d. Following Davidson and Woodbury (1998), it is helpful to think of effort as an input in the production of job applications, where the production function $a(e^d)$ is increasing in e^d and concave. In aggregate, the effective number of applications is $u\overline{a} = A$, where $\overline{a}$ is the average number of applications generated by the unemployed, *u*. Firms create jobs by posting vacancies (υ) each period, with the total number of matches determined by a linear homogenous function, $M(A,\upsilon)$. Market thickness is defined as $\theta = \upsilon / A$. A worker exerting effort, e^d, has a probability $p(\theta, e^d) = a(e^d)M(A,\upsilon)/A = a(e^d)\alpha(\theta)$ of finding a job and a firm has a probability of filling a position of $M(A,\upsilon)/\upsilon = q(\theta)$, where $\alpha'(\theta) > 0$ and $q'(\theta) < 0$.

FIGURE 1: EMPLOYMENT AND UNEMPLOYMENT FLOWS



Matches are destroyed exogenously and at random with a fixed probability, *s*. While a constant job destruction rate is an over-simplification, evidence from Hall (2005) and Shimer (2005a) suggest that separations are far less cyclical than accessions. Figure 1 diagrams the flows between the various labor markets, which are given by the following equations:

(1) $$u_{t+1}^1 = sn_t$$

(2) $$u_{t+1}^d = u_t^{d-1}(1 - p(\theta, e_t^{d-1})) \quad \text{for } d=2,..D\text{-}1$$

(3) $$u_{t+1}^D = u_t^{D-1}(1 - p(\theta, e_t^{D-1})) + u_t^D(1 - p(\theta, e_t^D))$$

The first period of unemployment in time *t+1* is given by *s* and the measure of employed workers, *n,* in time *t*. The number unemployed in *t+1* for states two to *D-1* is determined by the number of unemployed workers in the previous state at time *t* that have not found work.

Similarly for state *D,* the number unemployed is given by the number in *D-1* as well as *D* that did not find work at time *t*.

3.2 Workers

Employed workers receive a wage of *w* and face a payroll tax rate, τ. The unemployed are paid a benefit, *wb(d)*, where *b(d)* is the replacement rate. The notation *b(d)* is meant to stress that while the government may choose specific values for the replacement rate for states *d=1,..,D,* it may also choose parameters of a specific functional form that depends on *d*. In addition to receiving unemployment benefits, workers who are unemployed must choose a level of search effort, e^d. Workers are forward looking in terms of anticipating changes in productivity, but they are unaware that the government may adjust benefits as labor conditions change. Rogers (1998), who examines data from Pennsylvania, finds that the unemployed only imperfectly anticipate changes in their benefits. So while this assumption is somewhat unrealistic, it would also be incorrect to assume that workers are fully aware of adjustments to the benefits scheme.[7]

Workers are risk adverse and I use a separable form of the CRRA utility function adopted by Frederickson and Holmlund (2001). Specifically, the utility over consumption is $v(c) = c^{1-\sigma}/1-\sigma$ with *c* equal to $w(1-\tau)$ or *wb(d)* for employed and unemployed workers, respectively. I also assume that the cost of effort is proportional to the wage rate such that $h(w,e) = [w^{1-\sigma}/1-\sigma]e$.[8] It is convenient to define two terms that, under the assumed functional forms, do not vary with *w*.

$$\psi^d(\tau, b(d), e) = \frac{v(w(1-\tau)) - (v(wb(d)) - h(e^d, w))}{w(1-\tau)v'(w(1-\tau))} \quad \text{for } d=1,..,D \tag{4}$$

$$\Phi^d(b(d), b(d+1)) = \frac{v(wb(d)) - v(wb(d+1))}{w(1-\tau)v'(w(1-\tau))} \quad \text{for } d=1,..,D-1 \tag{5}$$

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[7] A simulation was conducted where workers partially anticipate changes in benefits and the conclusions presented in this paper are largely unchanged. However, under this simulation the anticipation of a benefit change in a recession generates a large amount of effort and may result in an unemployment rate that increases sharply with a productivity shock, but returns to its pre-recession levels even with the continuation of low levels of productivity. As a result I find the assumption that workers do not anticipate changes in UI more appealing.

[8] This is a separable version of the utility function used in Frederickson and Holmlund (2001), which effectively eliminates the impact of the wage on the worker's effort decision. Since labor market thickness and wages are both pro-cyclical, this dampens the magnitude of the fluctuations in effort through the business cycle, but not the direction.

$\psi^{d}(\tau, b(d), e)$ represents the change in utility from being unemployed *d* periods to employed, while $\Phi^{d}(b(d), b(d+1))$ is the change from being unemployed *d* to *d+1* periods, excluding the disutility of effort. Both are normalized by $w(1-\tau)v'(w(1-\tau))$ for mathematical convenience.

The standard value equations for an employed worker, V^{e}, and one in the d^{th} period of unemployment, $V^{u^{d}}$, is given by:

$$V^{u^{d}}(w_t) = \max_{e_t} \beta[v(w_t b_t(d)) - h(e_t^d, w_t) + p(e_t^d, \theta_t) E_t V^{e}(w_{t+1}) + (1 - p(e_t^d, \theta_t)) E_t V^{u^{\min(D,d+1)}}(w_{t+1})] \quad (6)$$

for *d=1,...,D*

$$V^{e}(w_t) = \beta[v(w_t(1-\tau_t)) + (1-s) E_t V^{e}(w_{t+1}) + s E_t V^{u^{1}}(w_{t+1})] \quad (7)$$

where $\beta = 1/(1+r)$ is the subjective discount rate. Since effort is unobservable, the unemployed are free to choose their level of effort, which they do according to the condition:

$$-h_e(e_t^d, w_t) + p_e(e_t^d, \theta_t) E_t[V^{e}(w_{t+1}) - V^{u^{\min(D,d+1)}}(w_{t+1})] = 0 \text{ for } d=1,...,D \quad (8)$$

As in Cahuc and Lehmann (2000) individuals in state *D-1* and *D* will find themselves in state *D* if they do not find a match. Consequently, they face identical problems and choose the same level of effort. However, those that are unemployed less than *D-1* periods may face different benefit levels in future periods, and as a result, will choose different levels of effort.

3.3 Firms

Firms can be in two states, waiting to find a match, J^{v}, and matched with a worker, J^{e}. There is a cost, *k,* of maintaining a vacancy each period and, when matched, firms earn *z* and pay wages, *w*. If a match is destroyed, either exogenously or because a wage cannot be agreed upon, firms incur a termination cost of *T,* which is non-transferable to the other agents in the economy. Similar to Silva and Toledo (2005), these costs can be interpreted as a disruption in the production process. The main purpose of including termination costs is to improve the model's ability to match the business cycle facts, which will be discussed in more detail in the next section.

The related value equations for unmatched, J^{v}, and matched firm, J^{e}, is as follows:

$$J^{v} = \beta[-k + q(\theta_t) E_t J^{e}(z_{t+1}) + (1 - q(\theta_t)) E_t J^{v}] \quad (9)$$

$$J^{e}(z_t) = \beta[z_t - w_t + (1-s) E_t J^{e}(z_{t+1}) + s E_t (J^{v} - T)] \quad (10)$$

As is standard, the free entry condition, which states that firms are competitive and open additional vacancies until $J^v = 0$, holds in every period.

3.4 Wage Setting

One of the notable contributions of the standard search model is its ability to match the direction of many of the key economic series over the business cycle. However, Shimer (2005a), notes that the model explains only a very small portion of the volatility in these series. A growing strand of literature (see Shimer, 2004; Hall and Milgrom; 2005; Hagedorn and Manovskii, 2008; Hornstein, Krusell and Violante, 2005; Silva and Toledo, 2005; Mortensen and Nagypal, 2007) has considered this issue and what adjustments to the model that may improve its ability to track the key economic series. Specifically, Silva and Toledo (2005) develop a model that includes newly employed entrants and incumbents. Firms must pay a termination cost when a separation occurs. This lowers the value of a newly filled position and makes it more sensitive to variations in productivity. As a result job creation becomes more volatile to productivity shocks. Since the primary concern of this paper is adjustments in unemployment insurance with the business cycle I want to ensure realistic fluctuations of the key variables with the business cycle. At the same time I do not wish to overly complicate the model. As a result I include termination costs that are described by Silva and Toledo (2005), but exclude differences between new entrant employees and incumbents.

The Nash bargaining mechanism is motivated by the power of insiders; whose fall back position is the first period of unemployment. As a result benefits paid early in one's spell have a strong positive influence on wages. Insiders negotiate the wage that is available throughout the economy. In this case the Nash bargaining equation takes the form:

$$\max_{w}[V^e(w) - V^{u^1}(w)]^{\phi}[J^e(z) - (J^v(z) - T)]^{1-\phi}$$

(11)

$$\Rightarrow \frac{\phi[J^e(z) - (J^v(z) - T)]}{(1-\phi)w} = \frac{[V^e(w) - V^{u^1}(w)]}{w(1-\tau)v'(w(1-\tau))}$$

The inclusion of termination costs means that $J^v(z)$ alone is no longer a credible fall back position for firms, since both sides know that termination costs must be paid if the negotiations are not successful. As a result, the threat point for firms is $(J^v(z) - T)$.

3.5 The Government

The optimal benefit sequence is determined by a benevolent government that has the ability to raise revenue from the current pool of employed workers. At the beginning of each period, the government can observe the status of the economy, which consists of productivity, employment, the level of unemployment and distribution of unemployment across the *d* states (referred to as the unemployment distribution). The government announces the schedule of benefits, *b(d),* and by virtue of a balanced budget constraint, the tax rate. The government's objective function, *SW*, is utilitarian:

(12) $$SW = \max_{\{b(d),\tau\}_t^\infty} = \sum_t^\infty \beta^t E_t[n_t v(w_t(1-\tau_t)) + \sum_d^D u_t^d (v(w_t b_t(d)) - h(w_t, e_t^d))]$$

subject to a balanced budget constraint:

(13) $$n_t \tau_t = \sum_d^D u_t^d b_t(d)$$

the laws of motion for unemployment as given by (1) - (3), the wage setting equation (11) and the free entry condition. In a perfectly flexible benefit scheme, where the government is free to set the replacement rate separately in each of the *d* states, the optimal level of benefits is given by the first order condition:

(14) $$\frac{dSW}{db(d)} = \frac{\partial SW}{\partial b(d)} + \frac{\partial SW}{\partial \tau}\tau_{b(d)} + \sum_j^D \frac{\partial SW}{\partial e^j} e_{b(d)} + \frac{\partial SW}{\partial w} w_{b(d)} + \frac{\partial SW}{\partial \theta}\theta_{b(d)} = 0$$

The first term on the right hand side of the first equality represents the benefits to insuring workers against a job loss, while the second measures the cost of raising taxes on the employed. The change in the benefit schedule will have implications in terms of the amount of search effort, which is captured by the third term. The impact on search may be positive for benefits early in the spell through what Mortensen (1977) termed the entitlement effect. A front loaded benefit schedule can increase incentives to search for a job because greater insurance exists if, subsequently a match is destroyed. However, as more commonly thought greater benefits, particularly later in one's unemployment spell decreases effort by making unemployment more comfortable. The fourth and fifth terms measure the influence of the benefit scheme on the outside economy. The fourth captures the increase in wages that comes from increasing the value of being unemployed, which is offset by the cost in terms of lower job creation as indicated by the last term. To gain some intuition regarding the first three terms, the next section analyzes the model with only short and long-term unemployment.

