Unemployed but Optimistic: Optimal Insurance Design with Biased Beliefs

Johannes Spinnewijn[*] [†]
London School of Economics

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Abstract

This paper analyzes how job seekers' biased perceptions about their employment prospects affect the optimal design of unemployment insurance. Biased perceptions change the perceived value of insurance and the perceived return to search efforts. Policies implementing standard "sufficient-statistics" formula become sub-optimal and a wedge arises between social and private insurance. A paternalistic social planner corrects for the implied search distortions, while private insurers respond to the misperceived value of insurance. Empirically, I find that unemployed job seekers greatly overestimate how quickly they will find work. As a consequence, privatizing unemployment insurance results in too low or rapidly decreasing unemployment benefits.

Keywords: Biased Beliefs, Unemployment, Optimal Insurance, Moral Hazard
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[*]Department of Economics, STICERD R515, LSE, Houghton Street, London WC2A 2AE, United Kingdom (email: j.spinnewijn@lse.ac.uk, web: http://personal.lse.ac.uk/spinnewi/)

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1 Introduction

Insurers face the trade-off between providing insurance against risks and providing incentives to avoid risks. The risk perceptions of the insured are central to this trade-off, affecting both the perceived value of insurance and the effectiveness of incentives. Risk perceptions, however, are often subject to systematic biases.[1] This paper analyzes theoretically how biased risk perceptions change the optimal design of insurance contracts and provides a complementary empirical analysis of the relevant biases. While the theoretical results generalize for any insurance context with moral hazard, the analysis focuses on unemployment insurance and the perceptions of unemployed job seekers about their employment prospects.

I start from a standard model of unemployment with search (Baily 1978, Chetty 2006), but allow the beliefs of the unemployed about their employment probability to be biased. The bias in beliefs drives a wedge between social insurance and private insurance, when a social planner would maximize the insured's *true* expected utility, while private insurers maximize the insured's *perceived* expected utility in a competitive equilibrium. Moreover, policy makers who naively follow reduced-form formula based on sufficient statistics (e.g., unemployment elasticities), thereby ignoring the presence of biased beliefs, will implement suboptimal policies. The differences in insurance design critically depend on how beliefs are biased in two particular dimensions; the *baseline beliefs* - the beliefs about the probability of finding a job for given search efforts - and the *control beliefs* - the beliefs about the marginal increase in the job finding probability when searching more. The baseline beliefs affect the perceived value of unemployment insurance. Private insurers respond to a lower perceived value by decreasing insurance coverage and vice versa. The control beliefs affect the unemployed's responsiveness to incentives and distort the choice of search efforts when they are biased. A social planner, in contrast with private insurers, tries to correct this distortion when designing the insurance contract. A *naive* planner - unaware of the underlying bias in perceptions - only responds to changes in the estimated responsiveness.

The theoretical analysis builds on a canonical result for social insurance known as the Baily formula. This formula states that for insurance to be optimal the marginal consumption smoothing benefits and the marginal moral hazard cost of additional insurance should be equal. In the case of unemployment insurance, this implies that the relative difference in marginal utilities of consumption in employment and unemployment has to be equal to the elasticity of the unemployment duration with respect to the unemployment benefit level. The Baily formula thus identifies "sufficient statistics" for welfare analysis, which can be estimated using reduced-form methods. Several recent studies have analyzed the implementation of this formula and its robustness (see Gruber 1997, Chetty 2006, 2008, 2009, Shimer and Werning 2007, Chetty and Saez 2010). I find that the Baily decomposition is also particularly helpful for shedding light on how biases in beliefs affect

[1] Psychological research has shown that people often overestimate the probability of positive events and underestimate the probability of negative events (e.g., Weinstein 1980, Slovic 2000) and can either be optimistic (Langer 1975) or discouraged about the degree to which they control outcomes (Jahoda 1971). These particular biases complement the heuristics and biases in probabilistic thinking documented by Tversky and Kahneman (1974).

social, private and naive insurance design differently. In the social optimum the smoothing benefit and the moral hazard cost are still equalized at the margin, but the moral hazard cost is corrected for the *search internality.* This internality arises when a job seeker misperceives the impact of her search efforts on her own true expected utility. When a job seeker is control-pessimistic, she exerts too little effort. As an increase in insurance coverage would decrease the induced effort level even further, the moral hazard cost of insurance needs to be revised upward. A naive social planner - implementing the standard Baily formula - ignores this effect and provides too much insurance as a consequence. Competing private insurers do not correct for the search internality either, but set the moral hazard cost equal to the *perceived* rather than the actual consumption smoothing benefit of additional insurance. When a job seeker is baseline-optimistic about the probability of finding employment, she underestimates the smoothing benefit of insurance. Private insurers respond by offering less insurance coverage. Competition does discipline insurers to charge actuarially fair prices, but not to correct people's distorted demand for insurance.

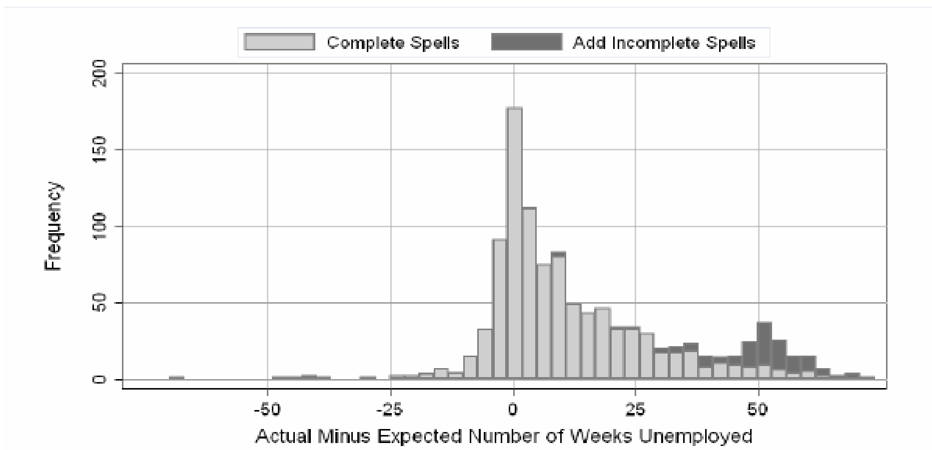

Figure I
Histogram of Differences between Actual and Expected Unemployment Durations

To evaluate the potential importance of biased perceptions for unemployment insurance, I link the expectations of unemployed job seekers with the actual outcome of their job search, using a survey of unemployed job seekers in the US by Price et al. (1998) described in Section 4. The main empirical result is that the considered job seekers largely underestimate the duration of their unemployment spell; on average they expect to remain unemployed for 7 weeks, but actually need 23 weeks to find new employment. Many more job seekers have underestimated rather than overestimated the length of their unemployment spell and the forecast errors are much more pronounced for the optimistic than for the pessimistic job seekers, as presented in Figure I. This suggests that the value of unemployment insurance is strongly underappreciated. Private insurers would respond to such substantial optimistic baseline bias by offering less or even no insurance. The low valuation may help explaining the puzzle of why unemployment insurance is almost always publicly provided.[2] A second empirical result is that the considered job seekers who report searching more intensively are less optimistic about the length of their unemployment spell. Job seekers who search harder expect shorter unemployment spells, but the actual reduction in the unemployment spell is larger than expected. This result may imply that job seekers are control-pessimistic and thus search too little. If current unemployment policies do not account for this, they should be adjusted to provide more incentives for search, even at the expense of insurance coverage.

The Baily decomposition into consumption smoothing benefits and moral hazard costs is also instrumental when considering some dynamic aspects of unemployment insurance. I analyze a simple, dynamic extension of the unemployment model, along the lines of Hopenhayn and Nicolini (1997), and show that the adjustment of the optimal dynamic characterization for the presence of biases in beliefs is similar to the adjustment in the static model; private insurers focus on the perceived smoothing benefits, while the social planner corrects the moral hazard cost for the search internality. In particular, private insurers exploit optimism about the duration of unemployment by making the unemployment benefits rapidly decreasing during the unemployment spell. The social planner, in contrast with private insurers, prefers to shift incentives towards the short-term unemployed, by making unemployment benefits more rapidly decreasing at the start of the unemployment spell and more slowly later on. The threat of receiving lower benefits when long-term unemployed increases the incentives for the short-term unemployed to search for work (Shavell and Weiss 1979). However, optimism about the duration of unemployment makes this threat less effective, explaining the response of the social planner. Similarly, the loss of unemployment benefits after six months of unemployment, like in the US, does not induce a newly disposed job seeker to search harder when she expects to have left unemployment before.

I calibrate the dynamic model in order to evaluate the impact of biased beliefs on the optimal design of unemployment insurance numerically. I find that the difference between the social planner and private insurers is particularly pronounced in response to baseline optimism, with the latter proposing low and rapidly decreasing unemployment benefits. The consumption subsidy required to make the agent insured by private insurers as well off as in the social optimum, also increases exponentially in the baseline bias. Although the risk of an unemployment spell may be small within a lifetime, privatizing the insurance provision could come at a substantial welfare cost if beliefs are and remain strongly biased. The conclusions, although less extreme, also generalize for welfare concepts putting positive weight on the perceived expected utility.[3] The use of the

[2] Exceptions are unemployment insurance provided by trade unions or voluntary public unemployment insurance systems in countries like Denmark, Finland and Sweden, grown out of trade union programs (Parsons et al. 2003). The latter are heavily subsidized by the government, as expected with baseline-optimistic insurees. The existence of private information and aggregate risk and the government's advantage in coping with moral hazard have been suggested as alternative explanations for the absence of private unemployment insurance (Chiu and Karni 1998, Barr 2001). Acemoglu and Shimer (2000) conclude: "Why unemployment insurance is almost always publicly provided, in contrast to most other insurance contracts, remains an important, unresolved question."

[3] Bernheim and Rangel (2009) argue that the presence of ancillary conditions, like framing issues, may distort people's choices. To the extent that better informing individuals alleviates ancillary conditions, the perceived probabilities after individuals are informed are more appropriate for evaluating their welfare than the perceived probabilities

true probabilities for evaluating welfare, however, highlights the contrast with the considerations of profit-maximizing insurers. The extreme comparison also relates to the distinction between a paternalistic and populist government, with the latter catering to its voters' beliefs.[4]

To keep the analysis tractable, I have made very specific choices about the decisions taken and the uncertainties faced by unemployed job seekers. For instance, job seekers do not only need to decide how much to search, but also whether or not to accept a job offer and how much to adjust consumption during unemployment. Moreover, these decisions are not only affected by the perceived probability of finding employment, but also by expectations about the wages of potential job offers, expectations about layoff probabilities, etc. The theoretical and empirical analysis can thus be extended in many directions. However, the provided insights regarding the policy implications of biased beliefs apply more generally. Paternalistic policy makers should use the available policy tools - also active labor market programs, information and other policies - to prevent or correct the resulting behavioral distortions and interpret the responsiveness to incentives cautiously when designing their policies. Private firms, however, have no incentive to correct for the behavioral distortions due to biased beliefs, but will try to exploit the resulting misvaluations.

Related Literature The analysis in this paper fits in the behavioral public economics literature, studying optimal policies with non-standard decision makers.[5] First, behavioral biases distort behavior and thus affect the impact of public policies. In the context of unemployment, DellaVigna and Paserman (2005) have analyzed theoretically how impatience affects job search behavior. More impatient job seekers search less, but have a lower reservation wage as well. Job seekers with hyperbolic preferences search too little. Paserman (2008) has estimated the discounting process to evaluate particular policy interventions numerically. Second, behavioral biases affect how observed behavior needs to be interpreted when designing policies. The characterization of the Baily formula adjusted for biased beliefs and the distinction with the naive implementation of the standard Baily formula adds to the recent literature, reviewed by Chetty (2009), analyzing conditions under which sufficient statistic formulas for taxation and social insurance apply or need to be adjusted. The empirical estimation of the bias in beliefs helps to identify agents' true preferences from their observed choices, as argued by Köszegi and Rabin (2007 and 2008). While previous research has analyzed perceptions about employment prospects (see Manski 2004), the relation to actual outcomes has received much less attention.[6] To my knowledge, this paper is the first linking empirically the perceptions of individual job seekers with their actual outcomes. Finally, behavioral biases may justify government intervention in competitive markets. The response by competing firms to behavioral biases and the potential welfare consequences have also been studied in several other contexts in the behavioral industrial organization literature (see Ellison 2006, DellaVigna 2009). Regarding

before they are informed.

[4] See Salanié and Treich (2009) for an example of such analysis.

[5] For reviews, see Kanbur, Pirttila and Tuomala (2004) and Bernheim and Rangel (2007).

[6] Dominitz and Manski (1997) are an exception, comparing the expectations of the 1994 wave in the Survey of Economic Expectations with the actual outcomes for the 1995 wave. They consider the probability of job loss and find that the expected and actual average match up closely for these two different samples.

insurance markets, Cutler and Zeckhauser (2004) have argued that people's poor understanding of risk and insurance choices is one of the reasons for the divergence between insurance theory and insurance practice.

The psychological and experimental evidence on the misperceptions of probabilities has lead to a theoretical literature proposing explanations for biases in beliefs and showing how these biases can be sustained in equilibrium.[7] This literature suggests that optimistic beliefs, either about the baseline probability of success or one's control, are more likely to arise and persist than pessimistic beliefs. This corresponds to the empirical evidence that I find for the unemployed's baseline beliefs, but contrasts with the suggestive evidence for the unemployed's control beliefs. The theoretical analysis in this paper is more related to the behavioral contract theory, taking behavioral biases as given and analyzing the consequences for contract design in the presence of moral hazard or adverse selection. In particular, De la Rosa (2007) and Santos-Pinto (2008) analyze the change in incentive contracts proposed by a profit-maximizing principal in response to particular optimistic biases. This change is often ambiguous. In contrast, this paper primarily focuses on the unambiguous comparison, for a given bias in beliefs, between social and private insurance on the one hand and optimal and naive implementation on the other hand.[8]

The paper is organized as follows. Section 2 introduces a static model of unemployment and defines the baseline bias and control bias in beliefs. Section 3 characterizes the optimal insurance contract given the biases in beliefs, as proposed by the social planner and private insurers. The analysis is extended to a dynamic framework and some other features of unemployment are briefly discussed. Section 4 discusses the data and shows the empirical estimates of the baseline and control bias. Section 5 calibrates the dynamic model in order to calculate the optimal contracts and the welfare cost of privatizing insurance numerically. Section 6 concludes. All proofs are presented in appendix.

