DISCUSSION PAPER SERIES

DP13959

A MENU OF INSURANCE CONTRACTS FOR THE UNEMPLOYED

Régis Barnichon and Yanos Zylberberg

LABOUR ECONOMICS

PUBLIC ECONOMICS

ISSN 0265-8003

A MENU OF INSURANCE CONTRACTS FOR THE UNEMPLOYED

Régis Barnichon and Yanos Zylberberg

Discussion Paper DP13959
Published 27 August 2019
Submitted 27 August 2019

Centre for Economic Policy Research
33 Great Sutton Street, London EC1V 0DX, UK
Tel: +44 (0)20 7183 8801
www.cepr.org

A MENU OF INSURANCE CONTRACTS FOR THE UNEMPLOYED

Abstract

Unemployment insurance (UI) programs traditionally take the form of a single insurance contract offered to job seekers. In this work, we show that offering a menu of contracts can be welfare improving in the presence of adverse selection and moral hazard. When insurance contracts are composed of (i) a UI payment and (ii) a severance payment paid at the onset of unemployment, offering contracts with different ratios of UI benefits to severance payment is optimal under the equivalent of a single-crossing condition: job seekers in higher need of unemployment insurance should be less prone to moral hazard. In that setting, a menu allows the planner to attract job seekers with a high need for insurance in a contract with generous UI benefits, and to attract job seekers most prone to moral hazard in a separate contract with a large severance payment but little unemployment insurance. We propose a simple sufficient statistics approach to test the single-crossing condition in the data.

JEL Classification: J65, D82

Keywords: Unemployment insurance, Adverse Selection, moral hazard

Régis Barnichon - regis.barnichon@sf.frb.org
Federal Reserve Bank of San Francisco and CEPR

Yanos Zylberberg - yanos.zylberberg@bristol.ac.uk
University of Bristol

A Menu of Insurance Contracts for the Unemployed*

Regis Barnichon   Yanos Zylberberg

August 15, 2019

Abstract

Unemployment insurance (UI) programs traditionally take the form of a single insurance contract offered to job seekers. In this work, we show that offering a *menu* of contracts can be welfare improving in the presence of adverse selection and moral hazard. When insurance contracts are composed of (i) a UI payment and (ii) a severance payment paid at the onset of unemployment, offering contracts with different ratios of UI benefits to severance payment is optimal under the equivalent of a single-crossing condition: job seekers in higher need of unemployment insurance should be less prone to moral hazard. In that setting, a menu allows the planner to attract job seekers with a high need for insurance in a contract with generous UI benefits, and to attract job seekers most prone to moral hazard in a separate contract with a large severance payment but little unemployment insurance. We propose a simple sufficient statistics approach to test the single-crossing condition in the data.

JEL: J65, D82.

Keywords: unemployment insurance, adverse selection, moral hazard.

*Barnichon: San Francisco Fed, CEPR; regis.barnichon@sf.frb.org; Zylberberg: University of Bristol, CESifo, Alan Turing Institute; yanos.zylberberg@bristol.ac.uk. We thank Bart Cockx, Bruno Decreuse, Gaetano Gaballo, Ramon Marimon, Michèle Müller-Itten, Francesco Pappadà, Johannes Spinnewijn, Jaume Ventura and seminar participants at the University of Bristol, CREI (Universitat Pompeu Fabra), the EEA/ESEM (Geneva), the Salento Macro Meetings and the SSES (Lausanne) for useful comments. Barnichon acknowledges financial support from the Spanish Ministerio de Economia y Competitividad (grant ECO2011-23188), the Generalitat de Catalunya (grant 2009SGR1157) and the Barcelona GSE Research Network. The usual disclaimer applies.

> *Government checks have been a lifeline for many people who would happily work if they could find a job. But the current system also creates perverse incentives and makes it hard to cut off the lazy while helping those in genuine need.*[1]

An important ingredient of social welfare policies is the unemployment insurance program. At heart, an optimal unemployment insurance contract involves a trade-off between the desire to provide unemployment insurance to job seekers and the need to minimize moral hazard as more generous unemployment insurance raises job seekers' reservation wage and thereby the length of unemployment spells.

In the wake of the Great Recession, the high unemployment rate in many developed economies revived the debate on the deterrent effect of unemployment benefits on job search behavior (e.g., Rothstein, 2011; Farber and Valletta, 2015). Notably, policy makers discussed the possibility to further restrict unemployment insurance (UI) to individuals with certain *observable* characteristics or appropriate behavior (e.g., not refusing too many decent offers or providing sufficient search efforts).[2]

Such conditional schemes are motivated by the idea that some categories of job seekers are more prone to moral hazard, i.e., more prone to "abuse" the generosity of UI benefits at the expense of other categories of job seekers in dire need of unemployment insurance. Unfortunately, as the characteristics and behavior of job seekers are never fully verifiable, conditioning schemes have clear limitations.

In this paper, we show that offering a menu of unemployment benefits can remedy these limitations. We propose to offer newly unemployed workers not just one type of unemployment benefit contract as is the norm in OECD countries, but instead a *menu* of unemployment benefit contracts. Specifically, each unemployment benefit contract will consist of two separate payments: (i) a traditional unemployment insurance scheme paid during unemployment, and (ii) a lump-sum (and unconditional) payment paid at the onset of unemployment. Different contracts will offer different ratios of unemployment insurance to lump-sum payment and will appeal to different types of workers.

Offering different insurance contracts to different types of job seekers is generally desirable but not always incentive-compatible. We show that a menu of contracts

[1] *Unemployment: How the Lazy Are Hurting the Needy*, US News and World Report, April 2012, https://www.usnews.com/news/blogs/rick-newman/2012/04/03/unemployment-how-the-lazy-are-hurting-the-needy.

[2] A large literature discusses the gains from conditioning unemployment benefits on observable behaviors. Among others, Lalive, van Ours and Zweimüller (2005); Lalive, Van Ours and Zweimüller (2006); Abbring, Berg and Ours (2005) show that sanctions could affect job search, and Boone et al. (2007) study optimal UI contracts with sanctions.

can lead to welfare Pareto improvements over the single pooling contract under the equivalent of a Spence-Mirrlees single-crossing property: The marginal utility of unemployment benefits should be higher for those job seekers who are less prone to moral hazard. Intuitively, if the job seekers who are in most need of UI are also the least prone to moral hazard, a welfare improving menu of contracts can be incentive compatible: the job seekers in high need of UI will choose a contract with a high unemployment insurance component, while the job seekers most prone to moral hazard will choose a contract with a large lump-sum payment but little insurance. This configuration happens for instance when workers differ in their propensity to receive a job offer. Indeed, job seekers with a low job offer rate (i) have a high expected unemployment duration, and thus have a high utility from unemployment insurance, and (ii) accept most job offers coming their way, so that moral hazard is of small concern. By contrast, job seekers with a high job offer rate have little need for unemployment insurance but are most prone to moral hazard.[3]

In the first part of paper, we formalize this intuition in a stylized model of sequential job offers with borrowing and saving à la Shimer and Werning (2008), where both the behavior and the type of job seekers are not verifiable. In that setting, optimal unemployment insurance under perfect information is summarized by two quantities, a flat unemployment insurance profile and an unconditional lump-sum payment at the onset of unemployment. The model is sufficiently tractable to (i) extract general conditions under which a menu of contracts is welfare improving over a single pooling contract, and (ii) provide a closed-form characterization of the optimal separating contracts.

We then generalize the argument in a framework with borrowing constraints and adjustable search effort. The unemployment insurance contract under perfect information is then characterized by a lump-sum payment and by a duration-specific unemployment insurance payment. We provide a sufficient condition under which a menu of contracts which separates job seekers is welfare improving over a single pooling contract.

In the second part of the paper, we propose a simple sufficient statistics approach to test the single-crossing condition in the data. We show how the condition is similar to a Baily-Chetty formula (Chetty, 2006) and could be tested using a sufficient statistics approach, where the sufficient statistics are the elasticities of reservation

[3]Two recent contributions suggest that job seekers strongly differ in the recall probability from previous employers (Nekoei and Weber, 2015; Fujita and Moscarini, 2017). Workers under temporary layoff have a much higher recall rate than workers under permanent layoffs and thus (i) have much less of a need for unemployment insurance, but (ii) are much more prone to moral hazard. This dimension of heterogeneity would call for a menu of contracts.

earnings and insurance payments to changes in the level of unemployment insurance. We illustrate how this test could be implemented in practice using a Swiss dataset that allows us to estimate these sufficient statistics for a (typically unobservable) dimension of heterogeneity: job seekers' search efficiency. We find that the single-crossing property is satisfied in this empirical application: the planner would like to attract the highly-efficient job seekers into a (relatively) low-insurance contract.

We discuss some implementation issues for our policy proposal. In particular, we explore a number of extensions that can be of importance in a real-world setting. We consider the possibilities that (i) there is a continuum of types of job seekers, (ii) job seekers are uncertain or have biased beliefs about their types (as in Spinnewijn, 2013, 2015), and (iii) selecting one contract versus another could have adverse consequences for future employment opportunities, if a job seeker's choice is used by future employers as a signal of that job seeker's type.

The contribution of this paper is to explicitly account for adverse selection in the design of optimal unemployment insurance. The design of unemployment benefits in the presence of moral hazard has received considerable attention from the economic literature. The literature has discussed the size of unemployment benefits relative to wages (Feldstein, 1985) and the shape of unemployment benefits with duration (Shavell and Weiss, 1979; Hopenhayn and Nicolini, 1997; Cahuc and Lehmann, 2000; Shimer and Werning, 2008; Chetty, 2008; Kolsrud et al., 2015). By contrast, there is surprisingly little work on the design of unemployment benefits in a world with heterogeneous job seekers (Shimer and Werning, 2006), and to our knowledge, our paper is the first one studying explicitly the unemployment insurance problem as an adverse selection problem.[4]

Our analysis is motivated by the existence of adverse selection and moral hazard between a job agency and job seekers. The existence of moral hazard is supported in the data by the response of job seekers to the generosity of unemployment insurance.[5] Adverse selection is supported by studies quantifying the importance of unobserved heterogeneity in the unemployment pool, from the hazard-based duration models (see Van den Berg, 2001, for a review) to more recent contributions exploiting multiple unemployment spells (see, for instance, Alvarez, Borovičková and Shimer, 2016).

Finally, our paper builds on an older literature on adverse selection and moral

[4]Heterogeneity across workers has been studied in the literature, but from a redistribution perspective (e.g., Lifschitz, Setty and Yedid-Levi, 2013). For instance, unemployment saving accounts have been proposed to limit such redistribution (Feldstein, 2005; Feldstein and Altman, 2007).

[5]See e.g., Nickell (1979); Narendranathan, Nickell and Stern (1985); Katz and Meyer (1988); Van den Berg (1990); Hunt (1995); Lalive, Van Ours and Zweimüller (2006); Chetty (2008); Card, Chetty and Weber (2007); Schmieder, Von Wachter and Bender (2012).

hazard in the context of social insurance. Some papers have looked at optimal contracting in competitive environments (Prescott and Townsend, 1984; Biglaiser and Mezzetti, 1993). Our approach instead considers a unique principal, the unemployment agency, in the spirit of Whinston (1983) and Picard (1987).

The remainder of this paper is structured as follows. In Section 1, we describe the physical environment of the stylized model. In Section 2, we derive the optimal contract(s) and discuss some extensions related to practical implementation issues. Section 3 describes our findings in the general framework. Section 4 presents our sufficient-statistic approach to test the single-crossing condition in the data, and the final section briefly concludes.

1 Environment

We start by describing the environment of the baseline model.

1.1 Preferences and technology

Time is continuous. We focus on the problem of one potential worker facing an exogenous labor demand. She lives for infinitely many periods and maximizes expected utility. Letting c_t denote her consumption at time t, her expected lifetime utility at t is:

$$E_t[U_t] = E_t \int_0^{\infty} e^{-\rho s} u(c_{t+s}) ds,$$

where $1 - \rho < 1$ denotes her discount factor and $u(\cdot)$ represents the utility function, which satisfies $u'(\cdot) > 0$ and $u''(\cdot) < 0$. The worker can either be unemployed or employed. When unemployed, she provides inelastically a unit of search and receives interviews at rate f. Upon meeting with the firm, the unemployed worker and the firm draw a wage. Conditional on receiving an interview, let $G(\cdot)$ denote the distribution of potential wages.[6] The worker can decide to accept the wage offer or instead re-integrate the unemployment pool. If she accepts the offer, the worker remains indefinitely employed in the same firm and under the same contractual terms.

While the worker is unemployed, she produces at home. Let z denote the value of home production.

[6]In the baseline, we assume an exogenous distribution of wage offers. Characterizing optimal insurance in a model with idiosyncratic match quality and Nash bargaining upon matching is relatively straightforward and is discussed in an extension.

1.2 Unemployment insurance and financial markets

As in Shimer and Werning (2008), we assume that the job seeker can freely borrow and save at rate r with $r = \rho$ (so that there is a preference for perfectly stabilizing consumption over time), but there exist no financial instruments contingent on the employment status of individuals.

Workers are facing two insurance problems. First, an unemployed worker wants to smooth consumption across time, i.e., wants to bring consumption from future states (in which she will be employed) to the present (where she is looking for a job). She can do so using private financial markets. Second, an unemployed worker would like to be insured ex-ante against unemployment risk, i.e., against the random nature of the time of re-employment. The only asset which can provide such insurance is provided by the unemployment agency.[7]

There is an unemployment agency minimizing its expenditures subject to a target utility constraint: The unemployment agency offers flat unemployment benefits b, whose payments depend on the job status of individuals, and an initial lump-sum payment a, in order to reach initial discounted utility U for the job seeker. Since agents can perfectly smooth their consumption across periods, the lump-sum payment is equivalent to any deterministic stream of payments with the same discounted value. This lump-sum payment may be positive and can be interpreted as a severance payment. This lump-sum payment may be negative and can be interpreted as a tax to finance unemployment insurance.

We model moral hazard through an enforcement friction at the job acceptance margin: the unemployment agency cannot force individuals to accept offers when they receive them, and it only observes the status of the worker (either unemployed or employed).[8]

2 Baseline model

The structure of the section is as follows. We describe the job seeker's program and we express her reservation wage as a function of unemployment insurance. We then analyze the planner's problem in two steps. In a first step, we study the perfect

[7] Alternatively, we could have considered a competitive environment in which private firms offer insurance contracts to job seekers. Such competitive models à la Prescott and Townsend (1984); Biglaiser and Mezzetti (1993) do not really reflect the structure of unemployment insurance in most countries, but they would generate similar implications with the severance payment being replaced by the price of the insurance policy.

[8] An alternative would be to model moral hazard with unobservable search efforts which affect the probability to receive job offers. We adopt an approach based on the job acceptance margin in order to abstract from non-monetary search costs, but our findings would go through with (unverifiable) search efforts.

information setting and perform useful comparative statics. In a second step, we analyze the optimal contract under adverse selection and we derive a general set of conditions under which a menu of contracts is preferred.

