

Wunsch, Conny

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Optimal Monitoring and Sanctioning Systems

Conny Wunsch*

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Abstract

Many countries rely on monitoring of unemployment insurance and welfare recipients and impose benefit sanctions in case of noncompliance with job search requirements to encourage job search and to prevent abuse of the social insurance system. This paper systematically analyzes the characteristics of optimal monitoring and sanctioning systems for the unemployed as a function of worker characteristics, unemployment duration, the monitoring technology, worker preferences and the generosity of the welfare system. I propose a theoretical framework where benefits, wage taxes, the job search requirement, the monitoring intensity and the size of a benefit sanction are endogenously chosen by the planner for each period of unemployment. I allow for arbitrary ex-ante heterogeneity in reemployment wages and job finding probabilities as well as for dependence of these key parameters on unemployment duration. I find that the optimal sanction is in the majority of cases a temporary cut in benefits to zero, i.e. full suspension of benefits. The optimal monitoring intensity increases as the returns to search deteriorate with falling reemployment wages and job finding rates during unemployment in order to restore search incentives. It also increases with the generosity of the welfare system because monitoring can be used to offset some of the disincentives to search implied by more generous benefit payments. I also demonstrate how very informative and large data can be used to considerably improve and extend the insights that can be obtained from numerically solving and simulating economic models. I propose and apply a new method that allows quantifying the impact of implementing the optimal policy on the job finding probabilities. I find that the optimal policy implies considerably higher job finding rates than the actual policy, especially for low-skilled workers.

Keywords: Optimal unemployment insurance, monitoring and sanctions

JEL classification: J24, J65, J68

* Swiss Institute for Empirical Economic Research, University of St. Gallen, Varnbuelstrasse 14, CH - 9000 St. Gallen, Switzerland, e-mail: conny.wunsch@unisg.ch. This paper has been presented in seminars at the University of St. Gallen and the RWI, Berlin. I particularly thank Evelyn Ribi for very helpful comments and discussions.

1 Introduction

Many industrialized OECD countries facing increasing expenditures on unemployment insurance and/or welfare payments have reacted by imposing stricter job search requirements, tightening monitoring and more extensive use of benefit sanctions in order to encourage job search and to prevent abuse of the social insurance system. Benefit sanctions are imposed in case of noncompliance with benefit conditions such as job search requirements. They are usually temporary cuts in benefits that may become permanent or may lead to full suspension of benefits in case of repeated noncompliance. See e.g. OECD (2001).

The empirical literature makes a rather strong case for the ability of these measures to increase the exit rate from unemployment to employment.¹ Experimental evidence for the U.S. reported by Johnson and Klepinger (1994), Benus et al. (1997) and Klepinger et al. (2002) shows that more stringent search requirements significantly reduce the length of benefit receipt. Dolton and O'Neill (1996) find in the RESTART experiments for the U.K. that exit rates from unemployment to employment were increased significantly when specific benefit conditions like attending interviews with caseworkers were imposed together with the threat of imposing a sanction in case of noncompliance. Based on a social experiment in the Netherlands, Gorter and Kalb (1996) find that a combination of counseling and monitoring reduces the time to find a job. Boone et al. (2004) show in a lab experiment that the positive effect of benefit sanctions on the exit rate from unemployment happens through two channels: the risk of being sanctioned (ex-ante effect), and the effect of imposing a sanction (ex-post effect). They find that the ex-ante effect is substantial and dominates the ex-post effect. The importance of the ex-ante effect is confirmed in a non-experimental study by Lalive et al. (2005) for Switzerland. They, as well as van den Berg et al. (2004) and Abbring et al. (2005) for the Netherlands, Svarer (2007) for Denmark and Müller and Steiner (2008) and Hofmann (2008) for Germany also provide strong non-experimental evidence for positive ex-post effects of sanctions.²

¹ Exceptions based on experimental data are Ashenfelter et al. (2005) who find negligible effects of a small and short-term job search verification intervention on benefit payments for the U.S.; and van den Berg and van der Klaauw (2006) who find no effects of counseling and monitoring on the exit rate from unemployment for the Netherlands which they explain by monitoring of formal search inducing a substitution away from informal search channels. Using non-experimental data no significant effects are also obtained by Keeley and Robins (1985) for the U.S. and by Schneider (2008) for Germany but there are some doubts about the causal nature of their estimated effects. Jensen et al. (2003) find only weak evidence for positive effects of imposing sanctions for unemployed youth. Manning (2009) finds reductions in the number of benefit claimants but no corresponding increases in employment in connection with the introduction of the Jobseeker Allowance in the U.K.

² A related paper is also van der Linden and Dor (2001) who analyze the effect of a mixture of exhaustion of UI benefits and a permanent reduction in benefits due to noncompliance with benefit conditions. See also the surveys by Meyer (1995) and Fredriksson and Holmlund (2006*a*).

The empirical results are in line with the predictions obtained from job search models: Abbring et al. (2005), Boone and van Ours (2006), van der Linden (2006) and van den Berg and van der Klaauw (2006) show that monitoring and sanctions increase the exit rate from unemployment to employment in a model where monitoring happens with exogenous probability and where sanctions are imposed as permanent reductions of benefits.³ The probability of being sanctioned depends positively on the probability of being monitored and negatively on job search effort. There is a positive probability of both type I errors (shirkers not being sanctioned) and type II errors (non-shirkers being sanctioned). With the exception of van der Linden (2006) there is no individual heterogeneity in the returns to search (e.g. in wages).⁴

Fredriksson and Holmlund (2006*b*), van der Linden (2006), and Boone et al. (2007) take a more normative perspective and compare social welfare under a monitoring and sanction system, under a uniform benefit system and under a two-tiered system with time-limits for high benefits. They find that the two-tiered system dominates the uniform system but is itself dominated by the monitoring and sanction system. Moreover, Boone et al. (2007) show that it is optimal to (i) use benefit sanctions i.e. to actually cut benefits and (ii) to make the imposition of sanctions dependent on job search effort. In addition, they use a simulation exercise to make statements about the optimal size of the sanction, the optimal monitoring intensity and an upper bound on the monitoring cost.

Besides largely neglecting worker heterogeneity and only considering permanent cuts in benefits, one drawback of the studies discussed so far is that they do not allow for switches between monitored and unmonitored search during unemployment. Pavoni and Violante (2007) and Wunsch (2007) study the optimal policy that chooses endogenously between different policy instruments, including monitored and unmonitored search, for each period during the unemployment spell. They show that (i) the optimality of monitoring depends on worker characteristics, and that (ii) switches between unmonitored and monitored search during unemployment are optimal if the returns to search change during unemployment, for example because of human capital depreciation. However, Pavoni and Violante (2007) and Wunsch (2007) only consider perfect monitoring where job search effort is fully verified against payment of a monitoring cost. Consequently, there is no role for sanctions because the information asymmetry is removed in this case.

³ The paper by van den Berg and van der Klaauw (2006) distinguishes formal and informal search channels and shows that in such a model this effect only exists for formal search channels.

⁴ In Ljungqvist and Sargent (1995) sanctions are used to punish refusal of suitable wage offers. In Boadway and Cuff (1999) monitoring and sanctions are used to distinguish voluntary from involuntary unemployment of the low-skilled, and both job search and acceptance of job offers are monitored.

The aim of this paper is to systematically analyze the characteristics of optimal monitoring and sanctioning systems for the unemployed as a function of worker characteristics, unemployment duration, the monitoring technology, worker preferences and the generosity of the welfare system. I propose a theoretical framework where benefits, wage taxes, the job search requirement, the monitoring intensity and the size of a benefit sanction are endogenously chosen by the planner for each period of unemployment. I allow for arbitrary ex-ante heterogeneity in reemployment wages and job finding probabilities as well as for dependence of these key parameters on unemployment duration. The proposed model is an extended version of Pavoni and Violante (2007) that accommodates imperfect monitoring and sanctions. Monitoring is imperfect because only a signal of the true search effort is observed where the probability of the signal indicating high effort depends positively on search effort. Following the existing literature, a benefit cut is imposed when the signal indicates low search effort.