2 Setup

A risk-averse agent, whom I refer to as the *insuree*, is employed with exogenous probability p and unemployed with probability $1-p$. When unemployed, the insuree exerts unobservable search effort at utility cost $e \in E$. She finds work with probability $\pi(e)$ and remains unemployed with probability $1-\pi(e)$. The insuree produces w when employed and 0 when unemployed. A risk-neutral principal, the *insurer*, offers a contract (b, τ) that provides insurance against the unemployment risk. When the insuree starts the period employed, she consumes her after tax wage $w - \tau$. When the insuree starts the period unemployed, she consumes the unemployment benefit b if she does not find work,

[7] Examples are Bénabou and Tirole (2002 and 2006), Compte and Postlewaite (2004), Glaeser (2004), Van den Steen (2004), Brunnermeier and Parker (2005), Gollier (2005) and Köszegi (2006).

[8] Jeleva and Villeneuve (2004), Sandroni and Squintani (2007), Eliaz and Spiegler (2008), and Grubb (2009) study adverse selection with heterogeneity in risk perceptions. Spinnewijn (2009) analyzes screening contracts with heterogeneity in baseline and control beliefs, building on the model presented here.

but wage w if she does find work. This static setup follows Baily (1978) very closely.[9]

Central to this model is the assumption that the insuree may perceive the probability of finding work differently from the true probability. I denote by $\hat{\pi}(e)$ the insuree's belief about the probability of finding work when she exerts effort e. I assume that the insurer knows the insuree's beliefs and that this belief cannot be manipulated by the insurer, nor changed in response to the contract being offered. These assumptions correspond to a setting with different priors where the insurer and the insured 'agree to disagree'. Both the true probability of success $\pi(e)$ and the perceived probability of success $\hat{\pi}(e)$ are increasing and concave in e. I deliberately put no other restrictions on how the true and perceived probability are related. The analysis, however, will show that the difference is essential in two dimensions; the difference in levels $\hat{\pi}(e) - \pi(e)$ and the difference in margins $\hat{\pi}'(e) - \pi'(e)$. The difference in levels, the *baseline bias*, determines the difference between the true and perceived value of insurance. The difference in the margins, the *control bias*, determines the difference between the true and perceived marginal return of search and therefore the distortion in the choice of search effort.

Definition 1 *An insuree is baseline-optimistic (-pessimistic) if* $\hat{\pi}(e) \geq (\leq) \, \pi(e)$*for all* $e \in E$.

Definition 2 *An insuree is control-optimistic (-pessimistic) if* $\hat{\pi}'(e) \geq (\leq) \, \pi'(e)$ *for all* $e \in E$.

Baseline and control beliefs are interdependent. For instance, complementarity between ability and effort implies that an agent who is optimistic about her ability is both baseline- and control-optimistic. The theoretical results hold for any baseline and control bias, but I focus the exposition mainly on baseline optimism and control pessimism, in line with the empirical evidence presented in this paper.[10]

2.1 The Insuree's Problem

The insuree's perceived expected utility from the insurance contract (b, τ) and search effort e equals

$$\hat{U}(b, \tau, e) = pu(w - \tau) + (1 - p)\left[\hat{\pi}(e) u(w) + (1 - \hat{\pi}(e)) u(b) - e\right].$$

The Bernouilli-utility u is increasing and concave in consumption. In this static model, the insuree exerts costly search effort when she starts without a job and either finds a job immediately or is unsuccessful and consumes the unemployment benefit b. The insuree weighs the uncertain outcomes of search with the perceived probabilities $\hat{\pi}(e)$ and $1 - \hat{\pi}(e)$. In a dynamic setting, the periodic probability of finding a job is the inverse of the expected duration of unemployment. A baseline-optimistic insuree overestimates the probability of finding a job or, similarly, underestimates the expected duration of unemployment.

[9] Like Baily, I assume that the unemployed agent does not pay taxes upon employment. This implies that the optimal search level does not depend on taxes and taxes can be written explicitly as a function of unemployment benefits only. I relax this assumption in the dynamic extension. I also relax Baily's assumption that once unemployed, the agent becomes risk neutral between being unemployed and employed.

[10] For expositional purposes, I consider biases in beliefs that are the same for all effort levels, although only the local biases in beliefs matter for the optimality conditions.

When unemployed, the insuree searches to maximize her perceived expected utility. Her effort choice $\hat{e}(b)$ equalizes the perceived individual benefit and cost of search at the margin,

$$\hat{\pi}'(e)\left[u(w)-u(b)\right]=1. \tag{IC}$$

Higher unemployment benefits reduce the utility gain of finding a job. The induced effort level $\hat{e}(b)$ is thus decreasing in the unemployment benefit b. Moral hazard arises since the insuree does not internalize the impact of her effort on the insurer's budget constraint. The first-best effort level is higher than the effort choice of the insuree and the difference between the two increases with control pessimism. A control-pessimistic insuree exerts less effort than an insuree with unbiased beliefs, since she perceives the marginal return to effort to be lower than the true marginal return, $\hat{\pi}'(e)<\pi'(e)$. Given the concavity of the insuree's problem, the first-order condition is sufficient for the unemployment benefit to be incentive compatible with search effort e.[11]

2.2 The Insurer's Problem

I contrast the contracts offered by two extreme types of insurers: a social planner, who is paternalistic and maximizes the insured agent's true expected utility, and competing private insurers, who maximize the insured agent's perceived expected utility. When beliefs are unbiased, the probability weights in the respective expected utility functions are the same; the social optimum and the competitive equilibrium coincide.

For both types of insurers, the expected profits from an insurance contract (b,τ) equal

$$P(b,\tau)\equiv p\tau-(1-p)\left(1-\pi\left(\hat{e}(b)\right)\right)b.$$

The expected expenditures depend on the true probability that the insuree does not find employment $1-\pi(\hat{e}(b))$. Since effort is not contractible, the insurer is constrained by the insuree's effort choice $\hat{e}(b)$. For a given contract, the insurer's profits are higher the more the unemployed insuree searches. I denote by $\hat{\tau}(b)$ the tax required in order to keep the budget balanced,

$$\hat{\tau}(b)\equiv\frac{(1-p)\left(1-\pi\left(\hat{e}(b)\right)\right)}{p}b.$$

I contrast two types of insurers with different objectives; a paternalistic social planner and competing private insurers.

The social planner cares about the insuree's true expected utility and weights the uncertain outcomes of the insuree's search effort with the true probabilities $\pi(e)$ and $1-\pi(e)$. Assuming a balanced budget, the (constrained) social optimum solves

$$\max_{b,\tau,e} U(b,\tau,e)=pu(w-\tau)+(1-p)\left[\pi(e)u(w)+(1-\pi(e))u(b)-e\right] \tag{1}$$

[11] I assume that a positive level of effort is exerted in the social optimum or the competitive equilibrium. The condition that $\hat{\pi}'(0)=\infty$ is sufficient for this to hold.

subject to (IC) and $P(b,\tau)=0$.

Private insurers maximize their profits and compete to attract insurees. Competition drives profits to zero and insurees choose the contract that maximizes their perceived expected utility. In contrast with the social planner's objective function (1), the uncertain outcomes of the insuree's search effort are weighted with the perceived probabilities $\hat{\pi}(e)$ and $1-\hat{\pi}(e)$.[12] The competitive equilibrium contract solves

$$\max_{b,\tau,e} \hat{U}(b,\tau,e) = pu(w-\tau) + (1-p)\left[\hat{\pi}(e)\,u(w) + (1-\hat{\pi}(e))\,u(b) - e\right] \tag{2}$$

subject to (IC) and $P(b,\tau)=0$.

3 Optimal Insurance Contracts

An insurer faces the trade-off between smoothing consumption between employment and unemployment and providing incentives for search. The insuree's perception of the probability to remain unemployed and the returns to her search effort is central to this trade-off.

3.1 Unbiased Beliefs: the Baily Formula

If the beliefs about the returns are unbiased (i.e. $\hat{\pi}(\cdot) = \pi(\cdot)$), the contracts proposed by the social planner and the private insurers in a competitive equilibrium coincide. The optimal contract equalizes the consumption smoothing benefit and the moral hazard cost of insurance at the margin.

Consumption Smoothing Unemployment benefits smooth the risk-averse insuree's consumption when unemployed. The smoothing benefit of further increasing the unemployment benefit b equals the relative difference in marginal utilities of consumption when unemployed and employed,

$$\frac{u'(b) - u'(w-\hat{\tau}(b))}{u'(w-\hat{\tau}(b))}.$$

Everything else equal, the smoothing benefit is decreasing in both the unemployment benefit b and the tax $\hat{\tau}(b)$. Less effort $\hat{e}(b)$ increases the required tax $\hat{\tau}(b)$ and thus decreases the marginal smoothing benefit.

Moral Hazard Higher benefits reduce the incentives for an unemployed insuree to search for work. A tax raise is required to balance the budget in response to an increase in the benefit b. This tax raise is higher the more search decreases. The tax $\hat{\tau}(b)$ is thus increasing in the benefit b, both because of the increased expenditures for an unemployed insuree and the increased probability that

[12] Chetty and Saez (2010) consider the optimal level of social insurance when private insurance is endogenous. I consider the insurance contract provided by either the social planner without the presence of private insurers or by competing private insurers without the presence of social insurance.

an insuree is unemployed,

$$\frac{d\log\left(\hat{\tau}\left(b\right)\right)}{d\log b} = 1 + \varepsilon_{1-\pi(\hat{e}(b)),b}$$

where $\varepsilon_{1-\pi(\hat{e}(b)),b} \equiv \frac{d\log(1-\pi(\hat{e}(b)))}{d\log b}$. The required tax increase due to moral hazard is uniquely determined by the elasticity $\varepsilon_{1-\pi(\hat{e}(b)),b}$, which describes the responsiveness of the true probability of unemployment with respect to unemployment benefits. This responsiveness determines the relative price of consumption during unemployment and employment. The lower the responsiveness, the better the rate at which consumption is being transferred from employment to unemployment.

Proposition 1 *With unbiased beliefs, optimal unemployment insurance is characterized by*

$$\frac{u'\left(b\right) - u'\left(w - \hat{\tau}\left(b\right)\right)}{u'\left(w - \hat{\tau}\left(b\right)\right)} = \varepsilon_{1-\pi(\hat{e}(b)),b} \ . \tag{3}$$

The maximization problems in (1) and (2) coincide when beliefs are unbiased. The proposition follows from the first-order condition with respect to b,

$$u'(b) - u'\left(w - \hat{\tau}\left(b\right)\right)\left[1 + \varepsilon_{1-\pi(\hat{e}(b)),b}\right] = 0.$$

The insurer sets the unemployment benefit such that the utility gain when unemployed from an increase in the benefit b equals the utility loss when employed, coming from the increase in taxes required to satisfy the budget constraint. The increase in the benefit also reduces the exerted effort. However, when insurees have unbiased beliefs, the impact of the reduced effort on the expected utility is of second order by the envelope condition.[13]

If the insuree is irresponsive to incentives, the moral hazard cost disappears and full insurance is optimal. Everything else equal, a higher elasticity implies a higher moral hazard cost and therefore a lower optimal unemployment benefit. However, if a change in the fundamentals does not only increase the elasticity, but also effort, an increase in both the consumption levels during employment and unemployment becomes feasible. The effect on the optimal unemployment benefit level is ambiguous.

Using a Taylor approximation for the marginal utility in the left hand side of (3) leads to the standard formula derived by Baily (1978),

$$\gamma\frac{\Delta c}{c} \cong \varepsilon_{1-\pi(\hat{e}(b)),b},$$

with γ the relative risk aversion, $\frac{\Delta c}{c}$ the relative change in consumption between employment and unemployment and $\varepsilon_{1-\pi(\hat{e}(b)),b}$ the elasticity of the unemployment duration with respect to benefits. The identification of these three statistics is sufficient to test for the optimality of the current unemployment insurance system (Gruber 1997). For instance, identifying the primitives underlying the

[13] The second order condition requires that $\frac{u'(b)-u'(w-\hat{\tau}(b))}{u'(w-\hat{\tau}(b))}$ decreases more in b than $\varepsilon_{1-\pi(\hat{e}(b)),b}$. I derive in appendix the condition on the primitives for the second order condition to hold globally.

moral hazard problem is not necessary if the elasticity $\varepsilon_{1-\pi(\hat{e}(b)),b}$ is known. Chetty (2009) reviews the recent literature developing "sufficient statistic formulas" for social insurance and optimal taxation. In particular, Chetty (2006) shows how the Baily formula is robust to the introduction of borrowing constraints, durable goods, search and leisure benefits during unemployment. However, in the presence of biased beliefs, the Baily formula prescribes an insurance level that is generally suboptimally high or low. The direction of the bias depends on the nature of the bias in beliefs.

3.2 Biased Beliefs: the Adjusted Baily Formula

If beliefs are biased (i.e. $\hat{\pi}(\cdot) \neq \pi(\cdot)$), the contracts proposed by the social planner and the private insurers in a competitive equilibrium diverge. The social optimum equalizes the true smoothing benefit and the moral hazard cost at the margin, with the moral hazard cost corrected for the search internality. The adjustment of the standard Baily formula depends only on the control bias. The competitive equilibrium equalizes the perceived smoothing benefit and the moral hazard cost, without correction for the search internality. The adjustment of the standard Baily formula depends only on the baseline bias.

3.2.1 Social Planner: Search Internality

The insuree equalizes the perceived marginal benefit and cost of effort at the margin. If the perceived and true marginal return to search differ, the insuree does not correctly internalize the effect of her search effort on her true expected utility. When determining the optimal unemployment benefit level, the social planner does account for both the externality the insuree imposes on the social planner's budget constraint and the externality she imposes on herself by misperceiving the returns to search. I refer to the latter as the *search internality,* in line with the behavioral public economics literature.