2.1 The worker's program

In this preliminary step, we consider as given the unemployment insurance scheme providing (i) a lump-sum payment a at the onset of unemployment, and (ii) a constant stream of unemployment benefits b conditional on being unemployed.[9] We assume that the worker's initial savings are 0.[10]

For tractability, we consider a CARA utility function, $u(c) = -e^{-\alpha c}$, with $\alpha > 0$. We relax this assumption in Section 3.

In this setting, the problem is quasi-stationary in unemployment duration, i.e., the reservation wage is independent of assets (see Appendix B). We thus drop time indices in what follows.

Lemma 1 (Reservation wage)**.** *Letting $U(a,b)$ denote the discounted utility of a job seeker who receives an UI scheme with lump-sum payment a and unemployment benefits b, the reservation wage $\omega(b)$ is independent of duration and verifies,*

$$U(a,b) = \frac{u\left(\rho a + \omega(b)\right)}{\rho}.$$

The reservation wage $\omega(b)$ is implicitly defined by,

$$\alpha\left(\omega(b) - b - z\right) = \frac{f}{\rho}\left(1 - G(\omega(b)) + \int_{\omega(b)}^{\infty} u(x - \omega(b))dG(x)\right). \tag{1}$$

Proof. See Appendix B. □

As is apparent in Equation (1), the reservation wage $\omega(b)$ increases in the level of unemployment insurance b, because higher unemployment benefits allow the worker to smooth income across the potential paths to re-employment. Similarly, it depends positively on expected future revenues either through a higher job arrival rate or through a more "generous" distribution of wage offers. With CARA utility and no restriction on inter-temporal smoothing, the reservation wage does not depend on savings, a, because the desire to smooth across periods is the same along different levels of wealth, as in Shimer and Werning (2008).

[9]The lump-sum payment can also be seen as the "price" of the insurance contract: the government can offer different levels of insurance coverage at different prices.

[10]This assumption is innocuous because, as we will see later, wealth does not modify the job seeker's behavior in this baseline model.

A very important quantity in our context is the job seeker's marginal rate of substitution between unemployment insurance and lump-sum payment, or:

$$MRS_{b,a} = \frac{\partial U}{\partial b} / \frac{\partial U}{\partial a}.$$

The following lemma implicitly characterizes this marginal rate of substitution and provides some comparative statics.

Lemma 2 (Comparative statics)**.** *The marginal rate of substitution between unemployment insurance and lump-sum payment verifies:*

$$MRS_{b,a} = \frac{\omega'(b)}{\rho} = \frac{1}{\rho + \frac{f}{\alpha} \int_{\omega(b)}^{\infty} u'\left(x - \omega(b)\right) dG(x)}. \tag{2}$$

$MRS_{b,a}$ is decreasing in the job arrival rate f and increasing in the value of home production z.

Proof. See Appendix B. □

The marginal rate of substitution, $MRS_{b,a}$, captures a job seeker's valuation of unemployment insurance compared to a lump-sum transfer, or stated differently, it captures a job seeker's willingness to pay for insurance.[11] For instance, job seekers with a low job arrival have a high valuation for unemployment insurance—high $MRS_{b,a}$—, because they are likely to stay unemployed for a long time. To take another example, job seekers with a high value of home production have a high valuation for unemployment insurance, because they are likely to reject many offers and thus stay unemployed for a long time as well. Importantly, while the two groups—low job arrival rate or high home production—have similarly high valuation of unemployment insurance, the mechanisms leading to such high $MRS_{b,a}$ are different, and the second group is much more prone to moral hazard. As we will see, this difference will be at the core of the design of optimal unemployment insurance in the presence of worker heterogeneity.

2.2 The planner's program

In order to introduce useful notations and a benchmark for the planner's problem, we analyze the problem of a planner under perfect information. Intuitively, we will see that the planner must balance the benefits of insuring job seekers against unemployment risk with the costs due to moral hazard: more generous UI benefits

[11] Note that this willingness to pay maps directly to the elasticity of the reservation wage to unemployment benefits.

raise job seekers reservation wage and lead workers to refuse more job offers with low wages and stay unemployed longer.

Notations and perfect information benchmark The planner minimizes the cost of an insurance policy which delivers at least utility U to the worker by choosing (i) initial lump-sum payment a, and (ii) a flow of unemployment benefits b:

$$C(U) = \min_{b,a} \left\{ \frac{b}{\rho + f\,(1 - G(\omega(b)))} + a \right\}$$

subject to $u\,(\rho a + \omega(b)) \geq \rho U$. In the expression above, the first term captures the expected cost of unemployment insurance: the flow of UI payments b is discounted by the discount rate and the probability to exit the unemployment pool, which is the probability to receive an offer (f) times the probability to accept it $(1 - G(\omega(b)))$.

We will see that it is helpful to reformulate the problem as if the planner was directly optimizing over the reservation wage w and the certainty equivalent consumption $v = \rho a + \omega(b)$. Using Equation (1) to substitute b as a function of ω, we can write the cost minimization problem as,

$$C(U) = \min_{\omega,v} \left\{ -\Psi(\omega) + \frac{v}{\rho} \right\},$$

subject to $v = u^{-1}(\rho U)$ and with $\Psi(.)$ defined by

$$\Psi(\omega) = \frac{f}{\rho} \frac{\omega\,(1 - G(\omega)) + \frac{1}{\alpha}\left(1 - G(\omega) + \int_\omega^\infty u(x - \omega) dG(x)\right)}{\rho + f\,(1 - G(\omega))}. \tag{3}$$

In this this equivalent representation, the two choice variables—the reservation wage w and the certainty equivalent consumption v—are pinned down separately. The reservation wage is chosen to minimize $-\Psi(\omega)$ and the lump-sum payment is adjusted such that $v = u^{-1}(\rho U)$. This separability will be convenient when we discuss the optimal contract with heterogeneous workers.[12]

The function $-\Psi$ is part of the government cost function; it captures the trade-off between insurance and moral hazard for the unemployment agency. On the one hand, a low reservation wage ω is inefficient for the unemployment agency, because reaching utility U only through the non-contingent payment a would be very costly for job seekers with a concave utility. On the other hand, a high reservation wage ω

[12]This separability derives from the functional form of the utility function and the unconditional access to borrowing and saving. Without a CARA utility or with restrictions on inter-temporal smoothing, the arbitrage between incentives and insurance would depend on initial wealth and optimal benefits would not be set independently of the utility target.

would also incur large costs because the job seeker would refuse many offers, remain in the unemployment pool for a long period and the total cost of the contingent payments b would be prohibitively high.

The following lemma summarizes the optimal contract under perfect information:

Lemma 3 (Perfect information)**.** *The solutions ω^* and v^* to the planner's program are such that ω^* minimizes $-\Psi(\cdot)$ and $v^* = u^{-1}(\rho U)$. Since $(b, a) \mapsto (\omega, v)$ is a one-to-one correspondence, there exists a unique pair (b^*, a^*) associated with (ω^*, v^*).*

The planner first sets benefits b^* such that $\omega(b^*) = \omega^*$, and then adjusts the lump-sum transfer a^* to reach utility U.

2.3 Optimal contract schedule with adverse selection

To model adverse selection, we assume the existence of unobservable heterogeneity across job seekers. Consequently, agents can have different marginal rate of substitution between non-contingent and contingent unemployment benefits, i.e., between the lump-sum payment a and the unemployment insurance payment b. Heterogeneity in $MRS_{b,a}$ could arise from heterogeneity in job arrival rates (f), in the value of home production (z), in risk aversion (α) or in the distribution of wage offers (G). Importantly, agents know their type, but the unemployment agency cannot observe nor verify the job seeker's type.

We posit that there exist two types of agents denoted by $\{h, l\}$. The high-type (h) are in proportion μ and have a higher $MRS_{b,a}$, i.e., a high valuation of unemployment insurance, for all possible values of b. The low-type (l) are in proportion $1 - \mu$ and have a lower $MRS_{b,a}$.

We consider the problem of a utilitarian planner who can offer two types of contracts: a pooling contract and a set of separating contracts.

Pooling contract With one pooling contract, the planner minimizes the total cost $C(U)$ of the policy by choosing a flow of benefits b and a lump-sum payment a such that:

$$C(U) = \min_{(b,a)} \left\{ -\mu\Psi_h(\omega_h(b)) - (1-\mu)\Psi_l(\omega_l(b)) + \mu\frac{\rho a + \omega_h(b)}{\rho} + (1-\mu)\frac{\rho a + \omega_l(b)}{\rho} \right\}$$

subject to:

$$\mu u_h(\rho a + \omega_h(b)) + (1-\mu)u_l(\rho a + \omega_l(b)) = \rho U$$

Letting $v_h = \rho a + \omega_h(b)$ and $v_l = \rho a + \omega_l(b)$ denote the certainty equivalent consumptions, it will be easier to rewrite the problem in terms of v_h and v_l instead of a_h and a_l, i.e.,

$$C(U) = \min_{b,v_h,v_l} \left\{ -\mu\Psi_h(\omega_h(b)) - (1-\mu)\Psi_l(\omega_l(b)) + \mu\frac{v_h}{\rho} + (1-\mu)\frac{v_l}{\rho} \right\}$$

subject to a target utility constraint:

$$\mu u_h(v_h) + (1-\mu)u_l(v_l) = \rho U,$$

and the fact that lump-sum payments are the same across types, i.e,

$$v_h - v_l = \omega_h(b) - \omega_l(b).$$

Separating contracts With two contracts, the planner minimizes the total cost $C(U)$ of the policy by choosing a flow of benefits (b_h, b_l) and certainty equivalent consumptions v_h and v_l such that:

$$C(U) = \min_{b_h,v_h,b_l,v_l} \left\{ -\mu\Psi_h(\omega_h(b_h)) - (1-\mu)\Psi_l(\omega_l(b_l)) + \mu\frac{v_h}{\rho} + (1-\mu)\frac{v_l}{\rho} \right\}$$

subject to a target utility constraint:

$$\mu u_h(v_h) + (1-\mu)u_l(v_l) = \rho U,$$

and two incentive-compatibility constraints:[13]

$$\begin{cases} v_h - v_l \geq \omega_h(b_l) - \omega_l(b_l) \\ v_h - v_l \leq \omega_h(b_h) - \omega_l(b_h) \end{cases}$$

Given our assumption that type-h workers have a higher valuation of UI than type-l workers, the two incentive-compatibility constraints imply that any feasible solution should verify $b_h \geq b_l$.

Optimal contracts We now derive the optimal contracting schedule. We assume that the government cost function $\Psi(\omega)$ is concave on an open convex set including

[13]These incentive-compatibility constraints are obtained as follows. The flow of benefits (b_h, b_l) and initial lump-sum payments payment (a_h, a_l) separate type-h and type-l if $v_h \geq \rho a_l + \omega_h(b_l)$ and $v_l \geq \rho a_h + \omega_l(b_h)$. Substituting in v_l and v_h in the first and second equations gives:

$$\begin{cases} v_h \geq v_l + \omega_h(b_l) - \omega_l(b_l) \\ v_l \geq v_h + \omega_l(b_h) - \omega_h(b_h) \end{cases}$$

the optimal levels of reservation wages for both types, ω_h^* and ω_l^*, under perfect information.[14]

Letting b_h^* and b_l^* denote the optimal benefits for both types under perfect information, i.e.,

$$\Psi_h'(\omega_h(b_h^*)) = 0, \quad \Psi_l'(\omega_l(b_l^*)) = 0,$$

the following proposition characterizes the optimal contract.[15]

Proposition 1 (Optimal contracts). *If the following condition is verified,*

$$b_h^* > b_l^*, \tag{C1}$$

then there exist separating contracts that are Pareto-equivalent to the best pooling contract (b^p), but incur a strictly lower cost. Condition (C1) is equivalent to the following condition,

$$\frac{\partial \Psi_h(\omega_h(b^p))}{\partial b^p} < 0 < \frac{\partial \Psi_l(\omega_l(b^p))}{\partial b^p}. \tag{C2}$$

Proof. See Appendix B. □

Equivalently, Proposition 1 can be restated as the following corollary.

Corollary 1. *In order to minimize the cost of a policy delivering utility U, the planner either offers one unique contract or two contracts.*

- *When Condition (C1) is not verified, i.e., $b_h^* \leq b_l^*$, the planner offers a unique contract with unemployment insurance b^p.*
- *When $b_h^* > b_l^*$, there exist separating contracts that are Pareto superior to the best pooling contract, and optimal insurance features two separating contracts b_h^s and b_l^s verifying $b_h^s > b_l^s$.*

Further, the contracts satisfy $b_h^* \geq b_h^s \geq b^p \geq b_l^s \geq b_l^*$.

[14] See Appendix B for a sufficient condition on the distribution of wage offers G. The function Ψ is concave on some interval if the density of wage offers is decreasing on that interval. This would be verified, for instance, if the distribution of wage offers is unimodal and the reservation wages at the optimal policy (ω_h^*, ω_l^*) are higher than the mode of wage offers.

[15] In this stylized framework, the planner's program can be decomposed into two successive programs: a standard moral hazard problem with perfect information about the agent's type, and an adverse selection model à la Rothschild and Stiglitz (1976). The unemployment agency first solves for the type-specific contract under perfect information. The first-best replacement rate then captures the endogenous risk due to moral hazard. Job seekers with low incentives to refuse job offers would be attributed a high replacement rate. Second, the unemployment agency solves an adverse selection problem à la Rothschild and Stiglitz (1976) in which the exogenous attribute, i.e., the risk, interacts with the endogenous risk due to moral hazard. A trade-off between efficiency and information rent savings shapes the optimal separating contracts.

Proof. See Appendix B. □

Separating contracts are preferred if, and only if $b_h^* > b_l^*$. Intuitively, under the single crossing property, $b_h^* > b_l^*$, the planner wants to offer more generous benefits to high $MRS_{b,a}$ job seekers. A set of separating contracts is desirable when the worker type who values unemployment insurance the most is also the type that is least prone to refusing job offers. In contrast, when $b_h^* < b_l^*$, separating contracts are not incentive-compatible. The planner would like to provide less insurance to the type-h job seekers but it cannot attract them in such a contract because the type-h are precisely the ones who value benefits unemployment insurance the most. The following corollary relates the single-crossing property to different dimensions of heterogeneity in the unemployment pool.

Corollary 2 (Heterogeneity and contracts)**.** *Under the assumption that the discount rate is negligible compared to the job finding rate, i.e., $f >> \rho$, we have that:*

- *if the two types of job seekers only differ along the job offer rate, the planner offers two separating contracts.*
- *if the two types of job seekers only differ along the value of home production, the planner offers a unique pooling contract.*

Proof. See Appendix B. □

Graphical illustration To illustrate graphically how offering separating contracts can be Pareto improving over a pooling contract, we consider the case of heterogeneity in job contact rates, i.e., $f_h < f_l$, under which Condition (C1) is verified. Starting from the optimal pooling contract, we will illustrate in Figure 1 how two separating contracts can generate the same welfare but at a lower budgetary cost for the government. For illustration purposes, we make the simplifying (and realistic) assumption that $f >> \rho$, which has the benefit that the government cost function $\Psi(.)$ becomes proportional to f and its shape is thus identical for both types of job seekers.