4. Model of Short and Long-term Unemployment

To clarify the changing costs and benefits of effort with differing values of productivity, this section imposes the following simplifying assumptions on the model:

(1) *D* is set to two. As in Cahuc and Lehmann (2000), two periods of unemployment can be interpreted as short-term (*d=1*) and long-term unemployment (*d=2*). As mentioned, the main implication of this assumption is that short-term and long-term unemployed will choose the same level of effort denoted simply as *e*.

(2) Productivity is deterministic, thus removing the expectation operator from the various value equations.

(3) The impact of UI on job creation and wages is left to the numerical exercises and, this section assumes that the government takes *w* and θ as given.

(4) Terminations costs are set to zero.

Under these four assumptions, a steady state equilibrium is characterized by a *w*, θ, *e, b(1), b(2),* τ, u^1, and u^2 that satisfy (11), the law of motion for unemployment (1) - (3), the optimal choice of effort (8), and maximize social welfare. For a given set of benefits and taxes rates, the following three conditions characterize an equilibrium for *w*, θ, and *e*:

(15) $$z - k(r+s)/q = w$$

(16) $$\phi k(r+s+p) = (1-\phi)(qz - k(r+s))(\psi^2 - \beta(r+p)\Phi)$$

(17) $$\phi k a' \alpha = (1-\phi)(qz - k(r+s))(\psi_e - \beta\Phi)$$

As in the Frederickson and Holmlund (2001) model, (16) uniquely defines θ, independent of either the wage or the amount of search. Implicitly differentiating equation (16), it can be shown that *b(1)≥b(2)* is a sufficient condition for: $\theta_{b(1)} < 0$, $\theta_{b(2)} < 0$, and $\theta_z > 0$. Increases in the benefit system puts upward pressure on wages and consequently lowers the value of creating vacancies, while higher levels of productivity increases profits leading to more job creation. Similarly, for a given level of market thickness, $e_{b(1)} > 0$, $e_{b(2)} < 0$, $e_\tau < 0$ and $e_z > 0$, for any choice of the benefits. As pointed out by Frederickson and Holmlund (2001), the effect of *b(1)* on search is driven by the entitlement effect. Benefits for the long-term unemployment decreases the value of transitioning to employment and consequently decrease effort. Higher taxes also decrease effort since they make employment less valuable. In equilibrium, productivity and market thickness increase effort as employment becomes more desirable. Consequently, as productivity increases the job finding rate increases directly through an increase in market thickness and effort, as well as indirectly through θ's effect on effort. (see Appendix 1).

Proposition 1: If the government can observe individuals effort the government perfectly insures workers against job loss and increases UI benefits (decreases taxes) when unemployment increases.

Proof: Observable effort implies that e is an additional choice variable for the government. Since effort can be observed, the government can penalize individuals who do not follow the proscribed level of search, and it is never optimal for them to deviate from the chosen level of e. As a result (8) is no longer a constraint in maximizing social welfare. First order conditions with respect to τ , *b(1),* and *b(2)* along with the budget constraint imply that $(1-\tau)=b(1)=b(2)=n$. See Appendix 2 for more detail.

In an economy where effort is observable, the government perfectly insures workers against the possibility of losing their job. In addition, when the government has more resources, as it does in expansions, and does not perceive the effect on wages and job creation, all individuals receive higher consumption.[9]

Frederickson and Holmlund (2001) Result: The authors show that too little effort is exerted when agents choose their own level of effort.

Proof: Following Frederickson and Holmlund (2001) evaluate $\frac{\partial SW}{\partial e}$ at steady state values to determine the marginal social benefit of effort where *b(1), b(2)* and τ are at their optimum, conditional on effort being observed:

(18) $$\frac{\partial SW}{\partial e} = w(1-\tau)v(w(1-\tau))'[-\psi_e + a'(e)\alpha(\theta)\frac{\psi}{r+s+a(e)\alpha(\theta)} + \frac{a'(e)\alpha(\theta)}{r+s+a(e)\alpha(\theta)}]$$

The first two terms in brackets represent the first order condition for an unemployed worker's effort decision and, consequently total zero when workers, not the government, optimally choose their effort level. If this condition was to also hold at the social optimum, when effort is observable, then $\frac{\partial SW}{\partial e}$ becomes:

(19) $$\frac{\partial SW}{\partial e} = a'(e)\alpha(\theta)\frac{w(1-\tau)v(w(1-\tau))'}{r+s+a(e)\alpha(\theta)} > 0$$

Thus the marginal social benefits have not been exhausted at the individual's choice of effort.

[9] Allowing savings on the part of the government would further complicate the model, but would imply that government smoothes consumption over time as well.

The effort chosen by workers for a given level of benefits and taxes is socially sub-optimal as a result of a positive externality to search. Increasing effort and moving a person to employment has two benefits in terms of the government's budget constraint. First, it increases tax revenue through higher employment levels and, second, it decreases expenditures by lowering total benefits paid. Higher effort enables the government to provide greater benefits and lower taxes, both of which are not considered in the private decision of how much effort to choose (see Appendix 3).

New Corollary 1: In steady states with higher productivity, the optimal level of search increases.

Proof: Consider a trial solution, where a constant level of effort, $\bar{e}$, is the solution for all values of *z*, then assume all first order conditions of *SW* hold with the exception of effort. Taking the derivative of $\frac{\partial SW}{\partial e}$, with respect to, *z* yields the following:

$$\frac{\partial^2 SW}{\partial e \partial z} = \frac{\partial w(1-\tau)v(w(1-\tau))'}{\partial z}\frac{a'(\bar{e})\alpha(\theta)}{(s+a(\bar{e})\alpha(\theta))} + \frac{swv(wb)'(\psi+1)\theta_z}{(s+a(\bar{e})\alpha(\theta))^2} > 0$$

where $\theta_z = \frac{\partial \theta}{\partial z} > 0$, and $\frac{\partial w(1-\tau)v(w(1-\tau))'}{\partial z} > 0$ applying proposition 1.

Consequently $\frac{\partial SW}{\partial e}$ increases with *z* for a fixed level of *e,* and an increase in *e* is needed to exhaust the marginal social benefits. Consequently, the optimal level of effort is pro-cyclical (increases with productivity). See Appendix 4 for more detail.

Corollary 2: Similarly, the gap between the optimum level of effort and effort chosen independently by workers increases with productivity.

Proof: The extent of the gap between the two levels of search is given by (19), which is increasing in *z* (see Appendix 4).

During periods of high productivity (expansions), θ increases which makes effort more productive in finding employment. This increases the private benefits since a higher effort level is more likely to yield a match. In addition to yielding more utility to workers by facilitating the transition to work, higher employment broadens the tax base and decreases expenditures through lower unemployment.

Monitoring the effort level of the unemployed however is likely to be expensive or infeasible. If effort is unobservable, the government must use UI benefits to extract a second best level of effort. In addition, by varying benefits over the business cycle the government can provide incentives for workers to provide additional effort in expansion, beyond what would be chosen if the benefits were fixed throughout the business cycle.

Proposition 2: Given assumptions (1) – (4) and a fixed tax rate, the optimal insurance scheme when effort is unobservable includes: (i) a higher short-term than long-term replacement rate, and (ii): a benefit schedule that gets steeper (*b(1)* increases while *b(2)* decreases) during expansions compared to recessions.

Proof: First order conditions with respect to *b(1), b(2)* and τ imply that $v'(wb(1)) < v'(wb(2))$ and consequently *b(1) > b(2)* for all levels of *z*. Solving these conditions for the ratio $B = -\frac{\Phi_{b(2)}}{\Phi_{b(1)}} = \left[\frac{b(1)}{b(2)}\right]^{\sigma}$ and differentiating with respect to *z* yields:

(20)
$$[s(1-p)+(1+\beta s)p-\left[\frac{(1-\tau)}{b(1)}\right]^{\sigma}(s\beta+p)]\frac{B_z}{B} = -(1+\beta s)\frac{p}{1-p}[1-\left[\frac{(1-\tau)}{b(1)}\right]^{\sigma}]\frac{p_z}{p}-\frac{(s\beta+p)}{\sigma}\left[\frac{(1-\tau)}{b(1)}\right]^{\sigma}\frac{b_z(1)}{b(1)}$$

With a fixed tax rate, the budget constraint and (20) can only hold if *b(1)* increases and *b(2)* falls as *z* increases. More detail can be found in Appendix 5.

When effort is unobservable, the UI agency must provide incentives to exert the optimal level of search. Since, the private and public returns to search both increase during an expansion, the government provides greater incentives to search by making the benefit schedule steeper. Increasing benefits in the first period makes employment more attractive through the entitlement effect while lower benefits in the second period makes unemployment less desirable, increasing the returns from transitioning to work.

While the results are consistent with Kiley (2003) and Sanchez (2008) the motivation for these adjustments in benefits is somewhat different. In these papers, the government must provide a reservation level of utility. When times are bad, the UI agency compensates the unemployed by offering a higher benefit, which at the same time provides more leisure by decreasing individuals' incentives to search. In the model presented in this paper, search simply is not as beneficial in bad times compared to good. During recessions, when more people are searching for work, additional search will not be as productive as when jobs are plentiful. As a result, the social opportunity costs of providing higher benefits, in terms of giving incentives for lowering search, are smaller in recessions compared to expansions. Consequently, during recessions a flatter benefit sequence from moving from short to long-term unemployed is optimal.

5. Numerical Experiments

In the following numerical exercises, the assumptions in the previous sections can be relaxed. First, the period length is set to a month and *D* is equal to 12 to consider variations in benefits in the first 11 months of unemployment, with the twelfth month being the absorption state. In most of the calibration exercises *D=12* is sufficient to allow nearly all of the unemployed to find matches before reaching the terminal state. Second, I return to the stochastic model, where *z* follows a Markov process. In addition, in this section the government considers the influence of the UI system on job creation and wages, which could have a strong affect on the choice of benefits, particularly early in an unemployment spell. Finally, as a robustness check I explore two additional wage setting mechanisms beyond Nash bargaining with termination costs.

5.1 Calibration

Calibration of the model relies on prior results from the literature, as well as U.S. data from the 1990 – 1991 recession. A summary of the parameters values can be found in Table 2. To fully parameterize the model, I need to choose values for β, *s*, ϕ, σ, *k*, and *T,* as well as functional forms for $M(u, \upsilon)$ and *a(e),* and the stochastic process governing the productivity shock.