With unbiased beliefs, the effect of increasing unemployment benefits on the true expected utility through the change in effort equals

$$(1-p)\left\{\pi'\left(\hat{e}\left(b\right)\right)\left[u(w)-u(b)\right]-1\right\}\frac{d\hat{e}\left(b\right)}{db}=0.$$

Since the insuree already chooses her effort level to maximize her true expected utility, the effect of a marginal change in effort on her true expected utility is of second order by the envelope condition. However, when the insuree is control-pessimistic, $\pi'(\cdot) > \hat{\pi}'(\cdot)$, she underestimates the marginal return to effort and exerts too little effort. An increase in benefits now causes a first-order decrease in the true expected utility by decreasing the insuree's effort choice. By the *IC* constraint, this first-order change equals

$$(1-p)\left\{\pi'\left(\hat{e}\left(b\right)\right)-\hat{\pi}'\left(\hat{e}\left(b\right)\right)\right\}\left[u(w)-u(b)\right]\frac{d\hat{e}\left(b\right)}{db}, \tag{4}$$

which needs to be added to the first-order condition. The sign of expression (4) depends on the sign of the control bias, but the magnitude is non-monotonic in the control beliefs. The effect of a change in the benefit level on the search internality depends on how much the effort choice would change in response to the change in the benefit level and how distorted the effort choice already is. For instance, a more control-pessimistic job seeker may reduce her effort less in response to an increase in benefits, but loses more from reducing her effort. Hence, the correction for the search internality does not necessarily affect the optimal policy more when beliefs are more biased. Although the correction has more value when beliefs are more biased, the correcting tool may become less effective. In the extreme case that a job seeker believes she has no control over her situation, the social planner cannot correct her behavior by changing the benefit level.

The constrained social optimum still equalizes the relative utility and the relative price of consumption in unemployment and employment, but the relative price is corrected for the search internality. Since control-pessimists exert too little effort, the corrected relative price of unemployment compensation exceeds the uncorrected relative price.

Proposition 2 *The socially optimal unemployment insurance is characterized by*

$$\frac{u'(b) - u'(w - \hat{\tau})}{u'(w - \hat{\tau})} = \varepsilon_{1-\pi(\hat{e}),b} \left[1 + \frac{\pi'(\hat{e}) - \hat{\pi}'(\hat{e})}{\pi'(\hat{e})} I(b)\right], \tag{5}$$

with $\hat{e} = \hat{e}(b)$, $\hat{\tau} = \hat{\tau}(b)$ *and* $I(b) = \frac{u(w)-u(b)}{bu'(w-\hat{\tau}(b))} > 0$.

Biased beliefs change the socially optimal unemployment benefit level only if they affect the insuree's behavior. In this static model, the insuree only chooses how much effort to exert and baseline optimism does not change the insuree's choice of effort. Hence, baseline beliefs do not change the social optimum.[14] Control beliefs change the insuree's effort choice and thus affect the social optimum. The impact on the optimal generosity of the contract is ambiguous though. Next to causing the correction for the search internality (the term between squared brackets in (5)), control beliefs also affect the standard smoothing benefits (by changing effort and thus the required tax $\hat{\tau}(b)$) and the moral hazard cost (by changing the responsiveness and thus the elasticity $\varepsilon_{1-\pi(\hat{e}),b}$) with potentially opposite effects on the optimal benefit level.[15]

The ambiguous impact of control beliefs is not surprising. The social planner's problem of providing insurance and inducing effort can be thought of as consumption problem with two goods. Control beliefs affect the price of inducing effort in terms of insurance coverage; the price is higher for control-pessimistic insurees, as the social planner needs to give up more insurance coverage to induce them to exert the same level of effort. Like in a standard consumption problem, an increase in the price of one good (effort) decreases the consumption of that good. The effect on the other

[14] Notice that this changes if the insuree chooses how much insurance coverage to buy at a given price. A baseline-optimistic insuree values insurance less than an unbiased insuree and thus buys less insurance at a given price.

[15] A control-pessimistic job seeker exerts less effort, but may be less responsive as well. The first effect decreases the consumption smoothing benefit of additional insurance by increasing the required tax. This lowers the optimal benefit level b. The second effect decreases the moral hazard cost of additional insurance. This raises the optimal benefit level b.

good (insurance) is ambiguous. The increase in the price of inducing effort makes the optimal contract substitute toward providing more insurance, but at the same time, the set of feasible combinations of effort and insurance coverage shrinks. In the one extreme case, in which an insuree becomes more and more pessimistic about her control, the relative price of inducing effort becomes so high that the social planner substitutes away from providing incentives and provides a contract converging to full insurance. In the other extreme case, in which the insuree becomes more and more optimistic about her control, a small share of the risk imposed on the insuree suffices to induce first-best effort. In the limit, the social contract converges to the first best, providing almost full insurance and inducing first-best effort.

Naive Planner Despite the ambiguous response to control beliefs, the difference between the balanced insurance schemes solving the standard Baily formula in (3) and the adjusted Baily formula in (5) unambiguously depends on the control bias. This comparison is relevant when a naive planner who is not aware of biases in beliefs implements the standard Baily formula. With control-pessimistic insurees, a naive planner ignores that a reduction in b would help correcting the distorted search incentives. The naive planner underestimates the relative price of unemployment compensation and sets the benefit level suboptimally high. This assumes that the naive planner knows the insuree's utility $u(\cdot)$, as well as the tax rate $\hat{\tau}(b)$ that keeps the budget balanced as a function of b, but forgets to correct the elasticity $\varepsilon_{1-\pi(\hat{e}),b}$ for the search internality.[16]

Corollary 1 *The standard Baily formula overestimates the socially optimal level of unemployment benefits with control-pessimistic job seekers.*

Similarly, for two societies where the consumption smoothing benefits coincide, policy makers implementing the standard Baily formula set the same level of insurance if the observed elasticities are the same. However, if job seekers in the one society are more control-pessimistic, the insurance level in that society should be lower. The corollary emphasizes that formulas based on reduced statistics should be used cautiously when designing insurance contracts.

3.2.2 Private Insurers: Perceived Consumption Smoothing

An insuree who underestimates the duration of unemployment underestimates the value of unemployment insurance. Private insurers respond by providing less insurance. In a competitive equilibrium, private insurers offer unemployment insurance that equalizes the perceived smoothing benefit of additional insurance coverage and the associated moral hazard cost, not corrected for the search internality.

[16] In section 6, I consider the suboptimal policies implemented by a naive policy maker who miscalibrates the dynamic model by matching empirical moments (the exit rate $1-\pi$ and the elasticity $\varepsilon_{1-\pi,b}$) under the assumption that the underlying beliefs are unbiased.

Proposition 3 *The equilibrium contract offered by competing private insurers is characterized by*

$$\frac{\frac{1-\hat{\pi}(\hat{e})}{1-\pi(\hat{e})}u'(b)-u'(w-\hat{\tau})}{u'(w-\hat{\tau})}=\varepsilon_{1-\pi(\hat{e}),b}\ , \tag{6}$$

with $\hat{e}=\hat{e}(b)$ *and* $\hat{\tau}=\hat{\tau}(b)$.

The proposition follows from the first-order condition of the insurer's profit maximization (2), which simplifies to

$$\frac{1-\hat{\pi}(\hat{e}(b))}{1-\pi(\hat{e}(b))}u'(b)-u'(w-\hat{\tau}(b))\left[1+\varepsilon_{1-\pi(\hat{e}(b)),b}\right]=0. \tag{7}$$

An increase in unemployment benefits is perceived by the insuree to be received with probability $(1-p)(1-\hat{\pi}(\hat{e}))$, but only paid by the insurer with probability $(1-p)(1-\pi(\hat{e}))$. The latter probability determines the tax increase required for the insurer to make zero profits. This explains why the marginal utility when unemployed relative to the marginal utility when employed is weighted by $\frac{1-\hat{\pi}(\hat{e}(b))}{1-\pi(\hat{e}(b))}$. Since the insuree searches to maximize her perceived expected utility, the effect through the change in search efforts is again of second order.

Baseline-optimistic beliefs lower the left-hand side in equation (6). The equilibrium insurance is therefore unambiguously lower when job seekers are baseline-optimistic. Equilibrium insurance would be even lower if workers are not only optimistic about finding employment when unemployed, but also about keeping their job when employed (i.e. $\hat{p}>p$). If the baseline bias is sufficiently optimistic, private insurers may provide no insurance in equilibrium.

Naive Insurers The standard Baily formula ignores the difference between the perceived and actual consumption smoothing benefits. This implies the following corollary.

Corollary 2 *The standard Baily formula overestimates the equilibrium level of unemployment insurance with baseline-optimistic job seekers.*

While the difference between the standard and adjusted Baily formula depends on the control bias for the social optimum, it depends on the baseline bias for the competitive equilibrium. A private insurer responds to the control beliefs as well, since these beliefs affect the effort choice $\hat{e}(b)$. This response, however, is the same as the response by an insurer who is unaware of biased beliefs and implements the standard Baily formula.

3.3 Comparing Private and Social Insurance

Moral hazard, in contrast with adverse selection, does not raise the need for government intervention by itself; competing private insurers offer the socially optimal insurance contract in equilibrium. However, this is only true if beliefs are unbiased. The analysis of optimal insurance design with biased beliefs sheds a new light on the topic of privatizing unemployment insurance. First of all, the analysis suggests an alternative explanation for the puzzle of why unemployment insurance is mostly publicly provided (see Acemoglu and Shimer 2000); if people are sufficiently optimistic about the risk of unemployment, providing insurance becomes unprofitable for private insurers. Second, the analysis suggests that privatizing unemployment insurance may be undesirable because of biases in risk perceptions. Competition forces private insurers to charge the actuarially fair price for insurance, but does not force them to sell the socially optimal amount of insurance.[17]

The nature of the regulation of private insurance markets depends in the first place on whether the insurance coverage provided in equilibrium is suboptimally high or low. Biases in baseline beliefs and control beliefs drive a wedge between the social optimum and the competitive equilibrium for different reasons. Baseline-optimistic insurees undervalue the consumption smoothing benefit of insurance. The focus of private insurers on the perceived smoothing benefit decreases the unemployment benefit in competitive equilibrium compared to the social optimum. Control-pessimistic insurees exert too little effort. The correction by the social planner for this search internality decreases the unemployment benefit in the social optimum compared to the competitive equilibrium. However, the social planner can only correct for the insuree's distorted effort choice if the insuree is responsive to incentives. The effort response to a change in benefits $\frac{d\hat{e}(b)}{db}$ is increasing in $\frac{\hat{\pi}'(e)}{-\hat{\pi}''(e)}$, the curvature of the perceived probability as a function of effort. The sign of the actual difference between private and social insurance depends on which bias dominates, conditional on the curvature.

Corollary 3 *If the maximization problems are globally concave, the equilibrium insurance provided to baseline-optimistic insurees is suboptimally low, unless the pessimistic control bias is such that*

$$\left\{\pi'(e) - \hat{\pi}'(e)\right\} \frac{\hat{\pi}'(e)}{-\hat{\pi}''(e)} > \hat{\pi}(e) - \pi(e),$$

evaluated at the effort level chosen in the social optimum.

A government could intervene in the private insurance market by regulating or subsidizing insurance provision such that insurees buy optimal insurance coverage. Clearly, the insurees would not value these interventions appropriately.

3.4 Dynamic Extension

The static framework restricts the analysis to insurance contracts transferring consumption between employment and unemployment. A dynamic framework admits transfers within an unemployment spell as well. Search can not only be induced by rewarding a job seeker with higher consumption when she finds employment, but also by lowering consumption when she remains unemployed.

[17] DellaVigna (2009) discusses similar findings when agents have irrational expectations about their self-control problems or inattention. For instance, DellaVigna and Malmendier (2004) find that competing firms will distort the consumption of naive individuals with self-control problems, pricing investment goods below and leisure goods above marginal cost. Still, competition will drive down the fixed contract fee.

In practice, declining unemployment benefits are an important feature of unemployment insurance systems. However, a declining benefit profile has a different impact on a job seeker's search decision and her perception of the associated consumption smoothing cost, when she is baseline-optimistic and thus underestimates the duration of unemployment.

I illustrate the role of biased beliefs in a simple dynamic extension considering an unemployed job seeker who continues to search for employment as long as she has not found employment. In a given period, she finds a job with probability $\pi(e)$ when exerting effort at cost e, but she believes this probability equals $\hat{\pi}(e)$. The setup and analysis are described in full detail in Appendix A. The setup follows Hopenhayn and Nicolini (1997) and abstracts from several features that are important in a dynamic context, notably the presence of unobservable savings and learning during the unemployment spell, which I leave for future research. The important issue of implementing consumption allocations when savings are unobservable is studied by Werning (2002) and Shimer and Werning (2008). The characterized optimal consumption allocation is not likely to be implementable when savings are unobservable.[18] The restriction on savings is particularly important in the presence of biased beliefs, since these distort the job seeker's savings decision as well. The social planner would adjust the insurance contract to correct both the distortion in savings and in effort. I discuss this briefly in section 3.5.

Use of Dynamic Incentives I restrict the analysis to linear unemployment schemes for which consumption during unemployment and upon reemployment depends linearly on the length of the unemployment spell l,

$$c_l^u = \bar{b} - \Delta l \text{ and } c_l^e = w - \bar{\tau} - \Delta(l-1).$$

This reduces the social planner's problem to the choice of a vector of three variables $z \equiv \left(\bar{b}, w - \bar{\tau}, \Delta\right)$: the starting levels of both the unemployment benefit $\bar{b}$ and the after-tax wage $w - \bar{\tau}$, and their mutual decrease Δ for each additional period of unemployment. Assuming CARA preferences with monetary cost of effort $u(c-e) = -\exp(-\sigma(c-e))$, the job seeker's effort is constant throughout unemployment for linear contracts. The level of effort depends on both the *static wedge* between $w - \bar{\tau}$ and b and the *dynamic wedge* given by the slope of the consumption profile Δ.

The optimal wedges can again be characterized by Baily-type conditions, decomposing a revenue-neutral change of the wedge into the associated consumption smoothing benefit and the moral hazard cost. This decomposition is useful because it shows clearly that the adjustments for biased beliefs are similar to those in the static model. The optimal characterization of the static wedge is a straightforward extension as discussed in Appendix A. The optimal characterization of the dynamic wedge is presented in Proposition 4. An increase in the slope Δ, jointly with a revenue-neutral increase in the intercepts of the consumption profile $\bar{c} \equiv \left(\bar{b}, w - \bar{\tau}\right)$, induces the insuree to search harder, but makes her consumption profile less smooth. Starting from a static contract with $\Delta = 0$, the consumption smoothing loss is of second order. This confirms that consumption should be decreasing with the length of the unemployment spell when beliefs are unbiased (Shavell

[18] One exception is when job seekers have CARA preferences as considered here.

and Weiss 1979 and Hopenhayn and Nicolini 1997). At the optimum, the two effects are exactly balanced. I use $U(z)$ and $\hat{U}(z)$ to denote the true and perceived expected utility given the exerted search effort and $U_{\bar{c}}(z)$ and $\hat{U}_{\bar{c}}(z)$ to denote the respective expected utility gains from increasing the intercepts of the consumption profiles $\bar{c}$.