Figure 1 relates any insurance contract (b, a) to a reservation wage ω and a corresponding cost of insuring the job seeker in three interconnected panels. The top-left panel displays the indifference curves for job seekers of type-h and type-l in the (b, a) plan, $\{(b, a),\ \omega(b) + \rho a = \bar{v}\}$. Crucially, high-MRS job seekers have a flatter indifference curve. The top-right panel then transforms the insurance contracts displayed in the left panel into their corresponding reservation wages ω for the two types. With heterogeneity in MRS stemming from heterogeneity in job contact rate (f), the reservation wage schedule $\omega(b)$ is lower for high MRS job seekers. Finally, the bottom-right panel translates the reservation wage associated with a certain contract into the cost function of the unemployment agency ($-\Psi$).

Consider first a world with perfect information (types are observable). The planner would offer two contracts b_h^* and b_l^* that minimize the government cost function $-\Psi$, as depicted in Figure 1.

Consider now a world with unobserved types. The optimal pooling contract P is depicted in the left panel along with the associated indifference curves for both types, $\{(b, a), \omega_i(b) + \rho a = \omega_i(b^{^P}) + \rho b^{^P}\}$. As apparent in the right panel, the optimal pooling contract implies that the reservation wage of the type-h (high $MRS_{b,a}$) is too low and the reservation wage of the type-l (low $MRS_{b,a}$) too high—compared to the perfect information benchmark. The cost function $-\Psi$ is no longer minimized and this implies a budgetary loss for the government.

However, and this is the key point of this paper, it is possible to construct a contract that can deliver the utility to both worker types at a lower budgetary cost. We deviate from the pooling contract as follows. We construct another contract S with $b^{^S} > b^{^P}$, and situated on the type-h indifference curve that passes through the pooling contract P. By construction, type-h workers are indifferent between this new contract and the pooling contract. In contrast, type-l agents are not attracted to this contract—it lies strictly below their indifference curve—, as the insurance component of this contract is too high for low $MRS_{b,a}$ job seekers. In that case, separating type-h and type-l workers into the new contract and the pooling contract is desirable for the planner because it raises type-h reservation wage $\omega_h(b^{^S}) > \omega_h(b^{^P})$ and brings it closer to the minimum of the government cost function. Thus, both types of job seekers are indifferent between the menu of contracts $\{P, S\}$ and the pooling contract P, but the menu generates a lower budgetary cost and lower informational rents.

2.4 Extensions

In this section, we explore a number of model extensions that can be of importance in a real-world setting. Specifically, we will see that our basic insight—that a menu of contracts can be welfare-improving under a single crossing condition like Equation (C2)—holds (i) with a continuum of types (instead of only two types), (ii) with uncertainty about one's own type as job seekers may not perfectly observe their own type when sorting themselves into an insurance contract, and (iii) when job seekers have biased beliefs about their own type, similar to Spinnewijn (2015). Finally, we will show that a menu of contracts can still be Pareto improving even in a context where revealing information may directly affect future job prospects for the unemployed. More specifically, we consider the possibility that employers can observe how workers sort themselves into contracts, infer their types and use this information during the wage negotiation.

We leave the proofs behind the main results in Appendix C.

Continuum of types In this first extension, we assume that there is a continuum of types indexed by $i \in [0,1]$, and, without loss of generality, we order types such that the marginal willingness to pay for insurance is decreasing in type i. As in the case with discrete types, we assume that the functions $\{\Psi_i\}_{i\in[0,1]}$ are concave on an open convex set including the reservation wages $\{\omega_i^*\}_{i\in[0,1]}$ at the optimal policy under perfect information. The optimal contract has the following features (see Appendix C.1). Similar to Condition (C1) in the discrete case, when the optimal benefit schedule under perfect information, $\{b_i^*\}_{i\in[0,1]}$, is decreasing in the worker type i, a continuum of separating contracts is optimal. Unemployment benefits $\{b_i^s\}_{i\in[0,1]}$ are decreasing in i, and high-MRS individuals sort themselves into high insurance contracts, while low-MRS individuals sort themselves into contracts with a more generous severance payment component.

Uncertainty In this second extension, we consider the possibility that job seekers only have a noisy signal about their own type, for instance they do not have a clear view about their labor market prospects.

To account for such uncertainty, we start again from the baseline framework but assume that there are two different types of job seekers *ex-ante*, type-h and type-l, who draw their *ex-post* type $i \in [0,1]$ from two distributions H_h and H_l. We suppose that H_h is (first-order) stochastically dominated by H_l, and that $MRS_{b,a}$ is decreasing in the ex-post type i—such that the ex-ante type-h is also more likely to be a type-h ex-post.

While more involved in terms of notations, the optimal contract is qualitatively similar to the one characterized in Proposition 1. The planner either offers one unique contract or two contracts. When the optimal benefit schedule under perfect information, $\{b_i^*\}_{i\in[0,1]}$, is increasing in the ex-post type i, the planner offers a unique contract. When the optimal benefit schedule under perfect information, $\{b_i^*\}_{i\in[0,1]}$, is decreasing in the ex-post type i, there exist separating contracts that are Pareto superior to the best pooling contract, and the planner offers two separating contracts with $b_h^s > b_l^s$. The formal derivations can be found in Appendix C.2. Importantly, uncertainty does not prevent the planner from separating agents: the planner separates job seekers based on their imprecise (but unbiased) prior regarding their type.

We explore next the case of biased beliefs or over-confidence.

Biased beliefs A crucial implementation issue with a menu of insurance contracts is that some workers may be over-confident about their job market prospects (Dubra, 2004; Spinnewijn, 2013, 2015), and some high-types, i.e., high-MRS individuals, may (wrongly) sort themselves into the low-type contract. To account for over-confidence, we come back to the baseline model with two *ex-post* types of agents $\{h, l\}$, in which the type-h worker—in proportion μ—has a higher willingness-to-pay for insurance than type-l worker. However, we also assume that, with probability ε, a type-h worker (wrongly) thinks that she is a low-MRS individual.

Over-confidence does modify the structure of optimal insurance, but we can show that there still exists a condition under which a menu of contracts is optimal. Letting b_h^* and b_l^* denote the optimal replacement rates under perfect information (for agents and the planner), the sufficient condition supporting separating contracts over the pooling contract is more stringent than in the baseline of section 2. Specifically, if there exists a function $f(\cdot)$ such that, when $b_h^* > f(b_l^*) \geq b_l^*$, the planner offers two separating contracts $(\hat{b}_h, \hat{b}_l)$, which verify $b_l^s \leq \hat{b}_l < \hat{b}_h \leq b_h^s$ with (b_h^s, b_l^s) the contracts offered in the baseline case with unbiased beliefs. If instead $b_h^* \leq f(b_l^*)$, the planner offers the same pooling contract as in the baseline.

Intuitively, the planner cannot force optimistic high-type job seekers to behave differently than low-type (i.e., low MRS) job seekers. When offered a menu of insurance, this share of high-type types will prefer the low-insurance contract which generates utility losses and thus budgetary losses through a compensation in lump-sum payment. However, a menu of contracts can generate budgetary gains from the non-zero share of unbiased high-types. These gains can compensate the losses incurred from attracting biased high-type workers into a low-insurance contract. This has two implications. First, a menu of insurance is less desirable than in the baseline, and the sufficient condition for its optimality is more stringent. Second, even when a menu of insurance is optimal, the variation in insurance coverage across types is less pronounced than in the baseline. We formally characterize the optimal contract in Appendix C.3.

Signaling One gain of offering a menu of contracts is to reduce the informational rent captured by the job seeker at the expense of the job agency. There is, however, another information asymmetry which provides some informational rent to the potential worker: the one arising, at the interview stage, with a potential recruiter. Revealing information with a menu of contracts may affect the wage negotiation between the job seeker and possible recruiters: the contractual choice sends a signal to employers on unobserved characteristics of the agent, and thus on their reservation wage. This signaling channel can distort how job seekers sort themselves into contracts.

In order to model this signaling channel, we modify the baseline framework as follows. First, we assume that there is an exogenous mass of possible vacancies and there is an idiosyncratic match-quality draw: let $G(\cdot)$ denote the distribution of potential match output y. Second, we assume that, upon matching, a wage bargaining process takes place between the firm and its only job candidate. For simplicity, we assume Nash bargaining such that a share ν of the surplus goes to the worker and a share $1-\nu$ goes to the firm. Third, we suppose that the worker's (insurance) contractual choice is verifiable such that the firm updates its priors on the worker's type accordingly.

This extension is more difficult to study than the previous ones because it introduces endogenous priors for the possible employer, and we only develop the full argument in Appendix C.4. Signaling reduces the set of incentive-compatible contracts. For individuals with a low reservation wage, there are gains from deviating, i.e., from choosing the contract intended for individuals with a high reservation wage: such deviating individuals would capture a larger share of output than under perfect information. This additional incentive to deviate restricts the capacity of the planner to separate types but does not fundamentally modify the optimal menu of contract when feasible. Letting b_h^* and b_l^* denote the optimal replacement rates under perfect information, the condition for separating contracts to be preferred is $b_h^* > g(b_l^*)$ (with $g(b_l^*) \geq b_l^*$), and the function g is decreasing in the bargaining power $\nu > 0$. Specifically, when $\nu = 1$, $g(b_l^*) = b_l^*$ and the contract is the same as the baseline because the worker captures all the match output. As the bargaining power ν decreases, the reservation wage becomes a larger share of the negotiated wage, and relative gains from sorting into the contract promised to individuals with high reservation wages are higher.

3 A general model

In this section, we extend the baseline model to a more general framework with sequential job offers. We relax the assumption of a CARA utility, relax the assumption of free access to borrowing and saving and posit imperfect access to borrowing (Lentz and Tranaes, 2005), and we model moral hazard with an unobservable search-effort margin. In that framework, reservation wages depend on unemployment duration (as in e.g., Burdett and Vishwanath, 1988; Vishwanath, 1989) and optimal unemployment benefits may be constant, declining or increasing with duration (see e.g., Hopenhayn and Nicolini, 1997; Shimer and Werning, 2008; Chetty, 2008; Kolsrud et al., 2015).

In contrast with the baseline model, we assume that time is discrete. Let $d \in \mathbb{N}$ denote the unemployment duration and β denote the discount factor.

3.1 The worker's program

Similar to our framework in Section 1, we consider unemployment insurance contracts consisting of two components: (i) a sequence of unemployment benefits $\{b_d\}_{d\in\mathbb{N}}$, and (ii) a lump-sum payment upon layoff, a, paid irrespectively of future employment status.[16]

We write below a general recursive program for the worker. At duration d and with savings s, the job seeker maximizes her value of being unemployed, U_d,[17]

$$U_d(s) = \max_{\omega,c,s',e} \left\{ u(c) - \varphi_d(e) + \beta G_d(\omega, e) U_{d+1}(s') + \beta \int_{\omega}^{+\infty} W(x, s') dG_d(x, e) \right\} \quad (4)$$

where ω is the worker's reservation wage, e is search effort, c is the period consumption, $G_d(\cdot, e)$ is the distribution of wage offers, $\varphi_d(\cdot)$ is the cost of search, and $W(x, s')$ is the value of being employed with wage x and savings s'. The job seeker is subject to a budget constraint,

$$c + s' = b_d + s/\beta,$$

and a credit constraint,

$$f(s', s) \leq 0.$$

We define $V\left(a, \{b_d\}_{d\in\mathbb{N}}\right)$ as the indirect utility evaluated at duration $d = 0$, for a job seeker with initial level of savings $s_0 + a$.

[16] In contrast to our previous model, modeling the non-contingent payment component as a lump-sum payment upon layoff rather than as a per-period transfer is not completely innocuous. While these two formulations are exactly equivalent under free access to borrowing and saving (as in Section 1), this is no longer the case with borrowing constraints and the two formulations would only be "qualitatively" equivalent. For the sake of exposure, we choose to focus on a (positive) initial severance payment rather than a per-period transfer, as the former generates higher welfare than the latter. With borrowing constraints, the job seeker would prefer to bring as much endowment as possible from future states of nature.

[17] For the sake of parsimony, we model the influence of search efforts along the extensive and intensive margins as affecting directly the distribution of wage offers G_d. A model with an explicit extensive margin of search efforts, e.g., not receiving any interview, would be equivalent to receiving interviews with unacceptable wages.

3.2 The planner's program

We start by deriving the cost of insurance from the viewpoint of the planner.

Recursive formulation and perfect information Consider the severance payment a and the sequence of benefits $\{b_d\}_{d\in\mathbb{N}}$ as given. Ignoring the severance payment for now, the planner faces the following discounted cost for a worker unemployed at duration d:

$$C(d) = b_d + \beta G_d(\omega_d, e_d)\, C(d+1) \tag{5}$$

where $\{\omega_d\}_{d\in\mathbb{N}}$ and $\{e_d\}_{d\in\mathbb{N}}$ are the reservation wage and search intensity policy functions which solve Equation (4). In what follows, we define the indirect cost $\Psi\left(a, \{b_d\}_{d\in\mathbb{N}}\right)$ as the solution of this program evaluated at duration $d = 0$ and accounting for the initial payment a, i.e.,

$$\Psi\left(a, \{b_d\}_{d\in\mathbb{N}}\right) = C(0) + a.$$

Under perfect information, the planner solves

$$\min_{a,\{b_d\}_{d\in\mathbb{N}}} \Psi\left(a, \{b_d\}_{d\in\mathbb{N}}\right),$$

subject to

$$V\left(a, \{b_d\}_{d\in\mathbb{N}}\right) \geq V_0.$$

As in Section 2, we assume that the government cost function Ψ is convex, while the indirect utility function, V, is concave.[18]

Adverse selection We now introduce unobservable worker heterogeneity as in the baseline model of Section 2.

We assume that there are two types of job seekers, type-h in proportion μ and type-l in proportion $1-\mu$. The type-h job seeker has a higher valuation of insurance irrespectively of duration, i.e., a higher marginal rate of substitution between unemployment insurance and non-contingent severance payment (at any duration d),

$$\frac{\partial V_h/\partial b_d}{\partial V_h/\partial a} > \frac{\partial V_l/\partial b_d}{\partial V_l/\partial a}, \quad \forall b_d, \forall d. \tag{6}$$

The previous conditions (6) are the equivalent of ranking workers according to their marginal rate of substitution between insurance and unconditional payments (Sec-

[18] The concavity of V can be shown using the envelope theorem and the additive separability of $\{b_d\}_{d\in\mathbb{N}}$ in the associated Lagrangian.

tion 2), but in a "dynamic" model where the job seeker may value differently unemployment benefits across periods.

