# Monitoring, Sanctions and Front-Loading of Job Search in a Non-Stationary Model*

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Date: November 21, 2011

**Abstract**

We develop and estimate a non-stationary job search model to evaluate a scheme that monitors job search effort and sanctions insured unemployed whose effort is deemed insufficient. The model reveals that such schemes provide incentives to the unemployed to front-load search effort prior to monitoring. This causes the job finding rate to increase above the post sanction level. After validating the model both internally and externally, we conclude that the scheme is effective in raising the job finding rate with minor wage losses. A basic cost-benefit analysis demonstrates that welfare losses for the unemployed are compensated by net efficiency gains for public authorities and society.

*Keywords:* Monitoring, sanctions, non-stationary job search, unemployment benefits, structural estimation.

*JEL Classification:* J64, J68, C41.

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# 1 Introduction

The provision of Unemployment Insurance (UI) involves a trade-off between insurance and work incentives. Many economic researchers have studied how limiting the coverage of UI and the duration of benefit entitlement can restore work incentives (see e.g. Lalive et al., 2006, and references therein). However, most UI schemes also provide work incentives by imposing job search requirements on benefit claimants and sanctions in case of non-compliance. This paper develops and estimates a non-stationary job search model to evaluate the recent introduction of a scheme that monitors job search effort within the UI system in Belgium.

In many countries monitoring of job search effort is organized along relatively standardized procedures (OECD, 2007). It starts off with a notification (often at initial registration) by which the unemployed worker is informed about the search requirements and the proofs thereof to deliver, about the timing of the evaluations of search effort, and about the associated sanctions in the case of noncompliance. At the prescribed dates, past job search effort is evaluated on the basis of transmitted paper proofs of job applications or in face-to-face interviews. If the outcome of the evaluation is negative, a sanction in the form of a temporary and partial reduction of unemployment benefits (UB) usually follows.

Early studies[1] found positive effects of monitoring programs, but, since programs themselves were often combining counseling with monitoring, they could not disentangle which of these components was responsible for such findings. A number of later contributions have succeeded in isolating the pure effects of monitoring. Klepinger et al. (1997) in the US and McVicar (2008) in Ireland demonstrate that monitoring significantly increases transitions to work.[2] Paserman (2008) arrives to a similar conclusion on the basis of simulations of a structural job search model estimated on the US data. His model also learns that the job finding rate increases by enhanced search intensity and not so much by a lower reservation wage. Re-employment wages are therefore hardly affected. In contrast to this evidence, Ashenfelter et al. (2005) find that tighter search requirements in the US have insignificant effects on transitions to employment and Klepinger et al. (2002) report even slightly decreasing job finding rates. This is in line with the insignificant effect of job search monitoring reported by van den Berg and van der Klaauw (2006) for the Netherlands. They argue that this result is caused by substitution of formal by informal search, a phenomenon that would be especially relevant for well qualified workers on whom they focus in their study. Finally, Manning (2009) reports that too strict search requirements may lead UB recipients to stop claiming and withdraw from the labor market. Petrongolo (2009) confirms this, demonstrating moreover that monitoring substantially decreases employment stability and annual earnings in the long run.

In Belgium job search effort is only monitored since 2004 and it targets only long-term unemployed workers, eligible to UI for more than 13 months. Evaluations comprise face-to-face interviews in which caseworkers have quite some discretion in the evaluation of the fulfillment of search requirements. The system is more lenient than in many other countries in that evaluations are much more spread out over time and the first negative evaluation does not lead to a monetary sanction. By contrast, if imposed, sanctions are substantial. If one does not comply with search actions stipulated after the first negative evaluation, benefits can be completely withdrawn: first temporarily during 4 months, but subsequently the entitlement to UI is completely halted. In addition, the threat that these sanctions are effectively imposed is high. The sanction probability ranges around 50-60 percent. This incomplete compliance reflects the uncertainty regarding the effective search requirements and regarding the measurement of their fulfillment. Contrary to the literature, that often assumes perfect monitoring, we will explicitly model this uncertainty.

[1]See Meyer (1995) for a review of US studies, and Gorter and Kalb (1996) and Dolton and O'Neill (1996, 2002) for a review of European studies.

[2]Borland and Tseng (2007) provide evidence of enhanced exits from unemployment, but could not identify the exit destination.

Cockx and Dejemeppe (2010) have evaluated the impact on the job finding rate of the first stage of the new monitoring scheme, i.e. of the time between notification and eight months later, just before the first evaluation takes place. Using the same data as in this research, their analysis is based on a Regression Discontinuity Design (RDD) that exploits the gradual introduction of the new scheme by age group. Between July 2004 and June 2005 only unemployed individuals younger than 30 on June 30 were targeted, while those aged between 30 and 40 were only concerned by the reform in the subsequent year. Based on this analysis they conclude that, in Flanders,[3] eight month after notification the transition rate for thirty year olds was significantly higher than in the absence of the monitoring scheme, but this effect was not estimated precisely. Since the RDD was only valid in the first year after notification, Cockx and Dejemeppe (2010) could only evaluate the first stage of the monitoring scheme. In this paper we aim at evaluating all stages. To that purpose, we first develop a structural job search model that captures the main features of a streamlined monitoring scheme and, subsequently, we adapt the model as to capture the specificities of the scheme that has been introduced in Belgium. We explicitly model the decisions with regards both the job search intensity and the level of the reservation wage. This allows to investigate the trade-off between enhanced job finding rates and reduced job quality in terms of the level of wages upon re-employment. We then estimate this model and ensure that the evaluation based on it is reliable by both internal validation of the estimation results and external validation on a control sample selected one year before the introduction of the monitoring scheme. Finally, we conduct a basic cost-benefit analysis.

Structural econometric modeling of job search has made progress in several directions. Non-stationarity in job search models was for the first time introduced in the seminal papers of Wolpin (1987) and van den Berg (1990) in discrete and continuous time, respectively. More recently, Ferral (1997), Garcia-Perez (2006), Frijters and van der Klaauw (2006), and Lollivier and Rioux (2010) have further developed the estimation of non-stationary models, all maintaining the assumption of exogenous job search intensity. Bloemen (2005), van der Klaauw and van Vuuren (2010) and Fougère et al. (2009) among others have estimated job search models with endogenous job search intensity, but assume a stationary environment. To our knowledge, only Paserman (2008) allows for endogenous search in a non-stationary setting.[4] The estimated model does not consider monitoring of job search effort, but simulations based on this model investigate the implications of a simplified monitoring scheme in which UB is withdrawn if search effort falls below a particular threshold. Finally, van den Berg and van der Klaauw (2009) estimate a stationary structural model that evaluates job search monitoring in the Netherlands. They assume that (formal) job search effort and the imposed requirement are perfectly known by both, the unemployed workers and the caseworkers who monitor - an assumption that is generally not tenable, in particular for the scheme we consider in this paper. However, in contrast to our approach and in line with the theoretical model presented in van den Berg and van der Klaauw (2006), they allow that informal search effort is unobserved to caseworkers and can be substituted by formal search. The model reveals that job search channel substitution does not only reduce the effectiveness of monitoring, but that, together with on-the-job search, it also mitigates the adverse effects of monitoring on job quality, as measured by accepted wages and job duration.

A distinctive feature of our model, compared to all other job search models that have explicitly integrated monitoring of job search effort, is that in a unified framework it simultaneously allows that: (i) both, job search effort from the perspective of the evaluator and job search requirements from the perspective of the unemployed are imperfectly observable, so that the outcomes of the evaluations are random; (ii) the outcome of the evaluation depends on realized job search effort; and (iii) the timing of the interviews is known in advance, so that forward looking unemployed agents anticipate them, leading to non-stationary behavior in case of imperfect monitoring.

[3]Our paper focuses on this region of Belgium, since only in this region the monitoring of job search effort was not systematically accompanied with counseling. Only in this region the "pure" monitoring effect is therefore identified.

[4]Launov and Wälde (2011) formulate and estimate a non-stationary matching model with endogenous effort and time-dependent benefits, but focus rather on equilibrium effects of UB reduction in a Mortensen-Pissarides setting.

In order to better understand the implications of this distinctive feature, we set up a streamlined model with monitoring which contains the UI scheme with a finite entitlement to UB, analyzed first in the seminal article by van den Berg (1990), as a special case.[5] We prove that in this generalized setting the unemployed worker monotonically strictly increases search effort and strictly decreases the reservation wage from the moment she is notified of the timing of the monitoring interview until the moment the evaluation of job search takes place. As in a scheme with benefit exhaustion, the expected lifetime utility is decreasing throughout this period. This behavior reflects that the unemployed worker anticipates the drop in expected welfare induced by a potential sanction at the monitoring interview. As she discounts the future, she increasingly values this drop in welfare and accordingly intensifies her actions to avoid it.

If the sanction probability is equal to one, job search effort and the reservation wage converges smoothly to the post-sanction level and the job finding rate exhibits no "spike". This contrasts with what has been repeatedly detected in empirical studies,[6] but is in line with the model of van den Berg (1990). However, in the presence of monitoring there is an additional incentive to search for jobs, since by searching more intensively the unemployed worker can reduce the sanction probability below one. If the sanction probability is sufficiently sensitive to past job search effort, we show that search effort and, hence, the job finding rate may then even temporarily increase above the level that would be attained after the actual imposition of a sanction. Nevertheless, since this rise in job search effort lowers the sanction probability, the worker will on average exert less effort after the monitoring interview than after benefit exhaustion. We label this increase "*front-loading*" of job search, since higher search effort before the interview substitutes for lower afterwards. Simulations of the behavior implied by the estimated model reveal that such temporary "front-loading" of search effort is not just a theoretical possibility.

The paper is organized as follows. Section 2 presents the streamlined model. Section 3 provides information on the institutional setting in Belgium and explains how we adjust the streamlined model to take the specificities of this setting into account. Section 4 develops the econometric model and includes a discussion on identification. Section 5 describes the data. Section 6 reports the estimation results: estimated parameters, goodness-of-fit, external validation of the estimated model and an interpretation of the results based on a model simulation. In Section 7 we use our estimations to evaluate the monitoring scheme introduced in Belgian UI in 2004, first by simulating average treatment effects and subsequently by conducting a cost-benefit analysis. Section 7 provides a brief summary and concludes.

## 2 Job-search in a streamlined monitoring scheme

In this section we derive in a continuous-time setting the job search behavior of infinitely-lived unemployed workers within a "streamlined" monitoring scheme. By describing a simplified scheme we aim at explaining the essential features of the model. We also briefly discuss how the simple model can be modified to take some features of monitoring schemes in other countries into account. In the next section the simple model is generalized as to capture the behavior of the unemployed within the new monitoring scheme that the Belgian government introduced in 2004.

### 2.1 The Problem

In the streamlined scheme, it is assumed that unemployed workers are entitled to a constant unemployment benefit (UB) level $b_h$. Calendar time starts at entry in unemployment so that (calendar) time and unemployment duration are synonyms. At $t_0 \geq 0$, the unemployed worker is notified about the timing of an interview at which monitoring of past job search effort (from $t_0$ onwards) takes place

[5] I.e. the case where the sanction probability is one and does not depend on search effort of the monitored individual.
[6] See e.g. Meyer (1990) and the literature spawned by his contribution, and Card et al. (2007) for a critical assessment.

and about the sanction she risks in case that job search effort is deemed insufficient. The worker does not anticipate the notification by assumption. In the streamlined scheme the sanction corresponds to a permanent reduction of the benefit level to $b_\ell < b_h$. In case of a positive evaluation, the worker remains entitled to $b_h$.

Job offers arrive according to a Poisson process. Since in the data we do not observe any indicator of job search effort, we can only identify the ratio of the marginal impact of job search on the job arrival rate to its marginal cost (van den Berg and van der Klaauw, 2006, p. 903). We choose to normalize the numerator of this ratio to one. Consequently, job search effort is measured in *effective* units: $s(\tau)$ directly measures the job arrival rate. The monetary equivalent instantaneous search cost is denoted by $c\left[s\left(\tau\right)\right]$. It is assumed that $c(0) = 0$, $c'\left[s\left(\tau\right)\right] > 0$ and $c''\left[s\left(\tau\right)\right] > 0$.

The evaluation of job search efforts takes place at $t_1$. This moment is announced and thus known from $t_0$ onwards. A caseworker evaluates the average job search effort $\bar{S}(t_1, t_0)$ exerted between $t_0$ and $t_1$:

$$\bar{S}(t_1, t_0) = \frac{\int_{t_0}^{t_1} s(\tau) d\tau}{t_1 - t_0} \tag{1}$$

where $s(\tau)$ denotes the instantaneous search effort at time $\tau$. Both instantaneous and average search are perfectly known to the unemployed, but not to the caseworker (see below). If the observed average search effort $\bar{S}^o(t_1, t_0)$ is lower than the imposed search requirement $R$, i.e. if $\bar{S}^o(t_1, t_0) < R$, a sanction is imposed by reducing the benefit level *indefinitely* to $b_\ell < b_h$. Otherwise the outcome of the evaluation is positive and the worker remains entitled to $b_h$ without any time limit.

As acknowledged by Boone and van Ours (2006) and Boone et al. (2007), it is very difficult for caseworkers to directly measure an unemployed's search intensity. Often evaluators use the observed average number of job applications per time unit, $\bar{S}^o(t_1, t_0)$, as a proxy for the true search intensity, measured in the model by the average number of job offers per time unit, $\bar{S}(t_1, t_0)$. We assume that the number of applications and offers are proportional to each other. To capture the idea of measurement error, the factor of proportionality is random: $\bar{S}^o(t_1, t_0) = \varepsilon \cdot \bar{S}(t_1, t_0)$, where $\text{supp}(\varepsilon) = (\underline{\varepsilon}, \overline{\varepsilon}) \subset [0, \infty]$, $\text{supp}(X)$ denotes the support of a random variable $X$ and $\underline{\varepsilon} \leq \overline{\varepsilon}$. In addition, we assume that caseworkers have some discretion in determining whether search effort is sufficient. Therefore, $R$ is treated as random with $\text{supp}(R) = [\underline{R}, \overline{R}) \subset [0, \infty]$ and $\underline{R} \leq \overline{R}$. On the one hand, this assumption fits well the institutional environment of the scheme that is analyzed. On the other hand, this is a more general formulation, since a deterministic search requirement is just a special case. The outcome of the evaluation is thus random from the perspective of the unemployed worker. For any given average search effort $\bar{S}(t_1, t_0)$, denoting $\Psi \equiv R/\varepsilon$, the probability of being sanctioned at $t_1$ is therefore:

$$\text{Prob}\left[\bar{S}^o(t_1, t_0) < R\right] = \text{Prob}\left[\Psi > \bar{S}(t_1, t_0)\right] = 1 - \text{Prob}\left[\Psi \leq \bar{S}(t_1, t_0)\right] \equiv \pi\left[\bar{S}(t_1, t_0)\right]. \tag{2}$$

We assume that $\Psi$ is a continuous random variable with $\text{supp}(\Psi) = [\underline{\Psi}, \overline{\Psi}) \subset [0, \infty]$ and $\underline{\Psi} < \overline{\Psi}$, so that $\forall \bar{S}(t_1, t_0) \in (\underline{\Psi}, \overline{\Psi}) : \pi'\left[\bar{S}(t_1, t_0)\right] < 0$. We also assume that $\overline{\Psi} > s^+$, where $s^+$ ($s^-$) denotes the stationary search effort after a positive (negative) evaluation, i.e. once the unemployed is entitled to $b_h$ ($b_\ell$) without any time limit and search effort is no longer monitored. Without this assumption the unemployed worker would always be positively evaluated without changing her behavior.

Observe that if search requirements become very tough ($\underline{R}$ and hence $\underline{\Psi}$ very high), then it may no longer be optimal for the unemployed worker to comply, since it is then too costly to bring the sanction probability down below one. In such cases the unemployed worker will behave as if a time limit has been imposed on the receipt of UB at $t_1$: $\bar{S}(t_1, t_0) < \underline{\Psi}$, so that $\pi(\bar{S}(t_1, t_0)) = 1$ and $\pi'(\bar{S}(t_1, t_0)) = 0$. As such, an UB scheme with a time limit is a special case of our model. In Proposition 3 in Subsection 2.3 we claim that this special case never applies if $\underline{\Psi} = 0$. In the empirical analysis we impose this condition, since in the data nobody is sanctioned for not showing up at the monitoring interview, the latter being the behavior of someone who expects to be sanctioned with probability one. In the remainder of this section we maintain, however, the general formulation.

The sensitivity of the sanction probability to average job search effort (i.e. the "precision of the inspection technology") increases with the absolute value of the derivative $\pi'[.]$. In the limit, this precision is perfect and neither $\bar{S}^o$, nor $R$ is random: $\bar{S}^o = \bar{S}(t_1, t_0)$ and $R = \underline{R} = \overline{R}$. Our model does not comprise this limiting case, however, since it is incompatible with the assumption that $\underline{\Psi} < \overline{\Psi}$. We argue in Subsection 2.3 this limiting case also has fundamentally different analytical properties.

Several researchers have assumed a perfect monitoring scheme. Manning (2009) and Petrongolo (2009) consider that those who do not comply with the job search requirements instantaneously and surely enter the "non-claimant" category. In the optimal unemployment insurance (UI) literature, Pavoni and Violante (2007) and Wunsch (2010) assume that the planner can perfectly observe search effort if it pays a monitoring cost.

Van den Berg and van der Klaauw (2006, 2009) introduce imperfection in the monitoring of job search by distinguishing between formal and informal search channels and by assuming that monitoring of job search effort in the formal channel is perfect, while job search effort in the informal channel cannot be monitored at all. We do not allow for such a distinction here, since in the empirical analysis below the monitoring is targeted at long-term unemployed individuals for whom the informal channel most likely has "dried up", as argued by the aforementioned authors and by Calvo-Armengol and Jackson (2004), and Ioannides and Datcher Loury (2004, p. 1069-1071). Given that virtually no sanctions are observed in their data, van den Berg and van der Klaauw (2006, 2009) assume that job-seekers do comply with the rules introduced by the monitoring scheme. As sanctions are frequent in the Belgian monitoring scheme that we analyze subsequently, such an assumption cannot be made here.

Boone et al. (2007) model the sanction probability similarly as we do, but impose (in a stationary environment) that (average) job search effort affects the sanction probability linearly and that $R$ is deterministic and known by the job-seeker (see their Appendix C). Abbring et al. (2005) assume (in a stationary environment) that "the individual does not exactly know the rules that he has to comply with and that he does not exactly know what type of behavior will generate a sanction" (p. 608). In their model this leads to a sanction probability that is completely independent of search effort below a threshold and zero above this threshold. We believe that complete independence is too strong an assumption. Boone et al. (2009) study a random sanctioning scheme in the lab where the probability of being sanctioned can only be affected by the acceptance rate of job offers. In the optimal UI literature with two levels of job search effort, Setty (2010) assumes a probabilistic monitoring technology in which upon inspection the probability of being sanctioned decreases with the level of effort.