TABLE 2: PARAMETER VALUES AND SOURCES

Parameter	Value	Source
β	0.996	Cahuc and Lehman (2000)
z^h	1.000	Normalization
P^h	0.985	Average duration of expansions since 1980
P^l	0.920	12 month recession to match simulations
s	0.026	Hagedorn and Manovskii (2008) based on estimate from Shimer (2005a)
η	0.720	Hagedorn and Manovskii (2008)
Φ	0.500	Literature standard
T	1.845	Silva and Toledo (2005)*
σ	2.500	Various empirical and theoretical sources
b_u	0.448	Department of Labor , 1991 U.S. average
b_w	0.305	U.S. Department of Health and Human Services, 1991
Calibration Targets		
u^h	0.054	January 1990
p^h/p^l	1.220	Shimer (2005b) job finding rates From 1990Q1 to 1991Q1.
$q(\theta^h)$	0.710	Hagedorn and Manovskii (2008)
u^l/v^l	0.634	Hagedorn and Manovskii (2008)

Notes: *T is set to zero under strategic bargaining and exogenous wages.
Super-scripts *h* and *l* indicate values for the variable for the system at rest with high and low productivity respectively.

Basics: The popularization of Markov switching models starting with Hamilton (1989) and later with Filardo (1994) among others have made it more common to characterize business cycles as the economy switching between discrete regimes. Hamilton (1989) states that his empirical estimates "suggest[s] that the business cycle is better characterized by a recurrent pattern of … shifts between recessionary state and a growth state rather than by positive coefficients at low lags in an autoregressive model" (382). Following this characterization of business cycles I assume that productivity follows a Markov process where *z* takes on one of two values, z^l and z^h, and normalize the high productivity state to unity. Continuing with super-scripts to denote low and high productivity states, the transitional probabilities are $\mathrm{P}^h = P(z_{t+1} = z^h \mid z_t = z^h)$ and $\mathrm{P}^l = P(z_{t+1} = z^l \mid z_t = z^l)$, with $1-\mathrm{P}^h$ indicating the probability of transitioning from the high to low productivity, and $1-\mathrm{P}^l$ the probability of moving from low to high. P^h is set to .985 and P^l to .920 to simulate recessions with an expected duration of 12 months and expansions with an expected duration equal to their average length since 1980 of about 70 months.

The period length of a month is consistent with a discount rate of $\beta = .95^{1/12}$, which is common in the literature. For the monthly separation rate I uses 0.026 as reported by Hagedorn and Manovskii (2008), along with the elasticity of market thickness to the job finding probability, η, of 0.72. While it is common to invoke the Hosios (1990) efficiency condition and set $\eta = \phi$, there is no reason to believe that policymakers face an efficient world and consequently ϕ may deviate from η . However, without good empirical estimates, ϕ is set to 0.50, as is typical in the literature. Following Silva and Toledo (2005), termination costs are set to 0.17 of annual wages. In addition, it is common to assume a Cobb Douglas matching function is commonly used in search models, such that $\alpha(\theta) = C\theta^{\eta}$ (see Petrongolo and Pissarides, 2001). Finally, the production function of applications, $a(e) = e^{\gamma}$, is borrowed from Cahuc and Lehmann (2000).

As shown in Frederickson and Holmlund (2001), numerical estimates are sensitive to the degree of risk aversion assumed and Gruber (1997) finds that for low levels of risk aversion the optimal replacement rate is zero. Although results are sensitive to the choice of σ, estimates in the literature provide a fairly large range. In Szpiro's (1986) account of the early literature, estimates ranged from 0.35 to as high as 10.00 and Mankiw's (1985) estimates range from 1.79 to 5.26. Chetty (2004) uses a hazard model to find the implied risk aversion among the unemployed and finds σ to be 4.79. Despite these estimates, the comparable literature has tended to use lower levels of σ, typically between 0 and 2. In light of the empirical evidence, and the desire to provide comparable estimates to the existing literature, σ is set to 2.5, a compromise between the empirical and theoretical literatures.

Calibration Targets: Four parameters still must be estimated, C, z^l, γ, and k. These parameters are chosen to match four targets: (1) the unemployment rate in the high productivity state should converge to 0.054, which is the unemployment rate prior to the 1990 recession; (2) a change in the job finding rate from moving from high to low productivity levels of 22%, which matches Shimer's (2005b) data from 1990Q1 to 1991Q1; (3) a job filling rate of 0.71 with high productivity; and (4) a ratio of unemployment to vacancies of 0.634 with low productivity. Targets three and four are based on Hagedorn and Manovskii (2008). To calibrate the model, the benefit system of the early 1990s is used. The Department of Labor reports that an average replacement rate, b^u, of 0.448.[10] While congress did extend benefits beyond the standard six months in the early 1990s, to establish a benchmark, the potential duration of UI benefits is held at six months. After six months, the benefit, b^w, is assumed to correspond to welfare payments. Health and Human Services Department data for this period show an average social assistance payment equal to 68% of the average unemployment benefit. While most people do not transition immediately to welfare benefits, using the average social assistance grounds the model in a simple two tier system of benefits. The parameters values that result from this calibration can be found in Table 3.

TABLE 3: CALIBRATED PARAMETERS

Parameter	z^l	k	C	γ
Value	0.829	2.597	0.491	0.530

5.2 Computational Strategy

To determine the adjustments in unemployment insurance that should take place over the business cycle I need policy functions for the parameters of *b(d),* or replacement rates for each state *d*, that are dependent on the measure of the unemployed in each period and productivity. To accomplish this, I use the methodology described by Judd (1996) to approximate the *SW* function with a second order Chebyshev polynomial. The algorithm proceeds by first defining a grid across all state variables.[11] Next, an initial starting point is chosen for the coefficients of the Chebyshev polynomial.[12] Then at each grid point the parameters of *b(d)* that maximizes welfare is found and the value of *SW* is stored. A continuous function of the state variables is interpolated by regressing the stored values of *SW* on the value of the Chebyshev polynomials at each grid

[10] Average for 1990 and 1991 based on data from the Department of Labor Unemployment Insurance Chartbook.

[11] As recommended by Judd (1996) evaluation points are chosen such that at each point, k=1,…,m, satisfy zeros of the k^{th} Chebyshev polynomial.

[12] Typically zeros are used as the starting point for all coefficients.

point to determine new coefficients. The maximization and interpolation steps are repeated until the coefficients converge to a fixed point. With the coefficients determined, simulations can be conducted with various time paths for *z*.

Applying this basic algorithm to the problem with *D=12* would be particularly difficult. Using the measure of workers at each of the 12 periods as state variables, and the two discrete values for *z,* would require maximizing the *SW* function more than a million times at each iteration, even using a fairly sparse grid. This would make interpolation nearly infeasible. In order to decrease the computational burden, I follow a method based on Krusell and Smith (1998). In their work, the authors find that the mean of the wealth distribution in their model is a sufficient statistic to infer agents' behavior and keeping track of this one statistic closely approximates knowledge of the entire wealth distribution. Applied to the problem in this paper, this suggests that there may be a small number of statistics that summarize the future distribution of unemployment that may provide a reasonable approximation of the entire distribution.

To motivate the use of a small number of statistics I assume that the government believes next period's unemployment distribution will follow a beta distribution. The beta distribution is an extremely flexible function and requires just two parameters. In addition GMM estimates of these parameters can be derived using only the duration's mean and variance.[13] This assumption decreases the state space from 13 variables (12 for the number unemployed in each state and *z*) to just 4 (the two parameters of the beta distribution, total number unemployed, and *z*).[14] Similar to Krusell and Smith (1998) the adequacy of this assumption is assessed by calculating the R^2 statistic, which ranges between 0.972 and 0.994 depending on the wage setting mechanism and point in the simulated business cycle. The high R^2 is strong evidence that the mean and variance are sufficient statistics to capture the unemployment distribution.[15]

5.3 Optimal Unemployment Insurance

In this section the government specifies *b(d)* such that the a separate replacement rate in each of the *d* states can be assigned. The remainder of this paper basis its results on a simulation which starts with the system at rest with high productivity, referred to as an expansion or high state. From the expansionary state a recession is simulated with 12 months of low productivity.

[13] Standard GMM estimates for the parameters of the beta distribution are used. However, for these calculations, duration is not limited to 12 months. Using the job finding rate in period *D*, the number unemployed for up to 24 months is calculated and then the mean duration and its variance is determined.
[14] I use a 54 point grid, 27 points with high and 27 with low productivity.
[15] I also make use of the fact that the number unemployed in the first period is always known with certainty. Given that the number employed is known by the government at time *t*, *sn* gives the measure unemployed in their first month of unemployment in *t+1*.

In the results throughout the rest of the paper values for the 12th month of productivity are labeled as a recession or low productivity state.[16] Table 4 displays the unemployment rate, wages, market thickness and average duration of unemployment ($\bar{d}$), in the high and low states. Figure 2 shows the results for the replacement rate (panel a), the proportion unemployed *d* periods (b), and the job finding rate (c). Each panel contains two lines, one indicating values for those unemployed 1-11 months and 12 months or longer in an expansion and one in a recession as defined previously. An additional line in panel (a) indicates the 1990s benefit system. In certain instances, these lines are truncated if the number unemployed falls to zero, in which case the benefit and effort level are undefined. This can occur if the government, in any one period, reduces benefits to a point where the employed exert enough effort to push the job finding rate to one. Alternatively, the number unemployed in their d^{th} period may be zero if the job finding rate is high enough in previous months, such that the probability of being unemployed *d* months is zero.

TABLE 4: SELECTED OUTCOME VARIABLES

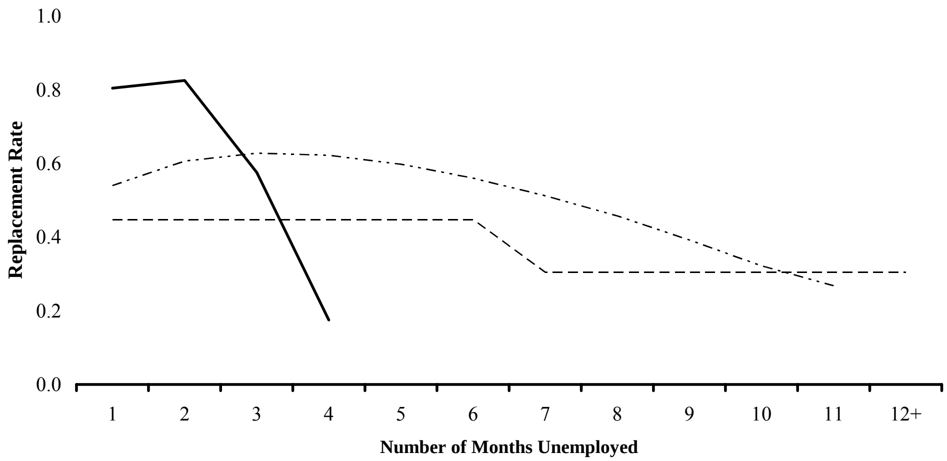
	Unemployment		Wage		Average Duration	
	High	Low	High	Low	High	Low
Simulated Values	0.047	0.095	0.849	0.737	1.629	3.329

Notes: High and low indicate values for the variable for the system at rest with high productivity and the 12th month of low productivity respectively.