The best *pooling* contract $P = \left(\tilde{a}, \left\{\tilde{b}_d\right\}_{d\in\mathbb{N}}\right)$ is the solution to:

$$\min_{a,\{b_d\}_{d\in\mathbb{N}}} \mu\Psi_h\left(a, \{b_d\}_{d\in\mathbb{N}}\right) + (1-\mu)\Psi_l\left(a, \{b_d\}_{d\in\mathbb{N}}\right),$$

subject to,

$$\mu V_h\left(a, \{b_d\}_{d\in\mathbb{N}}\right) + (1-\mu)V_l\left(a, \{b_d\}_{d\in\mathbb{N}}\right) \geq V_0.$$

It is straightforward to show that P verifies,

$$\mu\frac{\partial\Psi_h}{\partial b_d} + (1-\mu)\frac{\partial\Psi_h}{\partial b_d} = \frac{\mu\frac{\partial V_h}{\partial b_d} + (1-\mu)\frac{\partial V_h}{\partial b_d}}{\mu\frac{\partial V_h}{\partial a} + (1-\mu)\frac{\partial V_h}{\partial a}} \tag{7}$$

and the target utility constraint $\mu V_h + (1-\mu)V_l = V_0$.

In the following proposition, we provide a sufficient condition for a set of Pareto-equivalent incentive-compatible separating contracts to lower the cost of insurance relative to the best pooling contract.

Proposition 2 (Optimal contracts)**.** *If there exists a duration d for which the following condition is verified,*

$$\frac{\partial\Psi_h}{\partial b_d} < 0 < \frac{\partial\Psi_l}{\partial b_d}, \tag{C3}$$

when evaluated at the pooling contract P, then there exist separating contracts that are Pareto-equivalent to the best pooling contract but incur a strictly lower cost. Under Condition (C3), any set of contracts minimizing the cost function need to separate the two types into two distinct contracts.

Proof. See Appendix B. □

The proof of Proposition 2 proceeds exactly as the proof of Proposition 1 for the simpler model. We construct, for any of the duration d for which Condition (C3) holds, a contract which promises a more generous stream b_d of unemployment benefits than the pooling contract. As in Figure 1 for the baseline scenario, these contracts deliver the same utility for high-MRS job seekers but at a lower cost for the government. Such menu of contracts provides the same welfare level for both worker types at a lower budgetary cost.

4 A sufficient statistics approach to assess the desirability of a menu of contracts

In this section, we take a practical approach to our policy proposal and study how a government could set up its unemployment agency and insurance program so as to be able to test whether a menu of contracts would be an improvement over a single pooling contract.

We show that the sufficient condition underlying the optimality of a menu of contracts—Condition (C2) in the baseline framework and Condition (C3) in the general case—could be tested in the data in a relatively simple manner provided that one can observe two sufficient statistics: (i) the elasticity of the reservation wage to unemployment benefits, b, which allows to estimate the welfare gains of more generous UI payments and thus the marginal benefit of raising the level of unemployment insurance,[19] and (ii) the elasticity of insurance payments to b, which allows to estimate the extent of the moral hazard problem and thus the marginal cost of raising the level of unemployment insurance.[20]

We then illustrate this approach using Swiss data for which these two sufficient statistics are observable along an important but typically unobserved dimension of heterogeneity: search efficiency.

4.1 An empirical test for the single-crossing condition

Consider the baseline framework of Section 2 in which the planner minimizes, under perfect information, the cost of an insurance policy delivering at least utility U to the worker:

$$C(U) = \min_{b,a} \left\{ \frac{b}{\rho + f\,(1 - G(\omega(b)))} + a \right\}$$

subject to $u\,(\rho a + \omega(b)) \geq \rho U$. Under the assumption that $\rho << f$, the program can be written as follows:

$$C(U) = \min_{b,a} \{P(b) + a\}$$

subject to $\rho a + \omega(b) \geq u^{-1}\,(\rho U)$, where $P(b) = bD(b)$ and $D(b)$ are respectively the expected payment of benefits and the expected duration of the unemployment spell.

[19]The test exploits the fact that reservation wages directly capture welfare in our theoretical framework (as in Shimer and Werning, 2007).

[20]The traditional (and related) statistics that is used in most of the empirical literature assessing the disincentive effects of unemployment insurance is the elasticity of non-employment duration to the generosity of unemployment benefits. See Chetty and Finkelstein (2012) for a review.

The first-order conditions of this program are:

$$\begin{cases} \frac{\partial \mathcal{L}}{\partial b} = & -D(b) - bD^{'}(b) + \lambda\omega^{'}(b) & = 0 \\ \frac{\partial \mathcal{L}}{\partial a} = & -1 + \lambda\rho & = 0 \end{cases}$$

The optimal level of unemployment benefits should thus verify:

$$\underbrace{P^{'}(b)}_{MC(b)} = D(b) + bD^{'}(b) = \underbrace{\omega^{'}(b)/\rho}_{MB(b)} \tag{8}$$

The marginal cost of unemployment insurance is the loss in budget induced by an increase in benefits. This cost is composed of (i) a direct cost as more generous benefits need to be paid during $D(b)$ periods, and (ii) an indirect cost due to moral hazard, $bD^{'}(b)$, as the job seeker is more likely to reject offers and to experience a longer unemployment spell. The marginal benefit is the relative gain in budget induced by the lower lump-sum payment a required to reach utility U. This optimality condition for unemployment insurance is the same condition that we encountered earlier. With homogeneous job seekers, the optimal contract satisfies $\Psi^{'}(\omega(b)) = MC(b) - MB(b) = 0$ where $\Psi(\cdot)$ is the same cost function as in Section 2.

With heterogeneous workers, Proposition 1 states that a set of separating contracts is preferred to the pooling contract with benefits b^p if, and only if,

$$\frac{\partial \Psi_h(\omega_h(b^p))}{\partial b^p} < 0 < \frac{\partial \Psi_l(\omega_l(b^p))}{\partial b^p}$$

or

$$MC_h(b^p) - MB_h(b^p) < 0 < MC_l(b^p) - MB_l(b^p) \tag{C}$$

In the next empirical section, we propose to test whether this condition holds in the data, i.e., whether offering a menu of contracts can be Pareto improving in practice.

4.2 Application using a survey of reservation earnings

To illustrate how Condition (C) can be tested in the data, we exploit a dataset from Switzerland that allows us to estimate the marginal costs and marginal benefits of varying the generosity of unemployment insurance for two different categories of job seekers with high and low search efficiency.

Data and context Two pieces of information are necessary: (i) the elasticity of the reservation wage with respect to the generosity of unemployment insurance,

$MB(b^p)$, and (ii) the elasticity of total insurance payments with respect to the generosity of unemployment insurance, $MC(b^p)$.

In the context of the evaluation of a profiling system in the canton of Fribourg (Switzerland), all newly-registered job seekers between September 2012 and March 2014 had to report their reservation earnings during the first meeting with their caseworker, typically in the first three weeks after registration. During this first meeting, the caseworkers also evaluated various dimensions capturing the job seeker's search strategies, including a subjective assessment of their search efficiency. We merge this dataset covering about 8,000 different unemployment spells with unemployment insurance register data,[21]. For each job seeker in our dataset, we thus have the reservation wage and the total amount paid in unemployment benefits.

To measure the elasticities of the reservation wage and payments to changes in b, we exploit a discontinuity in the Swiss unemployment insurance system: eligible job seekers are entitled up to 200 working days of benefits if they register before 25 years old, but up to 400 working days if they register after 25.[22] This discontinuity can be used as exogenous variation in the generosity of unemployment insurance.[23] We thus select all job seekers between 18 and 35 without dependent children having reported a reservation wage during the first meeting and being eligible to some unemployment insurance (200 or 400 working days), which leaves us with about 4,000 unemployment spells.

Finally, to rank job seekers according to their valuation of unemployment insurance, i.e., to rank job seekers in terms of their $MRS_{b,a}$, we exploit the fact that caseworkers were required to assess the search efficiency of all job seekers assigned to them in the context of the profiling experiment. That way, we are able to condition on a typically unobserved dimension of heterogeneity: the individual search efficiency.[24] We divide job seekers along their search efficiency, type-h job seekers being those whose search efficiency is considered low by the caseworker, which implies that they have a high valuation of unemployment insurance, i.e., a high $MRS_{b,a}$ according to our model.

[21] UI register data allow us to observe for each individual their level of unemployment benefits, maximum duration of benefits, as well as realized unemployment duration.

[22] As apparent in Appendix Table A1, the Swiss unemployment insurance is quite generous among OECD countries with a high replacement rate and relatively long coverage duration.

[23] While this change may seem too large to estimate the effect of a *marginal* change, note that few workers stay unemployed 400 working days, so that the effective change in benefit payments is actually small. The change in payment will be estimated to be between 8 and 18%, which comes from the fact that less than 30% of job seekers benefit ex-post from this 100% increase in promised payments.

[24] For heterogeneity along observable characteristics (e.g., age, sex or last wage), introducing (incentive-compatible) separating contracts is not needed a priori, since unemployment insurance payments could be made conditional on these verifiable characteristics.

Empirical strategy The identification of the marginal cost and marginal benefits by worker type is then relatively straightforward. We use a standard local-polynomial regression-discontinuity treatment (the optimal bandwidth selection relies on Imbens and Kalyanaraman (2012)) and estimate

$$y_i = \alpha + \beta T_i + f(a_i) + \varepsilon_i, \tag{9}$$

where $f(a_i)$ is a local "polynomial" of degree 1, T_i is a dummy equal to 1 for individuals older than 25, and the sample is optimally chosen around the cut-off $a = 25$ years old. When we estimate the *marginal cost* of extending unemployment insurance, the dependent variable is the (log) reservation wage; when we estimate the *marginal benefit* of extending unemployment insurance, the dependent variable is the (log) total payment granted by the unemployment agency during the unemployment spell.[25]

Results Table 1 reports the marginal benefits—sensitivity of reservation earnings (column 1)— and marginal costs—sensitivity of insurance payments (column 2)— of extending insurance coverage for type-h job seekers with low search efficiency (Panel A) and type-l job seekers with high search efficiency (Panel B). The necessary and sufficient condition underlying the optimality of separating contracts is supported by the data. Specifically, the point-wise estimates imply that $MC_h(b^p) < MC_l(b^p)$ and $MB_l(b^p) < MB_h(b^p)$, and thus

$$\Psi_h'(\omega(b^p)) < 0 < \Psi_l'(\omega(b^p))$$

since $\Psi_h'(\omega(b)) = MC(b) - MB(b)$ and since $\Psi'(\omega(b^p)) = 0$ where $\Psi'(\omega) = \mu\Psi_h'(\omega) + (1-\mu)\Psi_l'(\omega)$.

In other words, the necessary and sufficient condition for offering a menu of contracts seems to be supported in our data, and a planner would want to offer a contract with a high unemployment insurance component for the low-efficiency job seekers and to offer a separate contract with a low insurance component to the high-efficiency job seekers.

[25] Note that the realized insurance payment for a particular individual i is different from the expected payment underlying Condition (8). However, with a large sample of job seekers, the average value of realized payments will coincide with expected UI payments so that the estimated elasticity β will capture the variation in expected payment, $P'(b^p)$.

5 Concluding remarks

While the level and the duration profile of unemployment benefits have been extensively discussed, this paper shows that one important step towards reducing moral hazard and raising welfare could be to offer a menu of contracts rather than a single contract, as is the norm in OECD countries.

We study a simple theoretical problem in which a planner—the unemployment agency—faces two frictions. First, there is an enforcement friction: as standard in the literature, the planner cannot force job seekers to accept job offers. Second, there is adverse selection: there exists unobservable heterogeneity among job seekers.

We consider the possibility to offer a menu of contracts and let job seekers select their preferred option. Each contract consists of a contingent payment—the traditional unemployment insurance payment—, and a severance payment. If job seekers who value unemployment insurance the most are also the ones least susceptible to moral hazard, we show that the optimal insurance scheme is a menu of insurance contracts. This configuration happens, for instance, if job seekers differ mostly in their capacity to find a job. When job seekers with low search efficiency "would happily work if they could find a job" (as suggested by our opening quote), offering a menu of contracts will be Pareto welfare improving over a single contract. Job seekers with high job finding rates would prefer a contract with a larger lump-sum payment component. A menu of contracts allows the government to reduce the extent of the moral hazard problem, while insuring the ones in most need.

In the final section of the paper, we take the perspective of a policy maker contemplating offering a menu of contracts. We propose a simple sufficient statistics approach to assess the desirability of a menu of contracts and demonstrate its feasibility using a Swiss dataset.

References

Abbring, Jaap H, Gerard J Berg, and Jan C Ours. 2005. "The effect of unemployment insurance sanctions on the transition rate from unemployment to employment." *The Economic Journal*, 115(505): 602–630.

Alvarez, Fernando E, Katarína Borovičková, and Robert Shimer. 2016. "Decomposing duration dependence in a stopping time model." National Bureau of Economic Research.

Biglaiser, Gary, and Claudio Mezzetti. 1993. "Principals competing for an agent in the presence of adverse selection and moral hazard." *Journal of Economic Theory*, 61(2): 302–330.

Boone, Jan, Peter Fredriksson, Bertil Holmlund, and Jan C Van Ours. 2007. "Optimal unemployment insurance with monitoring and sanctions." *The Economic Journal*, 117(518): 399–421.

Burdett, Kenneth, and Tara Vishwanath. 1988. "Declining Reservation Wages and Learning." *The Review of Economic Studies*, 655–665.

Cahuc, Pierre, and Etienne Lehmann. 2000. "Should unemployment benefits decrease with the unemployment spell?" *Journal of Public Economics*, 77(1): 135 – 153.

Caliendo, Marco, Konstantinos Tatsiramos, and Arne Uhlendorff. 2013. "Benefit Duration, Unemployment Duration and Job Match Quality: A Regression-Discontinuity Approach." *Journal of Applied Econometrics*, 28(4): 604–627.

Card, David, Raj Chetty, and Andrea Weber. 2007. "The Spike at Benefit Exhaustion: Leaving the Unemployment System or Starting a New Job?" National Bureau of Economic Research Working Paper 12893.

Centeno, Mário, and Álvaro A Novo. 2009. "Reemployment wages and UI liquidity effect: a regression discontinuity approach." *Portuguese Economic Journal*, 8(1): 45–52.

Chetty, Raj. 2006. "A general formula for the optimal level of social insurance." *Journal of Public Economics*, 90(10-11): 1879–1901.

Chetty, Raj. 2008. "Moral Hazard vs. Liquidity and Optimal Unemployment Insurance." National Bureau of Economic Research Working Paper 13967.

Chetty, Raj, and Amy Finkelstein. 2012. "Social insurance: Connecting theory to data." National Bureau of Economic Research.