I find that, in contrast to what most of the literature assumes when modeling monitoring and sanctions, the optimal sanction is in the majority of cases a temporary cut in benefits to zero, i.e. full suspension of benefits. The optimal monitoring intensity increases as the returns to search deteriorate with falling reemployment wages and job finding rates during unemployment in order to restore search incentives. It also increases with the generosity of the welfare system because monitoring can be used to offset some of the disincentives to search implied by more generous benefit payments.

My paper also makes a methodological contribution. I demonstrate how very informative and large data can be used to considerably improve and extend the insights that can be obtained from numerically solving and simulating economic models. On the one hand, besides providing estimates of input parameters that are more accurate and easier to interpret, being able to estimate the input parameters for any subgroup of individuals that may be of interest considerably broadens the amount of heterogeneity that can be analyzed. On the other hand, I propose and apply a procedure that allows eliciting the job finding probabilities that are implied by the optimal policy which can then be compared to actual job finding rates to assess the impact of implementing the optimal policy. The procedure combines a reduced-form estimate of the relation between job finding rates and endogenous variables of the model with an iteration procedure in the numerical simulation. I find that the optimal policy implies considerably higher job finding rates than the actual policy, especially for low-skilled workers.

The remainder of the paper is organized as follows. Section 2 contains the details of the model and the theoretical results that can be derived from the model with respect to the optimal policy. Section 3 describes the details and results of the simulation. Section 4 concludes. An appendix provides further details on the data, the estimation and the simulation.

2 The model

2.1 The setup

The analysis is based on an adapted version of the framework developed by Pavoni and Violante (2007) and extended by Wunsch (2007) that is characterized as follows. A planner (the principal), e.g. the representative of the unemployment insurance (UI) or the welfare system, faces an unemployed worker (the agent) who is risk-averse and whose job search effort is unobservable to the planner. The objective of the planner is to design a contract which insures the worker against failure of job search by providing some income in case of unemployment and which, at the same time, ensures an appropriate level of search effort from the worker.

At the beginning of unemployment at time $t = 0$ the planner offers the unemployed worker a contract that maximizes expected discounted net fiscal revenue of the insurer (or equivalently minimizes expected discounted net expenditures) subject to providing the agent with at least an expected discounted utility level of $U_0 > 0$. From a policy perspective this is the more relevant case than the dual problem of utilitarian expected welfare maximization subject to a budget constraint. Moreover, it allows writing the optimal contract in a convenient recursive form (see Spear and Srivastava, 1987). The promised utility U_0 is exogenously given, e.g. the outcome of voting, and can be regarded as a measure of the generosity of the UI or the welfare system. Its level may depend on worker characteristics. In particular, the planner can give different weights to different types of individuals in the social welfare function by requiring different U_0 . Net fiscal revenue is tax revenue if the worker is employed, and expenditures on benefit payments and monitoring if the worker is unemployed.

Workers are infinitely lived and maximize expected discounted lifetime utility. They have time-separable preferences over consumption $c \geq 0$ and disutility a from either work or job search effort. Agents discount the future at rate $\beta \in (0, 1)$, and period utility is given by $u(c_t) - a_t$ with $u(0) = 0$, $u'(c_t) > 0$, $u''(c_t) < 0$. It will be useful to assume that the first derivative of u^{-1} is convex which is

satisfied by a large range of utility functions.⁵ Effort is assumed to be e^w during work and either high ($a = e > 0$) or low ($a = 0$) during job search.⁶ The latter underlines the role of fixed costs and the extensive margin of participation decisions.⁷ When employed, workers earn a wage $w(x)$ which depends on their characteristics x . When unemployed, worker exit to employment with probability $\pi(x, a)$ which also depends on their characteristics x as well as on job search effort a . It is assumed that $\pi(x, 0) \equiv 0$ and that $\pi(x, e) \equiv \pi(x) \in (0, 1)$. Worker characteristics are allowed to change during unemployment, for example to accommodate negative duration dependence in wages and the exit rate to employment as has been shown in various empirical studies (see e.g. Pissarides, 1992; Blanchard and Diamond, 1994; Acemoglu, 1995; Machin and Manning, 1999).

The planner can observe the worker's employment status and the outcome $y \in \{s, f\}$ of the worker's job search activity, where s denotes success and f failure. But the planner cannot observe the worker's effort choice a , so that he faces a moral hazard problem. The planner can, however, use a monitoring technology that allows him to observe a signal about the worker's search effort. Monitoring is costly where the cost $\kappa(\mu)$ depends on the monitoring intensity $\mu \in [0, 1]$ with $\kappa' > 0$ and $\kappa'' \geq 0$. The probability of observing a signal that indicates high effort depends positively on the worker's job search effort: $\gamma(a) \in [0, 1]$ where $\gamma' > 0$. In the following, I will denote $\gamma(e) \equiv \gamma_e > \gamma(0) \equiv \gamma_0$. Thus, monitoring delivers a signal that indicates effort e with probability γ_e , if the worker exerts search effort e , and with probability γ_0 if his effort is 0. Usually, it should be relatively easy to verify high search effort if the worker actually exerts it, so that γ_e will be very close to one or even equal to one. In contrast, it will be more difficult to uncover shirkers, so that it will be unlikely that γ_0 will be close to zero or even equal to zero. If the signal does not indicate high effort, the planner imposes a benefit sanction of size $\sigma \in [0, 1]$ which reduces the benefit c to $(1 - \sigma)c$ where $\sigma = 1$ corresponds to full suspension of benefits.

For simplification it is assumed that workers do not have access to storage, insurance or credit markets. In particular, it is assumed that workers cannot self-insure against the random outcome $y \in \{s, f\}$ of their search or training activity, e.g. by saving. Pavoni and Violante (2005) show in

⁵ This assumption is satisfied for the whole CARA class and for the CRRA class with the coefficient of relative risk aversion greater than one half.

⁶ The disutility of effort during employment is generally not restricted to be the same as during unemployment, but it must be ensured that accepting a job offer always dominates staying unemployed.

⁷ Moreover, this considerably simplifies the analysis. Since the planner chooses endogenously among policy instruments during the unemployment spell and since there is negative duration dependence the model is not stationary. Consequently, the first-order conditions for continuous search effort would have a very complex form. Note, however, that two levels of search effort are sufficient here to illustrate the main points. In particular note that under the optimal policy scheme, the planner will always implement his preferred level of the worker's search effort.

their baseline model that when workers can save through credit markets but still face a no-borrowing constraint, which is a reasonable assumption for unemployed workers, the same optimal contract can be implemented by introducing a linear, time-invariant interest tax.

2.2 The planner's problem

The objective of the planner is to design an insurance contract for the unemployed worker that implements a job search requirement that corresponds to the effort level e and that delivers the worker expected utility of U_0 . The former is ensured by obeying an incentive compatibility (IC) constraint, and the latter by obeying a promise-keeping (PK) constraint. The contract specifies ex ante the job search requirement e , the benefit level c , the continuation utilities U^s and U^f in case of, respectively, success or failure of job search, the monitoring intensity μ , and the size of the benefit sanction σ for each potential unemployment period. Thus, $(e, c, U^s, U^f, \mu, \sigma)$ are the endogenous choice variables of the planner.