Proposition 4 *With CARA preferences, the linear unemployment contracts in the social optimum and the competitive equilibrium are characterized by respectively*

$$\frac{U_{\bar{c}}(\bar{c}-\Delta,\Delta)-U_{\bar{c}}(\bar{c},0)}{U_{\bar{c}}(\bar{c}-\Delta,\Delta)} = J^{\Delta}\times\left(-\varepsilon_{\frac{1}{\pi(\hat{e})},(\bar{c},\Delta)}\right)\left\{1+I^{\Delta}\left(\frac{\pi'(\hat{e})-\hat{\pi}'(\hat{e})}{\pi'(\hat{e})},\frac{\hat{\pi}(\hat{e})-\pi(\hat{e})}{\pi(\hat{e})}\right)\right\}, \quad (8)$$

$$\frac{\hat{U}_{\bar{c}}(\bar{c}-\Delta,\Delta)-\frac{1-\hat{\pi}(\hat{e})}{1-\pi(\hat{e})}\hat{U}_{\bar{c}}(\bar{c},0)}{\hat{U}_{\bar{c}}(\bar{c}-\Delta,\Delta)} = J^{\Delta}\times\left(-\varepsilon_{\frac{1}{\pi(\hat{e})},(\bar{c},\Delta)}\right), \quad (9)$$

with $J^{\Delta}>0, I_1^{\Delta}>0, I_2^{\Delta}>0$ *and* $I^{\Delta}(0,0)=0$.[19]

The true consumption smoothing effect, the left-hand side of condition (8), simplifies to the relative difference in expected utility gains from increasing the starting levels $\bar{c}$ for two contracts: a contract with a decreasing consumption profile ($\Delta>0$) and a contract with a constant consumption profile ($\Delta=0$). Private insurers, however, focus on the perceived consumption smoothing effect, the left-hand side of condition (9). Baseline-optimistic insurees, for instance, underestimate the duration of the unemployment spell and thus put little weight on consumption when long-term unemployed. Hence, they underestimate the consumption smoothing loss from a decreasing consumption profile. Private insurers respond by making consumption more rapidly decreasing during unemployment. The moral hazard cost, the right-hand side of condition (9), depends on the elasticity $\varepsilon_{\frac{1}{\pi(\hat{e})},(\bar{c},\Delta)}$ of the average unemployment duration $\frac{1}{\pi(\hat{e})}$ with respect to the considered change in the contract. The social planner corrects the moral hazard cost for the search internality, as in the right-hand side of condition (8). Baseline-optimistic insurees, like control-pessimistic insurees, exert too little effort as they overestimate the continuation value of unemployment. In order to correct this search internality, the social planner can induce more search by making consumption more rapidly decreasing. Like in the static framework, if the perceived consumption smoothing effect dominates the search internality effect, private insurers propose contracts to baseline optimists for which consumption decreases suboptimally fast during unemployment.[20]

Timing of Incentives A linear contract provides constant incentives for search throughout the unemployment spell. Werning (2002) shows that this is exactly optimal when job seekers have CARA preferences and unbiased beliefs. With biased beliefs, a linear contract is still optimal for private insurers, but not for the social planner. The social planner responds to the changed

[19] The functions I and J depend on the terms of the contract and are defined in appendix.

[20] In general, the impact of an increase in the bias in beliefs on the optimal level of Δ in the social optimum or the competitive equilibrium is again ambiguous as the bias also changes the induced effort level and the responsiveness to Δ.

effectiveness of future incentives. The suboptimal timing of incentives during unemployment is thus another dimension along which privatizing insurance may decrease welfare in the presence of biased beliefs.

A job seeker is induced to search for employment by the threat of losing unemployment benefits in the future. However, this threat becomes ineffective if the job seeker believes she will have left unemployment by the time she would lose her benefits. Hence, if a job seeker overestimates the probability of leaving unemployment, decreasing consumption for longer unemployment spells becomes an ineffective instrument for inducing effort. Starting from the optimal linear contract, the social planner improves the trade-off between consumption smoothing and inducing effort by making the consumption profile steeper at the beginning of the unemployment spell and flatter afterwards. This variation may increase or decrease the search internality, as it induces more effort at the start of the unemployment spell but less in any later period. Hence, the considered deviation from the optimal linear contract increases the insuree's welfare if the effect on the search internality is either positive or negative, but small.

Proposition 5 *With unbiased beliefs and CARA preferences, the social optimum is a linear contract. With baseline-optimistic beliefs and a negligible search internality $I^{\Delta} \approx 0$, making consumption steeper at the start of unemployment (i.e. $\Delta_1 = \Delta + \varepsilon$) and flatter afterwards (i.e. $\Delta_l = \Delta - \delta$ for all $l > 1$) in a revenue-neutral way increases welfare for small $\varepsilon, \delta > 0$.*

The proposition only shows one local variation that increases welfare. If similar variations for longer unemployment spells lead to the optimal contract, this suggests that the long-term unemployed should be incentivized less than the short-term unemployed. This is in contrast with the response by private insurers. For private insurers, the effect of the improved incentives is offset by the fact that insurees need less compensation in terms of current consumption for decreases in future consumption the more distant these decreases are.

Proposition 6 *With CARA preferences, the profit-maximizing contract offered by competing insurers is linear, whether or not beliefs are biased.*

3.5 Further Extensions

Job seekers face other uncertainties beyond the likelihood of employment that affect the perceived value of insurance and the perceived returns to search. A job seeker's decision process is more involved than just deciding how hard to search. For example, the decision how to set reservation wages and how to allocate consumption during the unemployment spell have been extensively analyzed in the literature, but were ignored to keep the analysis focused. Keeping the mathematical formalities to a minimum, I will briefly argue that the insights of this analysis apply more generally when considering other aspects of unemployment. Job seekers' misperceptions (or other behavioral biases) may distort their decisions. A social planner - when aware - adjusts its policy to correct the implied behavioral distortions. Private insurers, however, have no incentive to correct these distortions, but will respond to the implied misvaluation of insurance and other policies.

Job Loss Perceptions Workers may misperceive the probability of losing their job next to the probability of finding employment.[21] When optimistic about either not losing their job or, once they lost their job, about finding a new job, insurees underestimate the likelihood of unemployment and thus underestimate the value of unemployment insurance. Private insurers respond by providing less insurance coverage. The previous framework can easily be extended by allowing the belief about the probability to start employed $\hat{p}$ to differ from the true probability p. Condition (7) characterizing the competitive equilibrium becomes

$$\frac{1-\hat{p}}{1-p}\frac{1-\hat{\pi}\left(\hat{e}\left(b\right)\right)}{1-\pi\left(\hat{e}\left(b\right)\right)}u'(b)-\frac{\hat{p}}{p}u'\left(w-\hat{\tau}\left(b\right)\right)\left[1+\varepsilon_{1-\pi(\hat{e}(b)),b}\right]=0.$$

Private insurers thus respond in a similar way to optimism about p and $\pi\left(e\right)$. The social optimum would remain unchanged as long as beliefs about job loss do not affect a job seeker's behavior. However, job seekers are more willing to search if they perceive their future job as more secure. Optimism about job security thus mitigates the search distortion due to control pessimism. On the other hand, if workers are optimistic that they can find a secure job quickly after displacement, they will exert less effort to keep their job.

Wage Expectations and Reservation Wages Job seekers face uncertainty not only about the probability of a job offer, but also about the wage that will be offered. When overestimating the probability of receiving high wage offers, job seekers decline job offers they would accept otherwise. They set their *reservation wage* too high. An increase in unemployment benefits worsens this distortion as an optimistic job seeker would increase her reservation wage further. A social planner accounts for this effect on the insuree's true expected utility, when determining the optimal level of unemployment benefits. Similar to the search internality in equation (4), the effect depends on two factors: the responsiveness of the reservation wage $\hat{w}$ to an increase in b and the difference between the reservation utility $u\left(\hat{w}\right)$ and the utility of the reservation wage set by an unbiased job seeker $u\left(\bar{w}\right)$,

$$\left[u\left(\hat{w}\right)-u\left(\bar{w}\right)\right]\frac{d\hat{w}}{db}. \tag{10}$$

Shimer and Werning (2007) derive a sufficient statistics formula based on the reservation wage in a framework with sequential job search à la McCall (1970). They show how the (after-tax) reservation wage encodes all the relevant information about the unemployed's welfare when beliefs are unbiased. However, with biased beliefs a corrective term would enter the characterization depending on the responsiveness of the reservation wage and the difference between the biased and unbiased reservation wage, as in (10).

Notice that as the wage offers will turn out to be lower than expected, job seekers will remain unemployed for longer than they expect. Private insurers respond again by providing less insurance

[21] The analysis by Dominitz and Manski (1997), comparing expectations and realisations for different samples, suggests that this perception bias may be small on average. However, male workers tend to be optimistically biased, while female workers tend to be pessimistically biased.

coverage. Still, the source of the optimistic expectation is important as it helps identifying in which dimensions behavior may be distorted and thus what the appropriate policy responses are.

Unobservable Savings By being optimistic about the probability of leaving unemployment, people underestimate the welfare cost of unemployment. Hence, when given the choice, optimists will buy too little insurance or save too little for when they are unemployed. The option to save for unemployment can be analyzed when reinterpreting the previous framework with the insuree experiencing a first period of certain employment and a second period of potential unemployment. Assume that the insuree can save s when employed to receive sR when unemployed. The social optimal level of b is characterized by

$$u'(b+sR) - u'(w-\tau-s)\frac{d\tau/\tau}{db/b} + \frac{\pi'(e)-\hat{\pi}'(e)}{1-\pi(e)}\left[u(w)-u(b+Rs)\right]\frac{de}{db} + \frac{\hat{\pi}(e)-\pi(e)}{1-\pi(e)}u'(b+Rs)R\frac{ds}{db} = 0$$

As baseline-optimistic job seekers save less, the wedge between $u'(b+sR)$ and $u'(w-\tau-s)$ is larger. This reinforces the consumption smoothing role of unemployment insurance and suggests that unemployment benefits should be higher when job seekers are baseline-optimistic. However, an increase in unemployment benefits causes them to save even less, which negatively affects the true expected utility. This welfare effect, the third term in the first-order condition, depends again on the responsiveness of savings s to a change in b and the distortion in savings determined by the baseline bias $\hat{\pi}(e)-\pi(e)$. The implications are similar for the timing of unemployment benefits in the dynamic extension. Insurees will consume their savings too rapidly during unemployment, as they underestimate how long they may be unemployed. Hence, to avoid that consumption decreases too rapidly during unemployment, unemployment benefits should be sufficiently high for the long-term unemployed. However, this would again cause them to smooth their consumption even less.

Unemployment Policies The analysis has focused on the consequences of biases in beliefs for insurance design. Clearly, the perceptions of the unemployed are central to the evaluation and design of other unemployment policies as well. When job seekers are for instance control-pessimistic, a government could try to induce search efforts more directly through active labor market policies like job search monitoring and job search assistance. The more control-pessimistic job seekers are, the higher the value of inducing search and thus the value of policies that could still induce search at the same cost. Notice however that these policies may not be appreciated as such. Distorted control beliefs affect the insurees' willingness to accept or pay for contracts specifying explicit conditions on precautionary efforts. Private insurance companies may thus decide not to monitor job search efforts if job seekers are control-pessimistic, although this would be socially optimal. Turning back to the savings decision, misperceptions about employment prospects also affect the evaluation of individual unemployment savings accounts, as proposed by Altman and Feldstein (2006). These individual accounts from which workers can withdraw only when unemployed, reduce the moral hazard cost of unemployment insurance. However, when workers misperceive their employment prospects, both the contributions to these accounts and the withdrawals there from should be regulated to mitigate distortions in savings decisions.

If biases in beliefs have imperative consequences for policy design and people's welfare, policy makers should not take these beliefs as given. However, that people can be successfully informed about their biases is not obvious. Information policies have been successful in some areas (e.g. risk of smoking), but have proven to be difficult in general. Improving individual job seekers' perceptions about their employment prospects is challenging. Given the heterogeneity across job seekers, informing them about average durations is not sufficient, even less so when most of the job seekers believe they will do better than the average job seeker. Notice also that insurers may prefer not to inform insurees or even mislead them such that the information provided by insurers loses credibility: a paternalistic government prefers an insuree to be more control-optimistic to mitigate the moral hazard problem, a profit-maximizing insurer prefers an insuree to be more baseline-pessimistic to increase her willingness to pay for insurance. The question to which extent information policies can improve people's perceptions about their employment prospects is of first-order importance for policy design and an interesting avenue for future research.

4 Empirical Analysis

In this section, I analyze empirically the beliefs held by unemployed job seekers about their job prospects and link these beliefs to the actual outcomes. As the baseline and control bias jointly determine the difference between social, private and naive insurance, we are interested in knowing both. I find strong evidence that job seekers are optimistic in the baseline dimension and present some regression results suggesting that they may be pessimistic in the control dimension. I also analyze how baseline beliefs change during unemployment and find no evidence that unemployed workers are less biased the longer or the more often they have been unemployed.

4.1 Data

I use data collected by Price et al. (1998) in a study about preventing depression in couples facing job loss. The study was conducted in and around two major urban areas in Michigan and Maryland from 1996 to 1998. All participants were recruited through state unemployment offices. Initial screening retained $1,487$ job seekers, who were part of a couple. All retained subjects were unemployed for less than 15 weeks and looking for work, but did not expect to be recalled to their former job. About one month after the initial screening, the retained subjects and their partners were interviewed for the first time. Two follow-up interviews were organized about six months and twelve months later. A third follow-up interview was organized one month after the first interview, but only for a subsample of the initial group. In Table 1 in appendix, I show sample averages of the demographics of the retained job seekers. On average, the subjects have been unemployed for

6.9 weeks at the time of the first interview.