Dubra, Juan. 2004. "Optimism and overconfidence in search." *Review of Economic Dynamics*, 7(1): 198–218.

Farber, Henry S, and Robert G Valletta. 2015. "Do extended unemployment benefits lengthen unemployment spells? Evidence from recent cycles in the US labor market." *Journal of Human Resources*, 50(4): 873–909.

Feldstein, Martin. 1985. "The Optimal Level of Social Security Benefits." *Quarterly Journal of Economics*, 10: 303–320.

Feldstein, Martin. 2005. "Rethinking Social Insurance." *American Economic Review*, 95(1): 1–24.

Feldstein, Martin, and Daniel Altman. 2007. "Unemployment Insurance Savings Accounts." In *Tax Policy and the Economy, Volume 21. NBER Chapters*, 35–64. National Bureau of Economic Research, Inc.

Fujita, Shigeru, and Giuseppe Moscarini. 2017. "Recall and unemployment." *American Economic Review*, 107(12): 3875–3916.

Hopenhayn, Hugo A, and Juan Pablo Nicolini. 1997. "Optimal Unemployment Insurance." *Journal of Political Economy*, 105(2): 412–38.

Hunt, Jennifer. 1995. "The Effect of Unemployment Compensation on Unemployment Duration in Germany." *Journal of Labor Economics*, 13(1): pp. 88–120.

Imbens, Guido, and Karthik Kalyanaraman. 2012. "Optimal bandwidth choice for the regression discontinuity estimator." *The Review of economic studies*, 79(3): 933–959.

Johnston, Andrew C, and Alexandre Mas. 2016. "Potential unemployment insurance duration and labor supply: The individual and market-level response to a benefit cut." National Bureau of Economic Research.

Katz, Lawrence F., and Bruce D. Meyer. 1988. "The Impact of the Potential Duration of Unemployment Benefits on the Duration of Unemployment." National Bureau of Economic Research Working Paper 2741.

Katz, Lawrence F, and Bruce D Meyer. 1990. "The impact of the potential duration of unemployment benefits on the duration of unemployment." *Journal of public economics*, 41(1): 45–72.

Kolsrud, Jonas, Camille Landais, Peter Nilsson, and Johannes Spinnewijn. 2015. "The optimal timing of unemployment benefits: Theory and evidence from Sweden."

Krueger, Alan B, and Andreas Mueller. 2010. "Job search and unemployment insurance: New evidence from time use data." *Journal of Public Economics*, 94(3): 298–307.

Lalive, Rafael. 2007. "Unemployment benefits, unemployment duration, and post-unemployment jobs: A regression discontinuity approach." *The American economic review*, 97(2): 108–112.

Lalive, Rafael, Jan C. van Ours, and Josef Zweimüller. 2005. "The Effect of Benefit Sanctions on the Duration of Unemployment." *Journal of the European Economic Association*, 3(6): 1386–1417.

Lalive, Rafael, Jan Van Ours, and Josef Zweimüller. 2006. "How Changes in Financial Incentives Affect the Duration of Unemployment." *The Review of Economic Studies*, 73(4): 1009–1038.

Le Barbanchon, Thomas. 2016. "The effect of the potential duration of unemployment benefits on unemployment exits to work and match quality in France." *Labour Economics*, 42: 16–29.

Lentz, Rasmus, and Torben Tranaes. 2005. "Job search and savings: Wealth effects and duration dependence." *Journal of Labor Economics*, 23(3): 467–489.

Lifschitz, Avihai, Ofer Setty, and Yaniv Yedid-Levi. 2013. "Who Cares about Unemployment Insurance?" mimeo.

Narendranathan, W., S. Nickell, and J. Stern. 1985. "Unemployment Benefits Revisited." *The Economic Journal*, 95(378): pp. 307–329.

Nekoei, Arash, and Andrea Weber. 2015. "Recall expectations and duration dependence." *The American Economic Review*, 105(5): 142–146.

Nickell, S. J. 1979. "The Effect of Unemployment and Related Benefits on the Duration of Unemployment." *The Economic Journal*, 89(353): pp. 34–49.

Picard, Pierre. 1987. "On the design of incentive schemes under moral hazard and adverse selection." *Journal of Public Economics*, 33(3): 305–331.

Prescott, Edward C, and Robert M Townsend. 1984. "Pareto optima and competitive equilibria with adverse selection and moral hazard." *Econometrica*, 21–45.

Røed, Knut, and Tao Zhang. 2003. "Does unemployment compensation affect unemployment duration?" *The Economic Journal*, 113(484): 190–206.

Rothschild, Michael, and Joseph Stiglitz. 1976. "Equilibrium in competitive insurance markets: An essay on the economics of imperfect information." *The Quarterly Journal of Economics*, 629–649.

Rothstein, Jesse. 2011. "Unemployment Insurance and Job Search in the Great Recession." *Brookings Papers on Economic Activity*, , (2).

Schmieder, Johannes F, Till Von Wachter, and Stefan Bender. 2012. "The effects of extended unemployment insurance over the business cycle: Evidence from regression discontinuity estimates over 20 years." *The Quarterly Journal of Economics*, 127(2): 701–752.

Shavell, Steven, and Laurence Weiss. 1979. "The Optimal Payment of Unemployment Insurance Benefits over Time." *Journal of Political Economy*, 87(6): 1347–62.

Shimer, Robert, and Ivan Werning. 2008. "Liquidity and Insurance for the Unemployed." *American Economic Review*, 98(5): 1922–42.

Shimer, Robert, and Iván Werning. 2006. "On the Optimal Timing of Benefits with Heterogeneous Workers and Human Capital Depreciation." National Bureau of Economic Research, Inc NBER Working Papers 12230.

Shimer, Robert, and Iván Werning. 2007. "Reservation Wages and Unemployment Insurance." *The Quarterly Journal of Economics*, 122(3): 1145–1185.

Spinnewijn, Johannes. 2013. "Insurance and perceptions: how to screen optimists and pessimists." *The Economic Journal*, 123(569): 606–633.

Spinnewijn, Johannes. 2015. "Unemployed but optimistic: Optimal insurance design with biased beliefs." *Journal of the European Economic Association*, 13(1): 130–167.

Van den Berg, Gerard. 1990. "Search Behaviour, Transitions to Non-participation and the Duration of Unemployment." *The Economic Journal*, 100(402): pp. 842–865.

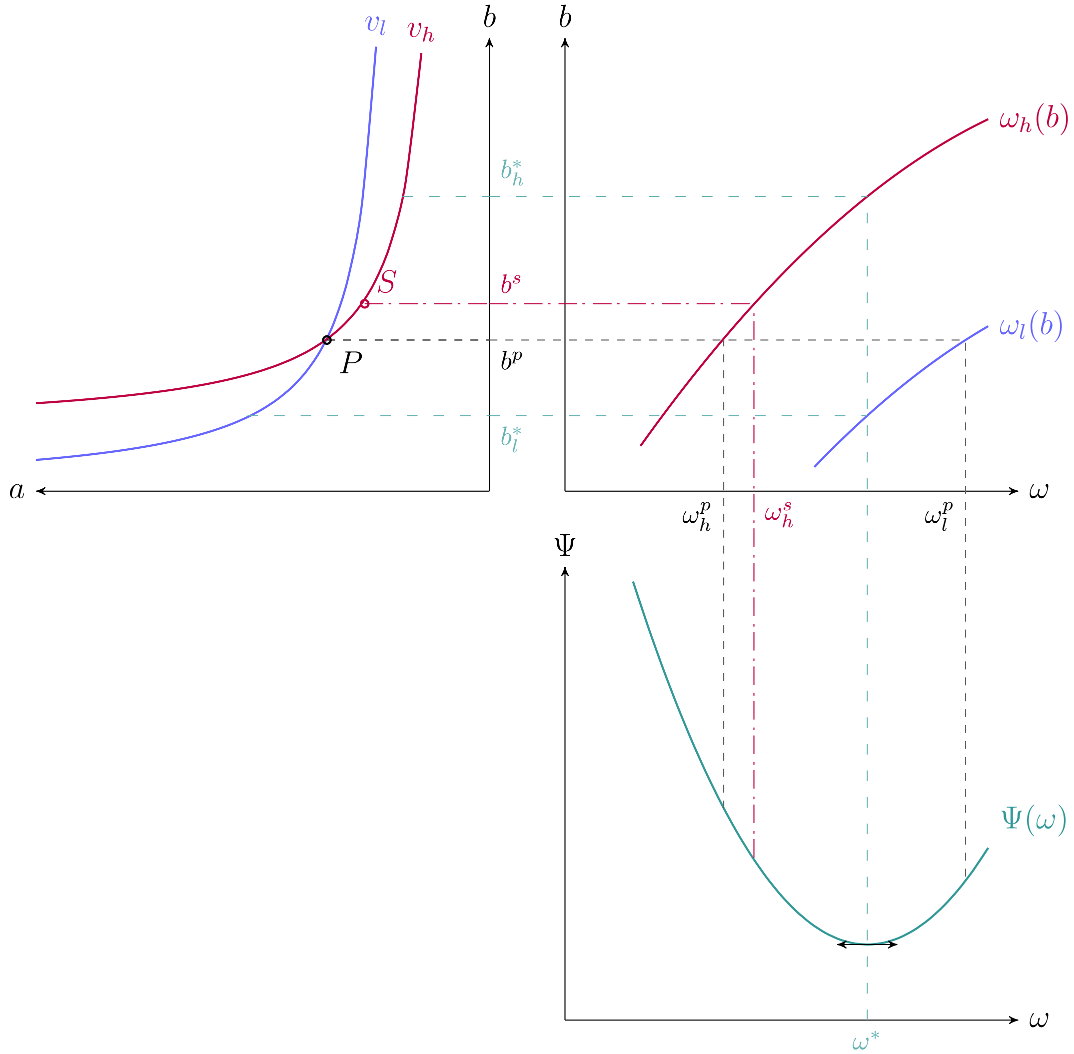
Van den Berg, Gerard J. 2001. “Duration models: specification, identification and multiple durations.” *Handbook of econometrics*, 5: 3381–3460.

Van Ours, Jan C, and Milan Vodopivec. 2006. “How shortening the potential duration of unemployment benefits affects the duration of unemployment: Evidence from a natural experiment.” *Journal of Labor economics*, 24(2): 351–378.

Vishwanath, Tara. 1989. “Job search, stigma effect, and escape rate from unemployment.” *Journal of Labor Economics*, 7(4): 487–502.

Whinston, Michael D. 1983. “Moral hazard, adverse selection, and the optimal provision of social insurance.” *Journal of Public Economics*, 22(1): 49–71.

Figure 1. Optimal pooling contract and gains from deviations for type-h and type-l with $f_h < f_l$.



Notes: This figure represents the optimal pooling contract and one Pareto-superior set of separating contracts when the single-crossing condition is verified ($b_h^* > b_l^*$). The top-left panel plots indifference curves $\omega(b) + \rho a = v$ for types h and l in the (b, a) plane. The top-right panel plots the reservation wage ω for both types as functions of the income replacement rate b. The bottom-right panel depicts the government cost function Ψ as a function of reservation wage ω. The point P represents the optimal pooling contract, with unemployment benefit b^p and corresponding reservation wages ω_h^p and ω_l^p. The point S represents an alternative contract offering $b^s > b^p$ and leaving type-h indifferent with the pooling contract P. Under the alternative contract, the reservation wage of type-h implies a lower budgetary cost Ψ for the government. Note that type-l agents strictly prefer the pooling contract since S is below their indifference curve going through P.

Table 1. Sensitivity of reservation wage and insurance payment to benefits, across job seekers with different search efficiency (type-h job seekers have *low* search efficiency).

	Reservation wage	Insurance payments
	Panel A: type-h job seekers	
Treatment	.1101	.0733
	(.0616)	(.1088)
	[1,882]	[2,034]
	Panel B: type-l job seekers	
Treatment	.0718	.1809
	(.0466)	(.0980)
	[2,527]	[1,607]

Robust standard errors are reported between parentheses. The number of observations is reported between square brackets. Note that the bandwidth is selected optimally following Imbens and Kalyanaraman (2012) and includes fewer observations, typically between 600 and 1,000. The dependent variable is the (log) reservation wage (column 1) and the (log) total payment granted by the unemployment agency during the unemployment spell (column 2). We report the conventional local-polynomial regression-discontinuity estimate, which are not bias-adjusted. Type-h job seekers are respondents whose search efficiency is estimated to be low by the caseworker; type-l job seekers are respondents whose search efficiency is estimated to be high.

ONLINE APPENDIX

A Additional Figures and Tables

Table A1. Labor market policies—insurance benefits.

	Duration	Replacement rate (%)
Belgium	Unlimited	60 (net)
Canada	11	55 (gross)
Denmark	24	90 (gross)
France	24	57-75 (gross)
Germany	12	60 (net)
Italy	8	60 (gross)
Japan	9	50-80 (gross)
Korea	7	50 (gross)
Netherlands	22	70 (gross)
Norway	24	62 (gross)
Spain	24	65 (gross)
Sweden	24	70 (gross)
Switzerland	18	70 (gross)
United States	23 (6)	53 (gross)

Source: OECD, 2010.

B Proofs

Proof. **Optimal reservation wage and concavity of Ψ.**

Consider the maximization program in the perfect information benchmark,

$$C(U) = \min_{\omega,v} \left\{ -\Psi(\omega) + \frac{v}{\rho} \right\},$$

subject to $v \geq u^{-1}(\rho U)$, where $\Psi(.)$ is defined by:

$$\Psi(\omega) = \frac{f}{\rho} \frac{\omega\left(1 - G(\omega)\right) + \frac{1}{\alpha}\left(1 - G(\omega) + \int_\omega^\infty u(x-\omega)dG(x)\right)}{\rho + f\left(1 - G(\omega)\right)}.$$

One can show that,

$$\frac{\rho\alpha}{f}\Psi^{'}(\omega) = \frac{A(\omega) + B(\omega)\int_\omega^\infty u(x-\omega)dG(x)}{\left(\rho + f\left(1-G(\omega)\right)\right)^2},$$

where

$$\begin{cases} A(\omega) = \rho\alpha\left[1 - G(\omega) - \omega g(\omega)\right] + f\left(1 - G(\omega)\right)\left(\alpha\left(1 - G(\omega)\right) + g(\omega)\right) \\ B(\omega) = \alpha\rho + f\left(\alpha\left(1 - G(\omega)\right) + g(\omega)\right) \end{cases}$$

The stationary point, verifying $\Psi^{'}(\omega^*) = 0$, is characterized by,

$$-\frac{\int_{\omega^*}^\infty u(x-\omega^*)dG(x)}{1 - G(\omega^*)} = 1 - \frac{\rho\alpha\omega^* g(\omega^*)}{\left(1 - G(\omega^*)\right)\left[\rho\alpha + f\left(g(\omega^*) + \alpha\left(1 - G(\omega^*)\right)\right)\right]}$$

We now focus on the curvature of Ψ around the stationary point. One can show that,

$$\frac{\rho\alpha}{f}\Psi^{''}(\omega^*) = \frac{A^{'}(\omega^*) + B^{'}(\omega^*)\int_{\omega^*}^\infty u(x-\omega^*)dG(x) + B(\omega^*)\left(g(\omega^*) + \alpha\int_{\omega^*}^\infty u(x-\omega^*)dG(x)\right)}{\left(\rho + f\left(1 - G(\omega^*)\right)\right)^2}.$$

We assume, for simplicity, that $\rho << f\left(1 - G(\omega^*)\right)$ in the considered range of reservation wages,

$$\alpha\rho\Psi^{''}(\omega^*) \approx \frac{B^{'}(\omega^*)\left(1 - G(\omega^*) + \int_{\omega^*}^\infty u(x-\omega^*)dG(x)\right) + \alpha B(\omega^*)\int_{\omega^*}^\infty u(x-\omega^*)dG(x}{\left(\rho + f\left(1 - G(\omega^*)\right)\right)^2}.$$

The curvature is locally negative around the stationary point, i.e., $\Psi^{''}(\omega^*) < 0$, as long as $B^{'}(\omega^*) = f(-\alpha g(\omega^*) + g^{'}(\omega^*)) < 0$. This condition is verified, for instance, if the density of wage offers is unimodal and decreasing after a value which is lower or equal than the optimal reservation wage. □

Proof. **Lemma 1.**

Without loss of generality, we posit that a newly unemployed job seeker has no initial wealth so that his initial wealth equals the UI contract lump-sum payment, i.e., $a_0 = a$.