The optimization problem of the planner is formulated in the recursive form used by Pavoni and Violante (2007) and Wunsch (2007) which is based on Spear and Srivastava (1987). For a given job search requirement e , monitoring intensity μ and benefit sanction σ the optimization problem under a monitoring and sanctioning system (MS) is given by

$$\begin{aligned}
V^{MS}(U, x) &= \max_{c, U^f, U^s} -[1 - \mu(1 - \gamma_e)\sigma]c - \kappa(\mu) + \beta[\pi(x)W(U^s, x^f) + (1 - \pi(x))V(U^f, x^f)] \\
s.t. \quad U &= [1 - \mu(1 - \gamma_e)]u(c) + \mu(1 - \gamma_e)u((1 - \sigma)c) - e + \beta[\pi(x)U^s + (1 - \pi(x))U^f] \\
U &\geq [1 - \mu(1 - \gamma_0)]u(c) + \mu(1 - \gamma_0)u((1 - \sigma)c) + \beta U^f.
\end{aligned} \tag{1}$$

The planner pays benefits c in case no sanction is imposed. He only pays $(1 - \sigma)c$ if the worker is sanctioned, which happens with probability equal to the monitoring intensity μ times the probability that the signal does not indicate high effort $1 - \gamma_e$. He also has to pay monitoring costs $\kappa(\mu)$.

With probability $\pi(x)$ the worker finds a job in which case the planner's optimization problem is given by

$$\begin{aligned}
W(U, x) &= \max_{c, U^w} w(x) - c + \beta W(U^w, x) \\
s.t. \quad U &= u(c) - e^w + \beta U^w.
\end{aligned} \tag{2}$$

The value of employment is determined by the wage tax or subsidy $w(x) - c$ that can be imposed on employed workers. To focus on the current unemployment experience employment is assumed to be absorbing.⁸ Because of the absence of the information asymmetry in case of employment it is easy to show that the optimal solution is to set $U = U^w$ and to keep consumption constant, yielding

$$W(U, x) = \frac{w(x) - c^w(U)}{1 - \beta}, \quad c^w(U) = u^{-1}((1 - \beta)U + e^w). \quad (3)$$

With probability $1 - \pi(x)$ the worker remains unemployed facing promised utility U^f and potentially changed characteristics x^f . The value of continued unemployment $V(U^f, x^f)$ is the one associated with the policy instrument that is optimal given (U^f, x^f) . It is easy to show that promised utility falls under MS, i.e. that $U \geq U^f$, which implies that benefits must fall. Moreover, applying Pavoni and Violante (2007) it can be shown that both V and W are concave in U .

Shirking is prevented by obeying the IC constraint (third line of (1)). Shirkers remain unemployed for sure and are sanctioned with probability $\mu(1 - \gamma_0)$ implying a probability of type I error of $1 - \mu(1 - \gamma_0)$. From the PK constraint (second line of (1)) it can be seen that non-shirkers are sanctioned with probability $\mu(1 - \gamma_e)$ which is therefore the probability of type II error. Note that if the signal is perfect, i.e. $\gamma_e = 1$, then this probability is zero and the sanction is never actually imposed in the optimal policy that implements e . Finally note that (1) nests what Pavoni and Violante (2007) and Wunsch (2007) label unmonitored search or unemployment insurance by setting $\mu = 0$, as well as perfect monitoring by setting $\mu = 1$, $\gamma_e = 1$ and $\gamma_0 = 0$.⁹

Because wages and the exit rate to employment may deteriorate with increasing unemployment duration because of changes in worker characteristics x , it may become too costly for the planner to incentivize the worker to provide positive search effort. In this case he would release the worker from the search requirement and just pay benefits that ensure promised utility U . This policy will

⁸ Qualitative results for the same unemployment spell do not change as long as the job separation rate is exogenous. Optimal contracts with endogenous job separation are studied by Zhao (2000) and Hopenhayn and Nicolini (2005) who show that in this case the optimal contract has to take into account the worker's full employment history.

⁹ Setty (2009) implements the sanction in terms of randomized continuation utilities in case of failure of job search rather than the benefits directly. Intuitively, because of the concavity of V in U , the additional randomization in the planner's objective function should make such a policy *ceteris paribus* more costly than sanctions implemented directly on current benefits.

be called social assistance (SA) in the following and is characterized as follows

$$\begin{aligned} V^{SA}(U, x) &= \max_{c, U^f} -c + \beta V(U^f, x^f) \\ \text{s.t. } &U = u(c) + \beta U^f. \end{aligned} \quad (4)$$

It is easy to show that because of the absence of the IC constraint the optimal transfer is constant. Moreover, Pavoni and Violante (2007) and Wunsch (2007) show that SA is an absorbing policy, meaning that whenever SA is optimal in one period, it will also be optimal for any period thereafter. Consequently, the optimal transfer is given by $c^{SA}(U) = u^{-1}((1 - \beta)U)$.

In contrast to part of the existing literature on monitoring and sanctions (Boone and van Ours, 2006; van der Linden, 2006; Boone et al., 2007), the model abstracts from general equilibrium considerations. Because of worker heterogeneity and the non-stationary nature of the model following from potential negative duration dependence and endogenous policy choice, both for a given period, and over time, the model is already very complex. Endogenizing wages and job finding probabilities in a non-stationary environment is not straightforward and would require an entirely different setup.

2.3 Optimal size of the sanction

The optimal size of the sanction σ can be characterized by looking at the derivative of (1) with respect to σ :

$$\frac{dV}{d\sigma} = \mu(1 - \gamma_e)c + [(1 - \gamma_0)\lambda_{IC} - (1 - \gamma_e)\lambda_{PK}]\mu c u'((1 - \sigma)c), \quad (5)$$

where $\lambda_{IC} \geq 0$ and $\lambda_{PK} \geq 0$ are the multipliers associated with the IC and the PK constraint, respectively. The marginal benefit of increasing the sanction is a reduction in the benefit payment and a relaxation of the IC constraint, at the marginal cost of tightening the PK constraint. The latter two effects are the results of the worker being risk-averse which implies that randomization of payments reduces utility. For this reason, sanctioning makes it more costly to provide a given utility level but also reduces the utility obtained from shirking which relaxes the IC constraint.

The marginal benefit is decreasing in γ_0 and γ_e , and the marginal cost is decreasing in γ_e . For the case that the signal is perfect when the worker actually exerts high effort, i.e. $\gamma_e = 1$, Proposition 1 shows that the optimal sanction is full suspension of the benefit for the current period. Note that the case $\gamma_e = 1$ is not unrealistic as it should be easy to verify high effort if high effort is exerted.

The important thing is that γ_0 , i.e. the probability that the signal indicates high effort when effort is actually low, remains unrestricted as it is much more difficult to uncover shirkers.

PROPOSITION 1: *If $\gamma_e = 1$ and $\mu, c > 0$, then the optimal size of the sanction is $\sigma^* = 1$. If $\lambda_{IC} > 0$, then $\sigma^* = 1$ is the unique optimum.*

PROOF: If $\gamma_e = 1$, (5) reduces to

$$\frac{dV}{d\sigma} = (1 - \gamma_0)\lambda_{IC}\mu c u'((1 - \sigma)c) \geq 0, \quad \forall \sigma \in [0, 1] \quad (6)$$

with the inequality being strict whenever $\lambda_{IC}, \mu, c > 0$. Note that $\mu > 0$ is the only relevant case and that $c > 0$ is satisfied whenever $U > 0$. The marginal cost of increasing the sanction is zero if $\gamma_e = 1$, and only the marginal benefit of the relaxation of the IC constraint remains. If $\lambda_{IC} = 0$ the IC constraint is irrelevant and the size of the sanction does not matter. ■

Note that in the case with $\gamma_e = 1$ the optimal sanction would be infinity if σ were not restricted to the interval $[0, 1]$. The upper bound of one is based on the implicit assumption that higher sanctions are not credible in the IC constraint.¹⁰

With perfect signals in case the worker provides the desired search effort ($\gamma_e = 1$) and $\sigma^* = 1$ the planner's optimization problem simplifies considerably. The benefit payment is just c in any case, the PK constraint reduces to $U = u(c) - e + \beta[\pi(x)U^s + (1 - \pi(x))U^f]$ and the IC constraint to $U \geq [1 - \mu(1 - \gamma_0)]u(c) + \beta U^f$. The sanction is never actually imposed in the optimal policy. Rather, sanctions are used in the IC constraint to ensure that the worker complies with high effort, i.e. as a (credible) threat in case of noncompliance to implement high effort in the optimum. The probability of type II errors is zero.

