Optimal Unemployment Insurance with Monitoring

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Abstract

Monitoring the job-search activities of unemployed workers is a common government intervention. Typically, a caseworker reviews the unemployed worker's employment contacts at some frequency, and applies sanctions if certain requirements are not met. I model monitoring in the *optimal unemployment insurance* framework of Hopenhayn and Nicolini (1997), where job-search effort is private information for the unemployed worker. In the model, monitoring provides costly information upon which the government conditions the unemployment benefits. In the optimal monitoring scheme, endogenous sanctions and rewards, together with random monitoring, create effective job-search incentives for the unemployed worker. I calibrate the model to the US economy and find that the addition of optimal monitoring to the optimal unemployment insurance scheme decreases the variance of consumption by about two thirds and eliminates roughly half of the government's cost. I also find that compared with the optimal monitoring scheme, US states monitor too much and impose the sanctions over too short a time span. For the US on average, shifting to the optimal monitoring policy would generate savings of about $500 per unemployment spell.

JEL Classification: D82; H21; J64; J65

Keywords: Recursive Contracts; Unemployment Insurance; Job Search Monitoring

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1 Introduction

Public spending on labor market policies was on average 1.6% of output in industrialized countries in 2001 (OECD 2005). These labor market policies can be divided into passive and active policies. Passive policies, such as constant benefits to the unemployed, are mainly concerned with the welfare of the unemployed worker, while active policies, such as job-search monitoring and training, are mainly concerned with increasing the unemployment exit rate. In the last three decades active labor market policies have gained a higher share of the total spending on labor policies[1] and have received increasing attention as governments seek to insure unemployed workers without damaging their incentives for becoming employed.

Given that additional policy instruments such as job-search monitoring are available and are implemented by governments, it is important to model these instruments, to examine to which extent these instruments increase the efficiency of unemployment insurance programs, and to compare existing policies to the optimal policy. This is a non-trivial task since such instruments, as valuable as they may be, are also costly.

In practice, monitoring requires the unemployed worker to record his job-search activities, typically by listing the employers he contacted in a given period. At the employment office, a caseworker evaluates occasionally whether the job-search requirements are met, e.g. by verifying that the contacts are authentic. If the caseworker finds the report unsatisfactory, then she may impose sanctions, usually in the form of benefits' reduction for a limited period.

The first objective of this paper is to model *monitoring* in the framework of *optimal unemployment insurance* developed by Hopenhayn and Nicolini (1997) and to characterize the optimal allocation in the presence of monitoring. In Hopenhayn and Nicolini (1997) a

[1] Between 1985 and 2001 the share of active labor market policies in OECD countries increased from 35% to 52% (OECD 2005).

risk neutral planner, the government, insures a risk averse worker against unemployment by setting transfers during unemployment and a wage tax or a subsidy during employment. During unemployment, the worker searches for a job by exerting an effort level which is his private information. The first best, had the information been observable to the planner, is to deliver to the worker constant benefits regardless of the employment status. Since, however, the planner cannot observe the job-search effort level, constant benefits would flaw the worker's incentives to search for a job. Therefore, to solve the incentive-insurance trade-off, during unemployment benefits should continuously decrease and the wage tax upon re-employment should continuously increase.

I incorporate monitoring into the optimal unemployment insurance framework as follows. The planner monitors the unemployed worker with some history-dependent probability. When a worker is monitored, the planner pays a cost and receives a signal that is correlated with the job-search effort of the worker. The planner uses that signal to improve the efficiency of the contract by conditioning future payments and the wage tax, not only on the employment outcome, but also on the signal. These future values create endogenous sanctions and rewards, that together with the random monitoring, create effective job-search incentives: the worker exerts a high job-search effort level in order to increase the probability of a good signal, and consequently to increase the probability of higher payments.

I find that at the constrained optimum, the planner chooses for each type of unemployed worker a specific combination of monitoring frequency and sanction severity: as the generosity of the welfare system increases, the planner monitors the unemployed more frequently but imposes lower sanctions. This policy pattern is linked to the worker's risk aversion: as the generosity of the welfare system increases, the planner finds it more costly to sanction the worker because the reward that is required to counterbalance a given sanction increases with the level of promised utility; at the same time the cost of acquiring the monitoring signal is fixed in units of consumption, and therefore the planner shifts gradually from applying severe sanctions at a low probability to applying less severe sanctions at a higher probability.

The second objective of the paper is to estimate the value of the additional instrument of monitoring by comparing the results of the model to the results of a model where monitoring technology is unavailable. I find that when comparing the two models at a balanced budget (zero net cost for the planner), monitoring decreases the variance of consumption by about two thirds and eliminates roughly half of the government's cost of the model without monitoring.

The third objective of the paper is to contrast the actual monitoring policy in the US with the optimal scheme and assess the gain from shifting to the optimal scheme[2]. Compared with the optimal monitoring scheme, US states monitor too much and impose the sanctions over too short a time span. For the US on average, shifting to the optimal monitoring policy would generate savings for the government of about $500 per unemployment spell or a permanent increase in consumption for the unemployed of about 2%.

The effect of job-search monitoring on labor market outcomes such as unemployment duration is usually significant and positive[3]. Johnson and Klepinger (1994) used random assignment of unemployed workers to treatment groups that differed in the job-search requirements. They find that waving the weekly requirement to record three contacts increased the average unemployment spell by 3.3 weeks. Klepinger et al. (1997) find that increasing the number of required contacts from two to four decreased the average unemployment spell by 5.9%, and that informing the unemployed workers that the contacts

[2]This exercise is quite different than the one presented in the second objective of the paper. There, the comparison was between two unemployment insurance schemes, one with monitoring and one without. The comparison here is between two policies that use the same technology (monitoring) differently.

[3]Van den Berg et al. (2001) consider a model where the efficiency of search is damaged because unemployed workers substitute formal channels for informal channels. For adverse effects of job search assistance see Van den Berg (1994) and Fougere et al. (2005).

will be verified decreased the average unemployment duration by 7.5%.

The evidence on the effects of sanctions is limited yet encouraging. In two empirical studies that were conducted in the Netherlands, Van den Berg et al. (2004) and Abbring et al. (2005) find that the unemployment exit rate doubles following a sanction.

Job-search monitoring has been previously examined by several authors. Pavoni and Violante (2007) consider monitoring as part of an optimal Welfare-to-Work program, where the planner can perfectly observe the worker's job-search effort by paying some cost. My model is more general in three ways. First, the monitoring signal is not necessarily perfect. This generalization is desirable because it may be impossible for the planner to extract the exact information on the worker's job-search effort. Furthermore, even if extracting the exact information was possible, it might be very costly, and it may be more efficient for the planner to extract imperfect information on the job-search effort for a significantly lower cost. Second, in Pavoni and Violante, when the planner chooses to monitor, he does so with certainty, whereas the model presented here allows the planner to optimally choose the frequency of monitoring. Finally, since the job-search effort is revealed to the planner, in Pavoni and Violante sanctions or rewards are never needed, whereas here sanctions and rewards are key components of the optimal contract.