We first derive the value of employment W as a function of remaining assets a_τ and the wage offer upon matching x. By assumption, the worker remains indefinitely in the firm with the same wage x and her discounted utility verifies:

$$W(x, a_\tau) = \frac{u(x + \rho a_\tau)}{\rho}$$

We now derive the value of being unemployed U in period τ for a job seeker with remaining assets a_τ. The worker's problem can be written as the following Hamilton-Jacobi equation:

$$\rho U(a_\tau) = \max_c \left\{ u(c) + \dot{a_\tau} U_a^{'}(a_\tau) + f\left(\int_w^\infty \max\left\{ W(x, a_\tau) - U(a_\tau), 0 \right\} dG(x) \right) \right\}$$

Given the job seeker's budget constraint, we have that $\dot{a_\tau} = \rho a_\tau + b + z - c$ such that the Hamilton-Jacobi equation can be expressed as follows,

$$\rho U(a_\tau) = \max_c \left\{ u(c) + (\rho a_\tau + b + z - c) U_a^{'}(a_\tau) \right\} + f\left(\int_w^\infty \max\left\{ W(x, a_\tau) - U(a_\tau), 0 \right\} dG(x) \right)$$

As the worker can borrow and save without constraints, she equalizes expected *marginal* utilities across periods and the optimal consumption choice should verify that $u^{'}(c) = U_a^{'}(a_\tau)$. With CARA utility, it implies that expected utilities across periods are equalized and $U(a_\tau)$ can be written as $u(\rho a_\tau + y)/\rho$ where y is constant over time and represents the worker's expected permanent income guaranteed by future potential unemployment benefits and future potential wage offers. Replacing $U(a_\tau)$ in the previous expression, we have:

$$0 = (\rho a_\tau + b + z - c) u^{'}(\rho a_\tau + y) + f\left(\int_w^\infty \max\left\{ u(x + \rho a_\tau) - u(\rho a_\tau + y), 0 \right\} dG(x) \right)$$

Interestingly, the worker's expected permanent income, y, is also the job seeker's reservation wage. Indeed, upon receiving an offer x, the job seeker accepts the offer as long as $u(\rho a_\tau + x)/\rho \geq u(\rho a_\tau + y)/\rho$, which can be reformulated as $y \leq x$.

$$0 = (b + z - y) u^{'}(\rho a_\tau + y) + f\left(\int_y^\infty u(x + \rho a_\tau) dG(x) - \int_y^\infty u(\rho a_\tau + y) dG(x) \right)$$

Dividing both sides by $u(\rho a_\tau + y)$, and letting $\omega(b)$ denote the solution:

$$\alpha\left(\omega(b) - b - z\right) = \frac{f}{\rho}\left(1 - G(\omega(b)) + \int_{\omega(b)}^{\infty} u(x - \omega(b))dG(x)\right),$$

and we know from our previous remarks that $U(a) = u(\rho a + \omega(b))/\rho$, which completes the proof. □

Proof. **Lemma 2.**

The following equation implicitly defines the reservation wage $\omega(b)$ as a function of unemployment benefits b, i.e.,

$$\alpha\left(\omega(b) - b - z\right) = \frac{f}{\rho}\left(1 - G\left(\omega(b)\right) + \int_{\omega(b)}^{\infty} u(x - \omega(b))dG(x)\right).$$

Assuming that G is a continuous distribution (i.e., without atoms and represented by an L(1) function g), we can apply the implicit function theorem,

$$\alpha\left(\omega^{'}(b) - 1\right) = \frac{f}{\rho}\left(-g\left(\omega(b)\right)\omega^{'}(b) - u(0)g\left(\omega(b)\right)\omega^{'}(b) - \omega^{'}(b)\int_{\omega(b)}^{\infty} u^{'}(x - \omega(b))dG(x)\right),$$

which brings:

$$\omega^{'}(b) = \frac{1}{1 + \frac{f}{\alpha\rho}\int_{\omega(b)}^{\infty} u'\left(x - \omega(b)\right)dG(x)}.$$

Providing comparative statics on $\omega^{'}(b)$ requires to apply the implicit function theorem once again to $\omega(b, f, h)$, using the previous equation. We start with the job offer arrival rate f:

$$\omega^{''}_{bf} = -\frac{\left(\omega^{'}_{b}\right)^{2}}{\rho\alpha}\left[\int_{\omega}^{\infty} u^{'}\left(x - \omega\right)dG(x) - f\omega^{'}_{f}g\left(\omega\right)u^{'}(0) - f\omega^{'}_{f}\int_{\omega}^{\infty} u^{''}\left(x - \omega\right)dG(x)\right].$$

Noting that $u^{''}(x) = -\alpha u^{'}(x)$, we can show that $\omega^{''}_{bf}$ is strictly negative if, and only if,

$$\int_{\omega}^{\infty} u^{'}\left(x - \omega\right)dG(x) > \frac{\alpha f\omega^{'}_{f}g(\omega)}{1 + \alpha f\omega^{'}_{f}}$$

which is verified for values of f that are sufficiently small.

Differentiating with respect to h brings:

$$\omega^{''}_{bh} = -\frac{\left(\omega^{'}_{b}\right)^{2}f}{\rho\alpha}\left[-\omega^{'}_{h}g\left(\omega\right)u^{'}(0) - \omega^{'}_{h}\int_{\omega}^{\infty} u^{''}\left(x - \omega\right)dG(x)\right].$$

Noting that $u^{''}(x) = -\alpha u^{'}(x)$, we can show that $\omega^{''}_{bh}$ is strictly positive if, and only if,

$$\int_{\omega}^{\infty} u^{'}(x-\omega)\, dG(x) < g(\omega).$$

Consequently, under the following condition,

$$\frac{\alpha f \omega_f^{'} g(\omega)}{1+\alpha f \omega_f^{'}} < \int_{\omega}^{\infty} u^{'}(x-\omega)\, dG(x) < g(\omega),$$

the willingness-to-pay for unemployment insurance, $\omega_b^{'}$, is decreasing in the job arrival rate f, and increasing in the value of home production h. □

Proof. **Proposition 1.**

Pooling contract We start by deriving the optimal contract among the set of feasible pooling contracts.

$$C(U) = \max_{b,v_h,v_l} \left\{ \mu\Psi_h(\omega_h(b)) + (1-\mu)\Psi_l(\omega_l(b)) - \mu\frac{v_h}{\rho} - (1-\mu)\frac{v_l}{\rho} \right\}$$

subject to:

$$\begin{cases} \mu u_h(v_h) + (1-\mu)u_l(v_l) = \rho U & (\lambda_u), \\ v_h - \omega_h(b) = v_l - \omega_l(b) & (\lambda_a). \end{cases}$$

The first-order conditions are:

$$\begin{cases} \mu\Psi_h^{'}(\omega_h(b))\,\omega_h^{'}(b) + (1-\mu)\Psi_l^{'}(\omega_l(b))\,\omega_l^{'}(b) + \lambda_a\left(\omega_h^{'}(b) - \omega_l^{'}(b)\right) = 0 \\ \frac{\mu}{\rho} - \lambda_u \mu u_h(v_h) - \lambda_a = 0 \\ \frac{1-\mu}{\rho} - \lambda_u(1-\mu)u_l(v_l) + \lambda_a = 0 \end{cases}$$

Consequently, the optimal replacement rate b^p needs to verify:

$$\mu\Psi_h^{'}(\omega_h(b^p))\,\omega_h^{'}(b^p) + (1-\mu)\Psi_l^{'}(\omega_l(b^p))\,\omega_l^{'}(b^p) = -\frac{\mu(1-\mu)\left(u_l^{'}(v_l) - u_h^{'}(v_h)\right)\left(\omega_h^{'}(b^p) - \omega_l^{R'}(b^p)\right)}{\rho(\mu u_h^{'}(v_h) + (1-\mu)u_l^{'}(v_l))}. \tag{B1}$$

and the lump-sum payments are set such that

$$\mu u_h(v_h) + (1-\mu)u_l(v_l) = \rho U, \tag{B2}$$

and

$$v_h - \omega_h(b^p) = v_l - \omega_l(b^p). \tag{B3}$$

In the program above, the reservation wages are implicitly determined by Equation (1) and the functions Ψ's are the sub-cost convex functions defined by Equation (3) in Section 2.

Deviation from pooling contract In order to understand when separating contracts are preferred, consider a small variation of the pooling contract: the planner still offers b^p to type-l but now offers $b^p + db$ to type-h. For type-h workers to prefer this contract and type-l workers to prefer the former pooling contract, we need to have v_h and v_l verifying:

$$\omega_h(b^p) - \omega_l(b^p) \leq v_h - v_l \leq \omega_l(b^p + db) - \omega_h(b^p + db)$$

There is a set of contracts verifying this inequality. Indeed,

$$\omega_l(b^p) - \omega_l(b^p) \leq v_h - v_l \leq \omega_h(b^p) - \omega_l(b^p) + \underbrace{db\left(\omega_h^{'}(b^p) - \omega_l^{'}(b^p)\right)}_{>0}$$

We will consider two particular contracts in this set of feasible separating contracts. First, there is the contract such that $v_h - v_l = \omega_h(b^p) - \omega_l(b^p) + db\left(\omega_h^{'}(b^p) - \omega_l^{'}(b^p)\right)$. We can show, by using the target utility constraint, that this contract would require the following changes in certainty equivalent consumptions:

$$\begin{cases} \mu dv_h = -\mu(1-\mu)\frac{u_l^{'}(v_l)}{\mu u_h^{'}(v_h)+(1-\mu)u_l^{'}(v_l)}\frac{\omega_h^{'}(b^p)-\omega_l^{'}(b^p)}{\omega_h^{'}(b^p)} \\ (1-\mu)dv_l = \mu(1-\mu)\frac{u_h^{'}(v_h)}{\mu u_h^{'}(v_h)+(1-\mu)u_l^{'}(v_l)}\frac{\omega_h^{'}(b^p)-\omega_l^{'}(b^p)}{\omega_h^{'}(b^p)} \end{cases}$$

Overall, the difference in total cost induced by this contract relatively to the pooling contract, dC_1, is:

$$dC_1 = \left(\mu\Psi_h^{'}\left(\omega_h(b^p)\right)\omega_h^{'}(b^p) + \frac{\mu(1-\mu)}{\rho}\frac{u_h^{'}(v_h) - u_l^{'}(v_l)}{\mu u_h^{'}(v_h) + (1-\mu)u_l^{'}(v_l)}\frac{\omega_h^{'}(b^p) - \omega_l^{'}(b^p)}{\omega_h^{'}(b^p)}\right)db$$

Using Equation (B1), this is equal to

$$dC_1 = -(1-\mu)\Psi_l^{'}\left(\omega_l(b^p)\right)\omega_l^{'}(b^p)db.$$

Second, there is the contract such that $v_h - v_l = \omega_h(b^p) - \omega_l(b^p)$. We can show, by using the target utility constraint, that this contract would require no changes in indirect utility compared to the pooling contract: $dv_h = dv_l = 0$. Overall, the difference in total cost between this contract and the pooling contract, dC_2, is:

$$dC_2 = \mu\Psi_h^{'}\left(\omega_h(b^p)\right)\omega_h^{'}(b^p)db.$$

As a consequence, we have shown that, when $\Psi_h^{'}(\omega_h(b^p)) > 0 \Leftrightarrow b^p < b_h^*$ or $\Psi_l^{'}(\omega_l(b^p)) < 0 \Leftrightarrow b^p > b_l^*$, there is a gain in separating type-h and type-l job seekers into two different contracts. One of the two conditions is always verified when $b_h^* > b_l^*$. When $b_h^* \leq b_l^*$ instead, there would be no gains in increasing benefits for type-h worker. The planner would prefer to reduce benefits for type-h instead. However, in such case, the set of contracts verifying the incentive-compatible constraints:

$$\omega_h(b^p) - \omega_l(b^p) \leq v_h - v_l \leq \omega_h(b^p) - \omega_l(b^p) - \underbrace{db\left(\omega_h^{'}(b^p) - \omega_l^{'}(b^p)\right)}_{<0}$$

would be empty and the only possible contract is a pooling contract.