Workers are assumed to be identical and risk-neutral, discount the future at rate $\rho > 0$ and consume their current income entirely. By risk-neutrality, non-labor income other than UB does not affect behavior and can thus be normalized to zero. This assumption is required in the empirical analysis since non-labor income is not observed. Workers can be either employed in full-time jobs or unemployed. All employment requires some search in a preceding unemployment spell. There are no job-to-job transitions. If employed, the worker earns a constant net wage $w > 0$ and enjoys leisure the value of which is normalized to zero. If unemployed, the value of leisure (net of stigma costs) is $\nu$. Jobs dissolve at an exogenous constant Poisson rate $\delta \geq 0$. Workers who return to unemployment are assumed to renew their entitlement to UB, irrespective of the length of their employment spell.[7] With these assumptions the expected lifetime utility of a worker who finds a job is time-independent:

$$W(w) = \frac{w + \delta U(0)}{\rho + \delta} \tag{3}$$

where $U(0)$ denotes the expected lifetime utility at the start of an unemployment spell.

An optimal search strategy implies that one accepts job offers that pay a wage $w$ as soon as, at any moment $\tau \geq 0$, $W(w) > U(\tau)$. Since from (3) it is clear that $W(w)$ is strictly increasing in $w$,

[7] This assumption is relaxed in the next section.

this strategy is equivalent to accepting any offer that exceeds a reservation wage $w_r(\tau)$: $w > w_r(\tau)$. Therefore, if $F(\cdot)$ denotes the wage offer distribution and $\bar{F}(\cdot) \equiv 1 - F(\cdot)$, the transition rate from unemployment to employment at time $\tau$ is then

$$p(\tau) \equiv p\left(s\left(\tau\right), w_r\left(\tau\right)\right) = s\left(\tau\right)\ \bar{F}\left(w_r\left(\tau\right)\right) \geq 0 \tag{4}$$

and the survivor function at $\tau$, conditional on being unemployed at $t_0 < \tau$ is

$$P\left(\tau, t_0\right) = \exp\left\{-\int_{t_0}^{\tau} p\left(x\right) dx\right\}. \tag{5}$$

With these assumptions the expected lifetime utility of an unemployed worker at $t_0$, $U(t_0)$, is the discounted sum of three terms: (i) the "sum" from $t_0$ to $t_1$ of the instantaneous monetary equivalent utility in unemployment ($y_h(\tau) \equiv b_h + \nu - c[s(\tau)]$) weighted by the probability of still being unemployed at each moment $\tau$ ($P(\tau, t_0)$); (ii) the "sum" from $t_0$ to $t_1$ of the expected utility of employment conditional on acceptance ($\bar{W}(\tau) \equiv E[W(w)|w > w_r(\tau)]$) weighted by the density of unemployment duration at $\tau$, $p(\tau)\, P(\tau, t_0)$; (iii) the expected lifetime utility right before the monitoring interview ($\mathbb{U}(t_1)$) weighted by the probability of surviving in unemployment up to $t_1$ ($P(t_1, t_0)$):

$$U(t_0) = \int_{t_0}^{t_1} \left[y_h(\tau) + p(\tau)\bar{W}(\tau)\right] P(\tau, t_0) e^{-\rho(\tau - t_0)} d\tau + \mathbb{U}(t_1) P(t_1, t_0) e^{-\rho(t_1 - t_0)}, \tag{6}$$

$$\mathbb{U}(t_1) = \pi\left[\bar{S}(t_1, t_0)\right] U^{-} + \left(1 - \pi\left[\bar{S}(t_1, t_0)\right]\right) U^{+} \tag{7}$$

where $U^{-}$ (resp., $U^{+}$) denotes the stationary expected lifetime utility after a sanction (resp., positive evaluation). Since $b_\ell < b_h$, $U^{+} > U^{-}$. In Appendix A.1 it is shown how $U(t_0)$ can be derived from the limit of its recursive definition in discrete time.[8]

The behavior of the unemployed over the interval $[t_0, t_1]$ can be derived by maximizing $U(t_0)$ with respect to ('wrt') the controls $\{s(\tau), w_r(\tau)\}_{\tau \in [t_0, t_1]}$ subject to the laws of motions for the two state variables: the survival probability $P(\tau, t_0)$ and the average search effort $\bar{S}(\tau, t_0)$. Differentiating (5) wrt $\tau$ yields the first law of motion

$$\dot{P}(\tau, t_0) = -p(\tau) P(\tau, t_0) \tag{8}$$

Similarly, from (1) one obtains the second law of motion

$$\dot{\bar{S}}(\tau, t_0) = \frac{s(\tau) - \bar{S}(\tau, t_0)}{\tau - t_0} \tag{9}$$

Observe that by writing the density of unemployment duration as $p(\tau)P(\tau, t_0)$ and treating $P(\tau, t_0)$ as a state variable the problem is drastically simplified, since it can then be solved by optimal control rather than by stochastic dynamic programming. Application of optimal control instead of dynamic programming technique in this framework has another decisive advantage, because it turns out that explicit dependence of the sanction probability on the effort accumulated up to the moment of evaluation makes dynamic programming approach intractable. In addition, the optimization problem is *autonomous* in the sense that time enters only directly through the generalized discount term, $\exp\left\{-\int_{t_0}^{\tau} \left(p(x) + \rho\right) dx\right\}$.[9] The discount term is generalized in that the discount rate $\rho$ is augmented by $p(\tau)$ and the current value $\tilde{x}$ of a variable $x$ is generalized to condition on survival in unemployment: $\tilde{x} \equiv x \cdot \exp\left\{\int_{t_0}^{\tau} \left(p(x) + \rho\right) dx\right\} = x \cdot \exp\left\{\rho(\tau - t_0)\right\} / P(\tau, t_0)$. In Appendix A.2 we show how to write the optimality conditions in terms of derivatives of the *generalized* current value Hamiltonian which no longer directly depends on time. In Appendix A.3 we derive on the basis of this Hamiltonian the necessary first-order conditions (FOC) of the controls for this maximization problem.

[8]Alternative derivation using continuous time Bellman Equations is available in the Internet Appendix, Section A.

[9]Note that, using expression (5) for the survivor function, $P(\tau, t_0)e^{-\rho(\tau - t_0)}$ in equation (6) can be rewritten as $\exp\left\{-\int_{t_0}^{\tau} \left(p(x) + \rho\right) dx\right\}$. See Spinnewyn (1990) for another example of this approach.

## 2.2 Optimality Conditions

The pair of optimal paths $\{w_r(\tau), s(\tau)\}$ obeys two FOC. The first one is:

$$w_r(\tau) + c[s(\tau)] + \delta\,[U(0) - U(\tau)] = b_h + \nu + \frac{s(\tau)}{\rho+\delta}\int_{w_r(\tau)}^{\infty} (w - w_r(\tau))\,dF(w) + \dot{U}(\tau). \tag{10}$$

Using that $\dot{w}_r(\tau) = (\rho+\delta)\dot{U}(\tau)$, this expression generalizes the condition reported by van den Berg (1990, p. 258) who assumes an exogenous job arrival rate ($s(\tau) = \lambda(\tau)$ and $c[s(\tau)] = 0$) and no job destruction ($\delta = 0$). The interpretation is as follows. The right-hand side represents the benefits of continuing search if one is offered a job that pays the reservation wage. It consists of three components: (i) the flow of income $b_h$ to which one remains entitled by not accepting the job offer augmented with the net value of leisure; (ii) the probability of finding a job times the conditional expected discounted cumulative wage gain relative to the reservation wage; (iii) the rate of appreciation of the asset value of unemployment. In the optimum these marginal benefits should be equal to the marginal cost of continuing search, as expressed on the left-hand side of Equation (10) also consisting of three components: (i) the opportunity cost of not accepting the job; (ii) the cost of search effort; (iii) the opportunity cost induced by foregoing the entitlement effect if the job offer is rejected: one cannot benefit from a fresh entitlement to UB in case of redundancy from the offered job.

The second FOC is:

$$c'[s(\tau)] = \frac{1}{\rho+\delta}\int_{w_r(\tau)}^{\infty} (w - w_r(\tau))\,dF(w) + \frac{\pi'\left[\bar{S}(t_1,t_0)\right]}{t_1 - t_0}\left[U^- - U^+\right] P(t_1,\tau)e^{-\rho(t_1-\tau)}. \tag{11}$$

This generalizes the familiar condition that the marginal cost of search should equal its marginal return (Mortensen, 1986, p. 871). The monitoring of job search increases the marginal return by the second term on the right-hand side of (11). Increasing job search marginally at $\tau$ decreases the sanction probability by $-\pi'\left[\bar{S}(t_1,t_0)\right]/(t_1-t_0)$. The division by $(t_1 - t_0)$ reflects that the evaluation occurs on the basis of average rather than instantaneous search effort. The value of avoiding a sanction is $[U^+ - U^-]$. Since this return realizes only to the extent that the worker has not left unemployment before $t_1$, we need to weigh it by the survivor probability between $\tau$ and $t_1$. In addition since the evaluation occurs in the future ($t_1 \geq \tau$), the return is discounted by $e^{-\rho(t_1-\tau)}$.

## 2.3 Analytical Properties

When forward-looking agents have a finite entitlement to a flat UB, van den Berg (1990) shows that the reservation wage and, hence, the inter-temporal value in unemployment declines with duration until the end of entitlement. By contrast, when analyzing job search monitoring schemes with sanctions researchers have always assumed that the behavior of agents is stationary. Imposing stationarity is valid if (i) monitoring is perfect (Manning, 2009, e.g.) or (ii) if the unemployed cannot anticipate the future instant at which, or from which (as in the scheme studied here)[10] the evaluation takes place (Boone et al., 2007, e.g.). We have argued, however, that often job search requirements are not sharply defined or the measurement of search effort is imperfect, and evaluating caseworkers have some discretion in determining the outcome of the evaluation. Moreover, the moment at or from which the evaluation takes place is usually not completely random. In this case the behavior of the unemployed cannot be stationary. The intuition is that the risk of a benefit sanction induced by the monitoring provides incentives to reduce this risk. To the extent that the unemployed worker cannot perfectly control this risk, which is the case if monitoring is imperfect, she reduces this risk by searching more intensively for jobs and being less choosy in accepting job offers. Since the worker discounts the future, this effect becomes more important as one approaches the moment at which the evaluation takes place.

[10] See Section 3.

Proposition 1 formalizes this intuition. It generalizes the finding of van den Berg (1990) in that it demonstrates that this result does not require that the sanction is realized with certainty. Moreover, the sanction probability may depend on job search effort, as long as this relationship is not completely deterministic, as would be the case in a perfect monitoring scheme. Proposition 1 also states that, if the sanction probability $\pi[\bar{S}(t_1, t_0)]$ is less than one, the reservation wage and the expected lifetime utility jump discontinuously to their stationary level, which depends on the outcome of the evaluation. This contrasts to the van den Berg case in which no discontinuity occurs. Finally, according to this proposition, the sanction probability is in the optimum always strictly positive. This follows from the assumption that $\overline{\Psi} > s^+$.

**Proposition 1** *The solution $\{w_r(\tau), s(\tau)\}_{\tau=t_0}^{t_1}$ to the maximization of (6) subject to the laws of motion (8) and (9) has the following properties:*

1. $\forall \tau \in (t_0, t_1) : \dot{U}(\tau) < 0,\ \dot{w}_r(\tau) < 0 \ \wedge \ \dot{s}(\tau) > 0.$
2. *$s(\tau)$, $w_r(\tau)$ and $U(\tau)$ are discontinuous at $\tau = t_1$, unless $\pi[\bar{S}(t_1, t_0)] = 1$.*
3. $\pi\left[\bar{S}(t_1, t_0)\right] > 0.$

**Proof.** See Appendix A.4. ■

Returning now to equation (11), the additional term on its right-hand side is exactly the term that reflects *front-loading* of job search effort: By creating the opportunity to avoid the sanction if search effort is sufficiently high, monitoring of job search substitutes higher search effort before the evaluation for lower search effort afterwards, in case of a positive evaluation. Remarkably, job search effort *prior* to the evaluation may even raise above $s^-$, the level that is attained after a sanction is imposed. In Proposition 2 we provide a sufficient condition for search effort to increase above the post sanction level $s^-$ if $\bar{S}(t_1, t_0) < \overline{\Psi}$ and hence if $\pi[\bar{S}(t_1, t_0)] < 1$, i.e. if the monitoring scheme is distinct from the UI with benefit exhaustion. In the empirical analysis we report and discuss evidence of such behavior. This *front-loading* of job search effort reveals a new trade-off in the choice between a benefit exhaustion and monitoring scheme as competing instruments to fight moral hazard in UI. Compared to the scheme with benefit exhaustion, monitoring of job search may, depending on the monitoring technology, increase job search effort and therefore the job finding rate *ex ante*, but this needs to be traded off against a lower job search effort *ex post*. Intuitively, the front-loading of search effort induced by the monitoring scheme is desirable if the social discount rate is sufficiently high. A detailed analysis of this trade-off is, however, left for further research.

**Proposition 2** *If $\bar{S}(t_1, t_0) > \underline{\Psi}$ and if $\frac{\partial \ln\left(1-\pi[\bar{S}(t_1,t_0)]\right)}{\partial \bar{S}(t_1,t_0)} > \bar{F}(w_r^-)(t_1 - t_0)$, then $s(t_1) > s^-$.*

**Proof.** See Appendix A.5. ■

Front-loading of search effort is more likely, the more sensitive is the probability of a positive outcome to accumulated effort $\left(\partial \ln\left(1 - \pi[\bar{S}(t_1, t_0)]\right) / \partial \bar{S}(t_1, t_0)\right)$, since this increases the return to front-loading. On the other hand, increasing the length of the evaluation period $(t_1 - t_0)$ reduces the incentive to front-load, since, the probability of a positive outcome being based on the *average* job search effort, this effort must increase more durably to affect this probability. Finally, the lower is the expected lifetime utility in case of a sanction ($U^-$), reflected by a correspondingly higher $\bar{F}(w_r^-)$, the higher is $s^-$, making it more difficult for $s(t_1)$ to exceed $s^-$.

Lastly, in Subsection 2.1 we claimed that if $\underline{\Psi} = 0$ the behavior of the unemployed will fundamentally differ from the case in which a time limit is imposed on the receipt of UB at $t_1$. This is formalized in the following proposition.

**Proposition 3** *If* $\underline{\Psi} = 0$ *and* $s^+ > 0$*, then* $\pi[\bar{S}(t_1, t_0)] < 1$ *in the solution to the optimization problem that maximizes (6) with respect to the path* $\{w_r(\tau), s(\tau)\}_{\tau=t_0}^{t_1}$ *subject to the laws of motion (8) and (9).*

**Proof.** See Appendix A.6. ■

The model presented in this section is simplified, but it provides key insights that would obtain in more complicated schemes. In the next section we discuss the main additional features that are relevant for the Belgian monitoring scheme. More generally, if, as in most schemes, a worker remains subject to monitoring in case of a positive evaluation (OECD, 2007), this does not qualitatively affect the findings of the streamlined model to the extent that workers cannot learn from previous monitoring outcomes. This is likely if, as in the Belgian scheme described below, caseworkers have sufficient discretion in determining the outcome of the evaluation and if each evaluation occurs by different caseworkers. The optimization problem after any positive evaluation then differs only from the one described in this section in that the expected lifetime utility in case of a positive evaluation is lower, since the worker continues to be monitored.

# 3 The Belgian Job Search Monitoring Scheme

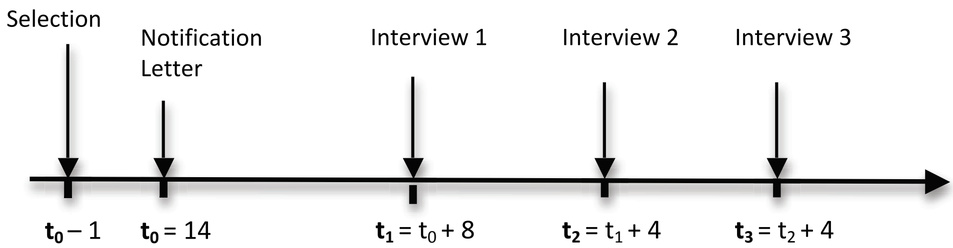
## 3.1 The Institutional Setting

In Belgium, UI is organized at the federal level. The Public Employment Services (PES) are organized at the regional level. They are in charge of counseling, job search assistance, intermediation services and training. In Belgium a worker is entitled to UI in two instances: (i) after graduation from school conditional on a waiting period of 9 months; (ii) after involuntary dismissal from a sufficiently long-lasting job. In contrast to many other countries there is no time limit to UI. School-leavers are entitled to flat rate benefits while dismissed workers earn a gross replacement rate ranging between 40% and 60% of past earnings, which is bracketed by a floor and a cap. The benefit level depends on household type (head of household, cohabitant or single) and on unemployment duration for dismissed singles and cohabitants.

Before 2004, job search effort was not monitored. In 2004, an important reform introduced such a monitoring scheme by which an end of entitlement can occur if search effort is insufficient. In order to focus on the pure effect of the monitoring scheme, the empirical analysis below is limited to a single region (Flanders), where the monitoring scheme was introduced without any additional policy.

The monitoring scheme was gradually phased in by age group. Between July 2004 and June 2005 only unemployed workers younger than 30 (on July 1) were concerned. In the following year those younger than 40 were included and between July 2006 and June 2007 those younger than 50. Individuals older than 50 years are not targeted by the scheme.

Figure 1: Timing of the Monitoring Procedure in Case of Negative Evaluation



The monitoring procedure consists of a notification and a sequence of face-to-face interviews. Figure 1 summarizes the timing of the notification, the first interview and the subsequent interviews in case of negative evaluation. If the outcome of the evaluation is positive at any of the interviews, a new sequence of interviews is scheduled: 16 months later after the first interview and 12 months later otherwise.

First, the administration selects individuals who have been entitled to UI for 13 months or more. Roughly one month later a notification is sent by mail ($t_0 = 14$). It states that entitlement to UB requires to actively search for a job and to participate in any action proposed by the regional PES. Some examples of search methods are provided and it is clearly stated that one should collect written proofs of the undertaken search actions. The letter announces that one will be invited at the UI office to evaluate the undertaken actions and that these evaluations start taking place 8 months after dispatch of the notification ($t_1 = t_0 + 8 = 22$).

These monitoring interviews last approximately half an hour. If search effort at the first interview is deemed insufficient an action plan is drawn up, but the worker is not yet sanctioned. If at the next interview, 4 months later ($t_2 = t_1 + 4 = 26$), it is established that the worker does not fulfill the plan, a second, stricter action plan is imposed and benefits are temporarily withdrawn during 4 months. If again, 4 months later ($t_3 = t_2 + 4 = 30$) at the third interview, the worker does not comply, benefits are completely withdrawn and the worker can regain entitlement only after being uninterruptedly full-time employed during at least one year. If an UB recipient is sanctioned, she can apply to means-tested social assistance benefits (more information about these in Table 3 below).

Table 1 presents aggregate statistics about the probability of a negative evaluation conditional on an interview. These probabilities are relatively high. As already argued in the introduction and in Section 2.1, this incomplete compliance reflects the uncertainty regarding the effective search requirements and regarding the measurement of their fulfillment.

Table 1: Aggregate Probability of a Negative Evaluation Conditional on an Interview[a]

| | |
|---|---|
| First interview | 44.0% |
| Second interview | 47.5% |
| Third interview | 60.0% |

[a] In Flanders averaged over the years 2004 to 2008, among those aged less than 30.