Boone et al. (2001) characterize the optimal monitoring policy in a general equilibrium search model. They restrict "ad-hoc" the set of policies among which the optimal one is chosen. First, the planner does not condition the benefits on the worker's history, and second, the planner can only punish the worker by applying a fixed decrease in benefits for the remaining unemployment spell. Their model, however, has the advantage of general equilibrium which my model lacks.

The rest of the paper is organized as follows. In Section 2, I describe the model. In Section 3, I calibrate the model to the US economy. In Section 4, I characterize the optimal monitoring policy, estimate the value of monitoring, and compare the optimal and actual monitoring policies in the US. In Section 5, I conclude and discuss further research.

2 The Model

2.1 The economy

Preferences: Workers have a period utility $u(c) - a$ where c is consumption, a is disutility from job-search effort or work, and u is assumed to be strictly increasing and strictly concave. Workers discount the future at the discount factor β.

Employment and Unemployment: The worker is either employed or unemployed. During employment the worker exerts a constant effort level e_w, and receives a fixed periodic wage w. Employment is assumed to be an absorbing state[4].

During unemployment, the worker searches for a job with an effort level $a \in \{e_l, e_h\}$ that is either low or high and is private information of the worker. The unemployment exit rate increases with the job-search effort level $j \in \{l, h\}$ and is denoted by π_j. The low job-search effort is interpreted as not actively looking for a job, and therefore I set $e_l = 0$ and $\pi_l = 0$. For brevity of notation, denote henceforth e_h as e, and π_h as π.

Monitoring technology: The monitoring probability $\mu \in [0, 1]$ is a decision variable of the planner. When the worker is monitored, the planner receives a signal on the worker's job-search effort that is either good or bad, denoted by $\{g, b\}$ respectively. The probability of a *good* signal given job-search effort $j \in \{l, h\}$ is θ_j. The signal is only informative if $\theta_h \neq \theta_l$, and I assume, without loss of generality, that $\theta_h > \theta_l$. This assumption implies that given a good signal, the worker is more likely to have had exerted the high job-search effort, than the low job-search effort.

[4] The assumption that employment is an absorbing state is widely used in the literature (e.g. Hopenhayn and Nicolini 1997, Pavoni 2006, and Pavoni and Violante 2007). This assumption allows us to analyze one unemployment spell at a time, and does not affect the qualitative characteristics of the optimal policy.

The cost of monitoring is κ per period[5], and it discourages the planner from setting the monitoring frequency to 1 under all circumstances. Finally, the model assumes that only one monitoring technology is available to the planner[6].

Information structure: Both the worker and the planner observe the employment state, the monitoring signal and the on-the-job effort level[7]. However, only the worker observes the job-search effort level.

Timing: Figure 1 shows the timing of the model and the four possible outcomes at the end of the period. At the beginning of each period, the planner delivers consumption c to the worker. Then, the worker looks for a job with an effort level e_j, and finds a job with probability π_j. If the worker becomes employed then the planner does not apply monitoring[8]. If, on the other hand, the worker remains unemployed then he is monitored with probability μ. When monitoring takes place, the planner pays the cost κ, and receives the signal $s \in \{g, b\}$.

Figure 1 Approximately Here

Given the realizations of the employment state, monitoring, and the signal, the four possible outcomes at the end of the period are: employment (e), unmonitored unemployment (n), monitored unemployment with a good signal (g), and monitored unemployment with a bad signal (b).

[5] Given that the administrative institutions for unemployed workers already exist, I assume that monitoring has no additional fixed cost.

[6] This assumption can be easily relaxed by allowing the planner to choose a monitoring technology m from the set $\mathcal{M} = \left\{\kappa^i, \theta_h^i, \theta_l^i\right\}_{i=1}^N$ which includes N monitoring technologies.

[7] The assumption that the effort level on-the-job is observed by the planner is used to simplify the problem and does not have any qualitative effect on the results. This assumption is standard in the optimal unemployment insurance literature, e.g. Hopenhayn and Nicolini (1997) and Pavoni and Violante (2007). Wang and Williamson (2002) consider the case where the worker's effort level affects the probability of transitions both from unemployment to employment and from employment to unemployment.

[8] When a worker becomes employed, it is clear to the planner that the worker exerted the high job-search effort (because the probability of finding a job associated with zero effort is zero) and therefore monitoring such a worker is never optimal.

2.2 The planner's problem

The optimal contract between the planner and the worker requires, in general, conditioning the benefits and the wage tax on the entire history of the worker. Spear and Srivastava (1987), Thomas and Worrall (1988), Abreu, Pearce, and Stacchetti (1990), and Phelan and Townsend (1991) found that all the relevant information for the recursive contract is contained in a one-dimensional object. In the monitoring recursive contract, as in the unemployment insurance contract, this one-dimensional state of the worker is the expected discounted utility U promised to the worker at the beginning of each period. At the end of each period, this value is updated according to the outcomes and is therefore governed by all the relevant information in the worker's history. Although this state is not a primitive of the model, using it makes the problem easier to solve, and once the model is solved the state is used to back out the allocation for each type of worker.

In what follows, I present the planner problems during employment and during unemployment.

2.2.1 The planner's problem during employment

Let $W(U)$ be the value for the planner from an employed worker who has promised utility U. The planner's problem during employment is:

$$\begin{aligned} W(U) &= \max_{c,U^e} -c + w + \beta W(U^e) \qquad (1) \\ s.t. &: \\ U &= u(c) - e_w + \beta U^e \end{aligned}$$

where U^e is the future promised utility contingent on employment. If $c > w$ then the planner delivers the difference to the worker as a wage subsidy and if $c < w$ then the planner extracts the difference as a wage tax. The constraint in the problem, commonly known as the *promise keeping* constraint, states that the expected utility for the worker given current consumption, disutility from work, and discounted future promised utility, has to deliver, in expected terms, the utility U that was promised to the worker at the beginning of the period.

Given the absence of moral hazard, the solution to the employment problem is full insurance and constant benefits, which implies a constant wage tax or subsidy.

2.2.2 The planner's problem during unemployment

For an unemployed worker, the planner chooses for each possible state six variables: consumption c, monitoring probability μ, and four continuation values, one for each possible outcome: employment U^e, unmonitored unemployment U^n, monitored unemployment with a good signal U^g, and monitored unemployment with a bad signal U^b. In addition to these six decisions, the planner recommends a job-search effort level[9]. When the planner recommends a high job-search effort level, he needs to support this recommendation by making it worthwhile for the worker to exert the high job-search effort. This is achieved by the *incentive compatibility* constraint that guarantees that the expected utility for a worker who exerts the high job-search effort is at least as high as that of a worker who exerts the low job-search effort[10].