In the simulation analysis in Section 3 I investigate the optimal size of the sanction in more detail. In particular, I assess the critical value of γ_e from which $\sigma^* = 1$ no longer holds.

¹⁰ Alternatively, γ_e could be set infinitesimally below one and the result would still hold.

2.4 Optimal monitoring intensity

Analogously to the sanction σ , the optimal monitoring intensity μ can be characterized by looking at the derivative of (1) with respect to μ :

$$\frac{dV}{d\mu} = (1 - \gamma_e)\sigma c - \kappa'(\mu) + [(1 - \gamma_0)\lambda_{IC} - (1 - \gamma_e)\lambda_{PK}][u(c) - u((1 - \sigma)c)]. \quad (7)$$

As for the sanction, the marginal benefit of increasing monitoring is a reduction in the benefit payment and a relaxation of the IC constraint which is decreasing in γ_0 and γ_e , at the marginal cost of tightening the PK constraint which is decreasing in γ_e . However, there is also an additional direct marginal cost of monitoring $\kappa'(\mu)$. This is the main difference between monitoring and sanctions: Increasing the sanction has no direct cost while increasing the monitoring intensity does. However, it is not clear whether increasing the sanction is overall less costly than increasing the sanction as μ enters the decision problem linearly while σ enters non-linearly as it appears inside the utility function.

For the special case that the signal is perfect when the worker actually exerts high effort, i.e. $\gamma_e = 1$ and $\sigma^* = 1$, Proposition 2 shows on the one hand that the optimal monitoring intensity increases with the generosity of the system, U . On the other hand, it shows that monitoring is not optimal if the IC constraint is not binding because the marginal benefit is zero while the marginal cost is (weakly) positive.

PROPOSITION 2: *If $\gamma_e = 1$ and $\lambda_{IC}, \mu, c > 0$, then the optimal monitoring intensity μ^* increases with U at an interior solution $\mu^* \in (0, 1)$. Moreover, if the IC constraint is not binding ($\lambda_{IC} = 0$), then $\mu^* = 0$.*

PROOF: As shown in Proposition 1, the optimal sanction is $\sigma = 1$ if $\gamma_e = 1$. Using this result and $\gamma_e = 1$, (7) simplifies to

$$\frac{dV}{d\mu} = -\kappa'(\mu) + (1 - \gamma_0)\lambda_{IC}u(c). \quad (8)$$

The remaining components are the marginal benefit of a relaxation of the IC constraint and the marginal direct cost. If $\lambda_{IC} = 0$ the IC constraint is irrelevant, so that only the marginal direct cost $\kappa'(\mu) \geq 0$ remains, making no monitoring, $\mu^* = 0$, optimal.

Now consider the case where $\lambda_{IC} > 0$. Using the optimality of c , U^f , U^s , W and V , as well as

the first-order conditions for (1), implicit differentiation yields

$$\left. \frac{d\mu^*}{dU} \right|_{\mu^* \in (0,1)} = [\kappa''(\mu^*)]^{-1}(1 - \gamma_0) \left[\lambda_{IC} u'(c) \frac{dc}{dU} + (V_{UU}(U, x) - W_{UU}(U^s, x^f))u(c) \right] \geq 0. \quad (9)$$

The sign follows on the one hand from $\lambda_{IC} > 0$, $\gamma_0 \in [0, 1]$, the convexity of the monitoring cost and the concavity of the utility function. Moreover, it is easy to show that $\frac{dc}{dU} > 0$. To show that $V_{UU}(U, x) - W_{UU}(U^s, x^f) \geq 0$ note the following: The first-order conditions for (1) imply that $V_{UU}(U, x) - W_{UU}(U^s, x^f) = (1 - \pi(x))[V_{UU}(U^f, x^f) - W_{UU}(U^s, x^f)] = (1 - \pi(x))[V_{UU}(U^f, x^f) - V_{UU}(U^s, x^f)]$. The sign then follows from the assumption that the derivative of u^{-1} is convex. ■

With increased generosity of the system, U , providing incentives via the utility spread between U^s and U^f becomes increasingly costly. Combining the PK and the IC constraint for the case $\gamma_e = \sigma = 1$ and $\lambda_{IC} > 0$, it can be shown that these so-called incentive costs can be reduced when the monitoring intensity μ is increased:

$$U^s - U^f = \frac{e - \mu(1 - \gamma_0)u(c)}{\beta\pi(x)}. \quad (10)$$

Thus, more intense monitoring can offset some of the increase in costs associated with an increase in the generosity of the system. Moreover, if there is negative duration dependence in the exit rate to employment, $\pi(x)$, e.g. because of human capital depreciation, the incentive costs increase with unemployment duration but could (partially) be offset by extending monitoring. Finally, providing the same utility U^s for the case when job search succeeds becomes more costly if there is negative duration dependence in the reemployment wage $w(x)$ because the wage tax must fall or the wage subsidy must increase in order to attain the same U^s . Again, intensifying monitoring can reduce the incentive costs, thus compensating part of the increased cost of providing U^s . As a result there are two competing forces. The optimal decline of promised utility with increasing unemployment duration under MS, $U \geq U^f$, requires the planner to reduce the monitoring intensity. On the other hand, negative duration dependence in the reemployment probability and wage provide incentives for the planner to intensify monitoring. Which force dominates will be assessed in the following quantitative analysis.

3 Quantitative analysis

The objective of the quantitative analysis is, on the one hand, to further characterize the optimal monitoring intensity and size of the sanction as a function of worker characteristics, unemployment duration, and labor market conditions as well as the monitoring technology and the preference parameters. On the other hand, I want to quantify the impact of implementing the optimal policy on the exit rates to employment compared to those that prevailed under the actual policy. I propose a methodology to combine a reduced-form estimate of the relation between benefits and the exit rate to employment with a classical numerical simulation of the model to obtain a measurement of the exit rates to employment implied by the optimal policy scheme.

The baseline scenario is the one resembling the West German economy in the period 2001 with respect to the distribution of worker characteristics and labor market conditions as obtained from the data. West Germany is an interesting case to study because it is comparable to most industrialized OECD countries. Moreover, in the course of substantial reforms of the German unemployment insurance and welfare system over the period 2002-2005, considerable emphasis has been put on job search requirements, monitoring, and sanctions.

3.1 Methodology

The starting point of the quantitative analysis is a classical simulation exercise commonly used in these type of studies, see e.g. Boone and van Ours (2006); Fredriksson and Holmlund (2006*b*); van der Linden (2006); Boone et al. (2007); Pavoni and Violante (2007). The usual approach is to choose the model parameters to resemble actual values, which are typically picked from statistics and empirical studies, and then solve the model numerically. Usually, the results of such exercises can be regarded as no more than illustrative because the studies from which parameter values are picked use different data, samples, time periods and potentially even different countries, and they are not necessarily consistent with the assumptions made in the model. Moreover, in the particular case of normative analysis it is especially doubtful that the chosen parameter values are actually consistent with the optimal policy derived on the basis of them because this would imply that the actual policy is equivalent to the optimal one or that changing the policy would have no effects on the model parameters.