4.2 Baseline Beliefs: Actual and Expected Duration

The strategy for identifying the baseline bias is simple, linking the expected duration of unemployment with the actual duration of unemployment for the same sample of subjects. The analysis suggests that job seekers are very optimistic about their chances to become employed again. The validity of the identification, however, depends on the absence of selection effects and errors in the measurement of job seekers' expectations, which I discuss below.

The subjects are asked about their baseline expectations in the question: "How many weeks do you estimate it will actually be before you will be working more than 20 hours a week?" I interpret the subjects' answers as the number of weeks they expect to remain unemployed. The average expected remaining duration of unemployment at the time of the first interview equals 6.8 weeks. The median expected duration is 4 weeks. More than 90 percent of the subjects expect that they will have found employment within the next 3 months. The cumulative distribution is shown in Figure II.

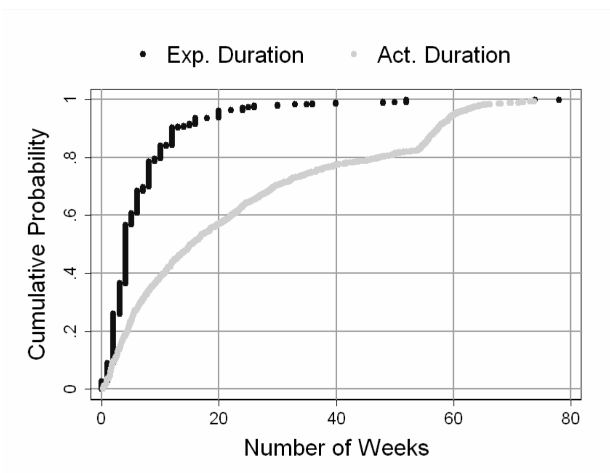

Figure II
Empirical cumulative distr.: actual duration vs. expected duration of remaining unemployment spell

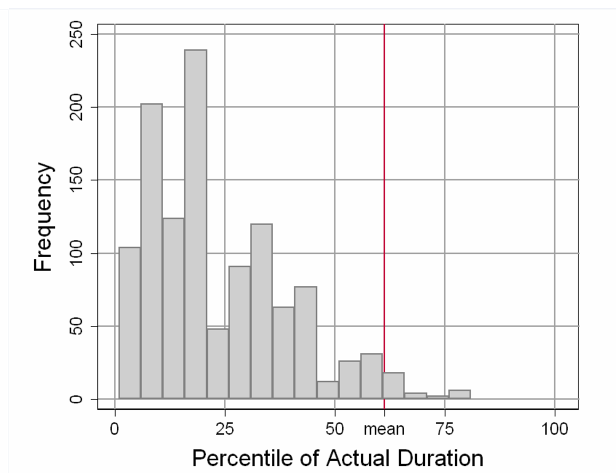

Figure III
Histogram of the reported expectations with bins labeled by the percentiles of the actual duration

In follow-up interviews, subjects are asked when they actually started working. 86 percent of the subjects found work for more than 20 hours a week before the last interview, about one year after the first interview. The average time they needed to find such a job was 17.0 weeks. I compute the *minimum duration* of an unemployment spell, assuming that the other 14 percent of the subjects found work on the date of the last interview. The average minimum duration equals 23.0 weeks, again starting from the first interview.[22] On average the unemployment spell lasts more than three

[22] The average optimistic bias for the sample of job seekers for whom the expectations and the actual duration are known ($n = 1,088$) equals 15.3 weeks. This excludes subjects who report to works less than 20 hours at the start

times as long as expected, suggesting an average baseline bias of more than 200 percent.

Matching the expectations and the actual realizations shows that 80 percent of the job seekers underestimate the duration of their unemployment spell and that the number of weeks by which the durations are underestimated exceed by far the number of weeks by which the durations are overestimated. The distribution of the differences between the actual and expected number of weeks of unemployment is shown in Figure I in the introduction. The difference between the minimum actual duration and the expected duration is shown in dark grey for the job seekers who have not found work before the last interview. The optimistic bias in baseline beliefs also appears clearly in Figure II, comparing the empirical distributions of the expected and actual unemployment durations. The cumulative distribution of the expected duration stochastically dominates the cumulative distribution of the minimum duration.[23] For any number of weeks, the number of job seekers who expect their unemployment spell will end within that time span exceeds the number of job seekers for whom the unemployment spell actually ends within that time span.

Selection Effects In this sample, job seekers largely underestimate the duration of unemployment. Selection effects seem to play a minor role in explaining this optimistic bias. First, the average unemployment duration decreases in the US between 1996 and 1998, as did the average unemployment rates in four out of the five counties considered in the sample. It seems unlikely that job seekers were surprised by an unexpected deterioration of economic conditions. Second, by screening through state unemployment offices, only job seekers who are filing for unemployment benefits are selected. These job seekers are the most policy relevant group of unemployed workers. Moreover, this selection effect does not necessarily increase the estimate of baseline optimism either. Anderson and Meyer (1997) document that the main reason why displaced workers do not take up unemployment benefits is that they expect that the unemployment spell will be short.[24] Third, the sample characteristics are similar to the characteristics of the unemployed in Maryland and Michigan between 1996 and 1998 in the Current Population Survey.[25] Fourth, the job seekers in this sample have been unemployed for 7 weeks on average at the time of the first interview. This implies that both job seekers with ex post short unemployment spells and baseline-pessimistic job

of the new job ($n = 117$) subjects. Including these subjects with the date they started this part-time job decreases average optimism by less than a week. This also excludes subjects who report they have found a different job before the one they are currenly working on, but for which no start date is known ($n = 89$). Including these subjects with the date they started their current job increases average optimism by 1.5 weeks. Including these subjects assuming they immediately found a job decreases average optimism by 1.5 weeks.

[23] The kink in the cumulative distribution of the actual duration is due to the fact that I include the minimum duration for the job seekers with incomplete spells. These minimum durations are bunched around 52 weeks, which is the average time between the first and the last interview.

[24] Anderson and Meyer (1997) find that 37 percent of the job losers and leavers eligible for UI give 'Expected to get another job soon/be recalled' as the reason for not applying for UI, whereas no other single reason is given by more than 7 percent of them.

[25] Out of the 425 unemployed in Maryland and Michigan in the March CPS between 1996 and 1998, 54 percent are male and 69 percent are white, compared to 53 percent and 73 percent respectively in the sample considered in this paper. The unemployed in the CPS sample have less education and are younger. This may be explained by the fact that this sample is restricted to couples. Compared with the married unemployed in the CPS, the distributions of education and age are more similar. Notice that baseline optimism is significantly higher for the less educated and not significantly lower for the young job seekers.

seekers, who search more intensively, are likely to be underrepresented in the sample. However, the average baseline-optimistic bias is hardly smaller for the newly unemployed. For the 249 job seekers who have been unemployed for 3 weeks or less, the average optimistic bias equals 14.5 weeks. The Wilcoxon rank-sum test does not reject that the baseline bias has the same distribution for the recently displaced job seekers and the other job seekers (p-value = .79). Finally, exit rates tend to decrease with the duration of unemployment, which may explain why the average remaining duration in the sample considered here is high. The average duration of unemployment for newly unemployed is about 14 weeks in the US in 1996 (Valletta 1998). This is still twice as long as the average expectation in the sample.

The US economy was expanding during the period that the survey was organized. The survey cannot shed light on whether the bias persists throughout the business cycle. When a crisis hits, the average unemployment duration increases. However, with unemployment at the centre of attention during the crisis, expectations may adjust even more such that the optimistic bias would be smaller or even reversed. Uncovering the cyclicality in the bias is important for policy analysis, but I leave this for further research.

Reported Expectations One may be concerned about the extent to which the duration predictions capture the job seekers' expectations on which they act. First, the job seekers are not explicitly incentivized to report their expectations truthfully. I do not observe actual behavior either, like their savings for instance, to verify to what extent their behavior is explained by the reported expectations. The expectations do however explain half as much variation in the actual duration of the unemployment spells as all other demographic and employment variables together.[26] Also, the growing literature on the measurement of expectations confirms the predictive value of surveyed expectations for both actual outcomes and future behavior (Manski 2004). Second, I interpret the job seekers' reported point predictions as their subjective means. However, some job seekers may report different distributional features as their point predictions, like the median or any other percentile.[27] Figure III suggests that it is unlikely that these alternative interpretations of the question play an important role in explaining the optimistic bias. The figure shows the distribution of the reported expectations by the percentiles of the actual duration distribution. That is, for each job seeker it shows the percentile he or she should have had in mind if his or her reported point prediction were to be accurate ex post. This assumes that the population distribution is the true distribution that all job seekers are facing. The point predictions are centered around the 20th percentile of the actual duration distribution, and more than 90 percent of the predictions are below the median (and thus below the mean). Finally, an alternative question in the survey asking for a probabilistic forecast suggests similar optimism about the baseline probability of finding work,

[26] The R^2 for regression (1) in Table 2, which regresses the actual duration on all considered covariates, increases from .087 to .128 when including the expected duration as an explanatory variable. The R^2 for regressing the actual duration on only the expected duration equals .052.

[27] Engelberg, Manski and Williams (2009) argue that the elicitation of probabilistic forecasts is therefore more instructive. Notice hovever that the use of these point predictions about the duration of unemployment does avoid bunching issues that arise when eliciting probabilities.

although it does not allow quantifying the bias, as discussed in Appendix C.

4.3 Control Beliefs: Actual and Perceived Returns to Effort

The identification of the control bias is difficult, as I have no direct information on the perceived returns to search. Instead, I estimate to what extent subjects who report to search more expect shorter unemployment spells and to what extent they actually experience shorter unemployment spells. A comparison of the two estimates can shed light on the control bias. Unfortunately, I can only imperfectly control for heterogeneity and endogeneity issues. This empirical exercise suggests that, if anything, job seekers are control-pessimistic. The estimated control bias is opposite in sign to the baseline bias. However, the control bias seems much less pronounced and the IV-estimates of the bias are insignificant.

Subjects are asked how frequently they have searched for work during the month before the interview. The questions ask about reading the newspaper for job opportunities, checking with employment agencies, checking with friends, sending out resumes, etc. I aggregate the answers to these questions, giving each answer the same weight, and I estimate the impact of this search index on the actual and expected duration of unemployment.[28,29] The regressions of interest are

$$\textit{actual duration}_i = \beta_1 \; \textit{search}_i + X_i\gamma_1 + \varepsilon_i, \tag{11a}$$

$$\textit{expected duration}_i = \beta_2 \; \textit{search}_i + X_i\gamma_2 + \nu_i, \tag{11b}$$

$$\textit{act. duration}_i \text{ - } \textit{exp. duration}_i = (\beta_1 - \beta_2) \; \textit{search}_i + X_i(\gamma_1 - \gamma_2) + \varepsilon_i - v_i \tag{11c}$$

with the durations starting from the first interview.

Table 2 reports the ordinary least squares estimates for these three regressions. Unemployment spells are actually shorter for unemployed workers who report to search more intensively and they also expect their spells to be shorter. The first effect is stronger than the second effect. If the search index increases by one unit, which corresponds to doubling the frequency in every search dimension, the actual unemployment spell is 3.4 weeks shorter, but the expected unemployment spell is only 2.0 weeks shorter. This suggests that job seekers underestimate the returns to search and thus may be control-pessimistic. Higher search levels correspond to lower optimism about the duration of unemployment. While the coefficients of search are significant at the 1 percent level in regressions (11a) and (11b), the estimate of the difference in regression (11c) is only significant at the 10 percent level (p -value = .08). The estimated average control bias equals -67 percent. This

[28] The correlation between this search index and any of its nine components varies between 0.48 and 0.70. The partner of each subject is asked the exact same questions about the subject's efforts. The correlation between the search index as reported by the job seekers and their partners is 0.57.

[29] The nine questions are: "During the past month, how often have you; read the newspaper and other publications for job opportunities? checked with employment agencies? talked to friends, family, or other people you know to get information about jobs? used, or sent out a resume? filled out application forms for a job? telephoned, written or visited potential employers? done things to improve the impression you would make in a job interview? contacted a public employment service? went out on information interviews?" The answer options are; 1. Not at all, 2. Once every 3 to 4 weeks, 3. Once every couple of weeks, 4. Every week, 5. Two or three times a week, 6. Every day.

is much less pronounced than the baseline bias and opposite in sign.[30]

Notice that the baseline-optimistic bias does not only change with search efforts. I control for many covariates, as reported in Table 2. Optimism about the duration is more than 5 weeks lower for white and married job seekers. White job seekers have significantly shorter unemployment spells, but do not have different expectations. The same is true for married job seekers. Unemployed workers who earned more at their last steady job believe their unemployment spell will last longer, but it does not actually last longer, making them significantly less optimistic. Notice that heterogeneity in beliefs is ignored in the theoretical analysis here, but analyzed in Spinnewijn (2009).

Heterogeneity and Endogeneity The theoretical analysis considers the difference between the actual and perceived impact of search efforts on the duration of unemployment. The causal nature of this relation is essential, but may be inconsistently estimated due to unobserved heterogeneity and endogeneity. Some job seekers may be more employable and have shorter actual unemployment spells, although they search less. This channel suggests that ordinary least squares underestimate the actual returns to search in regression (11a). However, if job seekers accurately perceive the impact of their employable nature on the actual duration of unemployment, the estimate of the effect of search on optimism in regression (11c) is still consistent. This is not sufficient if for instance job seekers differ in their naiveté about their hyperbolic preferences, which affects at the same time the search decision and the optimistic beliefs about the duration of unemployment. Another problem is that search efforts depend on the perceived value of remaining unemployed. The theory suggests that someone who believes that it is very likely to leave unemployment in the near future is less inclined to search hard today. This channel suggests that ordinary least squares underestimate the perceived returns to search in regression (11b). I try to control for unobserved heterogeneity and endogeneity using instrumental variables.

Both the utility difference between employment and unemployment and the marginal cost of search determine how intensively someone searches for a job. Candidates for instruments are variables that change either the utility differential or the cost of searching, but do not change the difference between the actual and expected duration of unemployment in other ways than through search. I consider two instruments that affect the utility differential: the potential unemployment benefit level and the importance of working to the job seeker. I do not observe the unemployment benefits received, but I calculate what a job seeker would have received if eligible, conditional on his or her monthly earnings before unemployment.[31] The schedule is approximately linear in earnings up to a maximum amount. The identification of the impact of search comes from the non-linearity in the benefit schedule. The identifying assumption is that by including monthly earnings linearly I control for the underlying relation between earnings and the duration of unemployment, actual or

[30] The estimated pessimism about control is similar when including alternative measures of search and controling for the willingness to work, as shown in Appendix C. There I also discuss censoring and truncation issues.