Optimal separating contracts When the condition $b_h^* > b_l^*$ is verified, the planner minimizes the total cost of a policy (b_h, v_h, b_l, v_l):

$$C(U) = \min_{b_h, v_h, b_l, v_l} \left\{ -\mu\Psi_h(\omega_h(b_h)) - (1-\mu)\Psi_l(\omega_l(b_l)) + \mu\frac{v_h}{\rho} + (1-\mu)\frac{v_l}{\rho} \right\}$$

subject to:

$$\mu u_h(v_h) + (1-\mu)u_l(v_l) \geq U,$$

and two incentive-compatibility constraints:

$$\begin{cases} v_h - v_l \geq \omega_h(b_l) - \omega_l(b_l) \\ v_l - v_h \geq \omega_l(b_h) - \omega_h(b_h) \end{cases}$$

This program is simple to solve:

1. when $\omega_h(b_l^*) - \omega_l(b_l^*) \leq 0 \leq \omega_l(b_h^*) - \omega_h(b_h^*)$, then the solution is to set (b_h^*, b_l^*), and $v_h = v_l$;

2. when $\omega_h(b_l^*) - \omega_l(b_l^*) > 0$, then $v_h > v_l$ and the planner sets (b_h^*, b_l^s) in which

$$(1-\mu)\Psi_l^{'}(\omega_l(b_l^s))\omega_l^{'}(b_l^s) = -\frac{\mu(1-\mu)(u_h^{'}(v_h) - u_l^{'}(v_l))(\omega_h^{'}(b_l^s) - \omega_l^{'}(b_l^s))}{\rho(\mu u_h^{'}(v_h) + (1-\mu)u_l^{'}(v_l))}; \quad \text{(B4)}$$

3. when $\omega_h(b_h^*) - \omega_l(b_h^*) < 0$, then $v_h < v_l$ and the planner sets (b_h^s, b_l^*) in which:

$$\mu\Psi_h^{'}(\omega_h(b_h^s))\omega_h^{'}(b_h^s) = -\frac{\mu(1-\mu)(u_h^{'}(v_h) - u_l^{'}(v_l))(\omega_h^{'}(b_h^s) - \omega_l^{'}(b_h^s))}{\rho(\mu u_h^{'}(v_h) + (1-\mu)u_l^{'}(v_l))}. \quad \text{(B5)}$$

These conditions, together with the characterization of the optimal pooling contract, fully characterizes the planner's optimal choice. □

Proof. **Proposition 2.**

Under the assumption that the discount rate ρ is negligible compared to the job finding rates, i.e., $f\left(1 - G(\omega)\right) >> \rho$, the solution ω^* to the minimization of $-\Psi(\cdot)$ is independent of the job arrival rate f or home production z. The optimal replacement rate under perfect information, b^*, needs to verify:

$$\omega(b^*(f,z), f, z) = \omega^*$$

Differentiating this equation with respect to f brings:

$$\frac{\partial \omega}{\partial b}\frac{\partial b^*}{\partial f} + \frac{\partial \omega}{\partial f} = 0,$$

and thus

$$\frac{\partial b^*}{\partial f} = -\frac{\partial \omega}{\partial f}/\frac{\partial \omega}{\partial b} < 0.$$

Differentiating this equation with respect to z brings:

$$\frac{\partial \omega}{\partial b}\frac{\partial b^*}{\partial z} + \frac{\partial \omega}{\partial z} = 0,$$

and thus

$$\frac{\partial b^*}{\partial z} = -\frac{\partial \omega}{\partial z}/\frac{\partial \omega}{\partial b} < 0.$$

Consequently,

1. if type-h and l differ along the job interview rate f, then $b_h^* > b_l^*$ and the planner offers two separating contracts;
2. if type-h and l differ along home production z, then $b_h^* < b_l^*$ and the planner offers a unique pooling contract.

□

Proof. **Proposition 3.**

In a first step, we construct a deviating contract (S_h^d) from the pooling contract (P) by moving along the indifference curve of type-h. Contract (S_h^d) is the same as contract (P) except for the tax rate and for the replacement rate at duration d, which we increment by an infinitesimal amount ε:

$$S_h^d = \left(\tilde{a} - \frac{\partial V_h/\partial b_d}{\partial V_h/\partial a}\varepsilon, \tilde{b}_1, \tilde{b}_2, \ldots, \tilde{b}_d + \varepsilon, \tilde{b}_{d+1}, \ldots\right)$$

The relative welfare of both types under the new contract is:

$$\begin{cases} U_h(S_h^d) - U_h(P) = 0 \\ U_l(S_h^d) - U_l(P) = -\frac{\partial V_l}{\partial a}\left[\frac{\partial V_h/\partial b_d}{\partial V_h/\partial a} - \frac{\partial V_l/\partial b_d}{\partial V_l/\partial a}\right]\varepsilon < 0 \end{cases}$$

which ensures that type-h is indifferent between both contracts while type-l unambiguously prefers the lower-insurance pooling contract. We now compute the difference in costs $\Delta\Psi(P, S_h^d)$ implied by the sorting of types into the two different contracts:

$$\Delta\Psi(P, S_h^d) = \mu\left[\frac{\partial\Psi_h}{\partial b_d} - \frac{\partial V_h/\partial b_d}{\partial V_h/\partial a}\right]\varepsilon$$

In a second step, we construct a deviating contract (S_l^d) from the pooling contract (P) by moving along the indifference curve of type-l. Contract (S_l^d) is the same as contract (P) except for a lower replacement rate at duration d:

$$S_l^d = \left(\tilde{a} + \frac{\partial V_l/\partial b_d}{\partial V_l/\partial a}\varepsilon, \tilde{b}_1, \tilde{b}_2, \ldots, \tilde{b}_d - \varepsilon, \tilde{b}_{d+1}, \ldots\right)$$

The relative welfare of both types under the new contract is:

$$\begin{cases} U_h(S_h^d) - U_h(P) = -\frac{\partial V_h}{\partial a}\left[\frac{\partial V_h/\partial b_d}{\partial V_h/\partial a} - \frac{\partial V_l/\partial b_d}{\partial V_l/\partial a}\right]\varepsilon < 0 \\ U_l(S_h^d) - U_l(P) = 0 \end{cases}$$

which ensures that type-l is indifferent between both contracts while type-h unambiguously prefers the higher-insurance pooling contract. The difference in costs $\Delta\Psi(P, S_l^d)$ implied by the sorting of types into the two different contracts is:

$$\Delta\Psi(P, S_l^d) = (1-\mu)\left[\frac{\partial V_l/\partial b_d}{\partial V_l/\partial a} - \frac{\partial\Psi_l}{\partial b_d}\right]\varepsilon$$

It is easy to show that $\partial\Psi_h/\partial b_d \leq \partial\Psi_l/\partial b_d$ is a sufficient condition for both $\Delta\Psi(P, S_h^d)$ and $\Delta\Psi(P, S_l^d)$ to be strictly negative, and thus for both sets of separating contracts to be preferred to the unique pooling contract. Indeed,

$$\begin{aligned}
&\frac{\partial \Psi_h}{\partial b_d} \leq \frac{\partial \Psi_l}{\partial b_d} \\
\Leftrightarrow &\mu \frac{\partial \Psi_h}{\partial b_d} + (1-\mu)\frac{\partial \Psi_h}{\partial b_d} \leq \frac{\partial \Psi_l}{\partial b_d} \\
\Leftrightarrow &\frac{\partial V_l/\partial b_d}{\partial V_l/\partial a} \frac{1-\mu+\mu\frac{\partial V_h/\partial b_d}{\partial V_l/\partial b_d}}{1-\mu+\mu\frac{\partial V_h/\partial a}{\partial V_l/\partial a}} \leq \frac{\partial \Psi_l}{\partial b_d} \\
\Rightarrow &\frac{\partial V_l/\partial b_d}{\partial V_l/\partial a} < \frac{\partial \Psi_l}{\partial b_d} \\
\Rightarrow &\Delta\Psi(P, S_l^d) < 0
\end{aligned}$$

because Condition (6) ensures that

$$\frac{1-\mu+\mu\frac{\partial V_h/\partial b_d}{\partial V_l/\partial b_d}}{1-\mu+\mu\frac{\partial V_h/\partial a}{\partial V_l/\partial a}} < 1$$

In the same vein, we have that:

$$\begin{aligned}
&\frac{\partial \Psi_h}{\partial b_d} \geq \frac{\partial \Psi_h}{\partial b_d} \\
\Leftrightarrow &\mu \frac{\partial \Psi_h}{\partial b_d} + (1-\mu)\frac{\partial \Psi_h}{\partial b_d} \geq \frac{\partial \Psi_h}{\partial b_d} \\
\Leftrightarrow &\frac{\partial V_h/\partial b_d}{\partial V_h/\partial a} \frac{\mu+(1-\mu)\frac{\partial V_l/\partial b_d}{\partial V_h/\partial b_d}}{\mu+(1-\mu)\frac{\partial V_l/\partial a}{\partial V_h/\partial a}} \geq \frac{\partial \Psi_h}{\partial b_d} \\
\Rightarrow &\frac{\partial V_h/\partial b_d}{\partial V_h/\partial a} > \frac{\partial \Psi_l}{\partial b_d} \\
\Rightarrow &\Delta\Psi(P, S_h^d) < 0
\end{aligned}$$

because Condition (6) ensures that

$$\frac{\mu+(1-\mu)\frac{\partial V_l/\partial b_d}{\partial V_h/\partial b_d}}{\mu+(1-\mu)\frac{\partial V_l/\partial a}{\partial V_h/\partial a}} > 1$$

□

C Extensions

In this section, we discuss four extensions of the baseline model. In a first step, we write the baseline model with a continuum of types $i \in [0, 1]$. In a second step, we introduce some uncertainty on the worker side about her own type. Specifically, we model two ex-ante types of workers drawing their ex-post types along two distinct distributions. In a third step, we come back to discrete types, with type-h and type-l workers, but we allow the type-h job seeker to have different priors than the planner about her own type. In a fourth step, we introduce wage bargaining upon matching with the firm and we allow the firm to use the signal conveyed by the agent's choice of insurance contracts.

C.1 Continuum of types

Suppose that there is a continuum of types indexed by $i \in [0, 1]$ verifying the following assumptions: (i) The functions Ψ_i are concave on an open convex set including the optimal levels of reservation wages $\{\omega_i^*\}_{i\in[0,1]}$ under perfect information; (ii) the marginal willingness to pay for insurance is decreasing in type i, i.e., $\frac{\partial^2 w(i,b)}{\partial i \partial b} < 0$ for all b and i.

Pooling benchmark With one pooling contract, the planner minimizes the total cost $C(U)$ of a policy by choosing a flow of benefits b such that:

$$C(U) = \min_{b,\{v_i\}_{i\in[0,1]}} \left\{ -\int_0^1 \Psi_i(\omega_i(b))di + \int_0^1 \frac{v_i}{\rho} di \right\}$$

under the following constraints:

$$\begin{cases} v_i = \omega_i(b) + \rho a, \quad a \text{ constant} \\ \int_0^1 u_i(v_i)di = \rho U \end{cases}$$

The solution verifies:

$$\begin{cases} -\int_0^1 (\Psi_i'(\omega_i(b))\omega_i'(b)di = \frac{1}{\rho}\left[\frac{\int_0^1 u_i'(v_i)\omega_i'(b)di}{\int_0^1 u_i(v_i)di} - \int_0^1 \omega_i'(b)di\right] \\ \int_0^1 u_i(v_i)di = \rho U \end{cases}$$

The pooling contract with continuous types is similar to the pooling contract with discrete types. In particular, the right term of the first equation captures the redistribution motive between types. When the marginal utility—evaluated at the certainty equivalent consumption—differs across types, the planner incorporates it in its choice of optimal replacement rate and reduces discrepancies in marginal utilities.

Separating contracts The planner minimizes the cost $C(U)$ of a policy by choosing a replacement rate schedule $\{b_i\}_{i\in[0,1]}$ and a certainty equivalent consumptions schedule $\{v_i\}_{i\in[0,1]}$ such that:

$$C(U) = \min_{\{b_i,v_i\}_{i\in[0,1]}} \left\{ -\int_0^1 \Psi_i(\omega_i(b_i))di + \int_0^1 \frac{v_i}{\rho}di \right\}$$

subject to a target utility constraint:

$$\int_0^1 u_i(v_i)di = \rho U,$$

and an incentive-compatibility constraint:

$$\frac{\partial v_i}{\partial i} - \frac{\partial \omega_i(b_i)}{\partial i} \geq 0, \quad \forall i \in [0,1].$$

The problem is formulated as an optimal control problem in which $v_i = v(i)$ is the state, $b_i = b(i)$ is the control, and the incentive-compatibility constraint is the law of motion.

Optimal contracts When the optimal benefit schedule under perfect information, $\{b_i^*\}_{i\in[0,1]}$, is decreasing in type i, a continuum of separating contracts is chosen by the planner, and such schedule has the same characteristics as in the discrete case. The replacement rate schedule $\{b_i\}_{i\in[0,1]}$ is decreasing, and high-risk individuals—with a low type i—sort into high insurance contracts, while low-risk individuals are attracted by contracts delivering most of their proceeds through a severance payment. When, instead, the optimal benefit schedule under perfect information $\{b_i^*\}_{i\in[0,1]}$ is increasing in type i, separating contracts for any pair of individuals is not incentive-compatible and a unique pooling contract is offered with the replacement rate minimizing a weighted average of the type-specific functions $-\Psi_i(\cdot)$, as in the discrete case.

Proof. The proof is similar as that of Proposition 1, but rather uses a "calculus of variation" argument, i.e., the deviation from the pooling contract continuously differs across type.

We assume that the optimal benefit schedule under perfect information, $\{b_i^*\}_{i\in[0,1]}$, is decreasing in type i. In such case, a pooling contract, offering benefits $\tilde{b}$, cannot be optimal. Indeed, consider instead the infinitesimal deviation $\tilde{b} + \varepsilon_i$ with ε_i infinitesimal, continuous and decreasing in type i, and adjust severance payments such as to keep $\frac{\partial v_i}{\partial i} - \frac{\partial \omega_i(\tilde{b}+\varepsilon_i)}{\partial i}$ similar as before. One can easily show that there is an infinitesimal gain in insurance cost if, for instance, we choose ε_i proportional to $\Psi_i'(\tilde{b})$, which is decreasing in type i given our initial assumption.

When, instead, the optimal benefit schedule under perfect information $\{b_i^*\}_{i\in[0,1]}$ is increasing in type i, no decreasing benefit schedule would satisfy the incentive constraint: only a pooling contract is feasible. □

C.2 Uncertainty

We now extend the baseline model to allow for uncertainty. We assume that there are two *ex-ante* different types of job seekers, type-h and type-l job seekers, and both types draw their *ex-post* type $i \in [0, 1]$ from two distinct distributions H_h and H_l. We suppose that (i) H_l is first-order stochastically dominant over H_h and (ii) the marginal willingness to pay for insurance is decreasing in the ex-post type i. Both assumptions ensure that type-h job seekers are more frequently high-risk ex-post.

Pooling contract The planner minimizes the total cost $C(U)$ of a policy by choosing a flow of benefits b and a certainty equivalent consumptions schedule $\{v_i\}_{i\in[0,1]}$ such that:

$$\begin{aligned} C(U) &= \min_{b,\{v_i\}_{i\in[0,1]}} && -\mu \int_0^1 \Psi_i(\omega_i(b))dH_h(i) - (1-\mu)\int_0^1 \Psi_i(\omega_i(b))dH_l(i) \\ & && +\mu \int_0^1 \frac{v_i}{\rho} dH_h(i) + (1-\mu)\int_0^1 \frac{v_i}{\rho} dH_l(i) \end{aligned}$$

subject to a target utility constraint and the fact that lump-sum payments are the same across types:

$$\begin{cases} \mu \int_0^1 u_i(v_i)dH_h(i) + (1-\mu)\int_0^1 u_i(v_i)dH_l(i) = \rho U \\ v_i = \omega_i(b) + \rho a \end{cases}$$

The solution verifies:

$$\begin{cases} -\int_0^1 (\Psi_i'(\omega_i(b))\omega_i'(b)h(i)di = \frac{1}{\rho}\left[\frac{\int_0^1 u_i'(v_i)\omega_i'(b)h(i)di}{\int_0^1 u_i(v_i)h(i)di} - \int_0^1 \omega_i'(b)h(i)di\right] \\ \int_0^1 u_i(v_i)h(i)di = \rho U \end{cases}$$

The pooling contract can be expressed in a similar fashion as with continuous types. Indeed, ex-ante differences between agents are irrelevant with only one contract and only the distribution of ex-post types $h(\cdot) = \mu h_h(\cdot) + (1-\mu)h_l(\cdot)$ matters.