Let $V(U)$ be the value for the planner, who recommends the high job-search effort, from an unemployed worker who has promised utility U. The problem of that planner

[9] If the planner recommends the low effort level then there is no need to set incentives and the solution is constant benefits and a constant wage tax. This solution can be achieved because while $\pi > 0$, the probability of finding a job associated with zero effort is zero. Therefore the planner knows that a worker who received a job offer must have searched for a job with a high effort level. The planner can use this observation to apply a punishment severe enough to discourage workers from not following the low job-search effort recommendation.

[10] For high enough values of promised utility, creating incentives by spreading future promised utilities is too costly and the planner recommends low job-search effort and implements full insurance (Pavoni and Violante (2007) refer to this state as Social Assistance). In the current calibration social assistance is optimal only for very high values of promised utility (associated with constant consumption that are higher than the gross wage). In the simulations the promised utility values of the workers are always lower than these values. Therefore, and in order to fully characterize the optimal monitoring policy, I describe the monitoring policy as if creating incentives for the worker to extract the high job-search effort is always desirable.

during unemployment is:

$$
\begin{aligned}
V(U) &= \max_{c,U^e,U^g,U^b,U^n,\mu} -c+\beta\left\{\pi W(U^e)+(1-\pi)\left\{(1-\mu)V(U^n)+\mu\left[-\kappa+\theta_h V(U^g)+(1-\theta_h)V(U^b)\right]\right\}\right\} \\
s.t. &: \\
U &= u(c)-e+\beta\pi U^e+\beta(1-\pi)\left[(1-\mu)U^n+\mu\left(\theta_h U^g+(1-\theta_h)U^b\right)\right] \qquad (2)\\
U &\geq u(c)+\beta\left[(1-\mu)U^n+\mu\left(\theta_l U^g+(1-\theta_l)U^b\right)\right]
\end{aligned}
$$

where the objective function includes: the cost of consumption payments to the worker; the discounted value of employment at future promised utility U^e; the discounted value of unmonitored unemployment; and the discounted value of monitored unemployment. Note that when monitoring is applied the cost of monitoring κ is included.

The first constraint is the *promise keeping* constraint and the second constraint is the *incentive compatibility* constraint discussed earlier. Note that since the probability of finding a job associated with zero effort is zero, the right-hand-side of the incentive compatibility constraint does not include an employment possibility.

I now discuss the trade-offs in the planner's problem, and their intuitive effects on the solution's properties:

- *Monitoring frequency.* As the monitoring frequency (μ) increases, the planner receives more information but pays a higher cost. Due to this trade-off, the planner will choose, in general, an interior point for μ. We expect the planner to choose a higher monitoring frequency the higher the efficiency of monitoring is. This efficiency increases when either θ_h increases, θ_l decreases, or both (more accurate information) and when κ decreases (less costly information).

- *Sanctions and rewards.* While an unmonitored unemployed worker is promised a lifetime utility of U^n, the same worker, when monitored, is promised a lifetime utility of either U^g or U^b depending on the signal. Therefore, it is intuitive to define the difference in promised utility relative to unmonitored promised utility ($U^g - U^n$, and $U^n - U^b$) as the worker's reward and sanction in utility terms, respectively.

It can be shown, by manipulating the first order conditions of the planner's problem (see Appendix A), that the three values, U^n, U^g, and U^b are closely related in the optimal solution as follows:

$$V'\left(U^n\right) = \theta_h V'\left(U^g\right) + \left(1-\theta_h\right) V'\left(U^b\right) \tag{3}$$

Hence, the carrot (the reward) and the stick (the sanction) balance each other in the optimal contract: the planner has to compensate the unemployed worker more, the higher the sanction is. Given that a typical value of θ_h is close to 1.0, as will be shown in the calibration, the severity of the sanction is expected to be significantly higher than the generosity of the reward. In other words, a monitored unemployed worker expects to receive a small reward with a high probability and a severe sanction with a low probability.

- *Monitoring frequency versus sanctions and rewards.* The planner sets the decision variables in the problem in accordance with the *incentive compatibility* constraint. In particular, the planner can magnify the effect of monitoring in two ways: he could increase the probability of monitoring, or he could increase both the reward and the sanction. Given that $\theta_h > \theta_l$, either of these two methods would be helpful in increasing the expected utility that the unemployed worker is promised when exerting a high job-search effort relative to that of the low job-search effort. We will see that the planner chooses a particular combination of the probability of monitoring (the intensity of the policy) and the magnitude of the reward and the sanction (the extensiveness of the policy), depending on the unemployment worker's state (U). I will discuss this choice in details in the results section.

3 Calibration

The calibration of the parameters that are not related to the monitoring technology follows Pavoni and Violante (2007). The unit of time is set to one month, and preferences are log utility in consumption. The monthly discount factor β is set to 0.9959 to match an annual interest rate of 5%. Using CPS data, monthly earnings, w, are set to \$1,540, which is the median monthly wage for workers with at most a high-school diploma, and the employment exit rate, π, is set to 0.22, which is the conditional average of the unemployment hazard rate. The disutility of work effort, e_w, which equals the disutility of job-search effort, e, is equal to 0.67[11].

The remaining parameters that need to be calibrated are those that characterize the monitoring technology: the monitoring cost κ, and the probabilities of a good signal given high and low job-search effort θ_h and θ_l, respectively.

The monitoring cost κ is based on data from The Minnesota Family Investment Program (2000), where each caseworker was responsible for 100 clients, and among other tasks, documented client activities, applied sanctions, and assisted with housing. Based on monthly gross earnings of \$3,000 per caseworker[12] and the caseload described above, the value of κ is \$30 per month per monitoring of an unemployed worker. This value is an upper bound because the caseworkers were also engaged in activities other than monitoring.

The probabilities of a good signal given high and low job-search effort levels (θ_h, θ_l) are determined simultaneously[13] by the following parameters: the monthly monitoring frequency $\left(\mu^{ACT}\right)$ of 0.20 (see Appendix B); the monthly probability of sanctions (ϕ) of 3.3% (Grubb 2000); and the measure of unemployed workers who exert a high job-search

[11] This value is based on a labor share of 0.60, a consumption-income ratio of 0.75, and a fraction of time worked of 0.3 (see Cooley 1995).

[12] The median of annual earnings for *Community and Social Services Occupations* in the US is \$36,390 (Department of Labor, 2006).