The frequency of monitoring contrasts quite starkly with that in many other countries: half of OECD countries require reports of job search (in most cases) every two weeks or at least monthly (OECD, 2007). On the other hand, sanctions in case of non-compliance of the action plan seem generally tougher in Belgium than in other OECD countries. For instance, in the Netherlands, a typical punishment for insufficient job search is a 10% reduction of unemployment benefits for a period of 2 months (van den Berg and van der Klaauw, 2006). Moreover, since, as shown in Table 1, the sanction probability is relatively high, the threat that the sanction is effectively imposed in Belgium is substantial. By contrast, in the Netherlands close to complete compliance is reported.

Job-search effort is evaluated on the basis of proofs delivered by the unemployed worker (copies of letters of application, registration in temporary help agencies, proofs of participation in selection procedures, etc.). Regulations do not specify, however, a minimum number of employer contacts to submit. Consequently, caseworkers have quite some discretion in the evaluation process. However, as this is a prerogative of the regional PES, they are not allowed to offer job vacancies nor propose participation in training programs. Moreover nothing guarantees that the unemployed will face the same caseworker at the different interviews. There is therefore no scope for learning about the evaluation standards across interviews.

### 3.2 Implications for the Job Search Model

In this section we extend the streamlined job search model of Section 2 as to capture the main specificities of the Belgian scheme. All derivations of the models with these extensions can be found in the Internet Appendix, Section B.

A first specific feature is that after a positive evaluation a next assessment of job search is scheduled, but this will not take place before 12 to 16 months later. Assuming, as in the streamlined scheme, that any positive evaluation entitles the unemployed worker to the high UB level $b_h$ without any time limit seems therefore a reasonable approximation. On the other hand, if the outcome of the monitoring is negative, the worker is not immediately excluded indefinitely from UI: (i) at the first interview an action plan is imposed, but the UB level remains at $b_h$; (ii) at the second interview benefits are temporarily reduced to $b_\ell$; (iii) the end of entitlement follows only at the third interview.

The succession of interviews in case of a negative evaluation does not have a major impact on the structure of the optimization problem, since the new problem just consists of a sequence of three independent optimization problems that resemble very closely the one presented in Section 2 and that are connected to each other through the transversality conditions. If $t_k$ denotes the moment at which the $k^{th}$ interview takes place ($k \in \{1, 2, 3\}$), then the optimization problem over the period $[t_0, \infty)$ can be split over the next four sub-periods: $[t_0, t_1)$, $[t_1, t_2)$, $[t_2, t_3)$ and $[t_3, \infty)$. For the last sub-period and for the periods that follow a positive evaluation at any of the interviews the problem corresponds to a standard stationary job search model. For the first three sub-periods, in case of a negative evaluation (or notification) the objective of the optimization problem can be written as follows:[11]

$$U_k(t_{k-1}) = \int_{t_{k-1}}^{t_k} \left[y_h(\tau) + p(\tau)\bar{W}(\tau)\right] P(\tau, t_0)e^{-\rho(\tau-t_0)}d\tau + \mathbb{U}_k(t_k)P(t_k, t_{k-1})e^{-\rho(t_k-t_{k-1})}, \quad (12)$$

$$\mathbb{U}_k(t_k) = \pi_k \left[\bar{S}(t_k, t_{k-1})\right] U_{k+1}(t_k) + \left(1 - \pi_k \left[\bar{S}(t_k, t_{k-1})\right]\right) U^+ \quad (13)$$

where $U_k(\tau)$ denotes the expected lifetime utility at time $\tau \in [t_{k-1}, t_k)$ of someone who is evaluated negatively (or notified) at $t_{k-1}$, $U_4(t_3) \equiv U^-$, and $\pi_k \left[\bar{S}(t_k, t_{k-1})\right]$ is the probability that average search effort between $t_{k-1}$ an $t_k$ is regarded as insufficient. This probability depends on $k$. The optimization problem can be solved by backward induction and the problem in each of the sub-periods hardly differ from the one described in Section 2.

Another adjustment concerns the entitlement effect if the worker returns to unemployment after an employment spell. In the streamlined model it was assumed that the worker is then entitled to the benefits and job search requirements of someone who starts a fresh unemployment spell at $t_0 = 0$ yielding lifetime utility $U(0)$. However, in the Belgian scheme this occurs only if the worker has been uninterruptedly full time employed for at least one year. For any employment spell that is shorter, the entitlement duration counter remains at the value at which unemployment was last left. We assume that the latter holds for all individuals.[12]

Apart from influencing the entitlement to benefits, short-lived jobs also occupy an important place in the evaluation process, because in the guidelines for evaluation the caseworkers are instructed to take work experience as a sufficient evidence of high enough job search effort. A descriptive analysis of the factors correlated with a positive evaluation confirms the importance of work experience. As we are compelled to take this feature into account, we assume that for workers returning to unemployment the sanction probability does no longer depend on past job search effort. Let superscript $e$ denote whether a worker has interrupted unemployment ($e = 1$) or not ($e = 0$) between two interviews. Then, it means that $\forall \bar{S}^1(t_k, t_{k-1}) : \pi_k^1 \left[\bar{S}^1(t_k, t_{k-1})\right] = \pi_k^1$ where $\pi_k^1$ is a fixed number.

[11]For $k = 3$, $y_\ell(\tau)$ replaces $y_h(\tau)$.

[12]A more general treatment would introduce a good deal of complexity without furthering our present purpose.

If $\tau$ refers to the moment at which unemployment is left, $U(0)$ should therefore be replaced by $U_k^1(\tau)$ in (3) and in (10), $U_k(.)$ and $\mathbb{U}_k(.)$ by $U_k^e$ and $\mathbb{U}_k^e(.)$ in (12) and (13), and $\bar{W}(\tau)$ in (12) by $\bar{W}_k^e(\tau) = \frac{1}{(\rho+\delta)\bar{F}(w_r(\tau))} \int_{w_r(\tau)}^{\infty} \left[w + \delta U_k^1(\tau)\right] dF(w)$. This introduces a new state variable, $U_k^1(\tau)$, in the problem. However, by the assumption of a constant sanction probability when $e = 1$, its law of motion is independent of the other state and control variables. It therefore does not affect the optimization problem for the case that $e = 0$ apart from introducing some exogenous time dependence. This time dependence can be found by solving the modified optimization problems sequentially, starting with $e = 1$ and then proceeding with $e = 0$. Note that if $e = 1$ the assumption of a constant sanction probability implies that $\pi_k^{1\prime}(.) = 0$, so that the second term on the right-hand side of (11) drops. The optimization problem then resembles the case of a benefit entitlement with a time limit except that the sanction probability is exogenously set to a level lower than one.

Finally, due to administrative delays in managing the interviews, the interviews do not take place at the scheduled moments ($t_1 = 22$, $t_2 = 26$ and $t_3 = 30$), but at some random instant later on. In order to get a better fit of the data, the model takes this delay into account. Each period $[t_{k-1}, t_k)$ is therefore split up in two sub-periods of which the second ends at a random instant and the first may start with delay. We denote these sub-periods by $[t_{k-1}^*, t_k')$ and $[t_k', T_k^*)$, where $t_0^* = t_0$. The first sub-period corresponds to the scheduled period during which no interviews can take place. In the second sub-period it is assumed that interviews occur at some random moment $T_k^*$, where $t_k^*$ denotes its realization. The realized delay, $(t_k^* - t_k')$, is assumed to be the minimum of a random draw from an exponential distribution with mean $1/q$ and some fixed maximum delay $\bar{t}_k^*$, which is determined in accordance to the maximum observed delay in the data.

This additional feature modifies the optimization problem in the following ways. Let us denote the expected lifetime utility for the first and second sub-period by $U_{k,1}^e$ and $U_{k,2}^e$. For the first sub-period $[t_{k-1}^*, t_k')$ only the transversality condition (13) is modified to

$$\mathbb{U}_{k,1}^e(t_k') = U_{k,2}^e(t_k'). \tag{14}$$

In the second sub-period the objective (12) becomes (for $k < 3$)[13]

$$U_{k,2}^e(t_k') = \int_{t_k'}^{\bar{t}_k^*} \left[y_h^e(\tau) + p^e(\tau)\bar{W}_k^e(\tau) + q\mathbb{U}_k^e(\tau)\right] P^e(\tau, t_k') e^{-[\rho+q](\tau - t_k')} d\tau + \mathbb{U}_k^e(\bar{t}_k^*) P^e(\bar{t}_k^*, t_k') e^{-[\rho+q](\bar{t}_k^* - t_k')}, \tag{15}$$

$$\mathbb{U}_k^e(\tau) = \pi_k^e\left[\bar{S}^e(\tau, t_{k-1}^*)\right] U_{k+1,1}^e(t_k^*) + \left(1 - \pi_k^e\left[\bar{S}^e(\tau, t_{k-1}^*)\right]\right) U^+ \tag{16}$$

where $U_{4,1}^e(\tau) \equiv U^-$ and the generalized discount rate is now $\rho + p(\tau) + q$. It follows that the benefit of search induced by monitoring, as expressed in the second term on the right-hand side of the FOC for search effort (11), is now furthermore discounted by $q$ and, rather than being evaluated at the predetermined moment $t_k$, it is now evaluated at any time between $t_k'$ and $\bar{t}_k^*$ the interview takes place. The details can be found in the Internet Appendix, Section B.2. Since this feature was just introduced to improve the fit of the model to the data and since this feature is not the focus of this paper, in the rest of the exposition we ignore interpretations with regards to delays in interviews.

# 4 The Econometric Model

## 4.1 Specification

Estimation of the structural model requires specification of the unknown functions $c(.)$, $F(.)$, $\pi_k^e(.)$ (for $e = 0, 1$ and $k = 1, 2, 3$) and a choice of the way in which these functions and unknown parameters of

[13] For $k = 3$ $y_\ell^e(\tau)$ replaces $y_h^e(\tau)$.

the model ($\rho$, $\nu$, $\delta$ and $q$) depend on individual characteristics. As to the latter, the level of benefits $(b_h, b_l)$ is a first source of heterogeneity. In addition, the cost of search and the separation rate depend on gender and three levels of education (low, medium and high),[14] which we denote - including the intercept - by $\mathbf{x}$. Computational limitations did not allow for a more extensive dependence on observed or on unobserved characteristics. However, this does not seem that restrictive in this particular study, since the target group of the monitoring scheme is long-term unemployed. Consequently, through the dynamic selection over the unemployment spell, this group is already relatively homogeneous. This is confirmed by the internal and external validation analysis reported in Sections 6.2 and 6.3.

The relative value of leisure and the job separation rate are specified respectively as $\nu = \exp\{\tilde{\nu}\}$ and $\delta(\mathbf{x}) = \exp\{\mathbf{x}'\zeta_\delta\}$. As explained in Section 2, the arrival rate of job offers is equal to the level of search effort measured in effective units. This normalization of search effort affects the interpretation once we allow for heterogeneous workers. Highly-educated workers for instance exert less effort than low-educated workers to attain the same effective search intensity. We account for this by allowing the marginal cost of effective search to depend on individual characteristics. However, we maintain the assumption that the monitoring is directly (but imperfectly) related to *effective* search intensity rather than to the underlying effort. The cost of search is chosen such that $c(0) = 0$, $c'(.) > 0$ and $c''(.) > 0$:

$$c\left[s(\tau)|\mathbf{x}\right] = \exp\left\{\exp\{\mathbf{x}'\zeta_c\}s(\tau)\right\} - 1. \tag{17}$$

The net wage offer density $f(w)$ is assumed to be log-normal: $w \sim \mathcal{LN}(\mu, \sigma)$. Observed net wages are measured with a multiplicative error $m$: $w^o = w \cdot m$, and the density function of the measurement error $h(m)$ is a unit-mean log-normal: $m \sim \mathcal{LN}\left(-\omega^2/2, \omega\right)$. Following Christensen and Kiefer (1994), it can be shown that the density function of observed wages $f_o(w^o;\tau)$ if unemployment is left at $\tau$ is given by

$$f_o(w^o;\tau) = \int_0^{w^o/w_r^e(\tau)} \frac{f(w^o/m)}{\bar{F}[w_r^e(\tau)]}\frac{1}{m}h(m)dm \tag{18}$$

The probability of being sanctioned at the $k^{th}$ interview ($k \in \{1,2,3\}$) for someone who did not leave unemployment since notification ($e = 0$) and someone who returned to unemployment after a temporary job ($e = 1$) takes the following functional form:

$$\pi_k^0\left[\bar{S}^0\left(t_k^*, t_{k-1}^*\right)\right] = \exp\left\{-\beta_k^0 \cdot \bar{S}^0\left(t_k^*, t_{k-1}^*\right)\right\}, \text{ with, } \beta_k^0 \geq 0 \tag{19}$$

$$\pi_k^1 = \exp\{-\beta_k^1\}, \text{ with, } \beta_k^1 \geq 0. \tag{20}$$

In relation with Proposition 3, notice that $\underline{\Psi}_k = 0$.

## 4.2 Identification

Individuals are sampled after 13 months of UI entitlement ($t_s \equiv t_0 - 1 = 13$). The data contain information on the observed individual characteristics ($\mathbf{x}$), on the UB level that is paid out to each individual and on the duration of the unemployment spell ($d_u$). For any observed unemployment spell of length $d_u$ the data provide information about the timing of monitoring within this spell: The unemployment duration at the moment of notification ($t_0^*$) and the unemployment duration at the moment of the $k^{th}$ interview ($\{t_k^*\}_{k=1}^3$), where $t_k^* = \varnothing$ if the $k^{th}$ interview did not yet take place. Furthermore, for each observed $k^{th}$ interview the data provide the outcome ($\{O_k\}_{k=1}^3$) of the evaluation of job search effort, where $O_k = 0$ if the outcome is positive, $O_k = 1$ the outcome is negative and $O_k = \varnothing$ if the interview did not yet take place.

Whenever the unemployed individual leaves to the destination other than full-time employment we right-censor the unemployment duration at the observed length $d_u$. Once the destination state is

[14] Respectively, (i) primary or lower secondary, (ii) upper-secondary education and (iii) higher education.

full-time employment, we record the net wage earned at the start of the employment spell ($w^o$) and the duration of the employment spell ($d_j$). Similar to the duration of unemployment, the observed employment spell is right-censored if one leaves for destinations other than unemployment.

The values for job search effort $s^e(\tau)$ and the reservation wage $w_r^e(\tau)$ at time $\tau$ are obtained from the solution of the optimal control problem as described in Appendix C. These control variables are conditional on functions of $\mathbf{x}$ and of all the parameters of the model. To avoid cumbersome expressions we ignore this dependence in the notation.

Identification of most parameters is quite standard (Flinn and Heckman, 1982; Eckstein and van den Berg, 2007; Keane et al., 2011). We briefly discuss identification for individuals with a given set of observed characteristics $\mathbf{x}$ and a particular level of UB. Since the log-normal is recoverable from a truncated distribution, the observed wages and the parametric assumption on the measurement error of wages is sufficient to identify the reservation wage, the complete wage offer distribution ($\mu$ and $\sigma$) and the variance of the measurement error ($\omega^2$). Given that the reservation wage and the wage offer distribution are identified, one can recover the job arrival rate (and hence search intensity)[15] from data on the duration at which jobs are found. In a stationary setting, since the level of UB and the length of the scheduled and delay intervals are observed, the relative value of leisure ($\tilde{\nu}$) and the marginal cost of search (and therefore $\zeta_c$) can be identified from the FOC of the reservation wage and the search effort for any given job separation rate ($\delta$), discount rate ($\rho$) and probability of negative evaluation ($\pi_k^e(.)$, for $e \in \{0, 1\}$ and $k \in \{1, 2, 3\}$). The parameters of job separation rate $\zeta_\delta$ are identified from the observed employment durations $d_j$. Since behavior is non-stationary, the discount rate $\rho$ can be identified from the differential equations describing the time paths of the control variables.[16] The parameter $\beta_1^e$ (for $e \in \{0, 1\}$) that determines the probability of negative evaluation at the first interview is identified from the observed outcome ($O_1$) at the first evaluation of job search effort ($e = 0$) and from the observation of an employment experience since notification ($e = 1$). Since the second and third evaluation interviews are observed for very few individuals (see Table 4 in Section 5.2), $\beta_2^e$ and $\beta_3^e$ are identified from aggregate observations on the outcomes of these evaluations. How this is done is explained in the next paragraph. Finally, $q$ is identified from observed lengths of interview delays.

Identification of $\beta_2^e$ and $\beta_3^e$ from aggregate observations of the probability of negative evaluation is achieved under the assumption that $\beta_k^e = \kappa_k \beta_1^e$, where $\kappa_k$ is a fixed constant independent of $e$, and that the sample average of the probability of a negative evaluation at the $k^{th}$ interview ($\bar{\pi}_k$) is proportional to the aggregate observed probability of negative evaluation ($\pi_k^a$) presented in Table 1, i.e. $\forall k \in \{1, 2, 3\} : \bar{\pi}_k = f \cdot \pi_k^a$, where $f$ is a fixed constant independent of $k$. With these assumptions $\kappa_k$ (and therefore $\beta_k$) for $k = 2$ and $k = 3$ can be found by solving the following implicit equation: $\bar{\pi}_k(\kappa_k) = f \cdot \pi_k^a = \frac{\bar{\pi}_1}{\pi_1^a} \pi_k^a$, where it is made explicit that $\bar{\pi}_k$ is a function of $\kappa_k$ and where all terms on the right-hand side are known or can be estimated ($\bar{\pi}_1$). A complication is that the aggregate probability of negative evaluation is conditional on being evaluated at the $k^{th}$ interview, while the sample average is calculated for the sample of notified individuals for whom these evaluations are not all observed. The sample average probability of negative evaluation is therefore estimated by a weighted sum of expected individual probabilities of negative evaluation (all of which a function of $\kappa_k$). The weights reflect that the likelihood of evaluation is not equal across notified individuals. In Appendix B it is shown how this weighted sum is constructed.

### 4.3 Likelihood Contributions

To write down the likelihood contribution of an unemployed individual consider first the probability of surviving in unemployment until some given moment $t$. For that, let $p^0(\tau)$ be given by (4) with superscript $e = 0$ denoting that the worker did not leave unemployment since $t_0$, and let $p^+ \equiv s^+ \bar{F}(w_r^+)$.

[15] Since we have no information on the intensity of search effort, we identify search effort with the job arrival rate (see Section 2).

[16] These differential equations provide over-identifying restrictions for the other parameters.