The simulation procedure I propose improves in both dimensions. On the one hand, with the

exception of the preference parameters and the monitoring cost, all parameters of the model are estimated from a large and exceptionally informative administrative database for the same well-defined sample. This approach has several advantages compared to the usual procedure of picking values from different studies. First, it ensures that all parameters represent the same population in a specific time period and a specific economic and institutional environment. Second, it is much more transparent as to how the estimates are generated, making it much easier to judge their validity. Third, it allows linking the simulation results to the population observed in the data, which considerably improves the interpretation and understanding of the results. Finally, it allows for arbitrary heterogeneity in the model parameters as they can be estimated for any sub-population of interest if the sample is large enough.

On the other hand, I propose a procedure that, starting from the parameters estimated given the actual policy, allows eliciting the model parameters that are actually consistent with the optimal policy derived in the simulation procedure. The elicited values of the parameters can then be used to assess the effect of implementing the derived optimal policy by looking at the difference between the values under the optimal and the actual policy.

The approach works as follows: The exogenous parameters in the model are the preferences (utility function, discount rate), the monitoring costs, reemployment wages, the exit rates to employment, and initial promised utility (generosity of the system). In the model, search incentives and promised utility are provided via the choice of the benefit level: The cost of providing search incentives, which is affected by monitoring and sanctions, directly translates into specific values of promised continuation utilities which, in turn, directly map into consumption and hence, benefits. Consequently, benefits summarize all choices made by the insurer and the key mechanism through which policy choices interact with the model parameters such as the job finding probabilities via the level and evolution of benefits.

I use a reduced-form approach to estimate the relation between benefits and the exit rates to employment conditional on a rich set of variables that may also effect the job finding probability which is described in detail in Section 3.5.¹¹ In the first step, I use the predicted values of the exit rates to employment for each month of unemployment as obtained from the data to simulate the model and obtain the optimal policy choices: the monitoring intensity, size of the benefit sanction,

¹¹ In the current version of the paper I only look the job finding probabilities. However, reemployment wages might be affected as well because changes in benefit levels may change reservation wages. This will be addressed in the next version of the paper which will be completed before the conference.

and benefit level for each period of unemployment. In the next step, I use the estimated coefficients for the variables capturing the relation between benefits and the exit rates to calculate new values for the exit rates based on values of the optimal benefits derived from the model in the numerical analysis given the original exit rates. Then the optimal policy given the new exit rates is derived. This process is repeated until the optimal policy derived no longer changes which then yields the job finding probabilities consistent with the derived optimal policy.

3.2 Data and population of interest

With the exception of the preference parameters and the monitoring cost, all parameters of the model are estimated using an exceptionally informative administrative database, which has been built up by the German Institute for Employment Research. The database is a 2% random sample from all individuals who have been subject to German social insurance at least once since 1990. They cover the period 1990-2006 and combine information from different administrative sources: (1) the records provided by employers to the social insurance for each employee (1990-2006), (2) the unemployment insurance records (1990-2006), (3) the programme participation register of the PES (2000-2006) as well as (4) the jobseeker register of the PES (2000-2006). Because these records are used to determine social insurance and unemployment benefit claims as well as programme eligibility, the data are very accurate with respect to employment status, earnings from employment, amount and duration of UI claims, and programme participation status. Moreover, the information collected by the PES on jobseekers is very good as well, because it is used for counseling, job referral, monitoring, and assessing jobseeker's compliance with job search requirements. The database is complemented with a set of regional indicators which include population density, migration and commuting streams, average earnings, GDP growth, unemployment rate, long-term unemployment, welfare dependency rates, urbanization, child care and public transport facilities.

For each individual the data comprise all aspects of their employment, earnings and UI history since 1990 including day of beginning and end of each spell, type of employment (full/part-time, high/low-skilled), occupation, industry, earnings, type and amount of UI benefit, remaining UI claim, compliance with benefit conditions (e.g. failure to show up at interview, refusal to participate in assigned labour market program, imposition of sanction), and periods when a UI recipient has reported in sick to the UI. The jobseeker register contains a wealth of individual characteristics, including date of birth, gender, educational attainment, marital status, number of kids, age of

youngest child, nationality, profession, the presence of health impairments and whether they affect employability as well as disability status. With respect to job search the data contain the type of job looked for (full/part-time, high/low-skilled, occupation), and whether the jobseeker is fully mobile within Germany.

For the simulation, the model is parameterized to resemble the population of West German workers who entered unemployment from regular full-time employment in 2001 and who received benefits from the unemployment insurance system. Moreover, to focus on the prime-age part of the population and to avoid issues of tertiary education and (early) retirement the sample is restricted to individuals of age 20-55. This yields a sample 18,479 individuals in the data.

3.3 Unemployment insurance in West Germany in 2001

Before discussing how the model is parameterized, the West German policy scheme that was in place 2001 is briefly described. In Germany, unemployment insurance is mandatory. In 2001, employees who had contributed for at least 12 months within the 3 years preceding unemployment were eligible for unemployment benefits (UB) if they registered with the PES. The minimum UB entitlement was 6 months and the maximum claim increased stepwise with total contribution time in the 7 years before becoming unemployed, and age, up to a maximum of 32 months at age 54 or above with previous contributions of at least 64 months. Since 1994, the replacement rate was 67% (60%) of previous average net earnings from insured employment with (without) dependent children.

After exhaustion of UB unemployed could become eligible for unemployment assistance (UA). In contrast to UB, UA was means-tested and potentially indefinite. However, like UB, UA was proportional to previous earnings but with lower replacement rates than UB (57% and 53% with and without dependent children, respectively). Unemployed who were ineligible for UB and UA could receive social assistance, which was a fixed monthly payment unrelated to previous earnings, means-tested and administered by local authorities.

Actual payment of benefits was conditional on availability to the labor market, willingness to take up any job, active job search, regular show-up at the PES and participation in labor market programs. In case of noncompliance with benefit conditions, sanctions, i.e. reductions in or suspensions of benefits, could be imposed. However, due to severe capacity constraints within the PES monitoring was only very weak in the period under consideration and sanctions were imposed only

in rare cases (sanction rate below 2%).

3.4 Parameterizing the model

In the simulation, time units are defined by months. The level of initial utility $U_0(x)$ that is promised to a worker with characteristics x is chosen to resemble the one implied by the actual policy scheme that was in place in 2001. It is obtained by plugging into the model the parameter values of the actual policy (wages, taxes, benefit levels, job finding rates) obtained from the data and solving backwards for $U_0(x)$.

Preferences are parameterized as follows. The monthly discount factor β is chosen to match an interest rate of 4% per annum, which prevailed in the EURO area in the period of interest. Period utility over consumption is assumed to be of the constant-elasticity-of-substitution type, i.e. $u(c) = \frac{c^{1-\alpha}}{1-\alpha}$. This utility function satisfies all assumptions made in Section 2.1. In the baseline scenario α is set to 0.5 but specifications with different inter-temporal elasticities of substitution are tested as well. The disutility of effort, e , is parameterized in terms of the participation cost in consumption equivalent terms, i.e. the fraction of consumption that compensates the worker for his effort in order to make him indifferent between choosing effort e and zero effort. Let p denote the participation cost. Then the disutility of effort is defined by $u(c) - e = u((1-p)c) \Leftrightarrow e = u(c) - u((1-p)c)$. In the baseline case the participation cost is set to an intermediate value of 0.45%. Later it will be varied between 30% and 60% which corresponds to the range of empirical estimates.¹²

The reemployment wages are calculated from the wage earned directly before becoming unemployed and the wage depreciation rate that is estimated as follows: Individuals who find employment in months 11-13 after entering unemployment are matched to the full entry sample to account for selection into employment using the estimator proposed and applied by Lechner et al. (2009). Matching is justified in this case because, as described in the next section, the data include all major determinants of the job finding probability. The wage depreciation rate is the difference between their last wage before unemployment and their reweighed reemployment wage as a fraction of the former, which yields a rate of 0.0112 per month.