[31] The replacement rates are different in Maryland and Michigan. I use the UI calculator used in Chetty (2008) to calculate the replacement rates based on the reported hourly wage before unemployment.

expected. The impact of search is identified only by the difference between the non-linear benefit schedule and the smooth relation between earnings and the duration of unemployment. For the importance of work, I use the job seeker's answer to the question: "How important is work to you as part of your daily life?" The identifying assumption is that the error terms in the equations in (11) are not correlated with the importance people attach to work. This is of course a very strong assumption, but seems most plausible for equation (11c), the main regression of interest. A job seeker's attachment to work is likely to be correlated with the actual and expected duration of unemployment, in other ways than through search, but may not be correlated with the difference between the two. However, if job seekers who attach more importance to work are more optimistic about the duration of the unemployment spell, I am underestimating how pessimistic they are about their control. If the opposite is true, I am overestimating how pessimistic they are about their control.

Table 4 reports the two stage least squares estimates and the first stage. The estimated impact of search on the job seeker's optimism increases. The optimistic bias decreases by -2.3 weeks when job seekers double their search intensity. This would confirm the control-pessimistic bias suggested by the least squares estimates, but the estimate becomes insignificant, since the standard error increases even more. The first stage regression shows that the potential unemployment benefit level is a weak instrument. The decrease in search when potential unemployment benefits increase is insignificant. However, job seekers who attach more importance to work search significantly more. Considering the actual and expected duration separately, we see that the estimates of the search coefficients increase in absolute value in both regressions compared to the least squares estimates. A job seeker who searches twice as intensively, finds employment 5.7 weeks earlier, but expects the reduction in the unemployment spell to be only 3.3 weeks.[32]

4.4 Changes in Beliefs

In the dynamic model, I have made the simplifying assumption that the perceived probability of finding work is not affected by the duration of unemployment. This contradicts learning by unemployed workers. However, the beliefs reported by the job seekers suggest that not much learning is going on.

First, the number of times a job seeker has been unemployed in the last three years does not significantly lower his or her optimism about the current unemployment spell (p -value = .48), as shown in Table 2. Second, the number of weeks a job seeker has been unemployed in the current spell even tends to increase the optimistic bias (p -value = .07). Both results are cross-sectional and do not necessarily rule out that the optimistic baseline bias decreases when job seekers become more experienced. Job seekers who are less optimistic about finding a job may search more and leave unemployment earlier. However, sufficient learning would overcome this selection effect. Finally, unsuccessful job seekers hardly increase their expectations during unemployment. I find

[32] I discuss alternative instruments that make the first stage stronger in appendix C. These alternative estimates again suggest a pessimistic control bias.

that the distribution of expectations held by job seekers about the remaining number of weeks of unemployment is very stable throughout the unemployment spell. The average of the expectations at the first interview is not significantly different from the average of the expectations one month or six months later, comparing the same sample of job seekers. Only the job seekers who are still unemployed at the time of the last interview, about twelve months after the first interview, report expectations that are significantly higher than at the first interview.[33] Together these results suggest that if some learning about the bias is going on, it is very modest.[34]

5 Numerical Analysis

In this section, I analyze numerically the importance of the biases in beliefs for insurance design. I calibrate the dynamic model for different specifications of the underlying beliefs in order to evaluate the potential impact on the social optimum and the competitive equilibrium. I discuss the implied welfare consequences of both the privatization of insurance and the naive implementation ignoring the presence of biases in beliefs.

Calibration The true probability function and perceived probability function in this numerical exercise are of the form

$$\pi(e) = \pi_0 + \pi_1 e^{\rho} \text{ and } \hat{\pi}(e) = \hat{\pi}_0 + \hat{\pi}_1 e^{\rho}.$$

I choose values for the parameters of these functions to match the beliefs and exit rates as a function of effort for the job seekers in the sample considered in the previous section. For the default specification, I consider a pessimistic control bias $\frac{\hat{\pi}'(e)-\pi'(e)}{\pi'(e)} = \frac{\hat{\pi}_1-\pi_1}{\pi_1}$ of -67 percent, which corresponds to the least squares estimates in Table 2, and an optimistic baseline bias $\frac{\hat{\pi}(e)-\pi(e)}{\pi(e)} = \frac{\hat{\pi}_0-\pi_0+(\hat{\pi}_1-\pi_1)e^{\rho}}{\pi_0+\pi_1 e^{\rho}}$ of 100 percent evaluated at the average effort level, which is less extreme than the bias in the sample. For the parameters of the cost of effort function I choose values such that the monthly exit rate in the calibrated model given the current UI system equals 0.188 and the implied elasticity of the unemployment duration to unemployment benefits equals -0.5. These values correspond to respectively the average exit rate in the sample and the empirical estimates of duration elasticities reviewed in Krueger and Meyer (2002). The details of the calibration are presented in Appendix B.

Optimal Static Contracts I first consider static contracts transferring consumption from those who start employed to those who start unemployed. The constant unemployment benefit b is

[33] The distributions and expectations are shown in Appendix C.

[34] Notice that if job seekers are uncertain about their ability to find a job at the start, a longer unemployment spell should make them revise their beliefs about the remaining duration upward. The data suggests that they are revising their beliefs upward, at least after twelve months, however they may not revise sufficiently and become more optimistic compared to an unbiased job seeker who is Bayesian updating, the longer they are unemployed. This is what Falk, Huffman and Sunde (2006) find in a laboratory experiment.

funded by a wage tax τ imposed on the share p of individuals who start employed (i.e. $\Delta = \bar{\tau} = 0$). With a baseline bias of 100 percent and a control bias of -67 percent, the unemployment benefit b is significantly lower in the competitive equilibrium than in the social optimum. The respective unemployment benefit levels are .16 and .40. I scaled the individual output level to 1 such that the unemployment benefit level b can be interpreted as a replacement rate. On the one hand, they respond to the perception of the value of insurance held by the baseline-optimistic insurees, which makes them offer lower unemployment benefits than what is socially optimal. On the other hand, they do not correct for the low effort level exerted by the baseline-optimistic and control-pessimistic insurees, which makes them offer higher unemployment benefits than what is socially optimal. Private insurers hardly offer any insurance against unemployment despite its value. The former effect strongly dominates the latter effect for this numerical example. Given the lower replacement rate, the insurees exert more search effort in the competitive equilibrium than in the social optimum. The monthly exit rate is .185 in the competitive equilibrium and .173 in the social optimum.

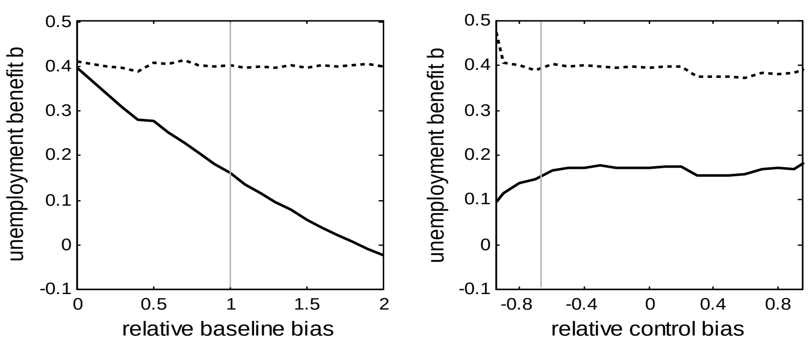

Figure IV
Static contract: unemployment benefit in competitive equilibrium (full) and social optimum (dash) for different baseline and control biases

The full line and dashed line in Figure IV show the optimal (constant) unemployment benefit level in the competitive equilibrium and the social optimum for different biases in beliefs underlying the data. For every alternative beliefs specification, I recalibrate the cost function to match the exit rate and duration elasticity. In the left panel, I present the respective replacement rates for a baseline bias $\frac{\hat{\pi}(e)-\pi(e)}{\pi(e)}$ ranging from 0 to 200 percent, evaluated at the average effort level. I change the baseline bias by changing $\hat{\pi}_0$, which leaves the control bias unaffected. Private insurance is much more responsive to changes in the baseline beliefs than social insurance, accommodating the baseline optimists' changing perception of the value of insurance. The private insurers decrease the replacement rate from .40 to even negative values for sufficiently high baseline optimism. The social planner only responds to the changed price of inducing effort and corrects for the search internality due to the baseline-optimistic beliefs. The socially optimal replacement rate varies between .39 and .41 for the considered range of baseline optimistic biases. In the right panel of Figure IV, I present the respective replacement rates for a control bias $\frac{\hat{\pi}'(e)-\pi'(e)}{\pi'(e)}$ ranging from -95 to 95 percent. I change the control bias by changing $\hat{\pi}_1$. I also change $\hat{\pi}_0$ such that the baseline bias, evaluated at the average effort level, remains at 100 percent. Both the responses by private insurers and the social planner to a change in the control bias are relatively modest. The two panels together show that the wedge between social insurance and private insurance is predominantly driven by the baseline bias rather than by the control bias; only for extreme control-pessimistic beliefs does the wedge between private and social insurance change significantly in response to changes in the control beliefs.[35]

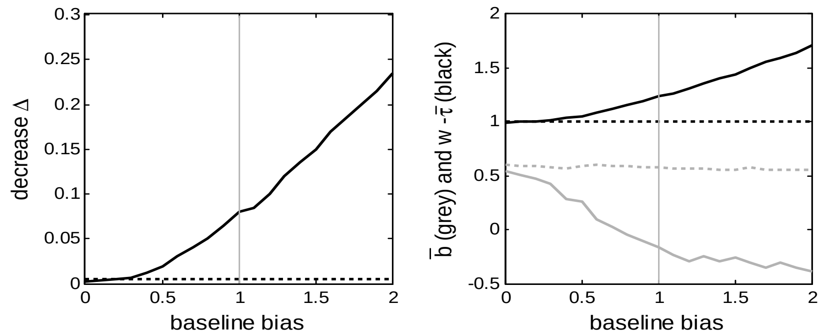

Figure V
Linear contract: dynamic and static wedge in the competitive equilibrium (full) and social optimum (dash) as a function of the baseline bias

Optimal Linear Contracts I now allow the insurers to impose a wage tax τ^u on the unemployed from the moment they find employment and to decrease the unemployment benefit b and the after-tax wage $w - \tau^u$ by Δ for any additional month of unemployment. This corresponds to the linear contracts considered in subsection 3.4. For the benchmark specification, search effort is induced both by a static wedge - rewarding a successful job seeker with a net wage $w - \tau^u$ that exceeds the unemployment benefit b - and by a dynamic wedge - punishing an unsuccessful job seeker by decreasing all future consumption levels by Δ. Both wedges are much more pronounced in the competitive equilibrium. The starting unemployment benefit level $\bar{b}$ equals .58 in the social optimum and at $-.16$ in the competitive equilibrium. The monthly decrease in consumption Δ, expressed as a percentage of production, equals only .5 percentage points in the social optimum, but 8 percentage points in the competitive equilibrium. Consumption jumps by .43 upon employment in the social optimum and by 1.40 in the competitive equilibrium. Figure V shows the slope Δ and the intercepts $\left(\bar{b}, w - \bar{\tau}\right)$ of the linear contracts in the social optimum and the competitive equilibrium for different baseline biases underlying the data (with the cost function recalibrated). In the social optimum, Δ is slightly higher when insurees are baseline-optimistic. This increase is very small compared to the increase in the competitive equilibrium.

[35] The control beliefs could also play a more substantial role if the search decision is made along the extensive margin such that insurers need to decide whether to induce the unemployed to search or not.

Naive Policies A policy maker uses data to adjust current policies or implement new policies. When unaware of biases in beliefs, the naive policy maker risks to implement suboptimal policies, either by using the empirical moments in the wrong model, as discussed before, or by miscalibrating the model by matching the empirical moments under the assumption that the job seekers' beliefs are unbiased. In the spirit of this calibration exercise, the policy maker who naively assumes that job seekers have correct beliefs, would use the cost function that matches the exit rate and unemployment duration elasticity if beliefs were to be unbiased. This miscalibrated cost function leads the naive policy maker to provide too little incentives to the unemployed, setting the static wedge $w - \tau^u - b$ at .37 and the dynamic wedge Δ at only .26 percentage points. The socially optimal contract has $w - \tau^u - b = .43$ and $\Delta = .5$, if the baseline bias is 100 percent and the control bias is -67 percent. This is in line with Corollary 1. The naive policy maker ignores that the additional incentives increase welfare by correcting the lowered incentives due to the bias in beliefs. Figure IV and V show how the changes in the social optimum when assuming different biases in beliefs underlying the data are small relative to the difference between the social optimum and the competitive equilibrium. This suggests that the impact of miscalibration is small relative to the impact of privatizing insurance.

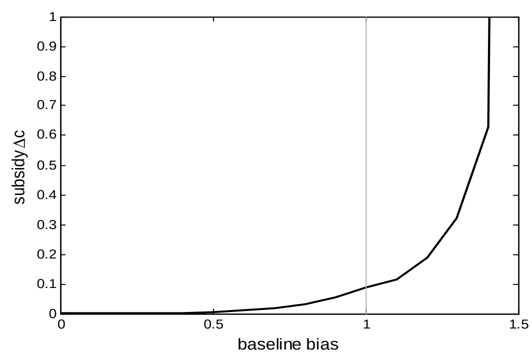

Figure VI
Welfare cost of privatizing insurance as a function
of the baseline bias

Welfare Effects An insuree does not internalize the impact of her effort on the insurer's budget constraint. This moral hazard problem lowers the insuree's welfare in the social optimum below the first best. Baseline optimism and control pessimism decrease the effort choice further and aggravate the moral hazard problem. The true expected utility in the social optimum is therefore decreasing in both biases. If in contrast insurees are sufficiently baseline-pessimistic or control-optimistic, the social planner could approximate the first best.

In the competitive equilibrium, the true expected utility is not only lower than in the social optimum when insurees have biased beliefs, but also tends to decrease more than in the social optimum when insurees become more, as private insurers exploit the biases to maximize profits. I calculate the consumption subsidy Δc required in every period of the insuree's life such that she achieves the same true expected utility in the competitive equilibrium as in the social optimum.