Furthermore define $\underline{t}'_k \equiv \min\{t, t'_k\}$, $\underline{t}^*_k \equiv \min\{t, t^*_k\}$ and $t'_4 \equiv t^*_4 \equiv \infty$. With these definitions, the probability of surviving in unemployment until $t$, being notified at $t^*_0$ and being evaluated at $\{t^*_k\}_{k=1}^3$, conditional on being unemployed at sample selection, i.e. at $t_s \equiv t^*_0 - 1$, and on the outcome of the notification ($O_0 \equiv 1$) and of the evaluations ($\{O_k\}_{k=1}^3$) is

$$\mathcal{P}\left(t, \{t^*_k\}_{k=0}^3 \,|t_s, \{O_k\}_{k=0}^3\right) = \exp\left\{-(\underline{t}^*_0 - t_s)p^+\right\}$$
$$\times \exp\left\{-1[t \geq t^*_0]\sum_{k=1}^{4} O_{k-1}\left[\int_{t^*_{k-1}}^{\underline{t}'_k} p^0(\tau)d\tau + 1[t \geq t'_k]\int_{t'_k}^{\underline{t}^*_k}[p^0(\tau)+q]d\tau\right]\right\}$$
$$\times \prod_{k=1}^{3} q^{1[t\geq t^*_k]} \exp\left\{-\sum_{k=1}^{3}(1-O_k)(t-t^*_k)p^+\right\}. \quad (21)$$

Note that if $O_3 = 1, \forall \tau > t^*_3, e \in \{0,1\} : p^e(\tau) = p^- \equiv s^- \bar{F}(w^-_r)$. The first term on the right-hand side in (21) is the survivor rate in unemployment between sample selection $t_s$ and $t$ or the notification $t^*_0$, depending on which of the two comes first. The term following on the next line gives for each $k$ the survivor rates in the scheduled interval $[t^*_{k-1}, t'_k)$ and in the delay interval $[t'_k, t^*_k)$. In the latter interval re-employment and the occurrence of an evaluation are competing risks, which explains the presence of $q$ in the expression. However, if an evaluation takes place, the worker still remains unemployed. Consequently, the probability of surviving in unemployment after $t^*_k$ is the density of being evaluated at $t^*_k$ times the probability of surviving in unemployment beyond $t^*_k$. Since this density at $t^*_k$ is the product of the arrival rate of evaluation $q$ and the corresponding survivor function, this explains the presence of $q$ in the last term on the third line on the right-hand side of (21). The last term also contains the survivor rate in unemployment after a positive evaluation at any interview $k$.

The duration data are grouped into monthly intervals. We account for this grouping by integrating over the corresponding time intervals and by assuming that at most one transition occurs within an interval. With the result in (21), an individual contribution of an unemployment spell lasting $d_u$ months, conditional on the outcomes of the evaluations, writes

$$\ell\left(d_u, d_j, w^o\right) = \int_{d_u-1}^{d_u} p^0(\tau)\mathcal{P}\left(\tau, \{t^*_k\}_{k=0}^3 \,|t_s, \{O_k\}_{k=0}^3\right)[f_o(w^o;\tau)]^{c_w}\,d\tau$$
$$\times \left[\exp\left\{-\delta(d_j - 1)\right\} - c_e \exp\left\{-\delta d_e\right\}\right] \quad (22)$$

where $c_e = 0$ if the employment spell that follows the transition from unemployment is right censored ($c_e = 1$ otherwise), and $c_w = 0$ if the wage upon this transition is unobserved ($c_w = 1$ otherwise). Whenever the unemployment spell is right-censored, neither $d_j$ nor $w^o$ are observed any longer. In this case the contribution to the likelihood (22) reduces to the survivor probability (21) evaluated at $t = d_u$.

Finally, the likelihood function for the realized evaluation outcomes at the first interview is

$$\ell\left(O_1, e\right) = \left[\exp\left\{-\beta^0_1 \bar{S}^0(t^*_1, t^*_0)\right\}^{O_1}\left(1 - \exp\left\{-\beta^0_1 \bar{S}^0(t^*_1, t^*_0)\right\}\right)^{1-O_1}\right]^{1-e}$$
$$\times \left[\exp\left\{-\beta^1_1\right\}^{O_1}\left(1 - \exp\left\{-\beta^1_1\right\}\right)^{1-O_1}\right]^{e} \quad (23)$$

for $e \in \{0,1\}$. Appendix C describes in detail how the model is solved and estimated.

# 5 Data

## 5.1 Sample Selection Criteria

The data originate from several administrative sources: (i) the federal UI agency for monthly information on UB claims and the new monitoring procedure; (ii) various Social Security institutions for information about employment spells (including self-employment) and earnings (for salaried workers). Our model does not explain the choice of working hours. Hence, as in the theoretical part, we restrict attention to jobs registered as full-time occupations. This information is available from January 2001 until the end of 2006.

As of July 2004, the notification in the new monitoring procedure was sent only to individuals who were younger than 30 years old. Our sample ignores individuals who were at that moment younger than 25 years old. The standardized average unemployment rate lies in the range between 4 and 5% among the 25-49 years old during the period 2004-2006 in the region under consideration. Despite these relatively good performances, about 45% of the total stock of unemployed was jobless for more than a year.

In order to determine the population to whom notifications are sent in a particular month (e.g. in July), the administration actually selects individuals who have been unemployed 13 months or more according to the information available at the end of the second month prior to the month of dispatch of the notification (on May 31 in the example). Our sample contains individuals for whom the entitlement duration was *exactly* 13 months at the end of each month between May and August 2004 and to whom therefore a notification was sent between July and October, 2004 if they were still UI claimants at that time. In accordance with the theoretical part of this paper, the notified people are entitled to a flat UB for an indefinite duration (except if they are sanctioned of course).[17] These criteria lead to a sample of 903 individuals. We also selected a sample according to exactly the same criteria one year earlier, in 2003. This pre-program data set made of 883 individuals will be used in the validation exercise in Subsection 6.3.

Note, since sampled individuals may have found a job between the selection date and the receipt of the notification, we can check whether claimants anticipate the notification. Cockx and Dejemeppe (2010) cannot find any evidence of such an anticipation (see their section 6.1.2). This means that we can safely assume that the moment of notification corresponds to $t_0$ in the theoretical model.

## 5.2 Descriptive Statistics

Table 2 reports summary statistics respectively for the sample selected in 2004 and 2003. Time-varying variables are evaluated at the sampling date. Monthly earnings are measured at the start of a salaried employment spell. All monetary variables are measured in 2004 euros. Table 2 reports information with respect to the observed characteristics that we actually use: gender, the level of education, the household type determining the benefit level (head of household, single or cohabitant) and the type of entitlement (school-leaver or work experience). The monthly levels of benefits $b_h$ vary between 325€ and 1005€, with an average in 2004 of 646€ and a coefficient of variation of 37%. Monthly net earnings amount to 1,200€ on average (with a coefficient of variation of 23%). These statistics are not very different for the sample selected in 2003. Table 3 provides the levels of the benefit, if any, in case of a sanction. Recall that there is no sanction after a first negative evaluation. The magnitude of the sanction is the same after the second and third negative evaluation. However, the sanction is temporary after the second while the entitlement to UB is completely lost after the third evaluation. The magnitude of the loss $b_h - b_l$ lies in the range $[0, 385]$ €/month (the lowest and the highest value of the sanction is presented for category in Table 3).[18]

Table 4 displays the number of claimants at the various steps of procedure and the outcomes of each evaluation in the 2004 sample. Since individuals in this sample may have found a job between the selection date and the notification, only 723 of the 903 sampled individuals are notified. Among those notified, 162 attend the first interview. Due to the length of the evaluation procedure, as well as delays in the scheduled timing and frequent exits out of unemployment before the interviews takes

[17] For cohabitants, this is not always the case. For them, we only retain those entitled to a flat benefit.

[18] The absence of sanction for some school leavers is due to the equivalence between unemployment insurance benefits and assistance benefits for this category. This concerns about 7% of the sample.

Table 2: Descriptive Statistics by Sample

| | **2004** | **2003** |
|---|---|---|
| Number of individuals | 903 | 883 |
| **Gender** | | |
| Women | 45.2% | 46.2% |
| **Schooling level**[a] | | |
| Primary or lower secondary | 34.8% | 36.8% |
| Upper-secondary | 40.0% | 42.4% |
| Higher education | 25.2% | 20.8% |
| **Type of entitlement**[a] **(monthly UB level in 2004 €)** | | |
| *Entitled by work experience* | 69.2% | 72.7% |
| Head of household ([865€-1005€]) | 22.1% | 24.8% |
| Single ([725€-835€]) | 32.7% | 33.7% |
| Cohabitant (385€) | 14.4% | 14.2% |
| *Entitled by schooling* | 30.8% | 27.3% |
| Head of household (835€) | 1.8% | 2.3% |
| Single (595€) | 7.2% | 6.8% |
| Cohabitant (325€) | 21.8% | 18.2% |
| **Unemployment benefits**[a] | | |
| Mean (2004 €) | 646 | 666 |
| Standard deviation | (242) | (235) |
| 25% | 385 | 385 |
| Median | 725 | 755 |
| 75% | 835 | 845 |
| **Observed net monthly earnings (1st spell)** | | |
| Number of individuals | 427 | 358 |
| Mean (2004 €) | 1,199 | 1,228 |
| Standard deviation | (279) | (265) |
| 25% | 1,066 | 1,100 |
| Median | 1,214 | 1,250 |
| 75% | 1,358 | 1,381 |

[a] At the sample selection date.

Table 3: Benefit Levels in Case of a Sanction and Size of Sanction (Monthly Level in 2004€)

| | **2nd and 3rd interview** | Min. sanction | Max. sanction |
|---|---|---|---|
| **Type of entitlement**[a] | | | |
| *Entitled by work experience* | | | |
| Head of household ([865€-1005€]) | 802 € | 63€ | 203€ |
| Single ([725€-835€]) | 601 € | 124€ | 234€ |
| Cohabitant (385€) | 0 | 385€ | 385€ |
| *Entitled by schooling* | | | |
| Head of household (835€) | 802 € | 33€ | 33€ |
| Single (595€) | 595 € | 0 | 0 |
| Cohabitant (325€) | 0 | 325€ | 325€ |

[a] At the sample selection date.

place, only very few sampled individuals are evaluated for a second and third time. Subsection 4.2 has explained how we deal with the low observed number of participants in these evaluations.

Table 4: Sampled Population at Each Step of the Monitoring Procedure[a]

| | |
|---|---|
| Number of individuals | 903 |
| **Steps of the monitoring procedure** | |
| *Notification letter* | 723 |
| | (80.1%) |
| *First interview* | 162 |
| | (17.9%) |
| Positive evaluation | 112 |
| | (69.1%) |
| Negative evaluation | 50 |
| | (30.9%) |
| *Second interview* | 18 |
| | (36.0%) |
| Positive evaluation | 16 |
| Negative evaluation | 2 |
| *Third interview* | 1 |
| | (50.0%) |
| Positive evaluation | 1 |
| Negative evaluation | 0 |

[a] % in the population at risk.

# 6 Results

## 6.1 Estimated Parameters

Table 5 presents the structural parameters estimated on the sample of treated selected in 2004.[19] Both unconditional and conditional specifications of the model are estimated, with the conditional one showing great improvement over its predecessor: the likelihood ratio test statistic for 6 degrees of freedom is equal to 61.08.

Table 5: Estimated Parameters

| | | Coeff. | SE | p-Value | Coeff. | SE | p-Value |
|---|---|---|---|---|---|---|---|
| $\zeta_c$ | intercept | 3.985 | 0.075 | 0.000 | 3.697 | 0.118 | 0.000 |
| | gender | | | | 0.350 | 0.115 | 0.002 |
| | low-skilled | | | | 0.335 | 0.139 | 0.016 |
| | medium-skilled | | | | 0.125 | 0.129 | 0.330 |
| $\zeta_\delta$ | intercept | −3.127 | 0.077 | 0.000 | −3.959 | 0.162 | 0.000 |
| | gender | | | | 0.442 | 0.151 | 0.003 |
| | low-skilled | | | | 1.123 | 0.196 | 0.000 |
| | medium-skilled | | | | 0.861 | 0.166 | 0.000 |
| $\rho$ | | 0.010 | 0.007 | 0.172 | 0.026 | 0.012 | 0.038 |
| $\mu$ | | 7.138 | 0.011 | 0.000 | 7.140 | 0.011 | 0.000 |
| $\sigma$ | | 0.112 | 0.012 | 0.000 | 0.124 | 0.009 | 0.000 |
| $\omega$ | | 0.068 | 0.012 | 0.000 | 0.048 | 0.014 | 0.001 |
| $q$ | | 0.197 | 0.017 | 0.000 | 0.197 | 0.018 | 0.000 |
| $\tilde{v}$ | | 5.543 | 0.155 | 0.000 | 5.323 | 0.171 | 0.000 |
| $\beta_1^0$ | | 10.876 | 1.335 | 0.000 | 13.162 | 1.627 | 0.000 |
| $\beta_1^1$ | | 1.705 | 0.320 | 0.000 | 1.705 | 0.320 | 0.000 |

From Table 5, the cost of search is significantly higher for women and low-educated unemployed. Unsurprisingly, the separation rate $\delta$ is notably affected by the education level and to a lesser extent by gender. Point estimates of the monthly discount rate differ importantly between the two specifications. In the unconditional specification, this corresponds to an annual discount rate of 11.6%, compared to 32.3% in the conditional specification. Although well-above usually accepted levels in welfare analysis, these values are not at all outliers in the structural search literature (see Postel-Vinay and Robin, 2002, for France and the overview provided by Hornstein, Krusell and Violante, 2011, in their section 7).[20] The net value of leisure in money equivalent ($\nu$) is estimated to be significantly positive. A number of studies in contrast report negative values (see e.g. Bunzel et al., 2001 and Paserman, 2008). As in Belgium, 80 to 90% of the unemployed are covered by UI, the stigma effect of claiming UBs is

[19] The parameters $\kappa_2$ and $\kappa_3$ that are solved as to make the individual probabilities of negative evaluation at the second and third interviews compatible with the aggregate observed frequencies (see Section 4.2), are equal to 0.7330 and 0.5216 for the unconditional and 0.7626 and 0.5599 for the conditional model, respectively.

[20] Discount rates elicited in the experimental literature are also of the same order of magnitude (see e.g. Harrison, Lau and Williams, 2002).

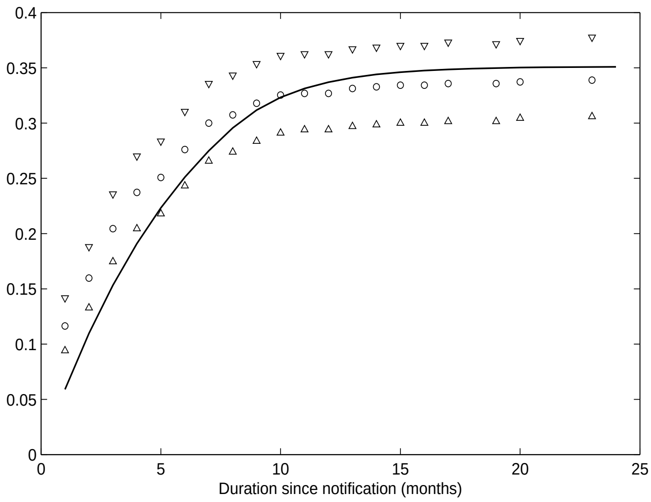
presumably lower than elsewhere. Finally, the standard error of the measurement error of wages is small (about 5%). This is a first evidence of the goodness-of-fit of the model, to which we turn now.

### 6.2 Internal Validation: Goodness-of-fit

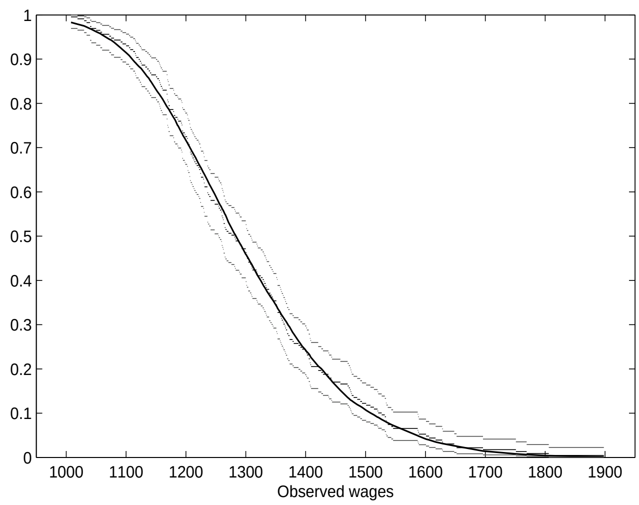
This subsection looks at the within-sample fit of the model. First, we consider the fraction of exits to a job between notification and the first interview. Second, we look at the distribution of monthly entry wages during the same period of time. Third, we focus on the probability of a negative evaluation at the first interview.

Figure 2(a) displays the cumulative probability of transitions to full-time employment between

Figure 2: Goodness-of-Fit




(a) Cumulative probability of transition to full-time employment between notification and first interview: model prediction (solid line), observed frequency (circles) and the 95% CI (triangles)




(b) Survivor function of monthly net earnings between notification and first interview: model prediction (solid line), observed frequency and 95% CI (broken curves) notification and the first interview. The horizontal axis measures actual duration since notification. Using the point estimates of the structural model, the theoretical distribution of exits to employment can be computed for each notified member of the sample. The solid line is the average of these distributions. This curve reaches a horizontal asymptote at about 0.35 because as time goes by more and more unemployed become interviewed for the first time or exit to nonemployment. To plot the circles, we have used the nonparametric estimate of the cumulative probability of transitions to full-time employment in the absence of regressors. Confidence intervals (CI) were computed by nonparametric bootstrap. We have drawn 5000 times from the original sample with replacement. The upper and lower triangles in Figure 2(a) correspond to the 0.025 and the 0.975 percentiles of the aforementioned cumulative probability. The fit is reasonable overall, and with the 95% CI starting from the fourth month since notification.

Figure 2(b) displays the survivor function of monthly net accepted earnings. To compute it, one needs the reservation wage. Based on the point estimates, three theoretical duration distributions can be computed for each individual, with respectively full-time employment, the first interview and the residual state as destinations. Taking 50 random draws from these distributions for each notified individual, an exit to employment obtains when the duration to this destination is the shortest one. Then, the reservation wage is calculated for the duration at which the unemployed exits to a job. With this information, the theoretical distribution of accepted earnings (with measurement errors) is computed. Finally, the average taken over all notified individuals leads to the solid and thick curve in Figure 2(b). The thin broken curve which is close to the latter is the Kaplan-Meier survivor function calculated on the basis of observed accepted earnings. The upper and lower broken curves provide the corresponding 95% CI. The fit of wage distribution turns out to be perfect throughout its entire support.

The correct specification of the probability of negative evaluation (at the first interview) is checked by testing the equality of theoretical frequencies of negative evaluation at the first interview to the observed frequencies. The Pearson chi-square goodness-of-fit test is asymptotically $\sim \chi^2_{(1)}$ and the p-value is 0.31, confirming the absence of significant difference between the data and the model prediction.

### 6.3 External Validation

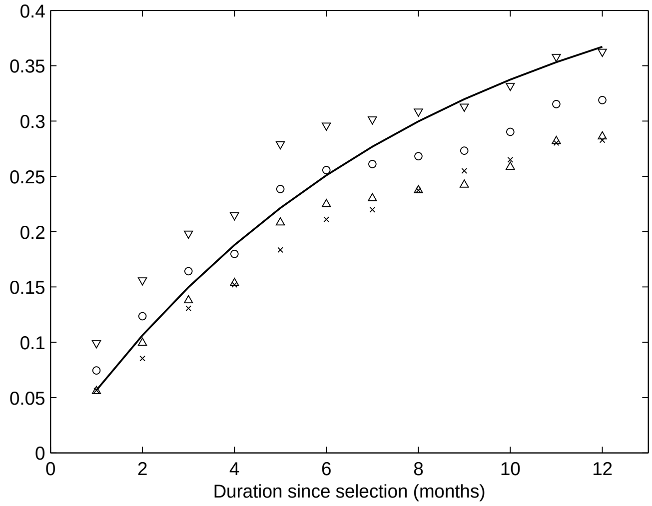
This section deals with out-of-sample validation (see e.g. Todd and Wolpin, 2006). The sample selected in 2003 has not been used for the estimation of the structural model. If they remain unemployed, the members of this sample will eventually receive the notification letter at some point after June 2004. If we pay attention only to the period before the notification however, as we do below, this sample provides pre-program observations.[21] We here address the following question: Is the model estimated in Subsection 6.1 able to predict exits to employment and the wage distribution prior to the introduction of the monitoring scheme? For this purpose, we have to consider the stationary version of the estimated model, that is, the version where the policy is not implemented.