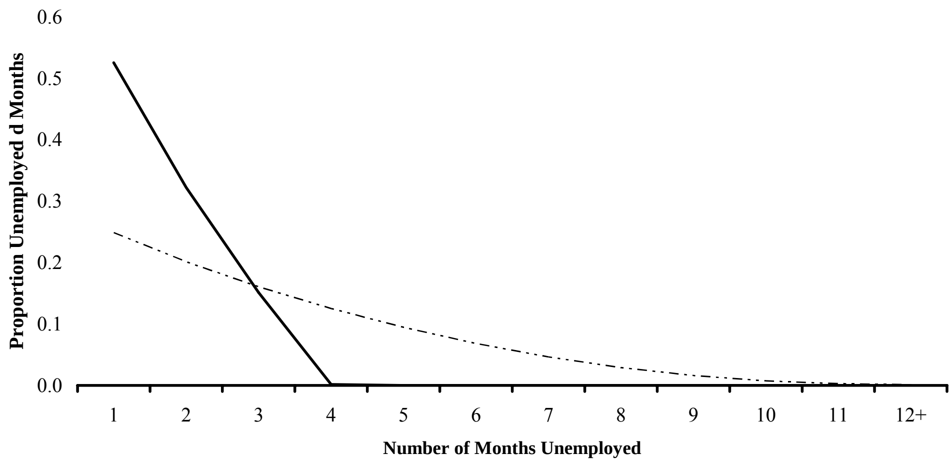
The results in Figure 2 strongly support the view that benefits should be more generous in recessions (low state) compared to expansions (high state) for the longer term unemployed. In expansions, the replacement rate early in the unemployment spell is just above 80%, much higher than the current UI system. This keeps the job finding rate relatively low (panel c) early in one's spell. However, the replacement rate declines quickly for those who have been unemployed more than two months and, at four months the replacement rate falls to a level consistent with a job finding rate of one. The net result of the benefit system is a low unemployment rate of just 4.7%, 0.7 percentage points below the calibrated unemployment target. In recessions, the return to effort falls and the unemployment distribution pivots outward (panel b) and the job finding rates shift down (panel c). Lower returns to effort and the larger number unemployed at longer durations, makes it optimal to increase the level of insurance for the long-term unemployed. While it is optimal to increase benefits in this way, the result is an unemployment rate of 9.5% and a more than doubling of average duration.

[16] In most cases, there is little difference between the 12th month of low productivity and the replacement rate when the system comes to a rest with low productivity. However, the 12th month was chosen to give comparability across models.

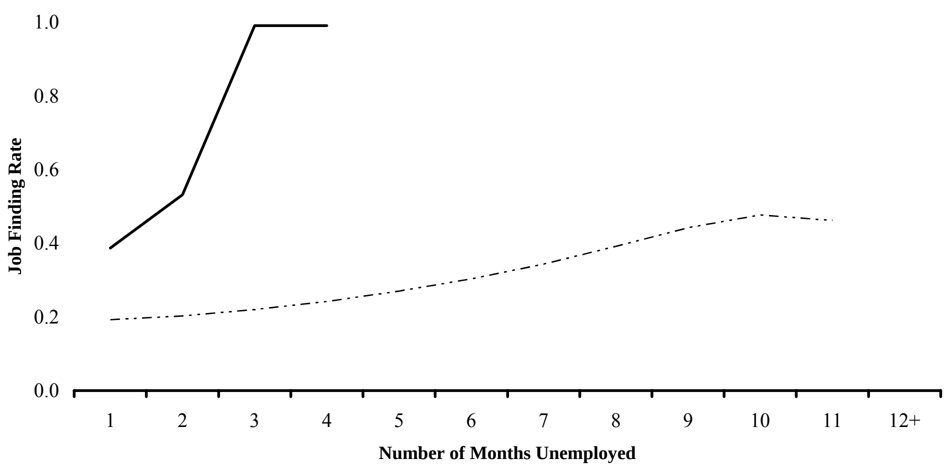
FIGURE 2: OPTIMAL UNEMPLOYMENT INSURANCE - NASH BARGAINING



(a) Replacement Rate



(b) Unemployment Distribution



(c) Job Finding Rate

Expansion — Recession — 1990s U.S. Benefit System

Nash bargaining implies that benefits early in one's, spell will have a relatively large affect on wages and job creation. This accounts for the strong non-monotonic benefit schedule in low state. In expansions, there is only a slight increase in benefits from the first to the second month of unemployment, while the increase in the low state is much more pronounced. In the low state, benefits increase for the first three months of one's spell. Since the threat point for insiders is the first spell of unemployment, higher benefits in earlier periods will increase workers' wages, but lower job creation since firms incur higher costs As a result, front loading benefits will increase social welfare at time *t* through higher earnings, but at the expense of fewer people transitioning to employment in time *t+1*. In expansions, where there are incentives for job creation through higher productivity, it is optimal to have high benefits in early periods of the unemployment spell to increase wages. However, in recessions, when job creation is already low, it is optimal to lower benefits early on to keep wages low and job creation high.

6.4 Sensitivity to Alternative Wage Setting Mechanisms

The inclusion of termination costs into the model along with the standard Nash bargaining wage setting mechanism significantly increases the volatility in unemployment in vacancies. However, in my calibration, with fixed UI system of the 1990s, wages increase more than 16% during expansions. This is still higher than what actually occurs during most recessions. In addition, while there is some empirical support for a positive relationship between unemployment insurance and wages other possibilities have been proposed. As a result I consider two additional wage setting mechanisms. The first follows the spirit of Hall and Milgrom's (2005) strategic bargaining. Using the bargaining theory from Binmore, Rubinstein and Wolinsky (1986) the authors assert that the threat points of Nash-bargaining are not realistic and that the opportunity costs are not breaking off negotiations, but extending them. In the bargaining system of Hall and Milgrom (2005), workers and firms alternate making offer and counter offer in real time. The time between offers is thought to be very small, with numerous offers being made in each of the discrete periods of search. Once an offer is made, the opposing party may accept, reject or break off negotiations. I assume that a positive surplus always results from a match, which ensures that leaving the bargaining table is never optimal. Let w be the firm's best response to the workers' offer of w', where w is the lowest wage that is acceptable to the worker and w' is the highest wage acceptable to the firm. These two wage offers are defined by ensuring that workers and firms are indifferent between accepting the offer or delaying negotiations and making a counter offer. The game can be described by two equations:

(21) $$V^e(w) = X\Delta + e^{-r\Delta}V^e(w')$$

(22) $$J^e(w') = Y\Delta + e^{-r\Delta}J^e(w)$$

where workers receive *X* while negotiations are on-going and firms receive *Y*. The time between offer and counter offer is given by Δ. I assume that firms make the first offer and the game ultimately resolves itself in the first period with the worker accepting *w*.[17] The resulting wage equation when $\Delta \to 0$ is (for the derivation, see Appendix 6):

(23) $$\frac{V^e(z) - [X - \beta v(w(1-\tau))(1-r)]/r}{w(1-\tau)v'(w(1-\tau))} = \frac{J^e(z) + [Y/r + \beta w]}{w}$$

There is a natural equivalence between the Nash and Strategic bargaining if $[X - \beta v(w(1-\tau))(1-r)]/r = V^{u^1}$ and $[Y/r + \beta w] = J^v - T$, which is exploited in the numerical exercises. There are two major differences between these two types of bargaining. First, since V^{u^1} no longer enters the wage setting equation directly, the influence of the benefit system on wages and, consequently job creation, enters only through $V^e(z)$. In this case higher benefits, particularly early in one's spell, increases the value of $V^e(z)$. This in turn raises the costs of waiting Δ to begin employment and consequently lowers the wage the worker is willing to accept. As a result, using a strategic bargaining framework higher benefits decrease wages and correspondingly increase job creation, just the reverse of Nash bargaining. However, the link is very weak as V^{u^1} enters $V^e(z)$ multiplied by *s*, which I take to be very low. So, the relationship is also much weaker in strategic bargaining. In addition to the change in the influence of UI on wages, under the calibration explored in this section, strategic bargaining more closely resembles the rigid wages observed over the business cycle.

The final wage setting mechanism assumes that wages take one value during high productivity states and another in low productivity states. This allows for a realistic change in wages over the business cycle, but also disconnects the UI system from wages and job creation allowing for comparability to the Hopenhayn and Nicolini (1998) type models. While it is beyond the scope of this paper to settle the growing debate on which mechanism resolves the differences in the implied volatility of the key series in the traditional search model and the data, by looking at the sensitivity of the Nash bargaining results to these two additional wage setting mechanisms provides a reasonable robustness check. In addition, considering these alternatives it

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[17] Hall and Milgrom (2005) assert that in the limit as $\Delta \to 0$ the results wage is equivalent regardless of who makes the first offer.

is possible to determine which, if any aspects of the optimal benefit sequence in expansions and recessions are sensitive to what we think about how wages are determined in the economy.

TABLE 5: CALIBRATED PARAMETERS – STRATEGIC BARGAINING AND EXOGENOUS WAGES

Parameter	z^l	k	C	γ	w^h	w^l	X	Y
Strategic	0.829	2.597	0.490	0.347			-2.138	0.003
Exogenous Wage	0.829	2.597	0.420	0.458	0.753	0.718		

In analyzing different wage setting mechanisms, comparability across models is important. To accomplish this, the same parameters from the Nash bargaining model are used across the other two wage setting mechanisms, with a few exceptions. The purpose of using an alternate wage setting mechanism is to better match the data on the volatility of the business cycle data, as well as to explore differing degrees of influence between the UI system and wages and job creation, and not necessarily affect search behavior. As a result, *C*, and γ are recalibrated for models with strategic bargaining and exogenous wages to ensure that the average elasticity of effort with respect to benefits are equal across the three wage setting assumptions.[18] Strategic bargaining also requires two additional parameters, *X* and *Y*. These were set to give equivalence to the Nash bargaining model in the low productivity state (see Section 3.4). Lastly, for exogenous wages two wage levels need to be chosen. When productivity is low, wages are set to 0.718, the same value as in the Nash-bargaining calibration. Than for high productivity, wages increase by 4.75%, consistent with the change in wages in the early 1990s recession. The parameter values for strategic bargaining and exogenous wages can be found in Table 5.

TABLE 6: SELECTED OUTCOME VARIABLES UNDER DIFFERENT WAGE SETTING MECHANISMS

	Nash Bargaining		Strategic Bargaining		Exogenous Wages	
	High	Low	High	Low	High	Low
u	0.047	0.095	0.060	0.087	0.047	0.082
w	0.849	0.737	0.816	0.820	0.753	0.718
$\bar{d}$	1.629	3.329	1.975	2.867	1.623	2.777

Notes: High and Low indicate values for the variable for the system at rest with high and the 12th month of low productivity respectively.
u indicates the total unemployment rate, w is the wage, θ indicates market thickness, and $\bar{d}$, average duration, is in months.