[13] The probability of a good signal given a *low* job-search effort (θ_l) is a source of imperfection that occurs, for example, due to an administrative failure or due to over-generosity of the caseworker.

effort[14] (ξ), as follows:

$$\phi = \mu^{ACT} * (\xi * (1 - \theta_h) + (1 - \xi) * (1 - \theta_l))$$

The lower bound of $\theta_h = 0.83$ is achieved by assuming that $\xi = 1$. This assumption is unrealistic since it implies that all the sanctions that workers experience in the US are unjustified and only happen due to the inaccuracy of the monitoring signal.

The upper bound of $\theta_h = 1$ is achieved for a wide variety of combinations of ξ, and θ_l (e.g. $\theta_l = 0.2$, and $\xi = 0.80$). Since the lower bound is unrealistic, and the upper bound is plausible for a wide variety of combinations of parameters I set $\theta_h = 0.95$ and $\theta_l = 0.20$. The sensitivity analysis at the end of the results section covers values of $\theta_h \in [0.85, 1.00]$ and $\theta_l \in [0.00, 0.80]$.

Table 1 lists the parameters of the model.

Table 1 Approximately Here

4 Results

The results of the model are organized as follows. First, I discuss the characteristics of the optimal monitoring policy. Then, I estimate the value of monitoring by comparing the current model to a model without monitoring technology and do a sensitivity analysis with respect to the key parameters of monitoring. At the end of the section, I compare the actual monitoring policy in the US with the optimal monitoring scheme. The solution method is described in details in the computational appendix.

[14] The unemployment insurance scheme in the model is such that workers always exert the high-effort. In the actual monitoring policy this is not necessarily the case due to heterogeneity in preferences, the fact that some of the US states do not monitor at all (see Appensix B), and other reasons.

4.1 Optimal monitoring policy

I assume that the government announces the optimal policy at time zero and commits itself to it. This assumption eliminates policies in which the planner deviates from the announced policy (e.g. the government does not monitor ex-post) and workers update their beliefs according to the observed government policy[15]. Given the commitment assumption, the question of whether the planner should monitor or not, need only be examined ex-ante: if the addition of monitoring improves the effectiveness of the contract then the government should use monitoring and follow the monitoring scheme.

The optimal contract, given the commitment assumption, is described recursively by six functions $\left\{c, U^e, U^g, U^b, U^n, \mu\right\}$, each depending on the state variable U. I start with two standard results in the optimal unemployment insurance literature (e.g. Pavoni and Violante 2007). First, the optimal consumption level (c) is increasing and convex in promised utility. Consumption increases in promised utility because, given the worker's desire for consumption smoothing, it is optimal for the planner to translate higher levels of promised utility into higher levels of consumption. The convexity of consumption in promised utility corresponds to the concavity of the utility function, which means that relatively more consumption is required to support a given increase in promised utility.

Second, since the planner is risk neutral, the upward slope and the convexity of consumption in promised utility imply that as promised utility increases, consumption increases both in absolute and relative terms. Therefore, the value function of the planner is downward slope and concave in promised utility.

The next result refers to the mapping of current promised utility to next period's promised utility, conditional on labor market outcomes. In the optimal contract, the four futures values, corresponding to the four possible outcomes, endogenously create implicit

[15] The commitment assumption is typical in the unemployment insurance literature, e.g. Hopenhayn and Nicolini (1997) and Pavoni and Violante (2007). There, too, the planner never deviates from the declared scheme.

rewards and punishments for creating effective incentives for the worker to exert the high job-search effort.

Figure 2 shows the mapping of the state across periods in utility units by outcome. The horizontal axis is the promised utility at the beginning of the period and the vertical axis is the next period's promised utility by outcome. The four future promised utilities in the figure are ordered as follows: U^e, U^g, U^n, U^b: upon employment, an outcome that can only happen in the model if the worker exerts a high job-search effort, promised utility increases; upon monitoring with a good signal, the worker receives a reward that is only slightly lower than that of employment[16]; upon unmonitored unemployment, the planner receives little information on the worker's effort level and therefore the promised utility changes only slightly; finally, upon monitoring with a bad signal the worker experiences a severe decrease in promised utility, implying that the planner finds the bad signal informative and helpful in creating the necessary incentives. This result follows the relation between U^n, U^g, and U^b (3), which states that the sanction level is significantly higher than the reward[17].

Figure 2 Approximately Here

The increase of the continuation values with the desirability of the outcomes $\{b, n, g, e\}$ is consistent with the monotone likelihood ratio property, which states that the second best consumption is correlated with the relative likelihood of an implemented effort rather than the lower levels of effort (see for example Zhao 2001[18]), i.e. consumption is higher for

[16]For a CRRA utility with a coefficient of relative risk aversion of two, I find that U^g is very close (from above) to U^n. Thus, the quantitative result depends on the parameters. Pavoni (2007) finds a closed form solution to the model without monitoring, an approach that provides analytical properties of the promised utility values, but is too cumbersome for the problem here, which includes six decision variables.

[17]The relevant ratio in (3), $\frac{\theta_h}{1-\theta_h}$, is equal to 19 in the current calibration.

[18]Zhao (2001) assumes that the likelihood ratio increases with productivity. Here, the necessary assumption for the monotone likelihood ratio property is: $\frac{p(e;e_h)}{p(e;e_l)} > \frac{p(g;e_h)}{p(g;e_l)} > \frac{p(n;e_h)}{p(n;e_l)} > \frac{p(b;e_h)}{p(b;e_l)}$. This condition is guaranteed as long as $\theta_h > \theta_l$.

outcomes where the ratio between the probability of an outcome given the high job-search effort and the probability of the same outcome given a low job-search effort, is higher.

We now move to discuss the sanction and the monitoring frequency decisions. Define the *relative consumption sanction* as the fraction by which benefits decrease relative to the benefits level of unmonitored unemployment[19]. Figures 3 and 4 show, respectively, the relative consumption sanction and the monitoring frequency by promised utility. The relative consumption sanction, which is a permanent decrease in consumption, varies a lot across promised utility, ranging roughly from 9% to 2%. The monitoring frequency varies a lot as well, ranging from 2% to 14%. Keeping everything else fixed, the lower the relative consumption sanction is, the higher the monitoring frequency should be to satisfy the incentive compatibility constraint.

Figures 3 and 4 Approximately Here

When combined, these two characteristics imply that as the generosity of the welfare system increases, the planner monitors the unemployed more frequently but imposes more moderate sanctions. This result is consistent with the observation of Boone et al (2001) that when comparing the monitoring policies of the US and Sweden, the number of sanctions is inversely related to the severity of the penalty.

The dynamics of the monitoring frequency and the relative consumption sanction are rooted in the concavity and downward-slope properties of the planner's value function. These properties imply that as the promised utility increases, the cost of spreading out the future promised values (i.e. the cost of providing incentives through sanctions and rewards) increases as well. Since the monitoring cost is independent of the promised utility level, the cost of the sanction relative to the cost of applying monitoring increases with promised utility and the planner substitutes sanctions with more frequent monitoring.