It turns out that economic conditions were notably worse in the pre-program period than during the time the program was in place: GDP real growth attained only 0.8% in 2003 against 2.7% on average between 2004 and 2006. This adversely affected the exit rates to employment in the pre-program period. Consequently, as no other data are available for another pre-program period, we need to adjust the 2003 sample before conducting the external validation. This adjustment relies on the assumption that the business cycle affects the transition rate to employment of the treatment group similarly as a slightly older group that was not affected by the policy until July 2005 (by virtue of being older). Appendix D provides more information about this adjustment.

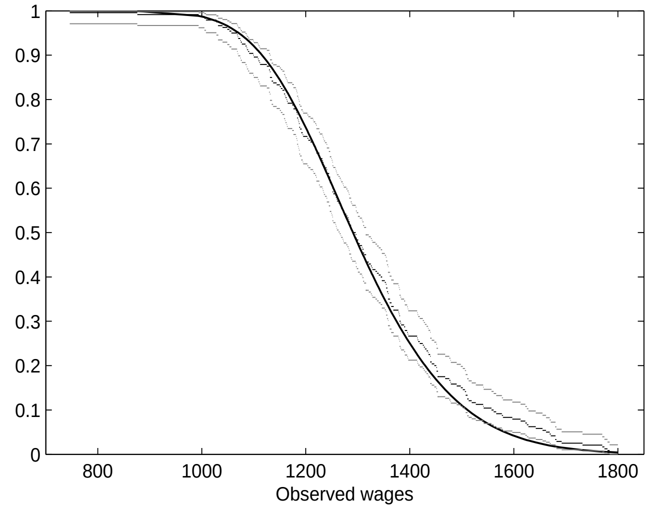
The external validation consists then in checking whether at each month after the sampling date the fractions of exits to employment, predicted under assumption of no monitoring by means of the

[21]These observations constitute a "non-random holdout sample" in the words of Keane and Wolpin (2007).

Figure 3: External Validation




(a) Cumulative probability of transition to full-time employment in 2004 in the absence of monitoring: model predictions (solid line) compared to the unadjusted (crosses) and adjusted (circles; triangles for the 95% CI) frequency in the control sample selected in 2003




(b) Survivor function of monthly net earnings in 2004 in the absence of monitoring: model predictions (solid line) compared to the distribution in the control sample selected in 2003 and its 95% CI (broken curves)

structural parameters reported in Subsection 6.1, closely fit the same fractions of the pre-program sample of the identical age adjusted for discrepancies in business cycle conditions. Figure 3(a) shows the prediction of the exit fractions based on the structural model (solid line), the unadjusted fractions (crosses), the adjusted fractions (circles) and the 95% CI around the latter (triangles).[22]

The validation exercise is also applied to accepted wages. Figure 3(b) displays the results. Here we do not adjust for the differential business cycle conditions, since the downward rigidity of wages is well documented in Belgium (see e.g. Fuss, 2009). Again, solid line is the prediction based on the estimates of the structural model and broken curves are the nonparametric estimates of the distribution

[22] Ignoring the randomness of the adjustment factor denoted $\hat{\Delta}_k^{oj}$ in Appendix D.

of observed wages, along with the corresponding CI.

Figures 3(a-b) firmly establish an excellent out of sample fit of the model in the environment with no policy. This validates that we can use the parameter estimates of the structural model to construct the counterfactual no-treatment outcomes for the treated sample and underscores the reliability of the Average Treatment Effects on the Treated (ATT) reported in Subsection 7.1.

### 6.4 Interpretation of Estimation Results Based on Simulations

Before reporting the average treatment effects, we simulate the estimated model for the treated sample. The aim is to gain insight into the behavioral adjustment of the unemployed as predicted by the model. The model is simulated for each unemployed in the sample under the assumption that each evaluation turns out to be negative. This choice is made here on purpose to keep the composition of the sample unchanged all along the the different stages of the monitoring scheme. Figure 4 displays the sample average of these paths. It comprises four panels. The upper-right panel displays average effective search effort levels. The measurement unit on the vertical axis is the monthly probability of a job-offer. The lower panels display the monthly net reservation wage (in euros) and the acceptance rate. Finally the upper-left panel provides the monthly exit rate towards full-time employment. On the horizontal axis, duration, measured in months, is normalized to zero at notification. Solid lines represent the case of an unemployed without an employment spell in the relevant period ($e = 0$) while the interrupted lines correspond to someone with such an employment spell ($e = 1$). Before notification, the average monthly exit rate equals 0.061 (implying an expected unemployment duration of 16.4 months in a stationary environment) and the acceptance rate is on average somewhat above 85%.[23]

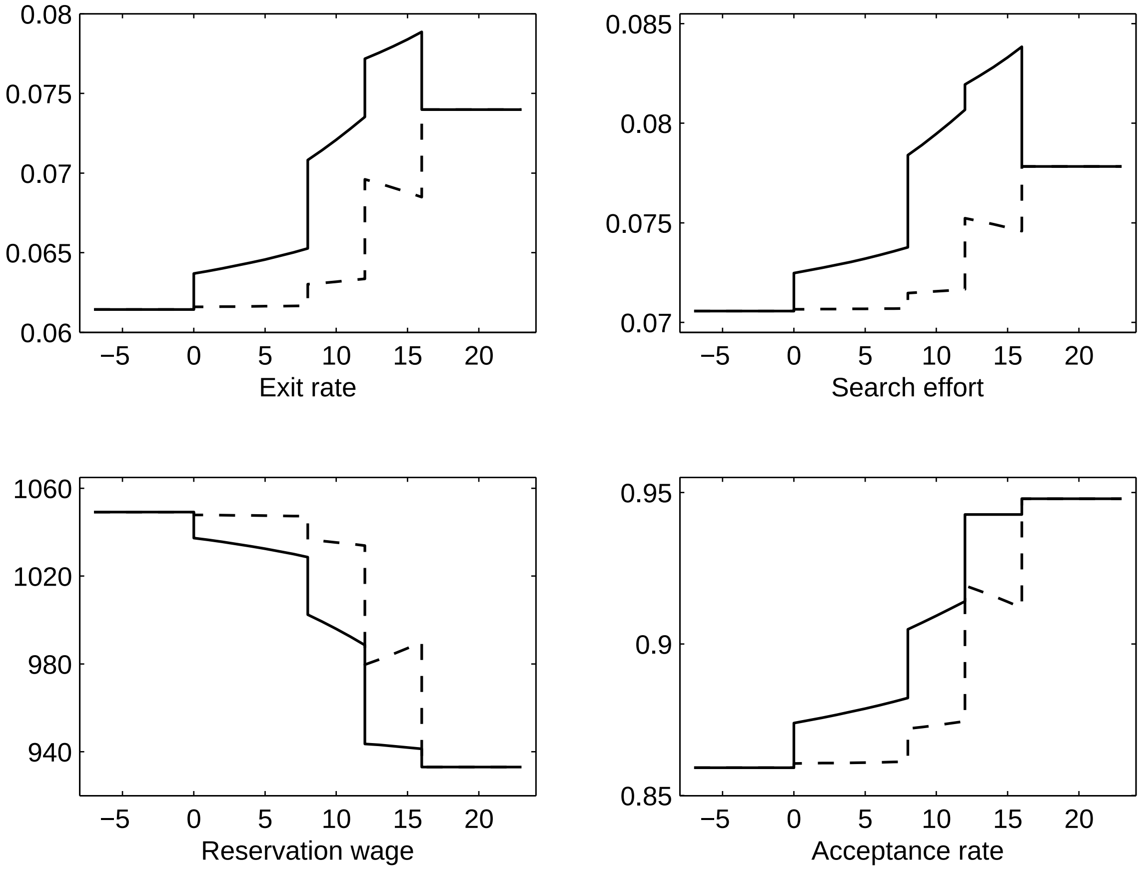
Let us first consider the case $e = 1$. If the unemployed is recruited after notification ($k = 0$) or after a negative evaluation ($k \in \{1, 2\}$) and if she returns to unemployment, the probability of a negative evaluation $\pi^1_{k+1}$ is given by (20) and hence the expected utility before any interview (13) is not affected by accumulated search effort $\bar{S}^1(t_{k+1}, t_k)$. The interrupted line describes the average path for an individual who finds a job after each stage of the scheme and returns to unemployment immediately after. Between notification and the first interview (where $\pi^1_1 = 0.18$), search effort and the reservation wage varies only slightly. The fact that a first negative evaluation only results in signing an action plan without any monetary sanction explains this. After the first negative assessment of search effort, the decision variables adjust somewhat more than previously, since the individual approaches the second evaluation at which she risks a temporary monetary sanction of the size indicated in Table 3. The effect of this sanction is especially apparent in the discontinuous jumps of the decision variables right after the second negative evaluation. Between the second and the third interview, however, search effort declines and the reservation increases. To understand this, remember that the level of benefits is not further reduced if the unemployed is negatively evaluated at the third interview. Conversely, if this evaluation is positive, the unemployed regains her entitlement to the high benefit level. So, the expected utility after the third evaluation is higher than the current expected utility between the second negative evaluation and the third interview. Consequently, as time evolves, the prospect of benefiting from this improvement gets closer and is increasingly valued because of discounting. The permanent loss of UB entitlement when the third evaluation is negative abruptly enhances further search effort and pushes the reservation wage further down. As of that moment, the average acceptance rate equals 95%.[24]

Figure 4 also shows that the average paths are substantially different if no job is found throughout the monitoring process ($e = 0$) and the probability of negative evaluation $\pi^0_k \left[\bar{S}^0\left(t^*_k, t^*_{k-1}\right)\right]$ for $k \in \{1, 2, 3\}$ is effort dependent, as in (19). The level of search effort (resp. reservation wage) is everywhere

[23] Note that these values also apply after a positive evaluation at any of the three interviews.

[24] Comparing the exit rate after the third negative evaluation to the one before notification provides the ex-post effect induced by an unanticipated withdrawal of UB. This would increase the exit rate to full-time employment by 1.3 percentage points on average (namely, $0.074 - 0.061$), which amounts to a relative increase of 21%.

Figure 4: Predicted Optimal Paths at Average Characteristics of the Treated




higher (resp. lower) than that under effort-independent evaluation ($e = 1$). The higher search effort level reflects the additional return to search induced by: (i) the dependence of the sanction probability on the average realized search effort and (ii) the fact that if the job is lost and the worker returns to unemployment, the probability of negative evaluation is lower. The lower reservation wage is caused by the decline in expected lifetime utility that results from the higher sanction probability for any given search effort and the cost of this enhanced search effort. The fact that search effort (resp., the reservation wage) monotonically increases (resp., decreases) with duration is in line with the prediction of Proposition 1, suggesting that the qualitative results for the streamlined monitoring scheme are robust to the introduction of more complex features. The most striking feature is the *front-loading* of search effort discussed in Section 2. This induces search effort to increase above the level attained after a permanent sanction, i.e. if a worker is negatively evaluated for a third time. This observation demonstrates that front-loading is not merely a theoretical possibility.

# 7 Evaluation

## 7.1 Average Treatment Effects on the Treated (ATT)

This section reports the treatment effects conditional on participation to a given stage of the scheme (i.e. respectively conditional on being notified and conditional on being negatively evaluated at a certain interview $k \in \{1, 2, 3\}$). Therefore, contrary to the previous subsection, a dynamic selection process is at work. Two outcomes are considered: the fraction of exits to full-time employment and net earnings. As by the length of the monitoring procedure only very few individuals in the original sample run through all stages of this procedure (cf. Table 4), it is not very informative to compute ATT on the original sample. We therefore increase the sample size by simulating the unemployment trajectory since notification for each and every individual in the original sample multiple times, where random draws are made from the structural model. The measurement of ATT takes administrative delays and the presence of the residual state into account. Once the discussion on the ATT is completed, we construct a measure of the net impact of the monitoring scheme on the expected stream of labor earnings, not conditioned on job finding, and conduct a *basic* cost-benefit analysis based on a number of synthetic inter-temporal indicators.

### 7.1.1 Exit to Full-Time Employment

The ATT at a particular duration since treatment at stage $k$ of the scheme ($k \in \{0, 1, 2, 3\}$) is computed in the following steps. In a first step one selects all individuals treated at stage $k$ in a simulation of the estimated model. In a second step one calculates for each individual the fraction of exits to full-time employment at the considered duration both in the actual case of treatment at stage $k$ and in the counterfactual case of not being notified and monitored.[25] In a last step one takes the difference of these fractions and averages these differences over the treated population.

Figure 5: ATT on the Cumulative Exit Rate to Full-Time Employment at Each Stage of the Scheme

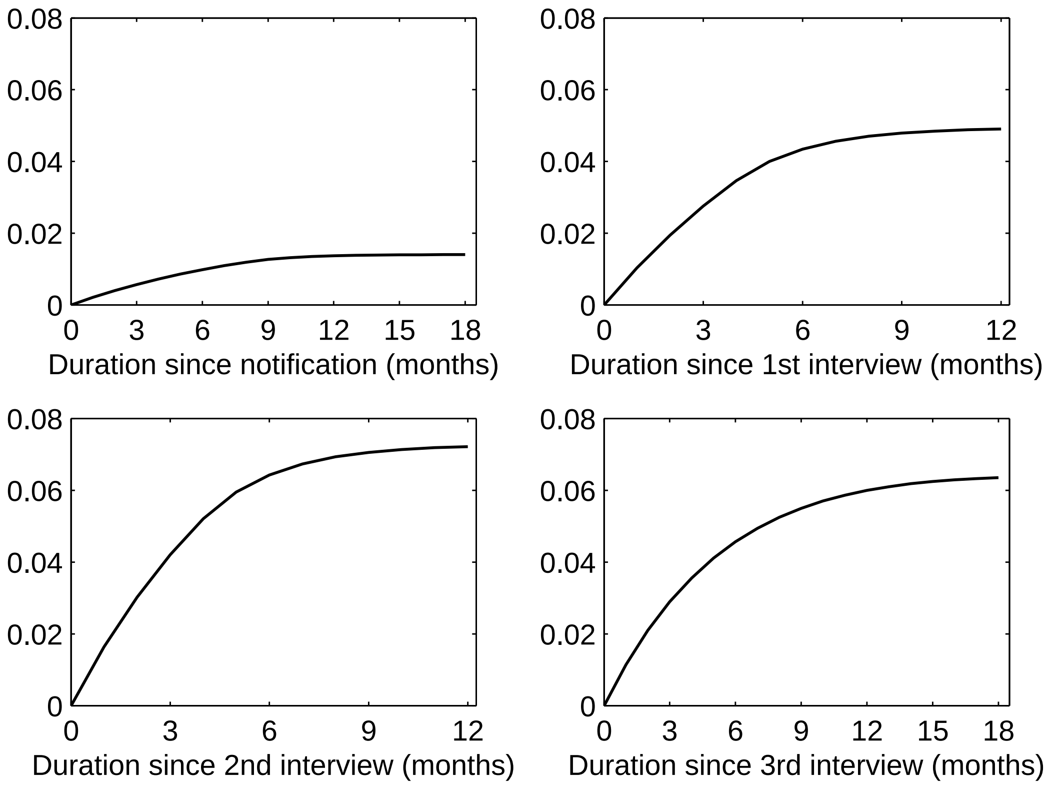



Figure 5 plots the ATT against duration elapsed since the corresponding stage of the scheme.

[25]In this counterfactual case the unemployed is therefore in a stationary environment where the highest benefit accrues for an indefinite duration.

Note that administrative delays have been explicitly taken into account in these calculations. This explains why the ATT are considered beyond the scheduled duration of each stage. Four months after each treatment, the ATT of the notification is small (+0.7 percentage points or + 6.5% in relative terms),[26] the ATT of the first negative evaluation is bigger (+3.5 p.p. or +30%), the ATT of the second negative evaluation is the largest one (+5.2 p.p. or +46%), and the ATT of the last negative evaluation amounts to +3.6 p.p. (+31%). The ATT in the three first panels of Figure 5 tend to an upper-bound as the most affected individuals have already found a job in case they did not yet enter the next stage. The ranking of the stage-specific ATT can be understood on the basis our explanation of the time paths displayed in Figure 4. Given the low chances of being hired, the spells not interrupted by a job experience ($e = 0$) weigh more in the computed averages than the others ($e = 1$). Then, the front-loading of search effort explains that the highest impact is found between the two last interviews.[27]

#### 7.1.2 Net Earnings

As the monitoring scheme lowers reservation wages, one expects a causal negative impact on take-home pay. The estimation of the ATT reveals, however, that this impact is weak.

The ATT are also computed in three steps. Compared to the computation of similar statistics in Section 7.1.1, only the second step is modified. In this step, the actual and counterfactual reservation wages are computed at all the considered durations and, subsequently, using this information the expected net accepted wages are found. Note that these expected wages are always calculated for all individuals treated in a particular stage $k$, irrespective of whether they are proposed a job at the considered duration after treatment. Thereby, we avoid the sample selectivity bias (Heckman, 1979).

Figure 6 shows that the decline in average net earnings reaches a maximum after the second negative evaluation, i.e. after the first sanction: The mean loss amounts to about 30 €, which is approximately 2% of net earnings in the absence of treatment.[28] Observe that shortly before the third interview (at least 4 months after the second interview) the expected net monthly earnings are only slightly lower than after a negative evaluation at the third interview. This is the result of two opposing factors. On the one hand the front-loading of job search intensity negatively affects welfare, and therefore the reservation wage, via the costs implied by such an intensified job search. On the other hand, the worker who has not been evaluated yet has the perspective of regaining entitlement to a high benefit level in case of a positive evaluation at the third interview. The two opposing effects roughly balance out.