Table 6 presents the unemployment rate (u), wages (w), and average duration ($\bar{d}$) for all three wage setting mechanism. While Nash bargaining results in wage volatility that is much greater than what is exhibited in the actual data, when using a strategic bargaining game, wages become much more rigid, even rising slightly in the low state. Also the unemployment rate and

[18] The elasticity of average effort and job finding rate at the end of the unemployment spell is -0.586 and -0.658 respectively which is within reasonable estimates. Frederickson and Holmlund (2001) and Cahuc and Lehmann (2000) calibrate their models to a partial elasticity of unemployment duration (inverse of the job funding rate) with respect to benefit of 0.5.

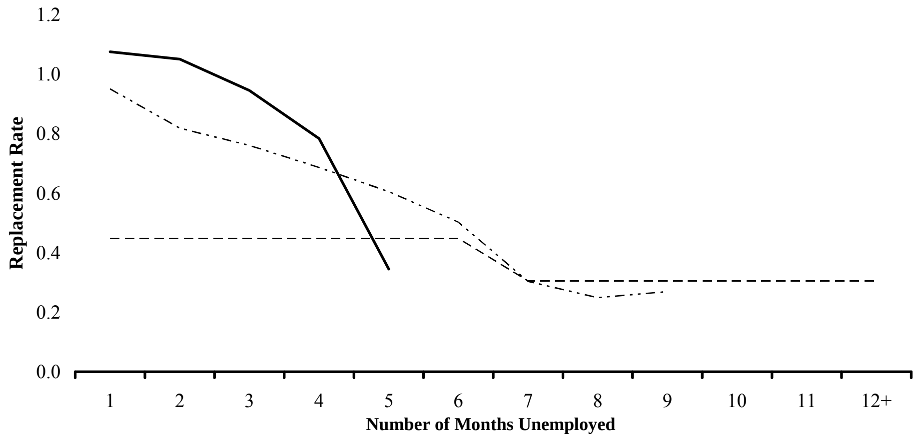
average duration are less volatile than in the Nash bargaining model. The benefits schedule, unemployment distribution and job finding rate for strategic bargaining are plotted in Figure 3. The figure indicates that similar to Nash bargaining the expansionary benefit schedule also has a sharp decline after the second month of unemployment. However, benefits are significantly higher early on during an unemployment spell than when compared to the Nash bargaining results. This is because increasing benefits has a negative effect on wages and consequently a positive effect on job creation. With strategic bargaining used to set wages, when the government wishes to increase the number of jobs in the economy it should increase benefits early in the spell, even to the point where the replacement rate is greater than 1.0. The differences are more striking during recessions. In recessions the job finding rate in the first month falls by slightly less than 10% (see panel c, Figure 3) and pivots outward, but slightly less dramatically than in Nash bargaining (see panel c, Figure 3). In addition, in strategic bargaining benefits fall almost throughout the unemployment spell, while in Nash bargaining, they increase in the early months.[19] Benefits in recessions also include more generous replacement rates in early periods compared to the 1990s benefit system, but are slightly less generous after month seven.

Finally, when wages are exogenous (increase by 4.75% in an expansion), the unemployment insurance system has no influence on either market thickness or wages, similar to the assumptions presented in Section 3 and in Kiley (2003). Figure 4 panel (a) presents the results for the replacement rate. The benefits schedule in expansions smoothly declines almost throughout one's unemployment spell similar to Hopenhayn and Nicolini (1998).[20] In addition, through most of the spell benefits are considerably more generous than the 1990s U.S. system. Similar to Kiley (2003), when jobs become harder to find (job finding rate falls, see panel c Figure 4) and workers are more likely to be unemployed longer (see panel c, Figure 4), the benefits system becomes more generous. However, in contrast to Kiley (2003) benefits for those at the beginning of their spell receive lower benefits in recessions, with the degree of the decline dependent on the wage setting mechanism.

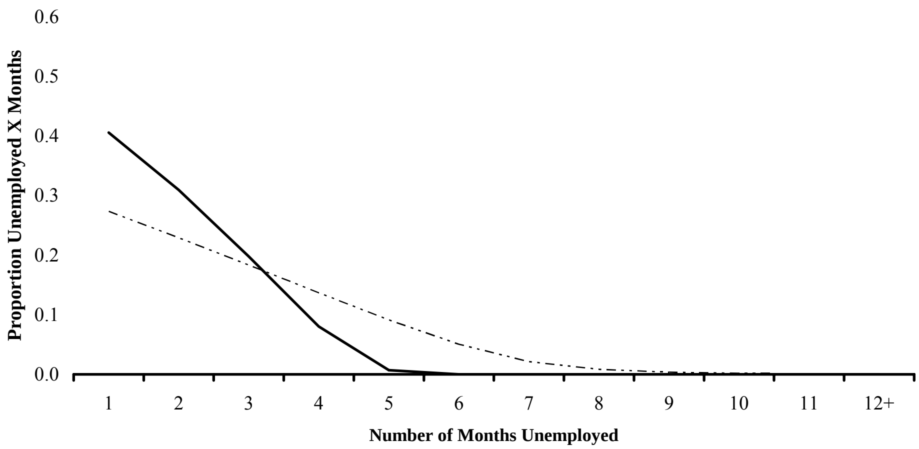
[19] The increase in benefits in the 10th month of the unemployment spell is likely due to it being weakly identified. Although the scenario does have a positive number unemployed in this period, it is close to the machine level precision such that a precise estimate for this period is difficult.

[20] The slight increase in the replacement rate during expansions in month two is related to the entitlement effect. As a result of discounting in order to provide the same incentives to search through the entitlement effect the benefit in second period must be higher than the first. In this case this not fully offset by the disincentive effects related to higher benefits in the second month.

FIGURE 3: OPTIMAL UNEMPLOYMENT INSURANCE – STRATEGIC BARGAINING



(a) Replacement Rate

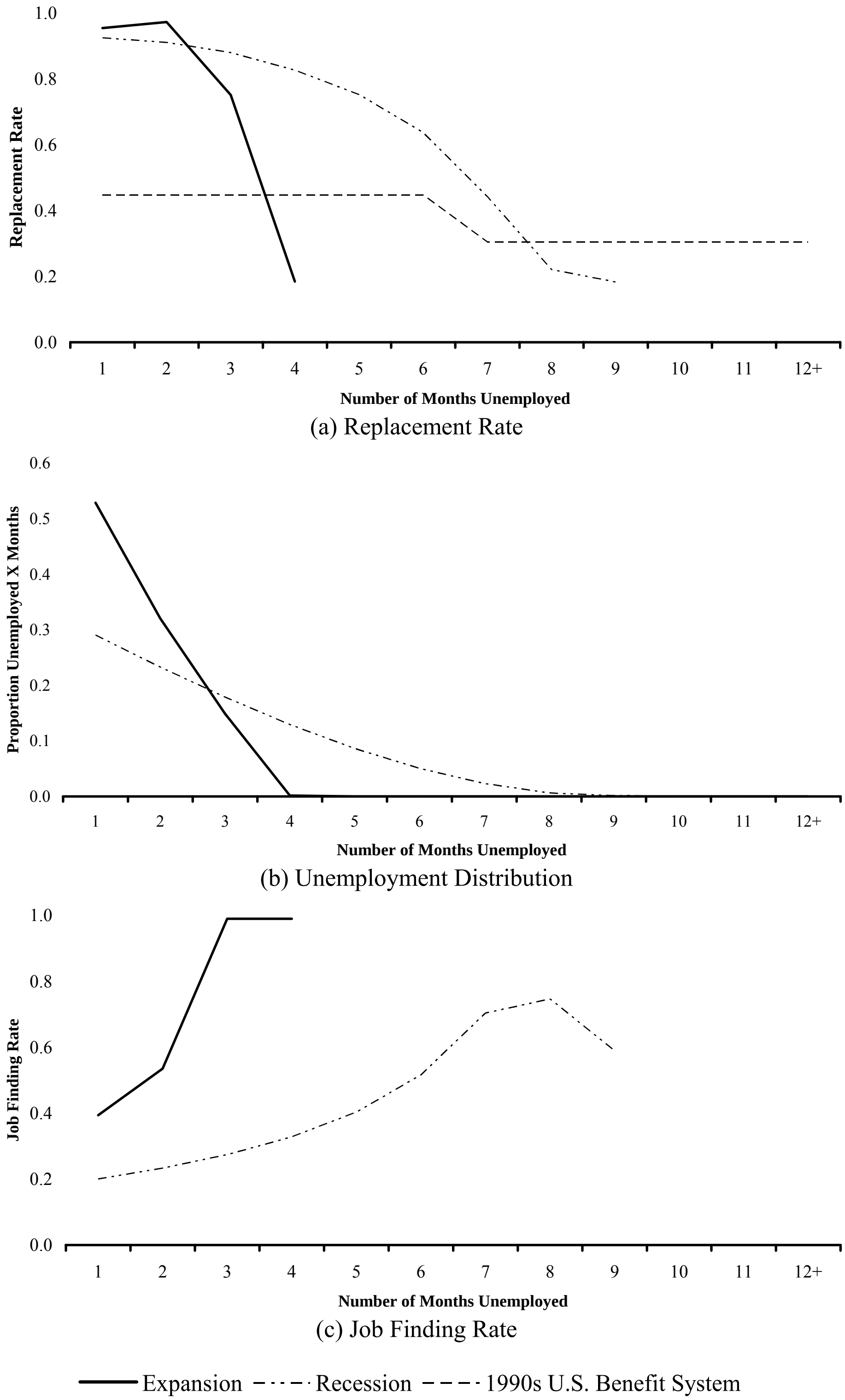


(b) Unemployment Distribution

(c) Job Finding Rate

Expansion – · · – Recession – – – 1990s U.S. Benefit System

FIGURE 4: OPTIMAL UNEMPLOYMENT INSURANCE - EXOGENOUS WAGES



(a) Replacement Rate

(b) Unemployment Distribution

(c) Job Finding Rate

A consistent result from all three wage setting mechanisms is that an optimal benefit system provides more generous benefits later in an unemployment spell during recessions compared to expansions. The shape of the benefit schedule however depends on what we think about the link between the UI system and wages, which differs across the three mechanisms, but are in general less generous. These results assume that the government is willing to manage a fairly complex structure of benefits that changes with each month of unemployment, as well as through changing states of the economy. The next section analyzes a simpler UI program that more closely resembles the U.S. system.

6.4 Optimal Benefit Extensions

To explore the question of how potential duration should change in a recession this section analyzes two additional UI systems that are closely related to current U.S. program. Both systems use an approximation of a step function where the benefit system consists of a unemployment insurance benefit, b_u that is available for δ months, and a welfare benefit, b_w, available thereafter. In both cases the step function is approximated by a logistic function of the form:

(24) $$b(d) = \left[1 - \frac{1}{1+\exp(-K(\delta - d))}\right]b_u + \left[\frac{1}{1+\exp(-K(\delta - d))}\right]b_w$$

where K, which I set to four, is a parameter that affects the steepness of the transition from unemployment benefits to welfare benefits.[21] The function does not exclude the possibility that unemployment benefits could be exhausted in the middle of a month with workers receiving a portion of their consumption from UI and a portion from welfare for the period. In addition throughout this section, Nash bargaining with termination costs is used.