Separating contracts The planner minimizes the total cost $C(U)$ of a policy by choosing an insurance schedule (b_h, b_l) and initial lump-sum payments payment (a_h, a_l) such that:

$$\begin{aligned} C(U) \quad = \min_{b_h,b_l,a_h,a_l} \quad & -\mu \int_0^1 \Psi_i(\omega_i(b_h))dH_h(i) - (1-\mu)\int_0^1 \Psi_i(\omega_i(b_l))dH_l(i) \\ & +\mu \int_0^1 \frac{\omega_i(b_h)+\rho a_h}{\rho} dH_h(i) + (1-\mu)\int_0^1 \frac{\omega_i(b_l)+\rho a_l}{\rho} dH_l(i) \end{aligned}$$

subject to a target utility constraint:

$$\mu \int_0^1 u_i(\omega_i(b_h) + \rho a_h)dH_h(i) + (1-\mu)\int_0^1 u_i(\omega_i(b_l) + \rho a_l)dH_l(i) = \rho U$$

and two incentive-compatibility constraints:

$$\begin{cases} \int_0^1 u_i(\omega_i(b_h) + \rho a_h)dH_h(i) \geq \int_0^1 u_i(\omega_i(b_l) + \rho a_l)dH_h(i) \\ \int_0^1 u_i(\omega_i(b_l) + \rho a_l)dH_l(i) \geq \int_0^1 u_i(\omega_i(b_h) + \rho a_h)dH_l(i) \end{cases}$$

One can show, following the exact same proof as in Proposition 1, that the planner offers a pooling contract (resp. separating contracts) when the optimal benefit schedule under perfect information, $\{b_i^*\}_{i\in[0,1]}$, is increasing in the ex-post type i (resp. decreasing in i). The only difference with Proposition 1 is that the infinitesimal gain in insurance costs driven by an infinitesimal change in benefits would appear as $db \int_0^1 \Psi_i'(\omega_i(\tilde{b}))\omega_i'(\tilde{b})dH_h(i)$ (if we slightly decrease benefits) or $-db \int_0^1 \Psi_i'(\omega_i(\tilde{b}))\omega_i'(\tilde{b})dH_l(i)$ (if we slightly increase benefits). Following the same reasoning as in Proposition 1, one of these two quantities needs to be positive if $\{b_i^*\}_{i\in[0,1]}$, is decreasing in i.

C.3 Biased beliefs

In this extension, we consider two types of agents $\{h, l\}$, and the high-risk type-h worker—in proportion μ—has a higher willingness-to-pay for insurance than type-l worker. The two types are unobserved to the unemployment agency, as in the baseline model, and we suppose that Ψ_h and Ψ_l are concave on an open convex set including the optimal levels of reservation wages ω_h^* and ω_l^* under perfect information. In contrast with the baseline model, however, we assume that a share ε of type-h worker think—upon layoff and during their entire unemployment spell—that they are low-risk.[26]

[26] We abstract from learning during the unemployment spell in order to keep simple expressions for the planner's valuations of each contract. With learning, the results would be qualitatively similar, but the reservation wage of these disillusioned high-risk job seekers would not be stationary and would not be straightforward to characterize.

We first derive the certainty equivalent consumption of these biased type-h workers. While these agents will behave as type-l workers in terms of contractual choices and in setting their schedule of reservation wages along the unemployment spell, the true valuation of the insurance contract—from the planner's viewpoint—will differ from type-l valuation.

The problem is stationary in unemployment duration and the reservation wage is independent of assets and similar to type-l reservation wage. Letting $w_h^\varepsilon(b)$ denote the certainty equivalent consumption of biased type-h workers, we have that

$$\alpha\left(w_h^\varepsilon(b) - b - h_h\right) = \frac{f_h}{\rho}\left(1 - G_h(\omega_l(b)) + \int_{\omega_l(b)}^{\infty} u_h(x - w_h^\varepsilon(b) dG_h(x)\right),$$

in which h_h, f_h, G_h, and u_h denote the (actual) home production, job arrival rate, wage offer distribution and utility of these type-h job seekers. In parallel, the certainty equivalent consumption (and reservation wages) of unbiased type-h and type-l workers are still characterized by the same Equation (1) as in Lemma 1.

We also need to define the budget cost of an insurance contract for biased agents, $\Phi_h(\omega_l(b))$:

$$\Phi_h(\omega_l(b)) = \frac{\omega_l(b) - \frac{f_l}{\alpha_l \rho}\left(1 - G_l(\omega_l(b)) + \int_{\omega_l(b)}^{\infty} u_l(x - \omega_l(b)) dG_l(x)\right)}{\rho + f_h\left(1 - G_h(\omega_l(b))\right)} - \frac{\omega_l(b)}{\rho}$$

Pooling contract With one pooling contract, the planner minimizes the total cost $C(U)$ of a policy by choosing a flow of benefits b and certainty equivalent consumptions for unbiased workers (v_h, v_l) such that:

$$C(U) = \min_{b, v_h, v_l}\left\{-\mu(1-\varepsilon)\Psi_h(\omega_h(b)) - \mu\varepsilon\Phi_h(\omega_l(b)) - (1-\mu)\Psi_l(\omega_l(b)) + \mu\frac{v_h}{\rho} + (1-\mu)\frac{v_l}{\rho}\right\}$$

subject to a target utility constraint and the fact that lump-sum payments are the same across types:

$$\begin{cases} \mu(1-\varepsilon)u_h(v_h) + \mu\varepsilon u_h(v_l + w_h^\varepsilon(b) - \omega_l(b)) + (1-\mu)u_l(v_l) = \rho U, \\ v_h - \omega_h(b) = v_l - \omega_l(b). \end{cases}$$

The solution verifies:

$$\begin{cases} -\mu(1-\varepsilon)\Psi_h'(\omega_h(b))\omega_h'(b) - \mu\varepsilon\Phi_h'(\omega_l(b))\omega_l'(b) - (1-\mu)\Psi_l'(\omega_l(b))\omega_l'(b) = R(\omega_h(b), \omega_l(b), v_h, v_l) \\ \mu(1-\varepsilon)u_h(v_h) + \mu\varepsilon u_h(v_l + w_h^\varepsilon(b) - \omega_l(b)) + (1-\mu)u_l(v_l) = \rho U \end{cases}$$

where $R(\omega_h(b), \omega_l(b), v_h, v_l)$ the redistribution term is defined as follows:

$$R(\omega_h(b), \omega_l(b), v_h, v_l) = \frac{\mu(1-\varepsilon)u_h^{'}(v_h)\omega_h^{'}(b)+\mu\varepsilon u_h^{'}(v_l+w_h^{\varepsilon}(b)-\omega_l(b))w_h^{\varepsilon'}(b)+(1-\mu)u_l^{'}(v_l)\omega_h^{'}(b)}{\mu(1-\varepsilon)u_h^{'}(v_h)+\mu\varepsilon u_h^{'}(v_l+w_h^{\varepsilon}(b)-\omega_l(b))+(1-\mu)u_l^{'}(v_l)} - \mu\frac{\omega_h^{'}(b)}{\rho} - (1-\mu)\frac{\omega_l^{'}(b)}{\rho}$$

Separating contracts With two contracts, the planner minimizes the total cost $C(U)$ of a policy by choosing a flow of benefits (b_h, b_l) and certainty equivalent consumptions v_h and v_l such that:

$$C(U) = \min_{b_h, v_h, b_l, v_l} \left\{ -\mu(1-\varepsilon)\Psi_h(\omega_h(b_h)) - \mu\varepsilon\Phi_h(b_l) - (1-\mu)\Psi_l(\omega_l(b_l)) + \mu\frac{v_h}{\rho} + (1-\mu)\frac{v_l}{\rho} \right\}$$

subject to a target utility constraint:

$$\mu(1-\varepsilon)u_h(v_h) + \mu\varepsilon u_h(v_l + w_h^{\varepsilon}(b_l) - \omega_l(b_l)) + (1-\mu)u_l(v_l) = \rho U,$$

and two incentive-compatibility constraints:

$$\begin{cases} v_h - v_l \geq \omega_h(b_l) - \omega_l(b_l) \\ v_h - v_l \leq \omega_h(b_h) - \omega_l(b_h) \end{cases}$$

Note that, given that biased type-h workers incorrectly consider themselves as type-l, they cannot be attracted in a third contract and will behave exactly as type-l agents do.

If ε is sufficiently small, the same reasoning as in Proposition 1 applies. An infinitesimal deviation from the pooling contract with more generous benefits would attract a fraction $1-\varepsilon$ of type-h and generate a variation in insurance costs proportional to $\Psi_h^{'}(\omega_h(\tilde{b}))\omega_h^{'}(\tilde{b})$. An infinitesimal deviation from the pooling contract with less generous benefits would attract a fraction ε of type-h and all type-l; it would generate a variation in insurance costs equal to $-(1-\mu)\Psi_l^{'}(\omega_l(\tilde{b}))\omega_l^{'}(\tilde{b}) - \mu\varepsilon\Phi_h^{'}(\tilde{b})$. If ε is sufficiently small (and under the assumption that $b_h^* > b_l^*$), one of these two quantities would be positive and thus constitute an improvement over the pooling contract for the unemployment agency.

C.4 Signaling and endogenous wage offers

In this extension, we model how contractual choices could modify the behavior of firms upon matching with a job seeker. Intuitively, firms may use the contractual choice as a signal on unobserved characteristics, and revise its priors on the worker's reservation wage. In order to model such signaling channel, we need to modify wage-setting and allow wages to depend on the worker's inferred reservation wage.

We now assume that $G(\cdot)$ denote the (exogenous) distribution of match output y, and we assume that (i) there is Nash bargaining between the firm and the worker upon matching (with a share ν of the surplus going to the worker), (ii) the contractual choice can be observed and verified by the firm upon matching.

Under these assumptions, the reservation wage of the job seeker (and valuation of the insurance contract) depends upon the perceived reservation wage, w, upon matching with possible employers. The reservation wage is characterized as in Lemma 1:

$$\alpha\left(\omega(b,w)-b\right)=\frac{f}{\rho}\left(1-G(\omega(b,w))+\int_{\omega(b)}^{\infty}u(w+\nu(y-w)-\omega(b,w(b)))dG(y)\right) \tag{C6}$$

Two remarks are in order. First, the wage received by workers is $w+\nu(y-w)$ because workers receive their perceived outside option w, and a share of the perceived surplus, $y-w$. Second, under perfect information, we have $w(b)=\omega(b)$ and the reservation wage verifies,

$$\alpha\left(\omega(b)-b\right)=\frac{f}{\rho}\left(1-G(\omega(b))+\int_{\omega(b)}^{\infty}u\left(\nu(y-w(b))\right)dG(y)\right)$$

almost as in the baseline case. The baseline model of Section 2 is thus equivalent to a framework with Nash bargaining and no information asymmetry between the firm and the worker.

Pooling contract With one pooling contract, the firm cannot distinguish low-risk from high-risk job seekers and the verifiable reservation wage upon matching is constant across workers, $w=\mu\omega_h(b)+(1-\mu)\omega_l(b)$, where the reservation wages of type-i workers verify:

$$\alpha\left(\omega_i(b)-b\right)=\frac{f_i}{\rho}\left(1-G_i(\omega_i(b))+\int_{\omega_i(b)}^{\infty}u_i(w+\nu(y-w)-\omega(b))dG_i(y)\right) \tag{C7}$$

The planner minimizes the total cost $C(U)$ of a policy by choosing a flow of benefits b and certainty equivalent consumptions for unbiased workers (v_h,v_l) such that:

$$C(U)=\min_{b,v_h,v_l}\left\{-\mu\Psi_h(\omega_h(b))-(1-\mu)\Psi_l(\omega_l(b))+\mu\frac{v_h}{\rho}+(1-\mu)\frac{v_l}{\rho}\right\}$$

subject to a target utility constraint and the fact that lump-sum payments are the same across types:

$$\begin{cases} \mu u_h(v_h) + (1-\mu)u_l(v_l) = \rho U, \\ v_h - \omega_h(b) = v_l - \omega_l(b). \end{cases}$$

The only difference with the baseline pooling contract comes from the outside option in wage setting (see Equation (C7)), and the solution looks very similar (albeit the expressions for $\omega_i^{'}$). The optimal replacement rate b verifies:

$$\mu\Psi_h^{'}(\omega_h(b))\,\omega_h^{'}(b) + (1-\mu)\Psi_l^{'}(\omega_l(b))\,\omega_l^{'}(b) = -\frac{\mu(1-\mu)\left(u_l^{'}(v_l) - u_h^{'}(v_h)\right)\left(\omega_h^{'}(b) - \omega_l^{R'}(b)\right)}{\rho(\mu u_h^{'}(v_h) + (1-\mu)u_l^{'}(v_l))}.$$

and the lump-sum payments are set such that

$$\mu u_h(v_h) + (1-\mu)u_l(v_l) = \rho U.$$

Separating contracts Using the notation $\omega(b, w)$ to indicate the reservation wage of worker with perceived reservation wage w (see Equation (C7)), we now write the planner's program with separating contracts. The planner minimizes the total cost $C(U)$ of a policy by choosing a flow of benefits (b_h, b_l) and certainty equivalent consumptions v_h and v_l such that:

$$C(U) = \min_{b_h, v_h, b_l, v_l} \left\{ -\mu\Psi_h(\omega_h(b_h, \omega_h(b_h))) - (1-\mu)\Psi_l(\omega_l(b_l, \omega_l(b_l))) + \mu\frac{v_h}{\rho} + (1-\mu)\frac{v_l}{\rho} \right\}$$

subject to a target utility constraint:

$$\mu u_h(v_h) + (1-\mu)u_l(v_l) = \rho U,$$

and two incentive-compatibility constraints:

$$\begin{cases} v_h - v_l \geq \omega_h(b_l, \omega_l(b_l)) - \omega_l(b_l, \omega_l(b_l)) \\ v_h - v_l \leq \omega_h(b_h, \omega_h(b_h)) - \omega_l(b_h, \omega_h(b_h)) \end{cases}$$

With two contracts, the off-equilibrium reservation wages and perceived wages differ, and the incentive-compatibility constraints account for these differences. For instance, if a type-l deviates and chooses a type-h contract, her wage would be negotiated upon the alleged reservation wage ω_h.