To parameterize the cost of monitoring, the average gross salary of a caseworker per month (about 2600 EUR according to BA, 2001-2005) and administrative costs are taken into account. Consider

¹² See e.g. Hausman (1980); Cogan (1981); Eckstein and Wolpin (1989) for females and Keane and Wolpin (1997) for young males.

a caseworker that monitors with intensity $\mu = 1$. Assuming that such a caseworker works 20 days per month and spends twice per week one hour on one case yields personnel costs of 130 EUR per case and month. Allowing for some administrative cost, the base value is set to $\kappa(1) = 200$ EUR. Different functional forms for the monitoring costs are considered, including a linear $\kappa(\mu) = 200\mu$, a quadratic $\kappa(\mu) = 200\mu^2$ and a quartic case $\kappa(\mu) = 200\mu^4$. The baseline values of the signal parameters are set to $\gamma_e = 1$ and $\gamma_0 = 0.2$ but different values are considered as well.

3.5 Estimation of the exit rates and their relation to benefits

The exit rates from unemployment to employment are estimated using a discrete-time hazard rate model with fully nonparametric specification of the baseline hazard that captures potential duration dependence. The estimation is based on 211.791 person-month observations. Individuals are followed from entering unemployment in 2001 until the end of 2004, thus covering up to 48 months.¹³ The results presented in the next section are based on a logistic model for the hazard rate. Other models have been tested as well but the results are essentially the same.

In order to get a credible estimate of the relation between exit rates and benefits it is crucial to control for all factors that jointly affect both variables. In Germany, the level of benefits received is determined by the total number of months employed in the last three and seven years, age, previous unemployment experience, average wages in the last year before unemployment and, in case of unemployment assistance, household income and wealth. As all these factors are likely to impact on the job finding probability, I have to capture all of them. Moreover, they will also be correlated with local labor market conditions and the type of job held before becoming unemployed.

Taking up these arguments the following set of explanatory variables is used (see Appendix A for the exact specification and the estimation results): First of all, the key variables of interest are the features of the actual policy like type, amount and duration of benefits which are included in a flexible way. Next, dummies for different unemployment durations are used to pick up duration dependence. I also include dummy variables indicating the calendar month to capture seasonality effects. Region dummies and various indicators of local labor market conditions take up regional differences. Personal characteristics include gender, age, nationality, health and whether there are health problems that affect employability, marital/cohabiting status, number of kids and age of

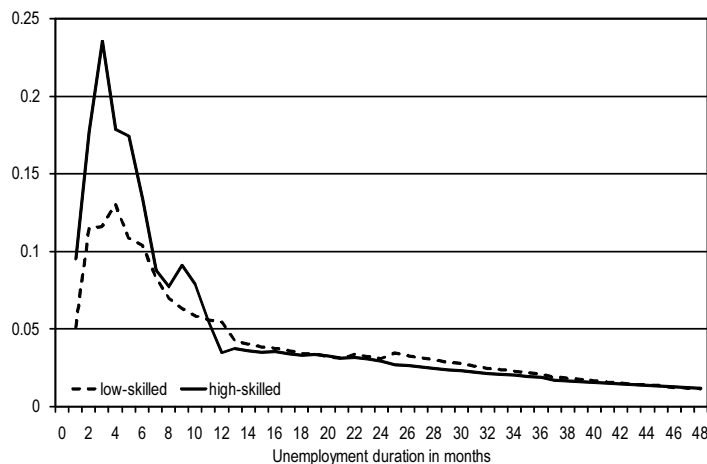
¹³ Information after 2004 is discarded in order to avoid picking up the major structural break implied by one of the largest reforms of the German unemployment insurance system that became effective in January 2005.

youngest child, as well as education.

The model also comprises a variety of measures of past performance in the labor market, including past work and unemployment experience and earnings. I also control for the characteristics of the last job held in terms of skill profile and occupation, as measure other components of skills and experience that affect employability and earnings. The model has been tested extensively against misspecification in terms of omitted variables, functional form and heteroscedasticity (including interaction terms with duration which where not significant). What is missing in the list of variables is household income or wealth. This is unobserved in the data but I control for marital/cohabiting status and earnings in the past 10 years before unemployment, and I use an indicator for unemployment without any benefits which collects the cases that are ineligible for any benefits.

Figure 1 displays the predicted hazard rate as a function of unemployment duration for low and high-skilled workers who are defined as having a wage below or above the sample median, respectively. The predicted exit rates are calculated for the median characteristics in each subsample at the beginning of unemployment. The hazard rates strongly increase during the first 4 months of unemployment which can be explained by labor market frictions. Afterwards the exit rates fall rapidly during the next 8-9 months. During this period the job finding probabilities of the low-skilled are considerably lower than those of the high-skilled. After the first year of unemployment the hazard rates of low and high-skilled workers are very similar and lie below 5% and falls continuously below 1% at unemployment durations of 4 years.

Figure 1: Predicted hazard rates



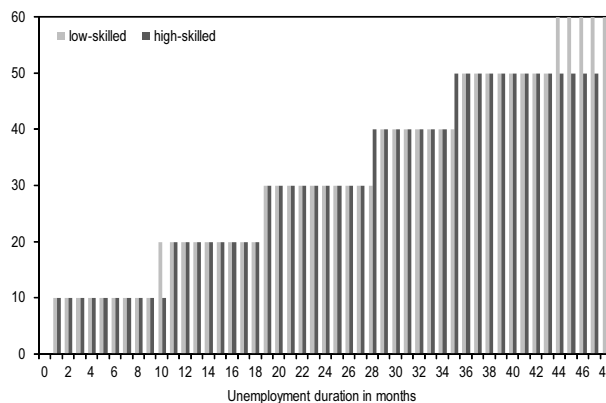
Note: The predicted hazard rates are calculated for a person with median characteristics at the beginning of unemployment in each skill group. Low-skilled: last wage below median. High-skilled: last wage above median.

To make the iteration procedure described in Section 3.1 computationally feasible, the model is solved backwards in the simulation rather than using for example Chebychev polynomials to approximate the value functions (which would have to be repeated for any new value of the exit rates). It is assumed that the exit rate to employment at an unemployment duration of 100 months is zero, which is reasonable given that the predicted exit rate at 100 month is well below 0.005. This implies that in month 100 social assistance (SA) is the optimal policy and we know that SA is absorbing. The model can then be solved backwards for any value of promised utility U .

3.6 Results

In this section I report first results for low and high-skilled workers for the case where the signal is perfect when high search effort is exerted by the jobseeker ($\gamma_e = 1$) which implies that the optimal sanction is full suspension of benefits ($\sigma = 1$).¹⁴

Figure 2: Optimal monitoring intensity



Note: Low-skilled: last wage below median. High-skilled: last wage above median.

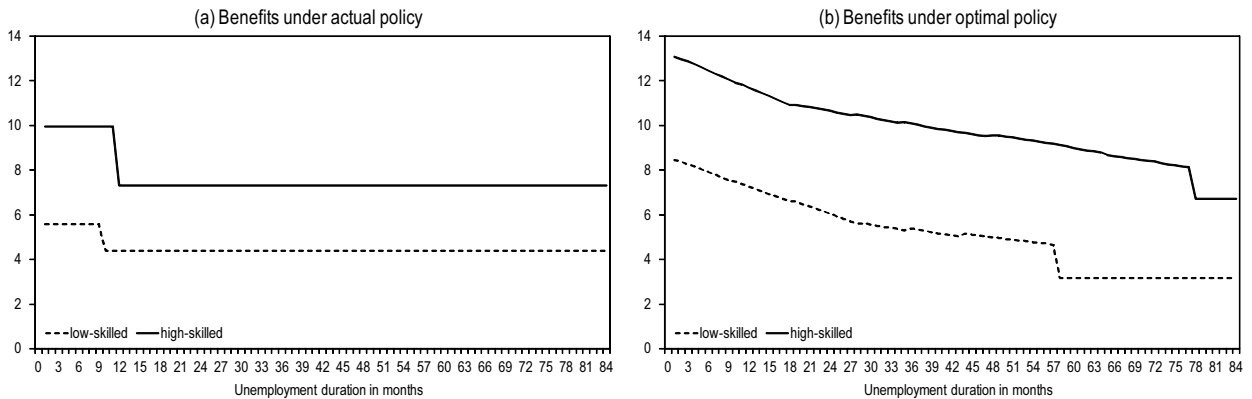
Figure 2 shows how the optimal monitoring intensity evolves with unemployment duration in this case when μ is varied in 10%-steps in the simulation. Taking up the discussion in Section 2.4, I find that the incentive to increase monitoring in order to offset some of the increasing incentive costs caused by the deterioration of reemployment wages and job finding probabilities clearly dominates the incentive to reduced monitoring because promised utility falls. For both low and high-skilled workers the optimal monitoring intensity increases with unemployment duration up to a level of 60% after four years of unemployment. The time pattern is similar for both types of workers, except