[19]The *relative consumption sanction* is different from the *sanction* defined earlier, which refers to the absolute decrease in the lifetime expected discounted utility.

Quantitatively, however, the optimal monitoring scheme is fairly insensitive to changes in promised utility that rise either from changes in the generosity of the welfare system or from changes in promised utility along the unemployment path. The planner can therefore use a relatively simple monitoring scheme with a fixed monitoring frequency and a fixed sanction that would deliver almost the same gains as the optimal one.

4.2 The value of monitoring

Figure 5 shows the difference in US$ between the planner's values for the policies with and without monitoring[20]. Monitoring is relatively more efficient at high levels of promised utility because as promised utility increases, spreading out future values, a necessary feature of optimal unemployment insurance schemes, becomes more costly. Thus, at low levels of promised utility (U), the optimal monitoring policy resembles the optimal unemployment insurance.

Figure 5 Approximately Here

Since the savings due to monitoring varies significantly across the state, it is of interest to measure the savings at the level of promised utility that balances the government's budget. The balanced budget point is U_0^* such that $V(U_0^*) = 0$. This is the level of promised utility for which the costs of benefits, wage subsidies and monitoring are exactly covered by the tax revenues[21]. At U_0^* (for the model with no monitoring) the addition of monitoring saves $25 per unemployment spell.

The low absolute saving does not indicate that monitoring is ineffective but that it is caused by a low potential for savings in the current framework. This low potential for savings follows the fact that the optimal unemployment insurance scheme already uses

[20] The model with no monitoring is very close to the model used in Hopenhayn and Nicolini (1997). The main difference is that in Hopenhayn and Nicolini the job-search effort level is continuous and not discrete. I use a discrete level of effort in both models for consistency.

[21] This point is unique because $V(U)$ is strictly monotone in U, .

all the relevant information in the worker's history. In order to get a better perspective of the potential of monitoring, it is useful to compare the savings induced by the use of monitoring to the maximum savings associated with the first best case, i.e. when the planner observes the job-search effort level and the allocation is constant consumption across time and states. I refer to the difference between the value of the first best and that of the optimal unemployment insurance scheme as the total cost of moral hazard. The saving due to monitoring as a fraction of the total moral hazard cost at the balanced budget point is equal to roughly half. This shows that monitoring is a useful policy instrument for lowering the moral hazard's cost intrinsic in the unemployment insurance problem.

4.2.1 What makes monitoring an effective policy

The reduction in the planner's cost due to monitoring is achieved by consumption smoothing. To demonstrate this, I simulate the consumption paths for the optimal unemployment insurance model and for the monitoring model. Figure 6 shows three examples of consumption paths following the two policies. In each example, the worker starts off as unemployed at a promised utility level of U_0^*, stays unemployed for 5 periods and then finds a job. In the top panel, monitoring is applied in periods 2,3 and 4 and in each monitoring event the signal is good. In the middle panel, there is no monitoring. In the bottom panel, monitoring is applied once, in period 2, and results with a bad signal.

Figure 6 Approximately Here

Consumption in the unemployment insurance model, where the planner has only two outcomes to condition on, decreases monotonically, and then increases significantly when the worker finds a job. These shifts in consumption are required for creating the necessary incentives for the unemployed worker to look for a job with a high effort. In contrast, consumption in the monitoring model varies very little, except for the third panel where the worker was sanctioned. Note, also, that a sanction is relatively a rare event that happens only when both monitoring and a bad signal happen. The probability of such event is $\mu * (1 - \theta_h)$, which is around 0.3% at the balanced budget point.

The simulation shows that thanks to the additional information regarding the job-search effort, monitoring allows the planner to smooth the unemployed worker's consumption. Simulating the model over 60 periods and 5,000 workers shows that the variance of consumption in the monitoring model is only one third of the variance of consumption in the model without monitoring.

4.2.2 Sensitivity Analysis

The comparison between the models with and without monitoring relies on the efficiency of monitoring, which in turn relies on the three parameters of the monitoring technology: the probabilities of a good signal given high and low job-search effort θ_h, θ_l, respectively, and the monitoring cost κ. In order to examine the robustness of the savings to these parameters I analyze the response of savings at the balanced budget point to various values of these parameters.

The probability of a good signal given the high job-search effort θ_h determines the value of the information extracted by applying monitoring. As θ_h, the planner receives more accurate information on the worker's job-search effort level and is therefore encouraged to monitor more frequently. Furthermore, as θ_h increases, the probability of a sanction decreases and the planner can use more severe sanctions to encourage the unemployed worker to exert the high job-search effort. In the extreme case when $\theta_h = 1$ it is possible to get arbitrarily close to the first best allocation by using a combination of very low monitoring frequency (that costs very little) with an extremely severe punishment that will never be applied but will still ensure that the worker exerts the high effort.

Table 2 presents the savings at the balanced budget point for various levels of θ_h.

Holding θ_l and κ fixed, as θ_h increases increases beyond the benchmark value, the efficiency of monitoring increases as expected. As θ_h decreases, the savings level decreases sharply and at a value of $\theta_h = 0.85$ (close to the unlikely lower bound) the savings is only 23%.

Table 2 Approximately Here

The sensitivity analysis of θ_l in Table 3 shows that monitoring's efficiency depends on the difference between the precision of the two signals (θ_h, θ_l). As θ_l gets closer to θ_h the savings decrease significantly.

Table 4 shows the savings for various values of the monitoring cost κ. First, note that when $\kappa = 0$ the first best is not achieved. This happens because in the model free monitoring does not imply that the effort is observable due to the imperfection of the signal[22]. Second, as the cost of monitoring increases, the planner finds that the price of the signal becomes more and more costly. As a result, the planner uses monitoring less frequently and the level of savings decreases.

4.3 Budget savings

In this section I compare the cost of the optimal monitoring scheme with the cost of the actual monitoring policy implemented in the US. The actual policy in the US includes three types of payments: a *net wage* for an employed worker, *net benefits* for an unemployed worker who is not sanctioned, and a *sanction* for an unemployed worker who is caught shirking.

The first two types of payments are calibrated based on a labor tax level of 0.29 (Mendoza et al 1994) and a replacement rate of 0.55 (OECD 2006). The calibration of the sanction is based on the sanction in the US, which is a complete loss of benefits

[22]The first best can only be achieved when there is no asymmetric information. When $\kappa = 0$, the planner monitors with probability 1.0 but since the signal is imperfect, the planner cannot know for sure what the job-search effort level was. Therefore, the planner still needs to condition the promised utility on outcomes that will happen in equilibrium, which is costly.

for one week (Grubb 2000). I assume, however, that some consumption smoothing is possible within a month, for example by using local networks, and model the sanction as a decrease of 23% in the net benefits[23]. These parameters, together with the monthly earnings calibrated earlier, imply a net wage of $\$1,093$, net benefits of $\$601$, and benefits net of sanction of $\$451$.