### 7.2 Basic Cost-Benefit Analysis

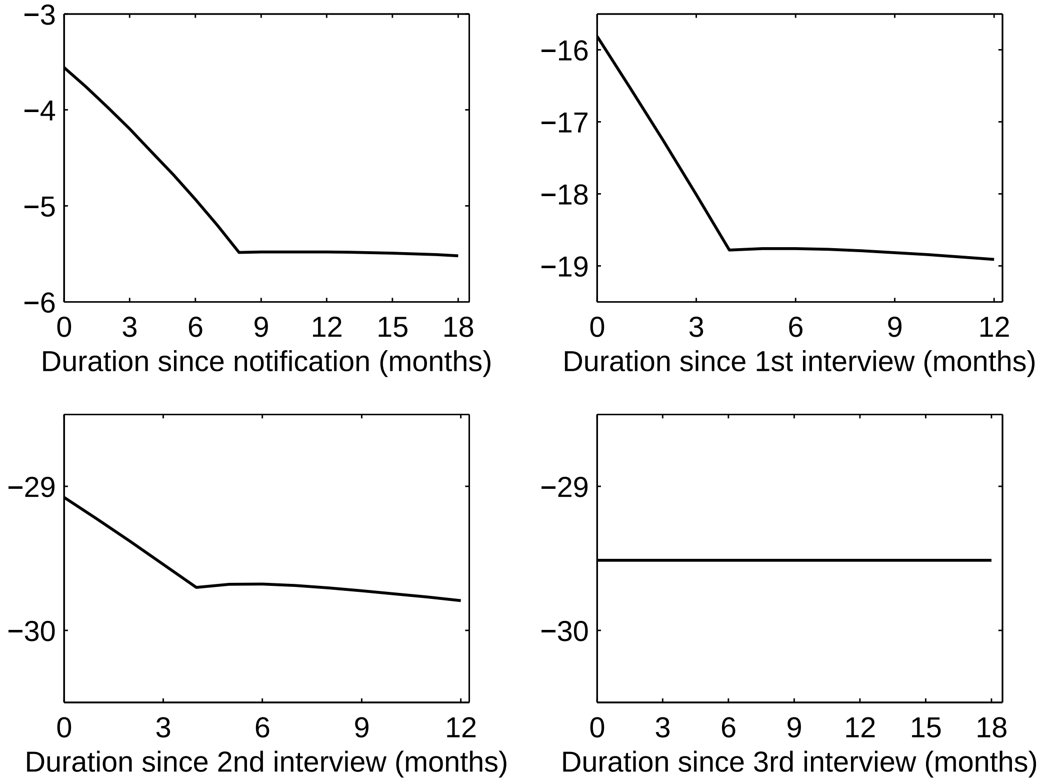
The previous subsections have shown that the monitoring scheme accelerates transitions to employment and causes a decline in expected net earnings if a transition to employment is made. Here we attempt to measure the net effect of these two outcomes. Subsequently, we engage in a modest cost-benefit analysis in which we evaluate the welfare gains of the new monitoring scheme for (i) the unemployed; (ii) the public authorities; and (iii) the society as a whole. In this analysis we ignore welfare impacts of the scheme on income risk, inequality and poverty, and make some simplifying assumptions. The cost-benefit analysis therefore only attempts to get a rough order of magnitude of the welfare effects.

[26] As mentioned in the introduction, Cockx and Dejemeppe (2010) estimate the ATT based on a RDD. If we replicate their analysis on the same sample using the same outcome as here (exit to full-time salaried employment), then the corresponding ATT are of the same order of magnitude: 1.4 and 3.4 percentage points, resp. four and eight months after notification. Both point estimates are not significantly different from zero.

[27] ATT for specific groups are available upon request.

[28] ATT for specific groups are available upon request.

Figure 6: ATT on the Mean Accepted Net Earnings at Each Stage of the Scheme




All indicators reported in this section are calculated according to the same principle. They are based on the expected discounted lifetime values computed in case of treatment and in the counterfactual of no treatment, where expectations are taken at the moment of notification. The impact of the monitoring scheme is measured by taking for each notified individual the difference in the values of a given indicator with and without treatment and averaging these differences over all individuals. By multiplying these results with the discount rate we express them in euro per month and per notified individual. We also report all the effects in terms of percentage changes. Formal definitions of all our welfare indicators can be found in Internet Appendix, Section C.

By comparing the stream of labor earnings with and without treatment we can evaluate how the earnings gain generated by the scheme through boosting exits to employment compares with the earnings loss induced by accepting jobs that pay lower wages. This initial comparison ignores the stream of benefits, net utility of leisure time and cost of search. It leads to the conclusion that the monitoring scheme has increased the net expected stream of earnings by 10€ per month, which amounts to a relative rise of 1.9%. Hence, the positive effect through the increased exit rate dominates, the net relative impact of the scheme on expected earnings being small.

From the previous analysis, we know that the monitoring scheme induces a loss in expected welfare for the unemployed. The question is how large this loss is. In order to compute this loss we do no more only take the flow value of net earnings into account, but also consider the flow of unemployment benefits (including the reduced amount in case of a sanction), the value of leisure, and the cost of search. We find that the monitoring scheme imposes only a small expected cost on the unemployed of 5€ per month and per individual (a loss of 0.5% in relative terms).

To calculate the net impact of the the monitoring scheme on the expenditures of the public authorities, we now include in the intertemporal indicator the flow of benefit payments and the costs of the interviews at the moment that they take place[29] as expenditures, and the social contributions and income taxes paid on labor earnings as revenues. Based on this calculation we conclude that the monitoring scheme decreases the expenditures of the public authorities by 17€ per month and per notified unemployed. This amounts to a relative gain of 19%, which is quite important.

The benefits for the public authorities do not correspond to the benefits for society as a whole, however. The reason is that part of the reduced expenditures of the public authorities consists in transfers from the unemployed to tax payers and is therefore not a net gain to society (ignoring distributional impacts). On the other hand, by inducing more individuals to work, more output is produced which benefits to society. To proxy net output, we subtract the individual costs of job search and the costs of the monitoring scheme from the wage costs (a lower-bound for the value of output) and the net value of leisure time. Besides, we assume that the employment generated by the monitoring scheme does not induce substitution or displacement effects. Using these assumptions, the expected discounted value of net output amounts to 16€ per month and per individual. There are, however, additional benefits to society. The aforementioned reduced public expenditures of 17€ lower the cost of public funding. Taking a value of 2 for the marginal cost of public funds (Kleven and Kreiner, 2006), we then obtain on average a net efficiency gain for society of 50€ ($= 16 + 2 * 17$) per month and per notified unemployed, or of 3.5% in relative terms.

# 8 Conclusion

Incentive schemes in which job search effort is monitored typically inform unemployed workers well in advance about the future instant at which, or from which (as in the scheme studied here), evaluations take place. At the same time, job search requirements are often not sharply defined or the measurement of search effort is imperfect, and evaluating caseworkers have some discretion in determining the outcome of the evaluation. Consequently, the outcome of the evaluation process and, hence, whether a sanction is imposed, is not deterministic: There does not exist a search effort threshold that separates sharply a positive evaluation from a negative one. In the past researchers have either assumed that job search requirements are exactly determined in terms of job search effort or, if not, that the timing of the evaluations is completely random. A consequence of either assumption is that search behavior of the unemployed worker is stationary. In the present paper we have relaxed these assumptions by simultaneously taking into account that the timing of the evaluations is not completely random, while the outcome of the evaluation may depend on past search effort but never in a completely deterministic way. In this institutional context, we have shown that the knowledge that at (or starting from) a particular future instant a sanction is potentially pending induces an unemployed worker to increase her job search intensity and reduce her reservation wage as she approaches this instant (see Proposition 1). Job search behavior is thus genuinely non-stationary. In addition, if the unemployed worker can influence the sanction probability by increasing search effort, we have shown that she has an incentive to *front-load* search effort such that, prior to the moment the evaluation takes place, search effort may even be higher than when the sanction is actually imposed (see Proposition 2 and the simulated behavior that results from our estimations reported in Figure 4). This front-loading of job search effort reveals a new trade-off in the choice between a time limit on the entitlement to UB and a monitoring scheme as competing instruments to fight moral hazard in UI: compared to a time limit, monitoring may enhance job search effort *ex ante*, but reduces it *ex post*. A detailed analysis of this trade-off is an avenue for future research.

In the light of these findings, we have developed and estimated a non-stationary job search model to evaluate the recently introduced scheme that monitors job search effort of long-term unemployed workers within the UI system in Belgium. The sample of treated individuals comprised young people

[29] Based on accounting information provided by the National Unemployment Office, we calculated that an interview costs on average 100€.

(aged between 25 and 30) living in a region where the average unemployment rate was rather low (less than 5%). After validating our model both internally and externally, we found that the subsequent stages of the monitoring scheme have boosted the job finding rate increasingly. Re-employment wages were only affected marginally and never more than 2% lower than what they would have been in the absence of the reform. On the basis of a simple cost-benefit analysis we conclude that as a consequence of the reform (i) the unemployed workers loose slightly: on average 5€ per month or 0.5% proportionally; (ii) public expenditures fall by 17€ per month and per individual, or 19% proportionally; (iii) the society as a whole gains 50€ per month and per individual, or 3.5% proportionally. These calculations ignore, however, welfare impacts of the scheme on income risk, inequality and poverty. Moreover, the results of this paper have assumed that the unemployed discount the future in a standard way and have correct perceptions about the return to their search effort. Introducing hyperbolic discounting (Paserman, 2008) or biased beliefs (Spinnewyn, 2010) would be another interesting research avenue.

## Acknowledgements

This research has been financed by Belgian Science Policy through its programs Société et Avenir (contract AP/04) and Interuniversity Poles of Attraction. We thank the Belgian Unemployment Agency (ONEM) and the Banque Carrefour de Sécurité Sociale for their cooperation. We also thank for their comments participants at workshops in Aarhus, Bonn (IZA), Mainz and Ghent, at conferences (the ESEM, the EALE conference and the Annual Meeting of the SED), at seminars at the University of Essex, the Ifo Institute, the University of Cyprus, the Paris School of Economics, the University of Tübingen, the Università Cattolica del Sacro Cuore, the University of Mannheim, the Université de Strasbourg, the Katholieke Universiteit Leuven, the Université Paris II and CREST. We thank in particular Marc Gurgand, François Langot and Klaus Wälde for useful comments and discussions.

## Appendix

In this Appendix all time derivatives of functions evaluated at $t_0$ and $t_1$, implicitly denote the left-hand side, respectively right-hand side derivatives of these functions at these points.

### A The Streamlined Monitoring Scheme

#### A.1 Derivation of $U(t_0)$

Consider time intervals of length $d\tau$. The lifetime utility of an unemployed worker at time $\tau$ can be written by the following recursive relation:

$$U(\tau) = \frac{\left\{y_h(\tau)d\tau + [1 - s(\tau)d\tau]\, U(\tau + d\tau) + s(\tau)d\tau \left[F[w_r(\tau)]U(\tau + d\tau) + \bar{F}[w_r(\tau)]\bar{W}(\tau + d\tau)\right]\right\}}{1 + \rho d\tau} \tag{A-1}$$

where $s(\tau)d\tau$ is the probability that a job offer arrives between $\tau$ and $\tau + d\tau$. Rearrangement yields

$$\rho d\tau U(\tau) = y_h(\tau)d\tau + s(\tau)d\tau\bar{F}[w_r(\tau)] \left[\bar{W}(t + d\tau) - U(t + d\tau)\right] + [U(\tau + d\tau) - U(\tau)]\,. \tag{A-2}$$

Dividing by $d\tau$, taking the limit for $d\tau \to 0$ and using that $s(\tau)\bar{F}[w_r(\tau)] \equiv p(\tau)$ leads to the following differential equation:

$$\dot{U}(\tau) - [p(\tau) + \rho]\, U(\tau) = -\left[y_h(\tau) + p(\tau)\bar{W}(\tau)\right] \tag{A-3}$$

Multiplying by $P(\tau, t_0)e^{-\rho(\tau-t_0)}$ gives

$$\frac{1}{d\tau}\left(U(\tau)P(\tau,t_0)e^{-\rho(\tau-t_0)}\right) = -\left[y_h(\tau) + p(\tau)\bar{W}(\tau)\right] P(\tau,t_0)e^{-\rho(\tau-t_0)} \tag{A-4}$$

Finally, integrating from $t_0$ to $t_1$ results in

$$U(t_1)P(t_1,t_0)e^{-\rho(t_1-t_0)} - U(t_0) = -\int_{t_0}^{t_1} \left[y_h(\tau) + p(\tau)\bar{W}(\tau)\right] P(\tau,t_0)e^{-\rho(\tau-t_0)}d\tau, \tag{A-5}$$

which after rearrangement yields equation (6), with $U(t_1) = \mathbb{U}(t_1)$ given by (7).

### A.2 The Generalized Current Value Hamiltonian

In this section we show how the optimization problem can be restated in terms of the generalized current value Hamiltonian. We first restate the optimization problem:

$$\max_{s(\tau),w_r(\tau)} U(t_0) = \int_{t_0}^{t_1} \left[y_h(\tau) + p(\tau)\bar{W}(\tau)\right] P(\tau,t_0)e^{-\rho(\tau-t_0)}d\tau + \mathbb{U}(t_1)P(t_1,t_0)e^{-\rho(t_1-t_0)}$$

$$\begin{aligned} s.t. \quad &: \quad \dot{P}(\tau,t_0) = -p(\tau)P(\tau,t_0) \\ &: \quad \dot{\bar{S}}(\tau,t_0) = \frac{[s(\tau) - \bar{S}(\tau,t_0)]}{(\tau - t_0)} \end{aligned}$$

The Hamiltonian of this problem is

$$H(\tau) = \left[y_h(\tau) + p(\tau)\bar{W}(\tau)\right] P(\tau,t_0)e^{-\rho(\tau-t_0)} - \lambda_P(\tau)p(\tau)P(\tau,t_0) + \lambda_S(\tau)\frac{s(\tau) - \bar{S}(\tau,t_0)}{(\tau - t_0)}. \tag{A-6}$$

where $y_h(\tau) \equiv b_h + \nu - c[s(\tau)]$ and $\lambda_P(\tau)$ and $\lambda_S(\tau)$ are the multiplier functions associated to the state variables $P(\tau,t_0)$ and $\bar{S}(\tau,t_0)$. Consider the FOC for $P(\tau,t_0)$:

$$\dot{\lambda}_P(\tau) = -\partial H(\tau)/\partial P(\tau,t_0) = \lambda_P(\tau)p(\tau) - \left[y_h(\tau) + p(\tau)\bar{W}(\tau)\right] e^{-\rho(\tau-t_0)}$$

Subtracting $\lambda_P(\tau)p(\tau)$ from both sides and multiplying by $P(\tau,t_0)$ yields

$$\frac{\partial}{\partial\tau}\left(\lambda_P(\tau)P(\tau,t_0)\right) = -\left[y_h(\tau) + p(\tau)\bar{W}(\tau)\right] P(\tau,t_0)e^{-\rho(\tau-t_0)}.$$

Integrating this equation from $\tau$ to $t_1$ gives

$$\lambda_P(t_1)P(t_1,t_0) - \lambda_P(\tau)P(\tau,t_0) = -\int_{\tau}^{t_1} \left[y_h(x) + p(x)\bar{W}(x)\right] P(x,t_0)e^{-\rho(x-t_0)}dx. \tag{A-7}$$

The transversality condition for $P(t_1,t_0)$ is

$$\lambda_P(t_1) = \frac{\partial\left(\mathbb{U}(t_1)P(t_1,t_0)e^{-\rho(t_1-t_0)}\right)}{\partial P(t_1,t_0)} = \mathbb{U}(t_1)e^{-\rho(t_1-t_0)}$$

Inserting this in (A-7), rearranging and using the fact that $P(x,t_0)e^{-\rho(x-t_0)} = P(x,\tau)e^{-\rho(x-\tau)}P(\tau,t_0)$ $e^{-\rho(\tau-t_0)}$ delivers

$$\lambda_P(\tau)e^{\rho(\tau-t_0)} = \int_{\tau}^{t_1} \left[y_h(x) + p(x)\bar{W}(x)\right] P(x,\tau)e^{-\rho(x-\tau)}dx + \mathbb{U}(t_1)P(t_1,\tau)e^{-\rho(t_1-\tau)} \equiv U(\tau). \tag{A-8}$$

By multiplying both sides by $e^{-\rho(\tau-t_0)}$ and inserting this in (A-6) one obtains

$$H(\tau)=\left[y_h(\tau)+p(\tau)\left[\bar{W}(\tau)-U(\tau)\right]\right]P(\tau,t_0)e^{-\rho(\tau-t_0)}+\lambda_S(\tau)\frac{s(\tau)-\bar{S}(\tau,t_0)}{(\tau-t_0)}.$$

Denoting the generalized current value of a variable $x(\tau)$ by $\tilde{x}(\tau)\equiv x(\tau)e^{\rho(\tau-t_0)}/P(\tau,t_0)$, we can define the generalized current value Hamiltonian as:

$$\tilde{H}(\tau)=y_h(\tau)+p(\tau)\left[\bar{W}(\tau)-U(\tau)\right]+\tilde{\lambda}_S(\tau)\frac{s(\tau)-\bar{S}(\tau,t_0)}{(\tau-t_0)} \tag{A-9}$$

Using the definition of $y_h(\tau)$, (4), the fact that $\bar{W}(\tau)\equiv E[W(w)|w>w_r(\tau)]$ and (3) allows to simplify this expression as follows:

$$\tilde{H}(\tau)=b_h+\nu-c[s(\tau)]+\frac{s(\tau)}{\rho+\delta}\int_{w_r(\tau)}^{\infty}\left\{w-\rho U(\tau)+\delta\left[U(0)-U(\tau)\right]\right\}dF(w)+\tilde{\lambda}_S(\tau)\frac{s(\tau)-\bar{S}(\tau,t_0)}{(\tau-t_0)}. \tag{A-10}$$

One can easily see that the FOC for the control variables are not affected if one uses $\tilde{H}(\tau)$ rather than $H(\tau)$. The FOC of the state variables need, however, a slight modification. To see this, consider any state variable $X(\tau)$. The FOC for this state variable in $\tilde{H}(\tau)$ is

$$\frac{\partial\tilde{H}}{\partial X(\tau)}=\frac{\partial H}{\partial X(\tau)}e^{\rho(\tau-t_0)}/P(\tau,t_0)=-\dot{\lambda}_X(\tau)e^{\rho(\tau-t_0)}/P(\tau,t_0)=\left[p(\tau)+\rho\right]\tilde{\lambda}_X(\tau)-\dot{\tilde{\lambda}}_X(\tau) \tag{A-11}$$

where the second equality follows from the FOC for $X(\tau)$ in $H(\tau)$ and the third equality from the relationship between $\dot{\tilde{\lambda}}_X(\tau)$ and $\dot{\lambda}_X(\tau)$. The transversality condition is modified as follows:

$$\tilde{\lambda}_X(t_1)\equiv\lambda_X(t_1)\frac{e^{\rho(t_1-t_0)}}{P(t_1,t_0)}=\frac{\partial\mathbb{U}(t_1)}{\partial X(t_1)} \tag{A-12}$$

where the second equality follows from the transversality condition for $\lambda_X(t_1)$ in $H(t_1)$.

### A.3 The Derivation of the FOC for $w_r(\tau)$ and $s(\tau)$

We can now define the remaining FOC of our problem on the basis of the generalized current value Hamiltonian defined in (A-10) using the adjustments stated in (A-11) and (A-12). The FOC for $w_r(\tau)$ is obtained by setting $\partial\tilde{H}(\tau)/\partial w_r(\tau)=0$:

$$w_r(\tau)=\rho U(\tau)-\delta\left[U(0)-U(\tau)\right]. \tag{A-13}$$

Now consider (A-3) and use the same arguments as in the step between (A-9) and (A-10). If one inserts (A-13) into this expression one obtains:

$$\rho U(\tau)=b_h+\nu-c[s(\tau)]+\frac{s(\tau)\int_{w_r(\tau)}^{\infty}[w-w_r(\tau)]d\bar{F}(w)}{\rho+\delta}+\dot{U}(\tau) \tag{A-14}$$

Differentiating (A-13) wrt to $\tau$ gives the law of motion of the reservation wage:

$$\dot{w}_r(\tau)=[\rho+\delta]\dot{U}(\tau) \tag{A-15}$$

Inserting (A-14) and (A-15) into (A-13) gives us the FOC for the reservation wage (10) in the main text.