¹⁴ Results for different worker characteristics such as the probability of becoming long-term unemployed, as well as different qualities of the signal, cost functions, worker preferences and the generosity of the welfare system will be available before the conference.

that the highest monitoring intensity is implemented four months earlier for the low-skilled than for the high-skilled.

Figure 3 displays the optimal time path of benefits (panel b) in comparison to the actual evolution of benefits (panel a). In line with the predictions derived from the model, optimal benefits fall with unemployment duration as long as positive job search effort is required from the worker, and remain constant once it is no longer optimal to incentivize the worker and social assistance is implemented. Naturally, low-skilled workers start at lower benefits levels than the high-skilled. Moreover, their reemployment wages and job finding probabilities deteriorate faster to levels where social assistance becomes optimal. Compared to the actual policy, optimal benefits are considerably higher at the beginning of unemployment but decline to lower levels at long unemployment durations. The reason why benefits start at rather high levels in these models is that benefits have to fall in order to provide intertemporal search incentives which requires sufficient scope for reductions over relatively long periods.

Figure 3: Benefits under the actual and the optimal policy

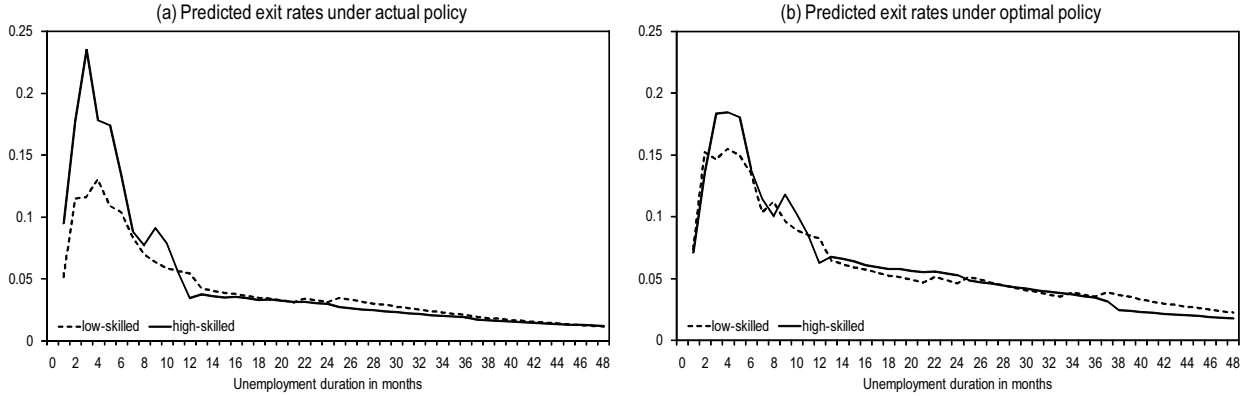


Note: Low-skilled: last wage below median. High-skilled: last wage above median.

Panel (b) of Figure 4 shows the exit rates from unemployment to employment that are implied by the optimal policy and which have been obtained from the iteration procedure described in Section 3.1. Panel (a) displays the corresponding exit rates obtained under the actual policy. The overall pattern of the evolution of the exit rates with unemployment duration remained unchanged: The exit rates increase sharply at the beginning of unemployment but decline rapidly between six and twelve months of unemployment. Thereafter, they continue to fall but much more slowly. During the first six months of unemployment the exit rates of the high-skilled are significantly larger than those of the low-skilled, and they are essentially the same after one year of unemployment. However,

as can be seen from Figure 5 which plots the difference between actual and implied optimal job finding probabilities in percentage points (panel a) as well as in percent (panel b), the implied optimal exit rates exceed the actual ones by about 1-4 percentage points. The only exception are the job finding probabilities of high-skilled workers in the first four months of unemployment.

Figure 4: Exit rates under the actual and the optimal policy



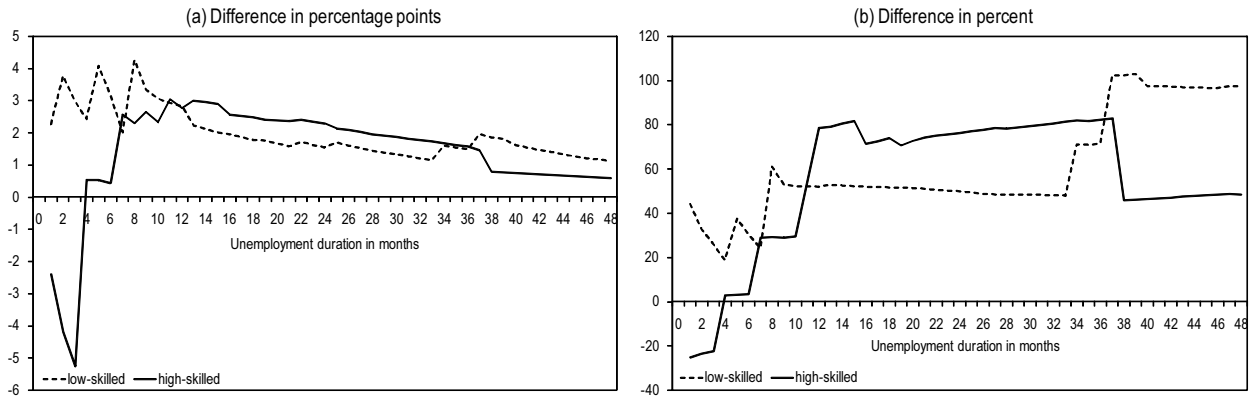
Note: Low-skilled: last wage below median. High-skilled: last wage above median.

The changes in the exit rates nicely reflect the key mechanics through which search incentives are provided in these types of models of optimal UI: For low-skilled workers the drop in actual benefits after exhaustion of UI is relatively small, so search incentives are altogether relatively weak. The continuous decline in optimal benefits strengthens search incentives considerably for the low-skilled. In particular, the intertemporal nature of providing search incentives under the optimal policy leads to particularly high increases in the exit rates for longer unemployment durations, where actual job finding rates are particularly low. For high-skilled workers, the very high optimal benefit levels at the beginning of unemployment provide some disincentives to search compared to actual benefits. However, already after four months of unemployment the intertemporal incentives provided by declining benefits start to work for the high-skilled as well.

4 Conclusion

Based on a theoretical framework where all key choice variables of the policy maker are endogenized I analyze the optimal design of monitoring and sanctioning systems for the unemployed in a dynamic environment with heterogeneous workers. My findings advise policy makers to threaten and impose severe sanctions in case of non-compliance with job search requirements. However, the monitoring intensity should initially be kept relatively low, but it should increase as workers remain unemployed

Figure 5: Effect of implementing the optimal policy



Note: Exit rate implied by optimal policy minus actual exit rate. Low-skilled: last wage below median. High-skilled: last wage above median.

for longer periods. Moreover, countries with more generous benefit systems should make more extensive use of monitoring than less generous countries.