Unlike the benefits levels, which are fairly consistent across states in the US, the monthly monitoring frequency in the US varies significantly and ranges from 0 to 0.67. For the calibration of the actual policy, I use the average of 0.20 (see Appendix B for more details on the monitoring frequency in the US).

Figure 7 shows the levels of consumption for both the optimal and actual policies for a worker who starts unemployed and goes through the following states: $\{n, g, n, b, e\}$. The top panel shows both policies on the same wide vertical scale. The bottom panel shows the optimal policy on a tighter vertical scale in order to emphasize those variations in consumption that cannot be visualized in the top panel. The sharp changes in consumption in the actual policy, where the planner conditions only on the current state, are replaced by quite moderate changes in the optimal policy, where the planner conditions consumption on the complete history of the agent. Specifically, the one time decrease of 23% in the monthly benefit in the actual policy is replaced by a persistent decrease of only 5% in the optimal policy.

Figure 7 Approximately Here

In order to estimate quantitatively the budget savings of moving from the actual policy to the optimal policy I simulate both policies as follows. First, I simulate $5,000$ workers across $T = 60$ months according to the actual policy in the US to find the average cost for the planner and the expected utility delivered to the worker for the T periods. Then, I fix an initial level of promised utility in the optimal policy to match the same level of

[23] This is the share of one week in a month. It is equal to one over the ratio of 52 weeks over 12 months.

expected utility as in the actual policy. Finally, I simulate the optimal scheme and find its cost. The difference between the two costs is the gain for the planner from applying the optimal policy in the US[24]. Shifting to the optimal monitoring policy in the US would save \$521 per unemployed worker per unemployment spell. These savings can be translated into an increase of 1.8% in consumption over time T[25].

To sum up, compared with the optimal monitoring scheme, US states monitor too much on average (20% compared with 8%) and impose the sanctions over too short a time span[26].

5 Concluding remarks

Governments monitor the job-search activities of unemployed workers in order to increase the efficiency of unemployment insurance: they randomly monitor job-search effort and receive, at a cost, a signal of the effort level. This additional information plays an important role in the design of unemployment insurance schemes.

This paper uses, for the first time, the recursive contracts framework to model monitoring of job-search activities and to solve for the optimal policy. This framework allows to characterize the optimal monitoring policy, to evaluate the gain from using the additional technology, and to compare the cost and characteristics of the actual policy to those of the optimal policy.

The quantitative results in this paper are based on the calibration of the model to the US economy. There are, however, striking differences in the characteristics of the actual policies across the US states. Unlike the benefits levels that are fairly consistent across

[24]To be more precise, this is the savings for unemployment spells of up to 60 months. The measure of unemployed workers after 60 months is, however, negligible.

[25]The constant consumption increase is a fraction of $\frac{\beta-1}{\beta^T-1}$ of the savings. The consumption increase is equal to that constant consumption over the average consumption over time T.

[26]Some countries indeed spread the sanctions out: e.g. in Australia the job-search sanction is a decrease of 18% of the benefits level for a duration of 26 weeks (Grubb 2000).

the states, the monthly monitoring frequency varies significantly and ranges from 0.00 to 0.67 (see Appendix B). These significant differences cannot be easily explained within the framework of the model, and imply that the efficiency of the monitoring policy can be increased more significantly for some states than for others. Using an extended version of the model presented here, with US states specific parameters, can shed light on the causes for the differences in policies as well as the potential to improve the efficiency of the policy for each state.

In addition to the variation in the characteristics of the actual use of monitoring across US states, there are also significant differences across countries in all the main characteristics of the policy: the monitoring frequency; the sanctions' frequency; the sanction duration; and the sanction severity (Grubb 2000). Here, too, an extended model could reveal whether the variation in policies follows variation in labor market environments or some inefficiencies.

As pointed out by Abdulkadiroglu et al (2002) and Shimer and Werning (2008), allowing the workers to hold unobservable savings may significantly affect the results. It is important, however, to keep in mind that while the target population of unemployment insurance is very diverse, monitoring is targeted at long term unemployed workers, whose savings are significantly lower than those of the median worker.

Heterogeneity can be introduced into the model in several ways. The most direct way is to introduce heterogeneity in wages. This would allow conditioning the initial level of promised utility on the wage of each type of worker as applied in most OECD countries. This heterogeneity in wages would reduce and possibly eliminate the result that for high levels of promised utilities the planner recommends a low job-search effort: once high levels of promised utilities will be associated with high wages, the gain from employment to the planner will dominate the cost of setting the incentives for the high job-search effort.

Alternatively, heterogeneity can be introduced through several types of workers, each with a specific level of disutility from job-search effort. Assuming that the type is unknown to the planner[27], the planner can design customized contracts that would only appeal to one or some specific types

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APPENDIX A: COMPUTATIONAL METHOD

This appendix describes the solution method for the problem of a planner who recommends the high job-search effort during unemployment[28].

We begin by transforming the maximization problem with six decision variables and two constraints into a maximization problem with four decision variables and no constraints. To do this, start by writing the incentive compatibility constraint as follows[29]:

$$u(c)-e+\beta\pi U^e+\beta(1-\pi)\left[(1-\mu)U^n+\mu\left(\theta_h U^g+(1-\theta_h)U^b\right)\right]=u(c)+\beta\left[(1-\mu)U^n+\mu\left(\theta_l U^g+(1-\theta_l)U^b\right)\right]$$

and express U^e in terms of U^n, U^g, U^b and μ :

$$U^e=\frac{e}{\beta\pi}+(1-\mu)U^n-\frac{\mu}{\pi}\left\{[(1-\pi)\theta_h-\theta_l]U^g+[(1-\pi)(1-\theta_h)-(1-\theta_l)]U^b\right\} \tag{4}$$

Then, use the promise keeping constraint to express c in terms of U^e, U^n, U^g, U^b and μ :

$$c=u^{-1}\left\{U+e-\beta\left[\pi U^e+(1-\pi)\left((1-\mu)U^n+\mu\left(\theta_h U^g+(1-\theta_h)U^b\right)\right)\right]\right\} \tag{5}$$

Then, use (4) in the RHS of (5) to express the consumption level (c) in terms of U^n, U^g, U^b and μ. Substitute this value of c and the value for U^e from (4) into (2) to receive the maximization problem with four decision variables: U^n, U^g, U^b and μ, with no constraints.