The first benefit system analyzed (referred to as flexible benefits) allows the government to choose values for b_u, b_w and δ. The second scheme (referred to as fixed benefits) allows the government to choose δ only and fixes b_u and b_w at their levels in the early 1990s. The results are reported in Table 7. As before these values correspond to the system at rest in a high productivity state (high), and for the 12th month of a recession (low). For the flexible benefits system I report the benefit levels and potential duration, as well as the unemployment rate, the average duration

[21] I find that setting K=4 provides a good approximation to a step function in that most of the transition, from unemployment benefits to social assistance occurs during one month.

of unemployment spells, $\bar{d}$, and the probability of exhausting UI benefits, *Pr(d>δ)* .[22] In addition, the table presents the elasticity of b_u, b_w, and δ with respect to *u*.[23] For the fixed benefit scheme the same statistics are reported with the exception of the two replacement rates and their elasticity's. For reference the table also reports *u*, $\bar{d}$, and *Pr(d>δ)* for a simulation with the 1990s U.S. benefit system.

TABLE 7: UI BENEFIT EXTENSIONS WITH FLEXIBLE AND FIXED BENEFITS

	Base Case (1)		Productivity z^l=0.79 (2)		Bargaining Power ϕ=0.45 (3)		Risk Aversion σ=2.40 (4)	
	High	Low	High	Low	High	Low	High	Low
Flexible Benefits								
b_u	0.713	0.584	0.755	0.553	0.765	0.662	0.692	0.582
b_w	0.180	0.391	0.216	0.369	0.408	0.475	0.194	0.432
δ	5.827	6.929	4.980	7.800	5.146	6.018	5.975	5.801
u	0.070	0.097	0.064	0.096	0.084	0.111	0.072	0.099
$\bar{d}$	2.420	3.522	2.174	3.482	3.075	4.188	2.500	3.719
Pr(d>δ)	0.082	0.195	0.136	0.125	0.175	0.258	0.102	0.277
Elasticity with respect to *u*								
b_u	-0.553		-0.679		-0.435		-0.523	
b_w	2.055		2.127		0.220		1.769	
δ	0.148		0.634		0.772		0.017	
Fixed Benefits*								
δ	4.297	7.302	4.262	8.473	3.195	5.488	4.564	8.085
u	0.049	0.065	0.049	.0.070	0.041	0.055	0.051	0.069
$\bar{d}$	1.854	2.511	1.842	2.705	1.686	2.106	1.945	2.667
Pr(d>δ)	0.040	0.025	0.038	0.022	0.047	0.036	0.055	0.020
δ 's elasticity with respect to *u*	1.818		1.893		1.840		1.943	
1990s UI Benefits*,**								
u	0.054	.0.064	0.054	0.066	0.049	0.058	0.056	0.066
$\bar{d}$	2.089	2.429	2.079	2.515	1.881	2.218	2.155	2.509
Pr(d>δ)	0.014	0.038	0.013	0.046	0.007	0.021	0.018	0.046

Notes: * b_u is equal 0.448, and b_w is equal to 0.306.
** δ is equal to 6.
High corresponds to a persistent high productivity state. Low corresponds to the 12th month of low productivity starting from the high state.

Definitions: b_u is the UI benefit, b_w is the welfare benefit, δ is the potential duration, *u* is the unemployment rate, $\bar{d}$ is average duration, and *Pr(d>δ)* is the probability of exhausting UI benefits.

[22] *Pr(d>δ)* in my calibrations is lower than the official statistics from the Department of Labor on exhaustion rates. However, exhaustion rates are based solely on the insured population, where the model described in this paper assumes a receipency rate of 100%. Those without benefits may have shorter spell lengths which may account for the differences between *Pr(d>δ)* and Department of Labor data on exhaustions.

[23] These elasticities are calculated by first generating 1,000 z's that follow the Markov process described in section 6.1. The model is then simulated with these values starting with the model at rest with a high level of productivity. The first 200 observations are dropped and the log of b_u, b_w, and δ are regressed on the log of *u*.

Column (1) of Table 7 provides the results using the parameters from the previous section with Nash bargaining. Using these parameters, along with the benefits available in the 1990s, implies an increase in the unemployment rate of 1.0 percent by the 12^{th} month of the simulated recession. In addition, average duration increases by 16.3%, and the probability of exhaustion almost triples. When the benefit levels can be chosen, the optimal UI system includes a UI replacement rate that declines slightly more than 10 percentage points during recessions, but a welfare rate that increases more than 20 percentage points. This is consistent with results presented analytically, where market thickness and wages were taken as given by the government, suggesting that within a step function type UI system the wage and job creation effects do not reverse the need for a "steeper" benefit profile in expansions. In addition, in recessions, UI is offered for 1.1 more months than in expansions. Overall, the optimal UI benefit is more generous generally compared to the 1990s UI system. This results in higher unemployment and a bigger increase from high to low states. In addition, the probability of exhausting benefits in recessions is 19.5%, more than two times as high as in expansions, but a higher welfare benefit becomes available when UI is no longer available.

In contrast to flexible benefits, the fixed benefits system has a less generous potential duration. In the high state, the optimal duration is just 4.3 months, which results in a lower unemployment rate and average duration than under the 1990s system. In the low state, potential duration expands by 3 months, consistent with the current SEB program.

To see how the results are affected by changes in some of the key parameters, z (column 2), ϕ (column 3) and σ (column 4) were decreased while leaving the other parameters unchanged. Column 2 illustrates the affects of increasing the size of the productivity shock. The flexible benefit system is characterized by a lower level of benefits in recessions than column (1) and the elasticities are all larger (in absolute values) than the baseline, with the elasticity for potential duration in particular increasing more than four fold. A similar result for potential duration is obtained when holding the benefit levels constant. In this case, the unemployment rate in expansions is 0.049, but increases sharply in recessions to 0.070. Potential duration increases by 4.2 months, more than one month longer than the increase in column (1). The increase in potential duration translates into just a 2.2% probability of exhausting benefits during recessions compared to 4.6% under the 1990s UI benefits, or 12.5% under the flexible benefit system. In general a larger shock results in larger changes in the parameters of the UI system.

Under the current UI system, a lower bargaining parameter (column 2) results in higher levels of market thickness as firms gain a larger portion of the surplus, which in turn increases the job finding rate. However, this is partially offset by the unemployed exerting less effort since their share of the surplus has declined. Overall, an increase in ϕ substantially lowers the unemployment rate in comparison to column (1) for the 1990s UI system. Since the returns to search have fallen, under the flexible benefits scheme both benefit levels increase, although UI is provided for a shorter period of time. This results in higher levels of unemployment and average duration under the flexible benefits system. Also, because average duration is relatively long in both high and low states, the welfare benefit does not change as drastically, as indicated by the lower elasticity of b_w. For fixed benefits potential duration is far less than in column (1). Since *SW* cannot be increased by adjusting the benefit levels the best means of maximizing welfare is to provide more incentives to find work by lowering the potential duration. The increase in potential duration is just 2.3 months.

In the final column, the coefficient of risk aversion is lowered to 2.4. Here workers are willing to accept more volatile consumption, which decreases the value of transitioning to work. As a result, a lower level of effort is exerted. Under the 1990s UI system, u, $\bar{d}$ and $Pr(d>\delta)$ are slightly higher than in column (1). The lower level of risk aversion decreases the value of insurance and consequently the optimal b_u declines and is provided for a shorter period. However, since lower risk aversion decreases the value of transitioning to work, a steeper benefit schedule is not as desirable and the savings from decreasing UI benefits is redistributed to welfare benefits. The result is higher unemployment, lower potential duration, and a greater probability of exhausting benefits. When benefits are fixed, this translates into slightly longer potential duration and an increase of 3.5 months in recessions and elasticity of 1.9.

After restricting the UI system to a step function with an UI benefit provided for δ months and a welfare benefit thereafter, it is still appropriate for benefits to be more generous for the longer-term unemployed in a recession. Despite these systems being optimal, for an utilitarian welfare function there may be losers in the system as well. The next section turns to analyzing the welfare implications of moving to an optimal UI system.

5.5 Welfare Analysis

Table 8 examines the source of the welfare improvements from moving to an optimal UI system and reports the percentage change in social welfare from the 1990s system that does not change over the business cycle. Each column continues with the Nash bargaining assumption. The first column is the system pictured in Figure 2, where benefits can take any value in each of the 12 states of unemployment. Column (2) restricts the benefit schedule to follow a beta function which, as mentioned earlier, is an extremely flexible smooth function that can capture many possible paths of benefits.[24] The last two systems are the flexible and fixed benefit step function approximations from the first column of Table 7.

The completely flexible benefits in column (1) provides between a 7.7% (high) and 7.3% (low) increase in welfare from the U.S. system in the 1990s. The sources of this increase can be decomposed based on the other columns in the table. For instance, the fixed benefit system, where only duration is adjusted, accounts for about 7.8% (high, 0.6/7.7) – 8.2% (low, 0.6/7.3) of this welfare improvement. However, allowing for flexible benefits accounts for 53.2% (high) to 54.8% (low) of the welfare improvement. While there are gains to be made through simply adjusting potential duration, as is done by the SEB program, most of the welfare improvement of optimal UI comes from adjusting the benefit levels. Further, looking at column (2), there is little improvement in having the replacement follow a flexible, but smooth beta function, compared to the step function approximation in column (3). The remaining increase in welfare is a result of removing all restrictions on the benefit system (37.6% in a high state and 33.7% in a low state).

TABLE 8: CHANGE IN WELFARE FROM MOVING TO AN OPTIMAL UI SYSTEM

	Optimal UI Benefits (1)		Beta Function (2)		Flexible Benefits (3)		Fixed Benefits (4)	
	High	Low	High	Low	High	Low	High	Low
Social Welfare	7.7%	7.3%	4.8%	4.7%	4.7%	4.6%	0.6%	0.6%

5.6 Political Viability of Alternative UI Programs

In addition to the flexible benefit scheme in column (3) of Table 8 being superior to the fixed benefit system (column 4), it is also likely to be more politically viable. Table 9 gives the results from the same scenarios captured by Table 8, but indicates the discounted utility for employed workers and those in their d^{th} month of unemployment, according to equations (6) and (7). It is important to remember that the values for the employed and unemployed are based on their perception of moving towards one of the optimal systems. Since individuals do not anticipate changes in benefits over the business cycle, this provides a measure of their willingness to accept a move to an optimal system during a recession or expansion, but does not include the value of the UI system adjusting if a productivity shock occurs.