Next the FOC for $s(\tau)$ is obtained by setting $\partial\tilde{H}(\tau)/\partial s(\tau) = 0$:

$$c'[s(\tau)] = \frac{\int_{w_r(\tau)}^{\infty}\{w - \rho U(\tau) + \delta\,[U(0) - U(\tau)]\}\,dF\,(w)}{\rho + \delta} + \frac{\tilde{\lambda}_S(\tau)}{(\tau - t_0)}. \tag{A-16}$$

Next, using (A-11) for $X = \bar{S}(\tau, t_0)$, one obtains

$$\frac{\partial H(\tau)}{\partial \bar{S}(\tau, t_0)} = -\frac{\tilde{\lambda}_S(\tau)}{(\tau - t_0)} = [p(\tau) + \rho]\tilde{\lambda}_S(\tau) - \dot{\tilde{\lambda}}_S(\tau) \tag{A-17}$$

Dividing by $\tilde{\lambda}_S(\tau)$, rearranging, noting that $\partial \ln \tilde{\lambda}_S(\tau)/\partial\tau = \dot{\tilde{\lambda}}_S(\tau)/\tilde{\lambda}_S(\tau)$ and that $(\tau - t_0)^{-1} = \partial \ln(\tau - t_0)/\partial\tau$ yields:

$$\frac{\partial}{\partial\tau}(\ln \tilde{\lambda}_S(\tau)) = \frac{\partial}{\partial\tau}\ln(\tau - t_0) + [p(\tau) + \rho]$$

Integrating from $\tau$ to $t_1$ and taking the exponential function of both sides simplifies this to

$$\frac{\tilde{\lambda}_S(t_1)}{\tilde{\lambda}_S(\tau)} = \frac{t_1 - t_0}{\tau - t_0} e^{\int_{\tau}^{t_1}[p(x)+\rho]dx} \tag{A-18}$$

Applying the transversality condition (A-12) for $X = \bar{S}(\tau, t_0)$ and using (7) yields

$$\tilde{\lambda}_S(t_1) = \frac{\partial \mathbb{U}(t_1)}{\partial \bar{S}(t_1, t_0)} = \pi'[\bar{S}(t_1, t_0)][U^- - U^+] \tag{A-19}$$

Inserting (A-19) into (A-18) and rearranging leads to

$$\tilde{\lambda}_S(\tau) = \frac{\tau - t_0}{t_1 - t_0}\pi'[\bar{S}(t_1, t_0)][U^- - U^+]P(t_1, \tau)e^{-\rho(t_1 - \tau)} \geq 0. \tag{A-20}$$

Inserting (A-13) and (A-20) into (A-16) yields the FOC for job search effort (11) stated in the main text.

### A.4 Proof of Proposition 1

The proof makes use of two lemmas: Lemmas 4 and 5. Lemma 4 is also required for the proof of Proposition 3.

**Lemma 4** $\forall\tau \in [t_0, t_1], \dot{U}(\tau) \leq 0 \wedge U(\tau) \leq U^+$.

**Proof.**

1. Introduce the following notation:

$$V[U(\tau)] \equiv \frac{\int_{[\rho U(\tau)+\delta(U(0)-U(\tau))]}^{\infty}\{w - [\rho U(\tau) + \delta(U(0) - U(\tau))]\}\,dF(w)}{\rho + \delta} = \frac{\int_{w_r(\tau)}^{\infty}[w - w_r(\tau)]dF(w)}{\rho + \delta} \tag{A-21}$$

   where the second equality follows from (A-13). The following property will be repeatedly used in the proofs in this Appendix:

$$V'[U(\tau)] = -\bar{F}[w_r(\tau)] < 0 \tag{A-22}$$

2. Four impossibilities for any $\tau \in [t_0, t_1]$ will turn out to be helpful. The proofs are always by contradiction and are repeatedly based on Equation (A-14) in which (A-21) is inserted.

   (ia) $U(\tau) > U^+ \wedge \dot{U}(\tau) \leq 0$ is impossible. If it was true, the following inequalities would hold:

$$\begin{aligned}\rho U^+ &= b_h + \nu - c(s^+) + s^+ V[U^+] \\ &\geq b_h + \nu - c(s(\tau)) + s(\tau)V[U^+] \text{ since } s^+ \text{ is optimally chosen} \\ &> b_h + \nu - c(s(\tau)) + s(\tau)V[U(\tau)] + \dot{U}(\tau) = \rho U(\tau) \text{ since } V' < 0.\end{aligned}$$

   (ib) $U(\tau) \geq U^+ \wedge \dot{U}(\tau) < 0$ is impossible. The proof of impossibility (ia) still holds because of the sign of $\dot{U}(\tau)$.

   (ii) $U(\tau) \leq U^+ \wedge \dot{U}(\tau) > 0$ is impossible. If it was true, the following inequalities would hold:

$$\begin{aligned}\rho U(\tau) &= b_h + \nu - c(s(\tau)) + s(\tau)V[U(\tau)] + \dot{U}(\tau) \\ &> b_h + \nu - c(s^+) + s^+ V[U(\tau)] \\ &\geq b_h + \nu - c(s^+) + s^+ V[U^+] = \rho U^+\end{aligned}$$

   (iii) $U(\tau) < U^+ \wedge \dot{U}(\tau) \geq 0$ is impossible. If it was true, the following inequalities would hold:

$$\begin{aligned}\rho U(\tau) &= b_h + \nu - c(s(\tau)) + s(\tau)V[U(\tau)] + \dot{U}(\tau) \\ &\geq b_h + \nu - c(s^+) + s^+ V[U(\tau)] \\ &> b_h + \nu - c(s^+) + s^+ V[U^+] = \rho U^+ \text{ since } V' < 0.\end{aligned}$$

3. Next, we show that $U(t_1) \leq U^+$. From Impossibility (ii), we can exclude that $\dot{U}(t_1) > 0$. For if $\dot{U}(t_1) > 0$, according to (ii), we should have $U(t_1) > U^+$ or, using (7),

$$\pi[\bar{S}(t_1, t_0)](U^- - U^+) > 0$$

   which requires a (strictly) negative sanction probability.

   Impossibility (iii) allows to exclude that $\dot{U}(t_1) = 0$ unless $\pi[\bar{S}(t_1, t_0)] = 0$. For if $\dot{U}(t_1) = 0$, according to (iii), we should have $U(t_1) \geq U^+$ or

$$\pi[\bar{S}(t_1, t_0)](U^- - U^+) \geq 0$$

   which requires $\pi[\bar{S}(t_1, t_0)] = 0$ i.e. $U(t_1) = U^+$.
   In sum, one can only have

   - either $\dot{U}(t_1) = 0$ and $U(t_1) = U^+$
   - or $\dot{U}(t_1) < 0$ and $U(t_1) < U^+$ by the Impossibility (ib).

4. Suppose $\exists \tilde{\tau} \in [t_0, t_1) : \dot{U}(\tilde{\tau}) > 0$, then by Impossibility (ii), $U(\tilde{\tau}) > U^+$. This and the fact that $U(t_1) \leq U^+$ implies that $\exists\, t^* \in (\tilde{\tau}, t_1) : \dot{U}(t^*) < 0 \wedge U(t^*) > U^+$, which cannot be true by Impossibility (ib). Therefore, $\forall \tau \in [t_0, t_1], \dot{U}(\tau) \leq 0$. Moreover, by Impossibility (ia), one has $U(\tau) \leq U^+$ , $\forall \tau \in [t_0, t_1]$.

■

**Lemma 5** $\forall \tau \in [t_0, t_1], \dot{s}(\tau) \geq 0$

**Proof.** Differentiating (A-16) wrt $\tau$ and using (A-13), (A-15), (A-21), (A-17) and (A-22) results in

$$\dot{s}(\tau) = \frac{1}{c''[s(\tau)]} \left\{ [s(\tau)\bar{F}[w_r(\tau)] + \rho] \frac{\tilde{\lambda}_S(\tau)}{\tau - t_0} - \bar{F}[w_r(\tau)]\dot{U}(\tau) \right\} \tag{A-23}$$

Lemma 4 and the non negative sign of $\tilde{\lambda}_S(\tau)$ (see (A-20)) imply that $\dot{s}(\tau) \geq 0$. ■

**Proof Proposition 1.** Insert (A-21) in (A-14). Evaluate (A-14) for $U(\tau) = U^+$ and subtract it from (A-21). Noting that $\dot{U}^+ = 0$, this yields:

$$\dot{U}(\tau) = \rho\left[U(\tau) - U^+\right] + c[s(\tau)] - c[s^+] - s(\tau)V[U(\tau)] + s^+V[U^+]$$

Using (A-16) and (A-21) this can be rewritten as follows:

$$\dot{U}(\tau) = \rho\left[U(\tau) - U^+\right] - \left[c(s^+) - c[s(\tau)] - c'[s(\tau)][s^+ - s(\tau)]\right] - s^+\left[V[U(\tau)] - V[U^+]\right] + \frac{\tilde{\lambda}_S(\tau)}{\tau - t_0}[s(\tau) - s^+]$$

Expanding $c[s(^+)]$ in a second order Taylor expansion around $c[s(\tau)]$ then yields

$$\dot{U}(\tau) = -\rho\left[U^+ - U(\tau)\right] - \frac{c''(s^*(\tau))}{2}[s^+ - s(\tau)]^2 - s^+\left[V[U(\tau)] - V[U^+]\right] + \frac{\tilde{\lambda}_S(\tau)}{\tau - t_0}[s(\tau) - s^+] \quad \text{(A-24)}$$

where $s^*(\tau) \in (s^+, s(\tau))$.

1. Proof of Claim 1:
   (a) $\exists \tau^* < t_1$ such that $\forall \tau \in (\tau^*, t_1] : \dot{U}(\tau) < 0$
   If $\dot{U}(t_1) < 0$, claim (a) follows immediately. From Lemma 4, we know that $\dot{U}(t_1) \leq 0$. Therefore, if $\dot{U}(t_1) \neq 0$, claim (a) must hold. Suppose instead that $\dot{U}(t_1) = 0$. We prove by contradiction. By Lemma 4, we know that $U(t_1) = U^+$ and $\pi\left[\bar{S}(t_1, t_0)\right] = 0$. This can only be true if $\bar{S}(t_1, t_0) \geq \overline{\Psi} > s^+$. If $s(t_1) \leq s^+$, by Lemma 5, $s(\tau) \leq s(t_1) \leq s^+$, $\forall \tau \leq t_1$, but this contradicts that $\bar{S}(t_1, t_0) > s^+$. Consequently, $s(t_1) > s^+$. Two cases can now be distinguished:
      i. Either $\tilde{\lambda}_S(t_1) = 0$. Equality (A-24) implies that $\dot{U}(t_1) < 0$, which contradicts that $\dot{U}(t_1) = 0$.
      ii. Or $\tilde{\lambda}_S(t_1) > 0$. Then $\dot{s}(t_1) > 0$ by (A-23). Using the definition in (A-21), differentiating (A-14) wrt $\tau$ and using (A-22) gives

      $$\rho\dot{U}(\tau) = \dot{s}(\tau)[V[U(\tau)] - c'[s(\tau)]] - s(\tau)\bar{F}[w_r(\tau)]\dot{U}(\tau) + \ddot{U}(\tau)$$

      where the double dot denotes the second derivative wrt $\tau$. Inserting (A-16) leads to:

      $$\ddot{U}(\tau) = [\rho + p(\tau)]\dot{U}(\tau) + \frac{\tilde{\lambda}_S(\tau)}{\tau - t_0}\dot{s}(\tau) \quad \text{(A-25)}$$

      Therefore, as $\dot{s}(t_1) > 0$ and since by assumption $\dot{U}(t_1) = 0$, we must have that $\ddot{U}(t_1) > 0$. Consequently, $\exists\, \epsilon > 0$ such that $\forall \tau \in (t_1 - \epsilon, t_1) : \dot{U}(\tau) < 0$ and hence $\exists\, \tau^* < t_1 : U(\tau^*) > U(t_1) = U^+$ which violates Part (ib) of Lemma 4.
   (b) $\forall \tau \in [t_0, t_1] : \dot{U}(\tau) < 0$.
   We prove again by contradiction. Suppose that $\dot{U}(\tau^*) = 0$. Then, $\ddot{U}(\tau^*) \geq 0$ by (A-25) since $\forall \tau : \dot{s}(\tau) \geq 0$ by Lemma 5. Consequently, $\exists\, \epsilon > 0$ such that $\forall \tau \in [\tau^*, \tau^* + \epsilon) : \dot{U}(\tau) \geq 0$, but this contradicts claim (a).
   (c) If $\forall \tau \in [t_0, t_1] : \dot{U}(\tau) < 0$, it follows from (A-23) and from (A-15) that $\forall \tau \in [t_0, t_1) : \dot{s}(\tau) > 0 \;\wedge\; \dot{w}_r(\tau) > 0$.

2. Proof of Claim 2:

   Since by (6) and (7) the lifetime utility is discontinuous at $t_1$, unless $\pi\left[S(t_1,t_0)\right]=1$, this must also be the case for the control variables. This can be directly deduced by evaluating the FOC (A-13) and (A-16) at the left-hand side and right-hand side of $t_1$.

3. Proof of Claim 3:

   By claim 1, $\dot{U}(t_1)<0$. Therefore by impossibility (ib) in Lemma 4, $U(t_1)<U^+$. Using (7) it must be that $\pi[\bar{S}(t_1,t_0)](U^+-U^-)>0$ and therefore $\pi[\bar{S}(t_1,t_0)]>0$.

■

### A.5 Proof of Proposition 2

**Proof.** By (11), using the notation defined in (A-21), acknowledging that after a negative evaluation the last term on the right-hand side of (11) is zero, and using that $c''(.)>0$, the following must hold:

$$s(t_1)>s^- \Leftrightarrow c'[s(t_1)]-c'[s^-]=V[U(t_1)]-V[U^-]+\frac{\pi'\left[\bar{S}(t_1,t_0)\right]}{t_1-t_0}\left[U^- - U^+\right]>0 \tag{A-26}$$

Expanding $V[U(t_1)]$ in a Taylor series around $V[U^-]$, and using (A-22), (A-13) and that $U(t_1)-U^- = (1-\pi[\bar{S}(t_1,t_0)])(U^+-U^-)$ by (6) and (7) yields:

$$V[U(t_1)]=V[U^-]-\bar{F}(w_r^-)\left(1-\pi[\bar{S}(t_1,t_0)]\right)(U^+-U^-)+\frac{f(w_r^*)(\rho+\delta)}{2}\left[U(t_1)-U^-\right]^2 \tag{A-27}$$

where $w_r^*\in[w_r^-,w_r(t_1)]$. Inserting (A-27) in (A-26), noting that the second order term is always positive, yields, if $\bar{S}(t_1,t_0)>\underline{\Psi}$ and hence if $\pi[\bar{S}(t_1,t_0)]<1$, the following sufficient condition for $s(t_1)>s^-$:

$$\frac{\partial \ln\left(1-\pi[\bar{S}(t_1,t_0)]\right)}{\partial \bar{S}(t_1,t_0)}>\bar{F}(w_r^-)(t_1-t_0) \tag{A-28}$$

■

### A.6 Proof of Proposition 3

**Proof.** If $s^+>0$, using (A-16) and (A-21), it must be that $c'(0)<V(U^+)$. Consequently, since by Lemma 4 $\forall\tau: U^+\geq U(\tau)$, it follows by (A-22) that $\forall\tau: c'(0)<V[U(\tau)]$. This cannot hold if $\pi[\bar{S}(t_1,t_0)]=1$. If $\underline{\Psi}=0$, this can only occur if $\bar{S}(t_1,t_0)=0$. But then, since $\forall\tau: s(\tau)\geq 0$, by (1) $\forall\tau\in[t_0,t_1]: s(\tau)=0$ and therefore $\forall\tau: c'[s(\tau)]=c'(0)<V[U(\tau)]$. But by (A-16), (A-20) and (A-21) $\forall\tau: c'[s(\tau)]\geq V[U(\tau)]$. A contradiction. Therefore $\pi[\bar{S}(t_1,t_0)]<1$. ■

## B Derivation of the Sample Average Probability of Negative Evaluation

In the main text it was explained that the sample average probability of negative evaluation at the $k^{th}$ interview $\bar{\pi}_k$ is estimated by a weighted sum of the expected individual probability of a negative evaluation for each notified individual in the sample. Subscript $i$ refers to a notified individual characterized by a specific UB level, gender and schooling level. $E\pi_{ki}$ denotes the expected probability of negative evaluation for a notified individual $i$ conditional on being evaluated for $k^{th}$ time ($k\in\{1,2,3\}$) and irrespective of having experienced an employment spell since the last evaluation ($e=0$ or $e=1$). $PE_{ki}$ denote the probability that the $k^{th}$ evaluation takes place for individual $i$. Then, if $N$ denotes the number of notified individuals, one can write the sample average probability as a weighted average of expected individual probabilities:

$$\bar{\pi}_k = \sum_{i=1}^{N} \frac{PE_{ki}}{\sum_{j=1}^{N} PE_{kj}} E\pi_{ki} \tag{A-29}$$

where

$$PE_{ki} = \prod_{l=0}^{k-1} E\pi_{li} \tag{A-30}$$

and where $E\pi_{0i} \equiv 1$. In the model one cannot escape a first evaluation ($PE_{1i} = 1$), since the duration counter that determines whether an evaluation will take place is temporarily halted rather than reset to zero if an individual leaves unemployment for employment. Since employment spells are exponentially distributed and since $\bar{t}_1^*$, the maximum duration at which the evaluation takes place, is finite, individuals will always eventually return to unemployment and be evaluated with probability one.[30] A second evaluation can only take place if one is negatively evaluated at the first: $PE_{2i} = E\pi_{1i}$. Finally, a third evaluation takes place only if the evaluation at the previous two was negative: $PE_{3i} = E\pi_{1i}E\pi_{2i}$.