These four remaining decision variables consist of three continuation values (U^n, U^g, U^b) and the monitoring frequency μ. While the support for the continuation values is, in general, the real line, the support for the monitoring frequency, μ, is obviously $[0,1]$. This closed support presents a computational challenge, which I overcome by distcritizing the support of the monitoring frequency into 101 values[30] and then solve the maximization problem for each of these 101 values.

[28] In absence of asymmetric information, the solution to the employment problem consists of constant benefits for the complete duration of employment.

[29] In the optimal solution, the incentive compatibility constraint always holds with equality. This is the case simply because delivering an expected discounted utility that is higher than the required one, costs more.

[30] The sensitivity of the solution is, therefore, 0.5% of monitoring frequency.

Thus, the maximization problem is reduced to three continuous variables: U^n, U^g, U^b. The solution to this problem is based on the three first order conditions (FOCs) with respect to U^n,U^g, and U^b respectively:

$$\left(u^{-1}\right)'(c\_arg) + \pi W'(U^e) + (1-\pi)V'(U^n) = 0$$

$$\left(u^{-1}\right)'(c\_arg)\,\theta_l - W'(U^e)\left((1-\pi)\,\theta_h - \theta_l\right) + (1-\pi)\theta_h V'(U^g) = 0$$

$$\left(u^{-1}\right)'(c\_arg)\,(1-\theta_l) - W'(U^e)\left((1-\pi)(1-\theta_h) - (1-\theta_l)\right) + (1-\pi)(1-\theta_h)\,V'(U^b) = 0$$

where I have defined for brevity of notation:

$$c\_arg = U + e - \beta\left[\pi U^e + (1-\pi)\left((1-\mu)\,U^n + \mu\left(\theta_h U^g + (1-\theta_h)\,U^b\right)\right)\right]$$

APPENDIX B: THE ACTUAL MONITORING POLICY IN THE US

Denote by τ^A the actual labor tax rate, by ρ^A the actual replacement rate, and by ζ^A the percent decrease in net benefits for a sanctioned worker. The three levels of payments under the actual policy in the US are[31]: net wage $w(1-\tau)$, net benefits $\overline{b} = w\rho^A(1-\tau)$, and benefits net of sanction of $\underline{b} = w\rho^A(1-\tau)\left(1-\zeta^A\right)$. The state of the unemployed worker in the actual policy is his last period's status $s \in \{u, p\}$ for unemployed, and penalized (sanctioned) respectively. Let W be the value for an employed worker and let $V(s)$ be the value for an unemployed worker. The unemployed worker faces a discrete decision of the job-search effort level as follows:

$$V(s) = \max_{a\in\{0,e\}} \left\{ \begin{array}{c} u(c_s) + \beta\left\{(1-\mu)V(u) + \mu\left[\theta_l V(u) + (1-\theta_l)\,V(p)\right]\right\}, \\ -e + u(c_s) + \beta\left\{\pi W + (1-\pi)\left\{(1-\mu)\,V(u) + \mu\left[\theta_h V(u) + (1-\theta_h)\,V(p)\right]\right\}\right\} \end{array} \right\}$$

[31]Note that in the actual policy there are only 3 possible outcomes and not 4 as in the model. This is because there are no awards in the actual policy for monitored unemployment with a good signal. Given, however, the proximity of U^g and U^n in the results, the lack of this additional outcome does not seem to be crucial to the design of the actual policy.

where I have used the assumption that a worker who exerts a low job-search effort stays unemployed, and where:

$$c_s = \left\{ \begin{array}{ll} \bar{b} & if\ s = u \\ \underline{b} & if\ s = p \end{array} \right\}$$

The value of an employed worker is:

$$W = \frac{u\left(w\left(1-\tau\right)\right) - e_w}{1-\beta}$$

The calibration of the actual monthly monitoring probability in the US, μ^{ACT}, is based on the frequency of required reports (of employment contacts) that the unemployed workers fill in and on the probability that these contacts are verified. While the weekly frequency of reports is fairly consistent across states (O'Leary 2004), the probability or verifying these contacts varies vastly across states: some states (e.g. Pennsylvania) do not monitor at all; some states (e.g. Washington) have a target monitoring frequency of 10%; and some states (e.g. South Dakota) consistently review contacts every 4-6 weeks (DOL 2003).

In addition to the vast variance in the probability of verifying contacts across states, the information is also usually vague, possibly because it is of the interest of states to conceal the actual probability of verifying contacts. As a benchmark for the probability of verifying employment contacts in the US I use a conservative value of 5% (the lower this probability the lower θ_h), which determines, together with a weekly frequency of reports, a monthly monitoring probability $\left(\mu^{ACT}\right)$ of 20%[32].

[32]The unemployed worker submits $52/12 = 4\frac{1}{3}$ reports a year. The probability of being monitored at least once in a month is: $1 - 0.95^{4.33} = 0.20$, where 0.95 is the probability of not being monitored in a given week.

TABLE 1

Calibration parameters

Parameter	**Symbol**	**Value**
Wage	w	$1,540
Monitoring cost	κ	$30
Disutility from exerting high job-search effort	e, e_w	0.67
Discount factor	β	0.9959
Unemployment exit rate	π	0.22
The probability of a good signal given a high effort	θ_h	0.95
The probability of a good signal given a low effort	θ_l	0.20
The actual monitoring policy in the US		
Monitoring frequency		0.20
Net wage		$1,093
Net benefits		$601
Benefits net of sanction		$451

TABLE 2

Sensitivity analysis for the value of θ_h

θ_h	0.85	0.90	0.95	0.99	1.00
Savings*	0.23	0.36	0.54	0.79	1.00

TABLE 3

Sensitivity analysis for the value of θ_l

θ_l	0.0	0.20	0.40	0.60	0.80
Savings*	0.62	0.54	0.41	0.19	0.00

TABLE 4

Sensitivity analysis for the value of κ

κ ($)	0	10	30	50	100
Savings*	0.94	0.71	0.54	0.43	0.27

*Fraction of the moral hazard cost

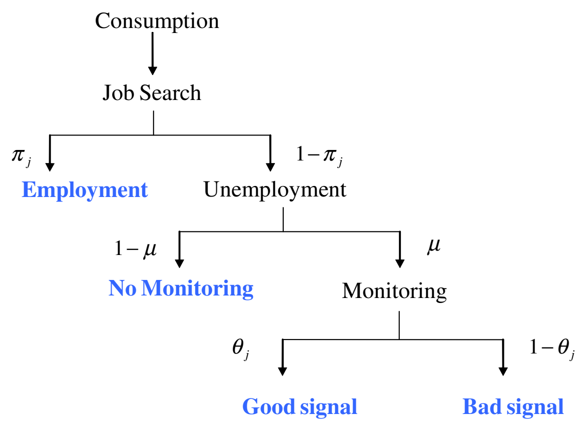

Fig. 1. The timing of the model and the four possible end-of-period outcomes: employment, unmonitored unemployment, monitored unemployment with a good signal, and monitored unemployment with a bad signal.