From the methodological point of view I demonstrate how very informative and large data can be used to considerably improve and extend the insights that can be obtained from numerically solving and simulating economic models. On the one hand, besides providing estimates of input parameters that are more accurate and easier to interpret, being able to estimate the input parameters for any subgroup of individuals that may be of interest considerably broadens the amount of heterogeneity that can be analyzed. On the other hand, I propose and apply a procedure that allows eliciting the job finding probabilities that are implied by the optimal policy which can then be compared to actual job finding rates to assess the impact of implementing the optimal policy. Based on this procedure, I find that the optimal policy implies considerably higher job finding rates than the actual policy, especially for low-skilled workers.

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Appendix

A Estimation results for the hazard rates

Table 1: Logit estimates of the hazard rates

Variable	Coefficient	Standard error	P-value in %
Constant	-3.7724	0.2618	0.0000
Unemployed for 1 month	1.0371	0.0924	0.0000
Unemployed for 2 months	1.7745	0.0901	0.0000
Unemployed for 3 months	1.9428	0.0893	0.0000
Unemployed for 4 months	1.9857	0.0893	0.0000
Unemployed for 5 months	1.9605	0.0900	0.0000
Unemployed for 6 months	1.7479	0.0915	0.0000
Unemployed for 7 months	1.4713	0.0941	0.0000
Unemployed for 8 months	1.4406	0.0959	0.0000
Unemployed for 9 months	1.4009	0.0971	0.0000
Unemployed for 10 months	1.3016	0.0996	0.0000
Unemployed for 11 months	1.1877	0.1022	0.0000
Unemployed for 12 months	1.0906	0.1022	0.0000
Unemployed for 13-15 months	0.9352	0.0892	0.0000
Unemployed for 16-18 months	0.8171	0.0910	0.0000
Unemployed for 19-21 months	0.6652	0.0935	0.0000
Unemployed for 22-24 months	0.6934	0.0942	0.0000
Unemployed for 25-30 months	0.6699	0.0841	0.0000
Unemployed for 31-36 months	0.1620	0.0937	8.3950
January	-0.5303	0.0485	0.0000
February	-0.3026	0.0452	0.0000
March	0.1535	0.0416	0.0228
April	0.2975	0.0413	0.0000
May	0.1212	0.0439	0.5776
June	0.0600	0.0456	18.8779
August	-0.0950	0.0469	4.2793
September	0.0143	0.0461	75.7071
October	-0.3352	0.0497	0.0000
November	-0.4821	0.0504	0.0000
December	-0.8345	0.0544	0.0000
Age/100	-4.0489	0.4369	0.0000
Age 20-25	-0.5641	0.0772	0.0000
Age 26-30	-0.3713	0.0569	0.0000
Age 31-35	-0.1181	0.0393	0.2629
Age 36-40	0.1496	0.0376	0.0068
Age 46-50	0.1192	0.0541	2.7677
Age 51-55	0.0673	0.0741	36.3952
Female	0.1090	0.0250	0.0013
Foreigner	-0.1347	0.0294	0.0005
Married	0.0421	0.0308	17.1062
Single	-0.0708	0.0322	2.8040
At least one child	0.0015	0.0255	95.2305
Child of age below 3	0.0138	0.0474	77.0997
Child of age 3-6	-0.0714	0.0379	5.9434
Has health impairments	-0.2641	0.0393	0.0000
Health impairments affect employability	-0.1851	0.0560	0.0945
No schooling degree	-0.1461	0.0344	0.0022
No vocational degree	-0.1421	0.0241	0.0000
Looking for fulltime job	0.2649	0.0382	0.0000
Replacement rate	-0.0875	0.0512	8.7600
Replacement rate 1-20%	0.3467	0.0810	0.0019
Replacement rate 21-35%	-0.0747	0.0314	1.7157
Replacement rate 41-45%	-0.0545	0.0291	6.1219
Replacement rate higher than 45%	-0.1791	0.0290	0.0000
Receives unemployment benefits	0.5345	0.0475	0.0000
Receives unemployment assistance	-0.3248	0.0553	0.0000

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Variable	Coefficient	Standard error	P-value in %
Log(daily benefits)/10	7.5352	1.0275	0.0000
No benefits	0.3054	0.1581	5.3397
Remaining UB claim in days/1000	-0.9884	0.1813	0.0000
No UB claim	0.6059	0.0479	0.0000
Remaining UB claim 1-90 days	-0.2397	0.0429	0.0000
Remaining UB claim 181-270 days	0.2536	0.0383	0.0000
Remaining UB claim more than 270 days	0.6870	0.0499	0.0000
Employed	0.7464	0.0234	0.0000
In employment program	0.3569	0.0670	0.0000
In labor market program	-1.1641	0.0610	0.0000
Duration of current program	0.0148	0.0049	0.2371
Total duration in program	0.0457	0.0038	0.0000
North-Rhine-Westphalia	-0.1149	0.0248	0.0004
Schleswig-Holstein-Hamburg	-0.1033	0.0365	0.4595
Rural area	0.1398	0.0553	1.1523
Local unemployment rate	-2.7564	0.3566	0.0000
Distance to next agglomeration/1000	1.2520	0.3011	0.0032
Fraction of foreigners in region	1.2622	0.2373	0.0000
Last job in manufacturing or technical occupation	-0.2090	0.0465	0.0007
Last job in service occupation	-0.1482	0.0478	0.1942
Last job in manufacturing industry	-0.1229	0.0246	0.0001
Last job in public, education, health sector	-0.0710	0.0305	1.9903
Last job as unskilled worker	-0.1037	0.0248	0.0029
Last job as clerk	-0.1043	0.0313	0.0862
Last daily gross wage 1-25 EUR	0.1550	0.0651	1.7269
Last daily gross wage 26-40 EUR	0.1062	0.0362	0.3310
Fraction unemployed in past 10 years 1-5%	0.2755	0.0429	0.0000
Fraction unemployed in past 10 years 6-15%	0.1370	0.0407	0.0772
Fraction unemployed in past 10 years 16-30%	0.0810	0.0501	10.6154
Fraction unemployed in past 10 years more than 30%	0.1104	0.0742	13.7181
Fraction out of labor force in past 10 years 1-10%	-0.0249	0.0235	28.8025
Fraction out of labor force in past 10 years 11-25%	-0.0255	0.0302	39.7865
Fraction out of labor force in past 10 years more than 25%	-0.1087	0.0317	0.0610
Duration of last employment 1-6 months	-0.0478	0.0393	22.4057
Duration of last employment 7-12 months	0.1213	0.0331	0.0242
Number of unemployment spells in past 12 months/10	0.9129	0.3369	0.6741
Number of unemployment spells in past 10 years/10	0.7774	0.0663	0.0000
Participated in labor market program in past 10 years	-0.1339	0.0378	0.0398
Number of months employed in past 3 years	0.0079	0.0018	0.0009
Average daily wage over past 10 years	-0.0037	0.0009	0.0037
Average daily wage over past 10 years 1-35 EUR	-0.0156	0.0432	71.7309
Average daily wage over past 10 years 36-50 EUR	0.0033	0.0306	91.5442
Unemployed in month 12 before unemployment	0.1613	0.0374	0.0016
Unemployed in month 24 before unemployment	0.0832	0.0287	0.3751
Unemployed in month 36 before unemployment	0.0753	0.0287	0.8793
Unemployed in month 48 before unemployment	0.1108	0.0292	0.0147
Months unemployed in past 10 years/100	-1.1249	0.1414	0.0000
Observed in data for less than 10 years before unemployment	0.0660	0.0255	0.9760
Months since last unemployment spell	-0.0024	0.0006	0.0096
Observations		211791	
Log-likelihood		-661018	

Note: All variables referring to the employment history are calculated at the beginning of unemployment.