The voting power clearly lies with the employed, who will bear directly the expense of the program, but also benefit from the additional insurance if their match is destroyed. Implementing a fixed benefit program in an expansion would likely be politically difficult. This program lowers potential duration to 4.297 months. While this results in lower taxes, the

[24] Other output for the beta distribution restriction is available upon request.

employed face a positive probability of becoming unemployed at which point there is a 0.40% probability of exhausting UI, almost three times as high as the 1990s benefit system. The loss in insurance more than offsets the lower costs of the employed. Similarly, the unemployed all perceive this as a net loss. Despite these perceptions, this scheme is optimal since it provides insurance against a productivity shock.

TABLE 9: CHANGE IN DISCOUNTED UTILITY FROM MOVING TO AN OPTIMAL UI SYSTEM.

	Optimal UI Benefits (1)		Beta Function (2)		Flexible Benefits (3)		Fixed Benefits (4)	
	High	Low	High	Low	High	Low	High	Low
Employed	1.7%	1.9%	2.9%	1.9%	2.8%	1.9%	-0.2%	0.0%
Unemployed *d* Months:								
1	1.6	2.3	3.4	2.2	3.2	2.2	-0.4	0.0
2	0.7	2.3	2.9	2.1	2.8	2.2	-0.5	0.0
3	-0.9	2.3	2.4	2.1	2.4	2.1	-0.6	0.0
4	-4.9	2.2	2.1	2.0	1.8	2.1	-1.0	0.1
5		2.1	1.8	2.0	0.9	2.1	-1.5	0.1
6		2.1	1.7	2.2	-0.8	2.1	-1.1	0.3
7		2.5	2.0	2.8	-2.6	2.5	-0.2	0.7
8		2.1	1.3	2.5	-2.8	2.2	-0.2	0.1
9		1.5	0.5	2.3	-2.8	2.2	-0.2	0.0
10		1.0	-0.5	2.0	-2.8	2.2	-0.2	0.0
11		0.6	-1.9	1.6	-2.8	2.2	-0.2	0.0
12+			-4.0	1.2	-2.8	2.2	-0.2	0.0

Notes: For column (1) welfare for unemployment greater than four months in expansion and greater than 11 months in recessions is not available because the probability of reaching these durations is zero.

This also provides the basic intuition for why the SEB program has been weakened in the last several decades. Rectifying the automatic extension program would likely mean redesigning the appropriate triggers prior to a recession, which would increase expenses to employers and employees. If agents do not perceive the benefit in terms of higher insurance in recessions, the plan is likely to be met with a great deal of resistance. In contrast, all employed and unemployed workers would support the plan if it is implemented in the low state, which is consistent with the public pressure to pass EEB programs once a recessionary shock has already occurred.

The flexible benefit program and beta function programs would likely have wide spread support if implemented either during a recession or an expansion. Both of these programs include considerably higher benefits in earlier periods of unemployment. This provides a higher degree of consumption for workers at the beginning of their unemployment spell, which is valued by the employed and most of the unemployed. The completely flexible UI system in column (1) would also be favored by workers in both the expansionary and recessionary states, but somewhat less so than the flexible benefit system in expansions. In this case the unemployed workers have just a few months of reasonable consumption levels until, at the fourth month, the benefit provided is so low that there is an incentive to increase effort to the point where employment is ensured. Thus, the employed and unemployed know that they may have to incur large costs in terms of effort if they become unemployed and do not perceive as large a welfare benefit as in the flexible benefit system.

7. CONCLUSION

The main conclusion of this paper is that unemployment insurance should become more generous for the longer-term unemployed during recessions. The result is robust to three different wage setting mechanisms. When there is a close link between the UI system and wages and job creation, it is optimal to decrease benefits for workers at the beginning of their spell in order to decrease wages and encourage job creation. This is in contrast to Kiley's (2003) work with the Hopenhayn Nicolini (1998) model where benefits, even for the short-term unemployed increase.

Policymakers in the United States have concentrated on extending potential duration during recessions with the current SEB program providing an additional three months of benefits. This paper suggests that this extension is about right. However, adjusting benefit levels would increase social welfare more than four times as much as just adjusting potential duration, and should be considered as part of a revision to the current automatic extension program. In addition, a program where benefit levels adjust may be more politically viable then just extending benefits.

Three limitations of the model may be worth further analysis, but likely do not influence the fundamental conclusions of this paper. First, throughout this paper neither the government nor workers can save or borrow. Within certain restrictions, states do have access to a UI trust fund and loans from the federal government. Incorporating government savings would likely increase consumption smoothing through time. Wang and Williamson (2001) show that if workers save, the benefit schedule may decrease for an initial period and then increase. Including individual savings may mitigate the increasing benefit profile that is exhibited in the Nash bargaining model. The second limitation is the assumption that agents do not anticipate changes in benefits. If the U.S. system was to return to an active SEB program, and workers become more educated about the possibilities that benefits may change, this assumption may be less appropriate. In addition, this may not fit certain groups, such as unions, which attempt to educate their membership on social assistance programs. However, the main result of this paper, that UI should become more generous for the longer-term unemployed in recessions, likely holds even if agents anticipate benefits or if government and individuals have access to credit markets. Finally, while the analysis in this paper was conducted with the government having full information of economic conditions, in fact the government cannot observe in real time whether the economy is in recession or expansion. While this brings up the issue of how to best time benefit extensions, it does not suggest such changes should not occur. In a companion paper I discuss how changes in benefits could be "triggered" on when the state of the economy is not observed using a Markov Switching model. Such a method would allow the government to closely approximate the optimal changes in benefits described in this paper.

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APPENDIX 1 - EQUILIBRIUM COMPARATIVE STATICS

Note that the differences in the value functions (6) - (7), after imposing symmetry, can be written as

(25) $$\frac{(V^e(z)-V^{u_1}(z))}{Wv(W)'}=\frac{[\psi^1+\beta(1-a(e)\alpha(\theta))\Phi]}{(r+s+a(e)\alpha(\theta))}$$

(26) $$\frac{(V^e(z)-V^{u_2}(z))}{Wv(W)'}=\frac{\psi^2+\beta s\Phi}{r+s+a(e)\alpha(\theta)}$$

(27) $$\frac{(V^{u_1}-V^{u_2})}{Wv(W)'}=\beta\Phi$$

Next, equations (9) and (10), the free entry equation and imposing symmetry on $J^e(z)$ determines the wage equation (15), reproduced below:

$$\frac{1}{q(\theta)}(q(\theta)zy-ky(r+s))=w$$

As in Frederickson and Holmlund, (2001) I utilize the decomposition $V^e(z)-V^{u_1}=(V^e(z)-V^{u_2})-(V^{u_1}-V^{u_2})$. To arrive at equation (16), using (9) along with the free entry equation, and equation (11) along with (26) and (27). Equation (17) is then derived in the same way, but using the first order condition for search, equation (8) instead of (26). To determine the comparative statics for market thickness define:

$$\xi=\phi k(r+s+a(e)\alpha(\theta))-(1-\phi)(q(\theta)z-k(r+s))(\psi^2-\beta(r+a(e)\alpha(\theta))\Phi)$$

where

$$\frac{\partial\xi}{\partial\theta}=\phi ka(e)\alpha'(\theta)-(1-\phi)q'(\theta)z(\psi^2-\beta(r+a(e)\alpha(\theta))\Phi)$$
$$+(1-\phi)(q(\theta)z-k(r+s))\beta a(e)\alpha'(\theta)\Phi$$

$\frac{\partial\xi}{\partial\theta}>0$ if $\Phi\geq 0$. If *b(1)* is much lower than *b(2)* than $\frac{\partial\xi}{\partial\theta}$ may be less than zero.

Implicitly differentiating ξ gives the following comparative statics:

$$\theta_{b(1)}=-\left[\frac{\partial\xi}{\partial\theta}\right]^{-1}(1-\phi)(q(\theta)z-k(r+s))\beta(r+a(e)\alpha(\theta))\Phi_{b(1)}$$

$$\theta_{b(2)} = \left[\frac{\partial \xi}{\partial \theta}\right]^{-1} (1-\phi)(q(\theta)z - k(r+s))\beta(r + a(e)\alpha(\theta))(\psi^2_{b(2)} - \beta(r + a(e)\alpha(\theta))\Phi_{b(2)})$$

$$\theta_{\tau} = \left[\frac{\partial \xi}{\partial \theta}\right]^{-1} (1-\phi)(q(\theta)z - k(r+s))(\psi^2_{\tau} - \beta(r + a(e)\alpha(\theta))\Phi_{\tau}$$

$$\theta_{z} = \left[\frac{\partial \xi}{\partial \theta}\right]^{-1} (1-\phi)q(\theta)(\psi^2 - \beta(r + a(e)\alpha(\theta))\Phi) > 0$$

where $(\psi^1_{b(2)} - \beta(r + a(e)a(\theta))\Phi_{b(2)}) \leq 0$. A sufficient condition for $\theta_{b(1)} < 0$, $\theta_{b(2)} < 0$, and $\theta_z > 0$ is *b(1)≥b(2)*. In addition, differentiating with respect to *e* and applying the agents first order condition for search implies that $\theta_e = 0$.

Defining: $\varsigma = \phi ka'(e)\alpha(\theta) - (1-\phi)(q(\theta)z - k(r+s))(\psi_e - \beta\Phi)$, with $\frac{\partial \zeta}{\partial e} = \phi ka''(e)\alpha(\theta) < 0$, the comparative statics with respect to *e* are as follows:

$$e_{b(1)} = -\left[\frac{\partial \varsigma}{\partial e}\right]^{-1} (1-\phi)(q(\theta)z - k(r+s))\beta\Phi_{b(1)} > 0$$

$$e_{b(2)} = -\left[\frac{\partial \varsigma}{\partial e}\right]^{-1} (1-\phi)(q(\theta)z - k(r+s))\beta\Phi_{b(2)} < 0$$

$$e_{\tau} = -\left[\frac{\partial \varsigma}{\partial e}\right]^{-1} (1-\phi)(q(\theta)z - k(r+s))(\psi_{e\tau} - \beta\Phi_{\tau}) < 0$$

since $(\psi_{e\tau} - \beta\Phi_{\tau}) > 0$ assuming that *b(1)* and *b(2)* <1

$$e_{z} = \left[\frac{\partial \zeta}{\partial e}\right]^{-1} (1-\phi)q(\theta)(\psi_e - \beta\Phi) > 0$$ since $(\psi_e - \beta\Phi) > 0$ assuming *b(1),b(2)*<1

$$e_{\theta} = -\left[\frac{\partial \zeta}{\partial e}\right]^{-1} [\phi ka'(e)\alpha'(\theta) - (1-\phi)q'(\theta)z(\psi_e - \beta\Phi) > 0$$

APPENDIX 2 - UNOBSERVABLE EFFORT OPTIMAL REPLACEMENT RATE

The bellman equation for the government's objective function when effort is observable can be written as follows:

(28)

$$SW(z, u^1_t, u^2_t) = \max_{\{b(d),\tau,e\}^\infty_t} [n_t v(w_t(1-\tau_t)) + \sum_{d=1}^{2} u^d_t (v(w_t b_t(d)) - h(w_t, e^d_t)) + \beta SW(z_{t+1}, u^1_{t+1}, u^2_{t+1})$$

subject to the balanced budget constraint, $\tau_t n_t = \sum_d^2 u_t^d b_t(d)$, and the laws of motion for those unemployed one period $u_{t+1}^1 = sn_t$ and two periods,

$u_{t+1}^2 = u_t^1(1 - a(e_t)\alpha(\theta_t)) - u_t^2(1 - a(e_t)\alpha(\theta_t))$.