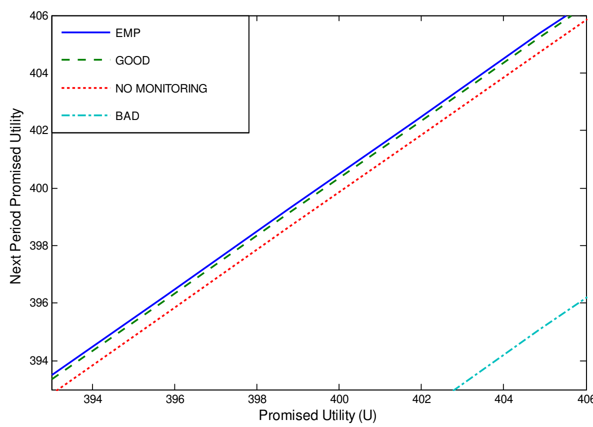

Fig. 2. The mapping of promised utility from the current period to the next period, conditioned on the four possible outcomes: employment, unmonitored unemployment, monitored unemployment with a good signal, and monitored unemployment with a bad signal. The values for employment and monitoring with a good signal are above the diagonal (the diagonal itself is not illustrated) and include a reward. The value for unmonitored unemployment is only slightly below the diagonal. Finally, the value for monitored unemployment with a bad signal is low due to the sanction.

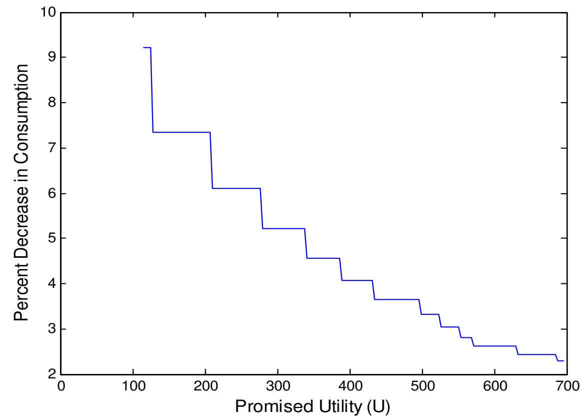

Fig. 3. The relative consumption sanction by promised utility.

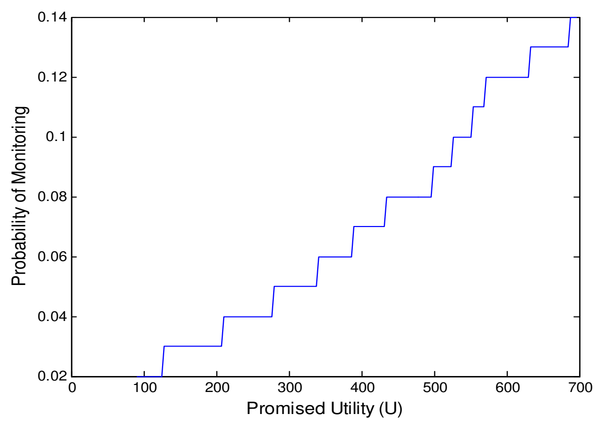

Fig. 4. The monitoring frequency by promised utility. As the generosity of the welfare system increases, the monitoring frequency increases and the relative consumption sanction (Fig. 3) decreases.

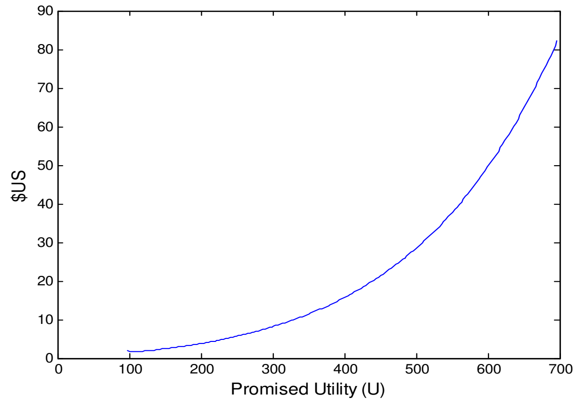

Fig. 5. The value function gap in US$ between the optimal monitoring and optimal unemployment insurance schemes.

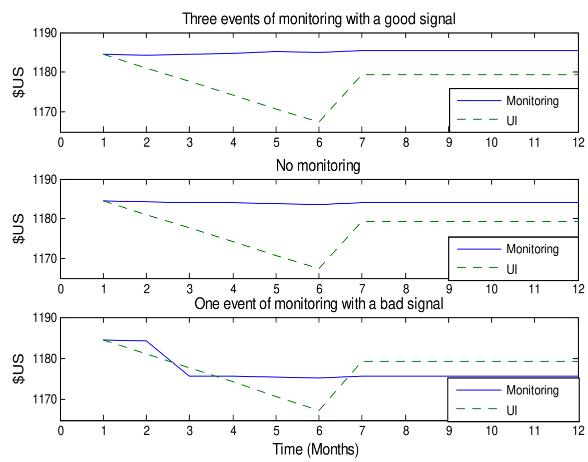

Fig. 6. Simulated consumption paths according to optimal and actual monitoring policies. The consumption paths for the unemployment insurance policy are identical. The consumption paths for the monitoring policy depends on whether monitoring was applied and the signal's result.

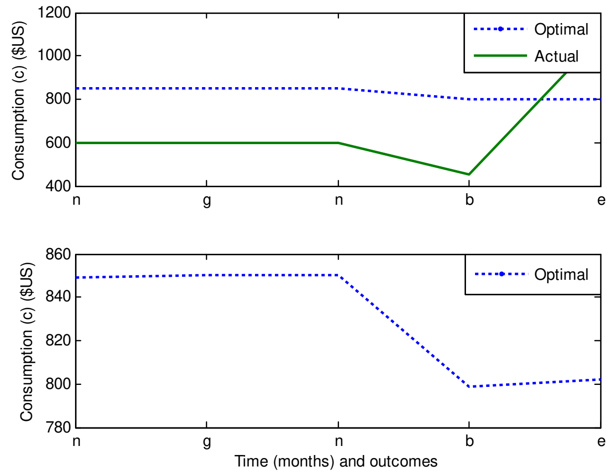

Fig. 7. Consumption according to the optimal and actual monitoring policies in the US for an unemployed worker who has the following sequence of outcomes: unmonitored unemployment, monitored unemployment with a good signal, unmonitored unemployment, monitored unemployment with a bad signal, and employment. The top panel shows both consumption paths for comparison and the bottom panel shows the consumption path for the optimal monitoring policy on a much tighter scale to better observe the shifts in consumption.