Interestingly, the numerical simulation suggests that the consumption subsidy increases exponentially in the baseline bias, as shown in Figure VI. When the baseline bias is small, the consumption subsidy is approximately zero and the welfare cost of privatizing insurance is small. However, when the baseline bias is large, the welfare cost of privatizing insurance may be very substantial. The exponential increase in welfare cost reflects the exponential increase in the monthly consumption reduction Δ and the wedge $w - \tau^u - b$ in the competitive equilibrium.

For an optimistic baseline bias of 100 percent and a pessimistic control bias of 67 percent, the consumption subsidy is 9 percent of the output produced when employed. That means that 9 percent of the economy's production is required to make people with competitive unemployment insurance as well off as they would be with an insurance system that is optimally designed. The welfare cost is so high because of the dynamic component of the contract. When the insurers are restricted to static contracts, the required consumption subsidy never exceeds 1 percent of output for the beliefs considered. In contrast with the static contracts, the dynamic contracts allow the private insurer to exploit that the insuree underestimates the probability of being unemployed for a long term. The insurer does so by offering very low (and eventually negative) consumption levels when the job seeker experiences a long unemployment spell, also in all future periods after re-employment. The potential immiserization is in practice bounded by limited liability of the insurees and also by learning by the insurees. However, the analysis suggests that the equilibrium contract could imply a strong disparity in lifetime utility between the long-term unemployed on the one hand and the employed and the short-term unemployed on the other hand. People accept this disparity, but only because they underestimate the probability of being long-term unemployed.

6 Conclusion

The perception of risk is at the heart of optimal insurance design. This paper focuses on the optimal design of unemployment insurance and presents new evidence suggesting that job seekers are optimistic about the probability of finding a job, but may be pessimistic about the returns to additional search. The theoretical analysis applies to insurance and wage contracts in other contexts in which biases in beliefs may be very different, but important as well: young drivers may overestimate the probability of avoiding car accidents, but underestimate the returns to driving safely; women may overestimate the probability of being spared from breast cancer, but underestimate the returns to preventive care; CEO's may overestimate the probability of success and at the same time their control over this probability. The theoretical analysis also generalizes for other behavioral biases to the extent that these biases distort the insuree's decisions or her perceived value of insurance.

The analysis assumed that the bias in beliefs is representative and stable. The assumption that the bias is representative is restrictive if insurers could offer a menu of contracts. People have heterogeneous perceptions of risks (Slovic 2000) and this heterogeneity is typically not observable to insurers, as analyzed in Spinnewijn (2009). The assumption that the bias in beliefs is stable excludes a natural way to correct for the behavioral distortions, that is by informing the insuree about her biased beliefs. Information policies have been successful in other areas (e.g. risk of smoking) and should be incorporated in unemployment policies, but may be difficult nevertheless.

The paper finds that biases in baseline and control beliefs drives a wedge between optimal and naive insurance design and between social and private insurance. First, policy makers should be aware of people's perceptions when evaluating or implementing policies. Biased beliefs distort behavior and affect the responsiveness to incentives. Observable measures of this responsiveness, like the response in employment to unemployment benefits, are often central in policy design. Other examples are responses in health outcomes to the copay and deductible, in production to taxes or in retirement decisions to pension benefits. The use of these statistics for policy design should be different when people's perceptions are biased. Second, policy makers have a reason to intervene when insurance is provided to insurees with biased beliefs by private insurers. Although competition disciplines private insurers to charge actuarially fair prices, it does not induce them to correct the insurees' distorted choices. The welfare gains from intervening may be substantial as they are exponentially increasing in the biases in beliefs.

Proofs of Propositions

Proof of Proposition 1

With unbiased beliefs, the two maximization problems (1) and (2) coincide. The first-order condition of this problem equals

$$\begin{aligned}(1-p)\left(1-\pi\left(\hat{e}\left(b\right)\right)\right)u'(b)-pu'\left(w-\hat{\tau}\left(b\right)\right)\tfrac{d\hat{\tau}(b)}{db}+\\ (1-p)\left[\pi'\left(\hat{e}\left(b\right)\right)\left[u(w)-u(b)\right]-1\right]\tfrac{d\hat{e}(b)}{db}=0.\end{aligned} \tag{12}$$

The third term equals zero by (IC). Under the assumption that $\pi\left(\hat{e}\right)<1$, dividing by $(1-p)\left(1-\pi\left(\hat{e}\right)\right)$ gives

$$u'(b)-u'\left(w-\hat{\tau}\left(b\right)\right)\frac{b}{\hat{\tau}\left(b\right)}\frac{d\hat{\tau}\left(b\right)}{db}=0.$$

Using $\frac{d\hat{\tau}(b)}{db}\frac{b}{\hat{\tau}(b)}=1+\varepsilon_{1-\pi(\hat{e}(b)),b}$, the Baily formula (3) follows by dividing both terms by $u'\left(w-\hat{\tau}\left(b\right)\right)$.□

Proof of Proposition 2

The first-order condition of the social planner's problem (1) equals

$$\begin{aligned}(1-p)\left(1-\pi\left(\hat{e}\left(b\right)\right)\right)u'(b)-pu'\left(w-\hat{\tau}\left(b\right)\right)\tfrac{d\hat{\tau}(b)}{db}+\\ (1-p)\left\{\pi'\left(\hat{e}\left(b\right)\right)\left[u(w)-u(b)\right]-1\right\}\tfrac{d\hat{e}(b)}{db}=0.\end{aligned}$$

Using (IC) to substitute the marginal cost of search, which equals 1, by the perceived return to search and dividing by $(1-p)(1-\pi(\hat{e}(b)))$, the first-order condition simplifies to

$$u'(b) - u'(w-\hat{\tau}(b))\left(1+\varepsilon_{1-\pi(\hat{e}(b)),b}\right) + \left\{\pi'(\hat{e}(b)) - \hat{\pi}'(\hat{e}(b))\right\}[u(w)-u(b)] \frac{\pi'(\hat{e}(b))\,b}{\pi'(\hat{e}(b))\,b} \frac{1}{(1-\pi(\hat{e}(b)))} \frac{d\hat{e}(b)}{db} = 0.$$

Rewriting this in terms of elasticities, I find

$$u'(b) - u'(w-\hat{\tau}(b)) = u'(w-\hat{\tau}(b))\,\varepsilon_{1-\pi(\hat{e}(b)),b} + \frac{\hat{\pi}'(\hat{e}(b)) - \pi'(\hat{e}(b))}{\pi'(\hat{e}(b))} \frac{u(w)-u(b)}{b} \varepsilon_{1-\pi(\hat{e}(b)),b}.$$

The adjusted Baily formula (5) for the social optimum follows by dividing both sides by $u'(w-\hat{\tau}(b))$.□

Proof of Proposition 3

The first-order condition of the problem characterizing the competitive equilibrium (2) equals

$$(1-p)(1-\hat{\pi}(\hat{e}(b)))\,u'(b) - pu'(w-\hat{\tau}(b))\tfrac{d\hat{\tau}(b)}{db} + (1-p)\left\{\hat{\pi}'(\hat{e}(b))[u(w)-u(b)]-1\right\}\tfrac{d\hat{e}(b)}{db} = 0.$$

The third term equals zero by (IC). Dividing by $(1-p)(1-\pi(\hat{e}(b)))$ gives

$$\frac{1-\hat{\pi}(\hat{e}(b))}{1-\pi(\hat{e}(b))}u'(b) - u'(w-\hat{\tau}(b))\frac{b}{\hat{\tau}(b)}\frac{d\hat{\tau}(b)}{db} = 0.$$

Using $\frac{d\hat{\tau}(b)}{db}\frac{b}{\hat{\tau}(b)} = 1+\varepsilon_{1-\pi(\hat{e}(b)),b}$, the adjusted Baily formula (6) for the competitive equilibrium follows by dividing both sides by $u'(w-\hat{\tau}(b))$.□

Proof of Proposition 4

I consider an increase in Δ together with an increase in $\bar{c}$ (i.e. both $\bar{b}$ and $w-\bar{\tau}$) such that the budget constraint, accounting for the changes in $\hat{e}(z)$, is still satisfied.[36] That is,

$$-d\bar{c} + \frac{\beta(1-\pi(\hat{e}(z)))}{1-\beta(1-\pi(\hat{e}(z)))}d\Delta - C_e(z,\hat{e}(z))(1-\beta)\frac{\partial\hat{e}(z)}{\partial\Delta}d\Delta = 0.$$

Only the change in Δ affects the effort choice, since the insuree has CARA preferences. Denote the elasticity of unemployment duration $\frac{1}{\pi(\hat{e})}$ with respect to an increase in $\bar{c}$ together with an increase in Δ by $\varepsilon_{\frac{1}{\pi(\hat{e})},(\bar{c},\Delta)} \equiv -\frac{\pi'(\hat{e}(z))}{\pi(\hat{e}(z))}\frac{\partial\hat{e}(z)}{\partial\Delta}\frac{d\Delta}{d\bar{c}}\Delta > 0$, then revenue-neutrality implies

$$\frac{d\Delta}{d\bar{c}} = \tfrac{1-\beta(1-\pi(\hat{e}(z)))}{\beta(1-\pi(\hat{e}(z)))}\left\{1+\tfrac{\beta\pi(\hat{e}(z))}{[1-\beta(1-\pi(\hat{e}(z)))]^2}\tfrac{\left(\bar{b}+\tau\right)(1-\beta)-\Delta}{\Delta}\varepsilon_{\frac{1}{\pi(\hat{e}(z))},(\bar{c},\Delta)}\right\}.$$

The gain in true expected utility from an increase in $\bar{c}$, balanced by an increase in Δ equals

[36] With abuse of notation, the change $d\bar{c}$ denotes the joint change in both $\bar{b}$ and $w-\bar{\tau}$ and the impact on a variable y from the joint change in $\bar{b}$ and $w-\bar{\tau}$, $\frac{\partial y}{\partial \bar{b}} - \frac{\partial y}{\partial \bar{\tau}}$, is denoted by $\frac{\partial y}{\partial \bar{c}}$.

zero if

$$U_{\bar{c}}(z,\hat{e}(z)) + U_{\Delta}(z,\hat{e}(z))\frac{d\Delta}{d\bar{c}} + U_e(z,\hat{e}(z))\frac{\partial\hat{e}(z)}{\partial\Delta}\frac{d\Delta}{d\bar{c}} = 0$$

with

$$\begin{aligned} U_{\bar{c}}(z,\hat{e}) &= -\sigma U(z,\hat{e}) > 0 \\ U_{\Delta}(z,\hat{e}) &= \sigma U(z,\hat{e})\tfrac{\beta(1-\pi(\hat{e}))\exp(\sigma\Delta)}{1-\beta(1-\pi(\hat{e}))\exp(\sigma\Delta)} < 0 \\ U_e(z,\hat{e}) &= \left\langle [\hat{\pi}(\hat{e}) - \pi(\hat{e})] + [\pi'(\hat{e}) - \hat{\pi}'(\hat{e})]/\sigma \left\{1 - \tfrac{1-\beta\exp(\sigma\Delta)}{(1-\beta)\exp(\sigma\Delta)}\tfrac{u(w-\bar{\tau})}{u(\bar{b}-\hat{e})}\right\}\right\rangle \\ &\qquad \times \tfrac{u'(\bar{b}-\hat{e})[\beta\exp(\sigma\Delta)]}{\{1-\beta(1-\pi(\hat{e}))\exp(\sigma\Delta)\}^2}. \end{aligned}$$

For the expression for $U_e(z,\hat{e}(z))$, I make use of the fact that $\hat{e}(z)$ maximizes $\hat{U}(z,e)$. Notice that $U_e(z,\hat{e})$ is increasing in $\hat{\pi}(\hat{e}) - \pi(\hat{e})$ and in $\pi'(\hat{e}) - \hat{\pi}'(\hat{e})$, since both $\frac{1-\beta\exp(\sigma\Delta)}{(1-\beta)\exp(\sigma\Delta)}$ and $\frac{u(w-\bar{\tau})}{u(\bar{b}-\hat{e})}$ are smaller than 1.Using similar algebraic manipulations as in the proof of Proposition 2, I find

$$\frac{\frac{u'(\bar{b}-\hat{e})+\beta\pi(\hat{e})\frac{u'(w-\bar{\tau})}{1-\beta}}{1-\beta(1-\pi(\hat{e}))} - \frac{u'(\bar{b}-\hat{e})+\beta\pi(\hat{e})\frac{u'(w-\bar{\tau})}{1-\beta}}{1-\beta(1-\pi(\hat{e}))\exp(\sigma\Delta)}\exp(\sigma\Delta)}{\frac{u'(\bar{b}-\hat{e})+\beta\pi(\hat{e})\frac{u'(w-\bar{\tau})}{1-\beta}}{1-\beta(1-\pi(\hat{e}))\exp(\sigma\Delta)}\exp(\sigma\Delta)} =$$

$$J^{\Delta} \times \varepsilon_{\frac{1}{\pi(\hat{e}(z))},(\bar{c},\Delta)}\left\{1 + I^{\Delta}\left(\frac{\pi'(\hat{e})-\hat{\pi}'(\hat{e})}{\pi'(\hat{e})}, \frac{\hat{\pi}(\hat{e})-\pi(\hat{e})}{\pi'(\hat{e})}\right)\right\}$$

with

$$\begin{aligned} J^{\Delta} &= \frac{\beta\pi(e)}{[1-\beta(1-\pi(e))]^2}\frac{(\bar{b}+\bar{\tau})(1-\beta)-\Delta}{\Delta} \\ I^{\Delta}\left(\frac{\pi'(\hat{e})-\hat{\pi}'(\hat{e})}{\pi'(\hat{e})}, \frac{\hat{\pi}(\hat{e})-\pi(\hat{e})}{\pi(\hat{e})}\right) &= \frac{1}{\frac{(\bar{b}+\bar{\tau})(1-\beta)-\Delta}{[1-\beta(1-\pi(e))]}\frac{\pi'(e)}{(1-\pi(\hat{e}))}}\frac{U_e(z,\hat{e}(z))}{-U_{\Delta}(z,\hat{e}(z))}. \end{aligned}$$

The first result in Proposition 4 immediately follows. $I^{\Delta}(0,0)$ equals 0. $I_1^{\Delta} > 0$ and $I_2^{\Delta} > 0$ again follow from the derivative from $U_e(z,\hat{e}(z))$ with respect to the biases in beliefs, as in Proposition 7.