The first order conditions with respect to the replacement rates and taxes are as follows:

(29) $$b_t(1) : v'(w_t b_t(1)) - \lambda_t^1 = 0$$

(30) $$b_t(2) : v'(w_t b_t(2)) - \lambda_t^1 = 0$$

(31) $$\tau_t : v'(w_t(1-\tau_t)) - \lambda_t^1 = 0$$

where λ^1 is the multiplier on the budget constraint. The concavity of the utility function along with (29) - (31) and the budget constraint implies $(1-\tau_t) = b_t(1) = b_t(2) = n_t$. Thus the benefit will increase with employment, as more resources become available.

APPENDIX 3 - OPTIMAL EFFORT LEVEL WITH OBSERVABLE EFFORT

Continuing with the maximization of equation (28) in Appendix 2, we have the following additional first order conditions:

(32) $$e_t : -h_e(w_t, e_t) + \lambda_t^3 a'(e_t)\alpha(\theta_t) = 0$$

(33) $$u_{t+1}^1 : \beta SW_1(u_{t+1}^1, u_{t+1}^2, z_{t+1}) + \lambda_t^2 = 0$$

(34) $$u_{t+1}^2 : \beta SW_2(u_{t+1}^1, u_{t+1}^2, z_{t+1}) + \lambda_t^3 = 0$$

(35) $$\begin{aligned} SW_1(u_t^1, u_t^2, z_t) = &-v(w_t(1-\tau_t)) + (v(w_t b_t(1)) - h(w_t, e_t)) \\ &- \lambda_t^1 w_t(\tau_t + b_t(1)) + \lambda_t^2 s - \lambda_t^3(1 - a(e_t)\alpha(\theta_t)) \end{aligned}$$

(36) $$\begin{aligned} SW_2(u_t^1, u_t^2, z_t) = &-v(w_t(1-\tau_t)) + (v(w_t b_t(2)) - h(w_t, e_t)) \\ &- \lambda_t^1 w_t(\tau_t + b_t(2)) + s\lambda_t^2 - \lambda_t^3(1 - a(e_t)\alpha(\theta_t)) \end{aligned}$$

where λ^2 is the multiplier for the law of motion for the short-term unemployed and λ^3 is the multiplier on the law of motion for the long term unemployed. Using equations (29) - (36) the optimal level of effort is given by:

(37) $$\frac{\partial SW}{\partial e} = wv'(wb)[-\psi_e + a'(e)\alpha(\theta)\frac{\psi + 1}{r + s + a(e)\alpha(\theta)}] \text{ where } \psi = \psi^1 = \psi^2$$

and *b(1)=b(2)=b*.

To show that too little effort is chosen by workers when effort is not monitored, apply the worker's first order condition for effort, (8), to (37):

$$\frac{\partial SW}{\partial e} = wv'(wb)\frac{\psi}{r+s+a(e)\alpha(\theta)} > 0$$

Thus search is sub-optimal, when not monitored and cannot be controlled perfectly by the government.

APPENDIX 4: CHANGE IN OPTIMAL EFFORT WITH PRODUCTIVITY WHEN SEARCH IS OBSERVABLE

Assume a trial solution where *e* holds for all values of z and that all other first order equations hold. Differentiating (37) with respect to:

(38) $$\frac{\partial^2 SW}{\partial e \partial z} = \frac{\partial wv(wb)'}{\partial z}\frac{a'(e)\alpha(\theta)}{(r+s+a(e)\alpha(\theta))} + \frac{swv(wb)'(\psi+1)\theta_z}{(r+s+a(e)\alpha(\theta))^2} > 0$$

where $\theta_z = \frac{\partial \theta}{\partial z} > 0$, and $\frac{\partial w(1-\tau)v(w(1-\tau))'}{\partial z} > 0$ applying proposition 1.

Thus as *z* changes, (37), the marginal social benefit of effort increases at a given level of effort.

$$\frac{\partial^2 SW(\hat{z})}{\partial e \partial z} > 0 \Rightarrow \frac{\partial e^*}{\partial z} > 0 .$$

Also, the gap between the effort level exerted by workers, when not monitored, for a given benefit level and what workers would choose is represented by:

$$G = a'(e)\alpha(\theta)\frac{wv'(wb)}{r+s+a(e)\alpha(\theta)}$$

with the derivative with respect to z given as:

$$\frac{\partial G}{\partial z} = \frac{\partial wv(wb)'}{\partial z}\frac{a'(e)\alpha(\theta)}{(r+s+a(e)\alpha(\theta))} + wv(wb)'\frac{s\theta_z}{(r+s+a(e)\alpha(\theta))^2} > 0$$

Thus the gap between the first and second best level of effort, evaluated at the first best replacement rate, increases with productivity.

APPENDIX 5: OPTIMAL EFFORT WHEN SEARCH IS UNOBSERVABLE

The first order conditions for the two benefit levels and taxes are as follows:

(39) $$b(1): u_t^1 w(v(w_t b_t(1))' - \lambda_t^1) + e_{b(1)}\frac{\partial SW}{\partial e} = 0$$

(40) $$b(2): u_t^2 w(v(w_t b_t(2))' - \lambda_t^1) + e_{b(2)}\frac{\partial SW}{\partial e} = 0$$

(41) $$\tau : (1-u_{1,t}-u_{2,t})w(-v(w_t(1-\tau_t))'+\lambda^1)+e_\tau \frac{\partial SW}{\partial e}=0$$

where λ_t^1 is the multiplier on the budget constraint. $e_{b(1)}$, $e_{b(2)}$, and e_τ are defined using equation (8):

$$e_\tau = \frac{a'(e)wv'(w(1-\tau))}{a''(e)[v(w(1-\tau))-(v(wb(2)-h(w,e))+\beta sv(wb(1))-v(wb(2)))]}<0$$
$$e_{b(1)} = -\frac{a'(e)\beta swv(wb(1))'}{a''(e)[v(w(1-\tau))-(v(wb(2)-h(w,e))+\beta sv(wb(1))-v(wb(2)))]}>0$$
$$e_{b(2)} = \frac{a'(e)wv(wb(2))')(1+\beta s)}{a''(e)[v(w(1-\tau))-(v(wb(2)-h(w,e))+\beta sv(wb(1))-v(wb(2)))]}<0$$

Given that $e_{b(1)}>0$, $e_{b(2)}<0$ and $\frac{\partial SW}{\partial e}>0$ the following inequality characterizes the relationship between b(1) and b(2): $v(w_t b_t(2))' > \lambda^1 > v(w_t b_t(1))'$ or *b(1) > b(2).*

To see how the benefit schedule should change with an increase in *z*, first re-write the first order condition for taxes as follows making use of the functional form for *v*:

(42) $$\frac{n-\dfrac{(1-\tau)nw\lambda^1}{Wv(W)'}}{\dfrac{e_\tau(1-\tau)}{Wv(W)'}}=\frac{\partial SW}{\partial e}$$

Next substitute, for $\frac{\partial SW}{\partial e}$ into (39) and (40) using (42). Then use (39) to eliminate λ^1 in (40) to get the following expression:

$$B=\frac{s(1-\beta)(1-p)}{[s(1-p)+(1+\beta s)p-\Phi_{b(1)}(1-\tau)(s\beta+p)]} \quad \text{where } B=-\frac{\Phi_{b(2)}}{\Phi_{b(1)}}=\left[\frac{b(1)}{b(2)}\right]^\sigma$$

B measures the spread between the UI benefit and welfare benefit or the slope of the benefits schedule. To determine how this slope changes with an increase in *z,* and consequently an increase in the job finding rate, *p*, differentiate to get the expression:

$$[s(1-p)+(1+\beta s)p-\left[\frac{(1-\tau)}{b(1)}\right]^\sigma(s\beta+p)]\frac{B_z}{B}$$
$$=-(1+\beta s)\frac{p}{1-p}[1-\left[\frac{(1-\tau)}{b(1)}\right]^\sigma]\frac{p_z}{p}-\frac{(s\beta+p)}{\sigma}\left[\frac{(1-\tau)}{b(1)}\right]^\sigma\frac{b_z(1)}{b(1)}$$

$B > 0$ implies the bracketed term on the LHS is greater than zero. The term multiplying $\frac{p_z}{p}$ is greater than zero (inclusive of the negative sign), assuming that $(1-\tau) > b(1)$. Finally, the last term on the RHS is negative if $\frac{b_z(1)}{b(1)} > 0$ otherwise it is positive. The proof proceeds by contradiction. Suppose that $\frac{b_z(1)}{b(1)} = 0$ this implies that $\frac{B_z}{B} > 0$. If *b(1)* is unchanged than *b(2)* must fall for *H* to increase. However, with a constant tax rate and greater employment with an increase in *z*, *b(2)* falling implies *b(1)* increasing a contradiction. Suppose $\frac{b_z(1)}{b(1)} < 0$. The RHS is unambiguously positive implying $\frac{B_z}{B} > 0$. However the budget constraint with *b(1)* falling implies *b(2)* increasing and $\frac{B_z}{B} < 0$ a contradiction. Thus $\frac{B_z}{B} > 0$ with $\frac{b_z(1)}{b(1)} > 0$.

APPENDIX 6: STRATEGIC BARGAINING WAGE SETTING EQUATION

To derive equation (23), first substitute the value equations into (21) and (22) to arrive at:

$$v(w(1-\tau)) = \phi\Delta + v(w'(1-\tau))e^{-r\Delta} + \beta(e^{-r\Delta}-1)[(1-s)\mathrm{E}V^e(z) + sEV^{u_1}(z)]$$
$$zy - w' + \beta(1-s)EJ^e(z) = -\delta\Delta + e^{-r\Delta}[zy - w + \beta(1-s)EJ^e(z)]$$

Solving the second equation for *w*` and substituting into the first gives:

$$\frac{(w(1-\tau))^{1-\sigma}}{1-\sigma} - [Y\Delta + (1-e^{-r\Delta})[zy + (1-s)\beta EJ^e(z)] + we^{-r\Delta}]^{1-\sigma}\frac{(1-\tau)^{1-\sigma}}{1-\sigma}e^{-r\Delta}$$
$$= \phi\Delta - (1-e^{-r\Delta})\beta[(1-s)\mathrm{E}V^e(z) + sEV^{u_1}(z)]$$

Taking the limit as $\Delta \to 0$, while noting that the left and right hand sides evaluated at $\Delta = 0$ is zero, which allows for the application of L'Hopital's rule. Rearranging and substituting $V^e(z)$ and $J^e(z)$ gives the wage setting equation in (23).