We now derive $E\pi_{ki}$. The probability of negative evaluation depends on whether the unemployment spell was interrupted by employment ($e = 1$) or not ($e = 0$), and if $e = 0$ on the timing $\tau$ of the interview within the delay interval ($\tau \in [t'_k, \bar{t}^*_k]$) and on the average search effort $\bar{S}_i^0(\tau, t_{k-1})$ of individual $i$:

$$\pi^0_{ki}\left[S_i^0(\tau, t_{k-1})\right] = \exp\left[-\kappa_k \beta_1^0 S_i^0(\tau, t_{k-1})\right] \tag{A-31}$$

$$\pi^1_k = \exp(-\kappa_k \beta_1^1) \tag{A-32}$$

where $\kappa_1 \equiv 1$. The expected probability of negative evaluation $E\pi_{ki}$ is a weighted average of these probabilities, where the weights depend on the probability of their realization:

$$\begin{aligned} E\pi_{ki} = &\left\{ \left[1 - e^{-\int_{t_{k-1}}^{t'_k} p_i^0(z)dz}\right] + e^{-\int_{t_{k-1}}^{t'_k} p_i^0(z)dz} \int_{t'_k}^{\bar{t}^*_k} p_i^0(\tau) e^{-\int_{t'_k}^{\tau}\left[p_i^0(z)+q\right]dz} d\tau \right\} \pi^1_k \\ &+ e^{-\int_{t_{k-1}}^{t'_k} p_i^0(z)dz} \left\{ \int_{t'_k}^{\bar{t}^*_k} q e^{-\int_{t'_k}^{\tau}\left[p_i^0(z)+q\right]dz} \pi^0_{ki}\left[S_i^0(\tau, t_{k-1})\right] d\tau + e^{-\int_{t'_k}^{\bar{t}^*_k}\left[p_i^0(z)+q\right]dz} \pi^0_{ki}\left[S_i^0(\bar{t}^*_k, t_{k-1})\right] \right\} \end{aligned} \tag{A-33}$$

The expression contains four terms. The first two terms weigh the probability of negative evaluation for $e = 1$ ($\pi^1_k$) by the probability of having found employment before the $k^{th}$ interview. This occurs if employment is found during the scheduled interval $[t_{k-1}, t'_k)$ (first term) or if employment is found during the delay interval $[t'_k, \bar{t}^*_k)$ before an interview takes place (second term). The third term weighs for each $\tau \in [t'_k, \bar{t}^*_k)$ the probability of negative evaluation for $e = 0$ ($\pi^0_{ki}\left[S_i^0(\tau, t_{k-1})\right]$) by the probability that an evaluation occurs before employment is found and integrates ("sums") this over the delay interval. The last term is the probability of negative evaluation for $e = 0$ if it takes place at the end of the delay interval ($\left[S_i^0(\bar{t}^*_k, t_{k-1})\right]$) weighted by the probability of neither having the $k^{th}$ interview nor a transition to employment before $\bar{t}^*_k$.

## C Solving the Optimal Control Problem and Estimation

Estimation requires that the optimal control problem described in Section 3.2 has to be solved at each iteration of the numerical optimization. Given a vector of all parameters of the model, for each sampled individual the problem is solved, both for $e = 0$ and $e = 1$, by backward induction in the following steps:

[30] This is an approximation, since in reality the duration counter determining the moment of evaluation is reset to zero after an uninterrupted full time employment spell of 12 months.

*Step 0:* The stationary problems are solved in case of a positive evaluation and in case of a sanction after a third interview; $U^+$ and $U^-$ are calculated.

*Step 1.1:* Given $U^+$ and $U^-$, the FOC for control variables are solved at $\bar{t}_3^*$ to determine the endpoint conditions for the paths of control variables at $\bar{t}_3^*$. First we solve for endpoint conditions under effort-independent evaluation ($e = 1$), since for $e = 1$ FOC depend only on the knowledge of $U^+$ and $U^-$. Then we solve for endpoint conditions under effort-dependent evaluation ($e = 0$), as for $e = 0$ FOC require knowledge of $U^1_{3,2}(\bar{t}_3^*)$, available now from the former solution. Moreover, these FOC also require knowledge of $\pi^0\left[\bar{S}^0(\bar{t}_3^*, t_2^*)\right]$, which itself contains an integral of the yet unknown path of the search effort. An initial guess for this probability is taken.

*Step 1.2:* Given the endpoint conditions of Step 1.1, the system of differential equations that describe the evolution of the optimal paths of control variables is solved in the interval $[t'_3, \bar{t}_3^*)$. This system is obtained by the differentiation of the FOC for control variables with respect to time. First we solve for optimal paths under effort-independent evaluation ($e = 1$). Then we solve for optimal paths under effort-dependent evaluation ($e = 0$), since the solution of the system of differential equations in this case requires knowledge of the path of $U^1_{3,2}(\tau)$, $\tau \in [t'_3, \bar{t}_3^*)$, available now from the former solution. Moreover, this system also requires knowledge of $\pi^0\left[\bar{S}^0(\bar{t}_3^*, \tau)\right]$, $\tau \in [t'_3, \bar{t}_3^*)$, for which the initial guess is maintained for the moment. Using both solutions, $U^1_{3,2}(t'_3)$ and $U^0_{3,2}(t'_3)$ at the scheduled date of the third interview $t'_3$ are computed.

*Step 1.3:* Given $U^1_{3,2}(t'_3)$ and $U^0_{3,2}(t'_3)$ from Step 1.2, the FOC for control variables are solved at $t'_3$ to determine the endpoint conditions for the paths of control variables at $t'_3$. The endpoint conditions are solved first for the effort-independent evaluation, followed by the effort-dependent evaluation (for the same reason as in Step 1.1).

*Step 1.4:* Given the endpoint conditions of Step 1.3 the system of differential equations that describe the evolution of the optimal paths of control variables is solved in the interval $[t_2^*, t'_3)$. First we solve for optimal paths under effort-independent evaluation, followed by effort-dependent evaluation (for the same reason as in Step 1.2). Likewise, the system of differential equations under effort-dependent evaluation requires knowledge of $\pi^0\left[\bar{S}^0(t'_3, \tau)\right]$, $\tau \in [t_2^*, t'_3)$, for which the initial guess is currently maintained.

*Step 1.5:* The solution of Steps 1.1-1.4 provides us with the optimal path of search effort $s^0(\tau)$ on $[t_2^*, \bar{t}_3^*)$. This is used to update the initial guess about $\pi^0\left[\bar{S}^0(\bar{t}_3^*, \tau)\right]$, $\tau \in [t_2^*, \bar{t}_3^*)$, and Steps 1.1-1.4 are repeated again until convergence in $s^0(\tau)$. Upon convergence the value of the lifetime utility $U^0_{3,1}(t_2^*)$ at the actual date of the second interview is evaluated.

*Step 2:* We go back to Step 1.1, replace $U^-$ by $U^0_{3,1}(t_2^*)$, as calculated in Step 1.5, and iterate until convergence. The result is the lifetime utility $U^0_{2,1}(t_1^*)$ at the actual date of the first interview.

*Step 3:* We continue in this way until arriving at $t_0^*$, the moment of notification.[31]

The above described solution algorithm takes the vector of all parameters of the model as given. Parameters of the model are described by two likelihood functions: (22) determines all parameters but $\{\beta_1^e\}_{e=0,1}$, and (23) determines $\{\beta_1^e\}_{e=0,1}$. Consequently the estimation is performed in two stages:

Stage 1: For the initial values of $\{\beta_1^e\}_{e=0,1}$ and the rest of the parameters, (22) is maximized conditional on $\{\beta_1^e\}_{e=0,1}$. The resulting estimates are used to compute, based on Steps 0 to 3, the average search effort at the first interview $\bar{S}^0(t_1^*, t_0^*)$ for all individuals who are observed to have the first interview.

[31] Detailed expressions of the systems of endpoint conditions and optimal paths at each step are provided in the Internet Appendix, Section B.

STAGE 2: Given $\bar{S}^0(t_1^*, t_0^*)$ from Stage 1, (23) is maximized with respect to $\{\beta_1^e\}_{e=0,1}$. $\{\beta_2^e\}_{e=0,1}$ and $\{\beta_3^e\}_{e=0,1}$ are updated as described at the end of Section 4.2 and in Appendix B. Based on these new parameter estimates Steps 0 to 3 are implemented as input for Stage 1.

Stages 1 and 2 are iteratively repeated until convergence in all parameters of the model.

## D Adjustment of pre-program data

In addition to the sample of treated and the pre-program sample, we exploit two other samples: A sample selected in 2003 and another one in 2004, both according to exactly the same selection criteria as in Section 5.1 except that the workers are now aged between 30 and 32 instead of between 25 and 30 years. Let

- $k = 1, 2..., 12$ denote the number of months of unemployment since the sampling date;
- $t = 0$ if the sampling date is in 2003 and $t = 1$ if the sampling date is in 2004;
- $j = e$ if exit is to employment and $j = r$ if exit is to the residual state;
- $l = y$ if one is aged between 25 and 30 and $l = o$ if one is aged between 30 and 32.

For these four samples (for $j \in \{y, o\}$ and $t \in \{0, 1\}$) the aggregate transition rate in the absence of monitoring to destination $j \in \{e, r\}$ after $k$ months of unemployment is assumed to be proportional in calendar time at sample selection:

$$h_{kt}^{lj} = \exp\{\alpha_k^{lj} + \Delta_k^j t\} \tag{A-34}$$

Parameters $\alpha_k^{yj}$ can be identified from the 2003 sample of the younger group, while $\alpha_k^{oj}$ and $\Delta_k^j$ can be identified from the 2003 and 2004 samples of the older group. The estimated parameters $\hat{\Delta}_k^j$ are then used to adjust the cumulative fraction of exits to employment among young workers sampled in 2003 in such a way that these exits reflect the business cycle conditions faced by the sample drawn in 2004: $\hat{h}_{k1}^{yj} = \exp\{\hat{\alpha}_k^{yj} + \hat{\Delta}_k^j\}$.

## E Internet Appendix, Code and Instructions for Replication

Internet Appendix is available at:

**http://www.empirical.economics.uni-mainz.de/Dateien/CDLViapp.pdf**

Data and code ready for replication can be downloaded at:

**http://www.empirical.economics.uni-mainz.de/Dateien/CDLV.zip**

Instructions for using the code and replicating our key results are accessible at:

**http://www.empirical.economics.uni-mainz.de/Dateien/CDLVusecode.pdf**

# References


Abbring, J. H., G. J. van den Berg, and J. C. van Ours (2005) 'The Effect of Unemployment Insurance Sanctions on the Transition Rate from Unemployment to Employment.' *The Economic Journal* 115(505), 602–630

Ashenfelter, O., D. Ashmore, and O. Deschênes (2005) 'Do Unemployment Insurance Recipients Actively Seek Work? Evidence from Randomized Trials in Four U.S. States.' *Journal of Econometrics* 125(1-2), 53–75

Bloemen, H. G. (2005) 'Job Search, Search Intensity, and Labor Market Transitions an Empirical Analysis.' *The Journal of Human Resources* 40(1), 231–269

Boone, J., A. Sadrieh, and J. van Ours (2009) 'Experiments on Unemployment Benefit Sanctions and Job Search Behavior.' *European Economic Review* 53, 937–951

Boone, J., and J. C. van Ours (2006) 'Modeling Financial Incentives to Get Unemployed Back to Work.' *Journal of Institutional and Theoretical Economics* 162(2), 227–252

Boone, J., P. Fredriksson, B. Holmlund, and J. C. van Ours (2007) 'Optimal Unemployment Insurance with Monitoring and Sanctions.' *The Economic Journal* 117(518), 399–421

Borland, J., and Y.-P. Tseng (2007) 'Does a Minimum Job Search Requirement Reduce the Time Spent on Unemployment? Evidenc from the Job Seekers Diary in Australia.' *Industrial and Labor Relations Review* 60(3), 357–378

Bunzel, H., B. Christensen, P. Jensen, N. Kiefer, L. Korsholm, L. Muus, and G. Neumann (2001) 'Specification and Estimation of Equilbrium Search Models.' *Review of Economic Dynamics* 4, 90–216

Calvo-Armengol, A., and M. O. Jackson (2004) 'The Effects of Social Networks on Employment and Inequality.' *American Economic Review* 94(3), 426–454

Card, D.E., R. Chetty, and A. Weber (2007) 'The Spike at Benefit Exhaustion: Leaving the Unemployment System or Starting a New Job?' *American Economic Review Papers and Proceedings* 97(2), 113–118

Christensen, B., and N. Kiefer (1994) 'Measurement Error in the Prototypal Job Search Model.' *Journal of Labor Economics* 12, 618–639

Cockx, B., and M. Dejemeppe (2010) 'The Threat of Monitoring Job Search. A Discontinuity Design.' IZA discussion paper 5337

Dolton, P., and D. O'Neill (1996) 'Unemployment Duration and the Restart Effect: Some Experimental Evidence.' *The Economic Journal* 106(435), 387–400

—— (2002) 'The Long-Run Effects of Unemployment Monitoring and Work-Search Programs: Experimental Evidence from the United Kingdom.' *Journal of Labor Economics* 20(2), 381–403

Eckstein, Z., and G. J. van den Berg (2007) 'Empirical Labor Search: A Survey.' *Journal of Econometrics* 136, 531–564

Ferral, C. (1997) 'Unemployment Insurance Eligibility and the Transition in Canada and the School-to-Work United States.' *Journal of Business and Economic Statistics* 15(2), 115–129

Flinn, C., and J. Heckman (1982) 'New Methods for Analyzing Structural Models of Labor Market Dynamics.' *Journal of Econometrics* 18, 115–168

Fougère, D., J. Pradel, and M. Roger (2009) 'Does the Public Employment Service Affect Search Effort and Outcomes?' *European Economic Review* 53, 846–869

Frijters, P., and B. van der Klaauw (2006) 'Job Search with Nonparticipation.' *The Economic Journal*

Fuss, C. (2009) 'What Is the Most Flexible Component of Wage Bill Adjustment? Evidence from Belgium.' *Labour Economics* 16, 320–329

Garcia-Perez, J. I. (2006) 'Job Separation in a Non-Stationary Search Model: A Structural Estimation to Evaluate Alternative Unemployment Insurance Systems.' *Journal of Applied Econometrics*

Gorter, C., and G. R. J. Kalb (1996) 'Estimating the Effect of Counseling and Monitoring the Unemployed Using a Job Search Model.' *Journal of Human Resources* 31, 590–610

Harrison, G., M. Lau, and M. Williams (2002) 'Estimating Individual Discount Rates in Denmark: A Field Experiment.' *American Economic Review* 92(5), 1606–1617

Heckman, J. J. (1979) 'Sample Selection Bias as a Specification Error.' *Econometrica* 46, 153–161

Hornstein, A., P. Krusell, and G. Violante (2011) 'Frictional Wage Dispersion in Search Models: A Quantitative Assessment.' *American Economic Review* 101, Forthcoming

Ioannides, Y., and L. Datcher Loury (2004) 'Job Information Networks, Neighborhood Effects, and Inequality.' *Journal of Economic Literature* XLII, 1056–1093

Keane, M. P., and K. I. Wolpin (2007) 'Exploring the Usefulness of a Nonrandom Holdout Sample for Model Validation: Welfare Effects on Female Behavior.' *International Economic Review* 48, 1351–1378

Keane, M. P., P. E. Todd, and K. I. Wolpin (2011) 'The Structural Estimation of Behavioral Models: Discrete Choice Dynamic Programming Methods and Applications.' In *Handbook of Labor Economics,* ed. Orley Ashenfelter and David Card, O. Ashenfelter and D. Card ed., vol. IV.A (Elsevier) pp. 331–461

Klepinger, D. H., T. R. Johnson, and J. M. Joesch (2002) 'Effects of Unemployment Insurance Work Search Requirements: The Maryland Experiment.' *Industrial and Labor Relations Review* 56(1), 3–22

Klepinger, D. H., T. R. Johnson, J. M. Joesch, and J. M. Benus (1997) *Evaluation of the Maryland Unemployment Insurance Work Search Demonstration* (Seattle and Bethesda: Batelle Memorial Instiute and Abt Associates Inc.)

Kleven, H. J., and C. T. Kreiner (2006) 'The Marginal Cost of Public Funds: Hours of Work versus Labor Force Participation.' *Journal of Public Economics* 90, 1955–1973

Lalive, R., J. C. van Ours, and J. Zweimüller (2006) 'How Changes in Financial Incentives Affect the Duration of Unemployment.' *The Review of Economic Studies* 73, 1009–1038

Launov, A., and K. Wälde (2011) 'Estimating Incentive and Welfare Effects of Non-Stationary Unemployment Benefits.' Working Paper, University of Mainz

Lollivier, S., and L. Rioux (2010) 'An Empirical Examination of the Sources of Changes over Time in the Job Finding Rate Using Reservation Wages and Rejected Wage Offers.' *International Economic Review* 51(4), 461–488

Manning, A. (2009) 'You Can't Always Get What You Want: The Impact of the UK Jobseeker's Allowance.' *Labour Economics* 16(3), 239–250

McVicar, D. (2008) 'Job Search Monitoring Intensity, Unemployment Exit and Job Entry: Quasi-experimental Evidence from the UK.' *Labour Economics* 15, 1451–1468

Meyer, B. D. (1990) 'Unemployment Insurance and Unemployment Spells.' *Econometrica* 58(4), 757–782

—— (1995) 'Lessons from the U.S. Unemployment Insurance Experiments.' *Journal of Economic Literature* 33, 91–131

Mortensen, D. (1986) 'Job Search and Labor Market Analysis.' In *Handbook of Labor Economics, Vol. II,* ed. O. Ashenfelter and R. Layard (Amsterdam: North-Holland) pp. 849–919

OECD (2007) *Employment Outlook* (Paris: OECD)

Paserman, D. (2008) 'Job Search and Hyperbolic Discounting: Structural Estimation and Policy Evaluation.' *The Economic Journal* 118, 1418–1452

Pavoni, N., and G. Violante (2007) 'Optimal Welfare-to-Work Programs.' *Review of Economic Studies* 74, 283–318

Petrongolo, B. (2009) 'The Long-Term Effects of Job Search Requirements: Evidence from the UK JSA Reform.' *Journal of Public Economics* 93, 1234–1253

Postel-Vinay, F., and J.-M. Robin (2002) 'Equilibrium Wage Dispersion with Worker and Employer Heterogeneity.' *Econometrica* 70, 2295–2350

Setty, O. (2010) 'Optimal Unemployment Insurance with Monitoring.' Working Paper, Tel Aviv University

Spinnewyn, F. (1990) 'On the Funding of Unemployment Insurance.' In *Panel Data and Labor Market Studies,* ed. G. Ridder J. Hartog and J. Theeuwes, J. Hartog, G. Ridder and J. Theeuwes ed. (Amsterdam: North-Holland) pp. 313–333

Spinnewyn, J. (2010) 'Unemployed but Optimistic: Optimal Design with Biased Beliefs.' Working Paper, London School of Economics

Todd, P. E., and K. I. Wolpin (2006) 'Assessing the Impact of a School Subsidy Program in Mexico: Using a Social Experiment to Validate a Dynamic Behavioral Model of Child Schooling and Fertility.' *American Economic Review* 96, 1384–1417

van den Berg, G. J. (1990) 'Nonstationarity in Job Search Theory.' *Review of Economic Studies* 57(2), 255–277

van den Berg, G. J., and B. van der Klaauw (2006) 'Counseling and Monitoring of Unemployed Workers: Theory and Evidence from a Controlled Social Experiment.' *International Economic Review* 47(3), 895–936

—— (2009) 'Structural Empirical Evaluation of Job Search Monitoring.' Working Paper, Free University of Amsterdam

van der Klaauw, B., and A. van Vuuren (2010) 'Job Search and Academic Achievement.' *European Economic Review*

Wolpin, K. I. (1987) 'Estimating a Structural Job Search Model: The Transition from School to Work.' *Econometrica* 55, 801–818

Wunsch, C. (2010) 'Optimal Use of Labor Market Policies: The Role of Job Search Assistance.' IZA Discussion Paper 4773