The gain in perceived expected utility from an increase in $\bar{c}$, balanced by an increase in Δ equals zero if

$$\hat{U}_{\bar{c}}(z,\hat{e}(z)) + \hat{U}_{\Delta}(z,\hat{e}(z))\frac{d\Delta}{d\bar{c}} = 0,$$

with

$$\hat{U}_{\bar{c}}(z,\hat{e}) = -\sigma\hat{U}(z,\hat{e}) \text{ and } \hat{U}_{\Delta}(z,\hat{e}) = \sigma\hat{U}(z,\hat{e})\tfrac{\beta(1-\hat{\pi}(\hat{e}))\exp(\sigma\Delta)}{1-\beta(1-\hat{\pi}(\hat{e}))\exp(\sigma\Delta)} < 0.$$

Using the same manipulations again, the second result immediately follows as well.□

Proof of Proposition 5

I consider an increase in Δ for the first period of unemployment $d\Delta_0$ and a decrease in Δ for all later periods $d\Delta_+$, such that the budget constraint is still satisfied,

$$\frac{d\Delta_0}{d\Delta_+} = -\frac{\beta\left(1-\pi\left(\hat{e}\right)\right)}{1-\beta\left(1-\pi\left(\hat{e}\right)\right)}.$$

With the effect on the search internality small, this increases welfare if and only if

$$U_{\Delta_0} d\Delta_0 - U_{\Delta_+} d\Delta_+ + \lambda\left[\frac{\partial \Pi}{\partial e_0}\left(\frac{\partial \hat{e}_0}{\partial \Delta_0} d\Delta_0 - \frac{\partial \hat{e}_0}{\partial \Delta_+} d\Delta_+\right) + \frac{d\Pi}{de_+}\left(\frac{\partial \hat{e}_+}{\partial \Delta_0} d\Delta_0 - \frac{\partial \hat{e}_+}{\partial \Delta_+} d\Delta_+\right)\right] > 0, \quad (13)$$

with $\hat{e}_0$ the effort exerted in the first period and $\hat{e}_+$ the effort exerted in all later periods. Using the fact that we introduce the variation starting from the optimal linear contract, i.e.

$$\begin{aligned} U_\Delta + \lambda\left[\frac{\beta\left(1-\pi\left(\hat{e}\right)\right)}{\left(1-\beta\right)\left[1-\beta\left(1-\pi\left(\hat{e}\right)\right)\right]} + \frac{d\Pi}{de}\frac{d\hat{e}}{d\Delta}\right] &= 0 \\ U_{\bar{c}} &= \frac{\lambda}{1-\beta}, \end{aligned}$$

condition (13) simplifies to

$$\left(\hat{\pi}\left(\hat{e}\right) - \pi\left(\hat{e}\right)\right)\left(-\sigma U\right)\beta \exp\left(\sigma\Delta\right)\left[\frac{\beta\left(1-\pi\left(\hat{e}\right)\right)\left[\exp\left(\sigma\Delta\right)-1\right]}{\left(1-\beta\left(1-\pi\left(\hat{e}\right)\right)\right)\left(1-\beta\left(1-\pi\left(\hat{e}\right)\right)\exp\left(\sigma\Delta\right)\right)}\right] > 0,$$

which holds if and only if $\hat{\pi}\left(\hat{e}\right) > \pi\left(\hat{e}\right)$.□

Proof of Proposition 6

Private insurers only care about the perceived expected utility of the contract they offer. The equilibrium contact solves

$$C(\hat{V}) = \min_{c^u, V', V^e, e} c^u + \beta\left[\pi(e)C^e(V^e) + (1-\pi(e))C(\hat{V}^u)\right]$$

such that

$$\begin{gathered} u(c^u - e) + \beta[\hat{\pi}(e)V^e + \left(1-\hat{\pi}\left(e\right)\right)\hat{V}^u] = \hat{V} \\ e \in \arg\max u(c^u - e) + \beta\left[\hat{\pi}(e)V^e + (1-\hat{\pi}(e))\hat{V}^u\right], \end{gathered}$$

and $C\left(\hat{V}\right) = 0$. The true expected utility of the contract plays no role. Starting from an optimal contract assigning expected utility $\hat{V}$, the optimal response to an increase in $\hat{V}$ is to increase all consumption levels, today and in the future, while employed and unemployed, by the same amount. This leaves the margins for search effort unchanged. Since an increase in $\hat{V}$ is accommodated by an equal increase in all consumption levels and $\hat{V}$ is the only state variable in the recursive problem, the optimal policy functions satisfy

$$\frac{\hat{V}}{\hat{V}^u\left(\hat{V}\right)} = \frac{\hat{V}}{V^e\left(\hat{V}\right)} = \frac{\hat{V}^u\left(\hat{V}\right)}{V^e\left(\hat{V}^u\left(\hat{V}\right)\right)} \text{ for any } \hat{V}.$$

This implies that the optimal contract is linear.□

Proofs of Corollaries

Proof of Corollary 1

When $\hat{\pi}'(\hat{e}) \leq \pi'(\hat{e})$, $1 + \frac{\pi'(\hat{e}) - \hat{\pi}'(\hat{e})}{\pi'(\hat{e})} I(b) \geq 1$. By the second order condition, $\frac{[u'(b) - u'(w-\hat{\tau})]/u'(w-\hat{\tau})}{\varepsilon_{1-\pi(\hat{e}),b}}$ is decreasing in b. In the standard Baily formula (3) this term needs to be equal to 1. In the adjusted Baily formula (5) this term needs to be greater than 1. Hence, the benefit implemented by the standard Baily formula exceeds the benefit implemented by the adjusted Baily formula.□

Proof of Corollary 2

When $\hat{\pi}(\hat{e}) \geq \pi(e)$, $\frac{u'(b) - u'(w-\hat{\tau})}{u'(w-\hat{\tau})} \geq \frac{\frac{1-\hat{\pi}(\hat{e})}{1-\pi(\hat{e})} u'(b) - u'(w-\hat{\tau})}{u'(w-\hat{\tau})}$. In the standard Baily formula (3) and the adjusted Baily formula for the competitive equilibrium (6), respectively the left hand side and the right hand side need to be equal to 1. Since $\frac{[u'(b) - u'(w-\hat{\tau})]/u'(w-\hat{\tau})}{\varepsilon_{1-\pi(\hat{e}),b}}$ is decreasing in b, the benefit implemented by the standard Baily formula exceeds the benefit implemented by the adjusted Baily formula.□

Proof of Corollary 3

The interior social optimum (b^s, e^s) with $e^s = \hat{e}(b^s)$ satisfies

$$\begin{aligned}&[(1-\pi(e^s))\, u'(b^s) - (1-\pi(e^s))\, u'(w - \hat{\tau}(b^s))] + \\ &\qquad \{\pi'(e^s)\,[u(w) - u(b^s)] - 1 + \pi'(e^s)\, u'(w - \hat{\tau}(b^s)) b^s\} \tfrac{d\hat{e}(b^s)}{db} = 0\end{aligned}$$

Given global concavity, a private insurer in the competitive equilibrium offers more insurance if and only if an increase in insurance, evaluated at the social optimum, increases the perceived expected utility. That is, if and only if

$$\begin{aligned}&\left[(1-\hat{\pi}(e^s))\, u'(b^s) - (1-\pi(e^s))\, u'(w - \hat{\tau}(b^s))\right] + \\ &\qquad \left\{\hat{\pi}'(e^s)\,[u(w) - u(b^s)] - 1 + \pi'(e^s)\, u'(w - \tau(e^s, b^s)) b^s\right\} \frac{d\hat{e}(b^s)}{db} > 0.\end{aligned}$$

Using the condition for the social optimum, this inequality simplifies to

$$\{\pi(e^s) - \hat{\pi}(e^s)\}\, u'(b^s) + \left\{\hat{\pi}'(e^s) - \pi'(e^s)\right\}[u(w) - u(b^s)] \frac{d\hat{e}(b^s)}{db} > 0.$$

With $\frac{d\hat{e}(b^s)}{db} = \frac{\hat{\pi}'(e^s)}{\hat{\pi}''(e^s)} \frac{u'(b^s)}{u(w) - u(b^s)}$, the result immediately follows.□

Condition for Concavity of the Maximization Problem
The program is strictly concave for the social planner if

$$\eta + \pi''(e)[u(w) - u(b)] + \pi'(e)\left(2\frac{u'(w-\tau)}{u'(b)} - 1\right)\xi + (1-\pi(e))\left(1 - \frac{u'(w-\tau)}{u'(b)}\right)\left(\zeta + 2\xi\frac{\hat{\pi}''(e)}{\hat{\pi}'(e)}\right) < 0,$$

and for the private insurer if

$$\eta + \pi'(e)\left[2\frac{u'(w-\tau)}{u'(b)} - \frac{\hat{\pi}'(e)}{\pi'(e)}\right]\xi + (1-\hat{\pi}(e))\left[1 - \frac{1-\pi(e)}{1-\hat{\pi}(e)}\frac{u'(w-\tau)}{u'(b)}\right]\left(\zeta + 2\xi\frac{\hat{\pi}''(e)}{\hat{\pi}'(e)}\right) < 0,$$

for all (e, b, τ) satisfying IC and BC/ZPC with

$$\begin{aligned}\eta &= \frac{(1-p)}{p}u''(w-\tau)\left\langle \pi'(e)\,b - \frac{1-\pi(e)}{u'(b)}\xi\right\rangle^2 \\ &\quad + \pi''(e)\,u'(w-\tau)b + (1-\pi(e))\frac{u'(w-\tau)}{u'(b)}\frac{u''(b)}{u'(b)^2}\xi^2 \\ \xi &= \frac{\hat{\pi}''(e)}{\hat{\pi}'(e)^2} \text{ and } \zeta = \frac{\hat{\pi}'''(e)}{\hat{\pi}'(e)^2}.\end{aligned}$$

Notice that every single term in η is negative as is ξ. Also $\pi''(e)$ and ξ are negative. The last term in the conditions may be positive, but is small if $\frac{u'(w-\tau)}{u'(b)}$ is close to 1. The term before is positive only if $\frac{u'(w-\tau)}{u'(b)} < \frac{1}{2}$ and $\frac{u'(w-\tau)}{u'(b)} < \frac{1}{2}\frac{\hat{\pi}'(e)}{\pi'(e)}$ respectively.□

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Table I

Summary Statistics

	Obs.	Mean	StDev		Obs.	Mean	StDev
Male	1,339	.55	.50	Partner's education	1,137	13.50	2.20
Age	1,339	38.48	9.96	Monthly wage[2]	1,320	2.60	1.72
White	1,339	.67	.47	Times unemployed	1,339	.34	.47
Married	1,339	.81	.39	Weeks displaced[3]	1,339	6.91	4.16
Children	1,339	1.30	1.25	Search (at 1st int.)	1,249	3.34	.87
Education[1]	1,334	13.63	2.14	Search (at 3rd int.)	1,249	3.35	.95
Maryland	1,339	.45	.50	Actual duration[4]	1,223	23.04	21.03
Partner empl.	1,139	.79	.41	Expected duration	1,182	6.83	8.60

[1] Expressed in number of years. [2] Earned on the last job before unemployment, expressed in 1000 USD. [3] Since the start of the current unemployment spell. [4] Includes censored spells with the duration between the first and last interview.

Table II

OLS Estimates of the Effect of Search and Covariates on the Actual Duration of Unemployment (1), the Expected Duration of Unemployment (2) and the Difference Between the Actual and the Expected Duration of Unemployment (3)

	Actual duration	Expected duration	Optimism
	(1)	(2)	(3)
Search	-3.30 [757]**	-2.03 [.369]**	-1.36 [.780]
Male	-3.45 [1.34]*	-1.88 [.457]**	-1.58 [1.39]
Age	.201 [.073]**	.048 [.021]*	.153 [.072]*
White	-5.82 [1.50]**	-.544 [.596]	-5.28 [1.54]**
Married	-5.07 [1.89]**	.306 [.576]	-5.37 [1.89]**
Children	.783 [.528]	.410 [.274]	.373 [.544]
Education	-.343 [.368]	.317 [.126]*	-.659 [.362]
Maryland	-2.97 [1.35]*	.124 [.493]	-3.09 [1.34]*
Partner employed	-2.78 [1.62]	.242 [.501]	-3.02 [1.64]
Partner education	.014 [.337]	.205 [.115]	-.192 [.333]
Monthly wage before unemp.	-.732 [.392]	.490 [.194]*	-1.21 [.369]**
Times unemployed	-1.22 [1.35]	-.294 [.453]	-.925 [1.32]
Weeks since displacement	.428 [.165]**	.134 [.064]*	.294 [.163]
Obs.	1,007	1,007	1,007
R^2	.087	.115	.078

Robust standard errors are in parentheses. * denotes statistical significance at the 5 percent level, ** at the 1 percent level.

Table III

2SLS Estimates of the Effect of Search. Dependent Variables: Actual Duration of Unemployment (1), Expected Duration of Unemployment (2) Difference Between the Actual and the Expected Duration of Unemployment (3), and the First Stage Regression (4)

	Actual Duration	Expected duration	Optimism	First Stage
	(1)	(2)	(3)	(4)
Search	-5.66 [3.20]	-3.32 [1.18]**	-2.34 [3.04]	
Potential Benefit				-.0004 [.0006]
Job Importance				.270 [.032]**
Observations	1,004	1,004	1,004	1,004
R^2	.08	.099	.077	.182
Overidentification	.011	.150	0.149	

Robust standard errors are in parentheses. * denotes statistical significance at the 5 percent level, ** at the 1 percent level. Other covariates are as in Table 2. Overidentification reports the p-value for the overidentification test using Hansen J statistic.

Appendix A: Dynamic Extension

This appendix provides more detail regarding the setup and analysis of the dynamic extension considered in subsection 3.4.

A.I. Setup

I follow the optimal contracting approach in Hopenhayn and Nicolini (1997), focusing on the consumption allocation throughout unemployment and upon employment for the insurees who start unemployed. This complements the static analysis of the insurance between insurees who start employed and unemployed in the previous section. A risk-averse insuree starts unemployed and exerts effort at cost e to find work. If the insuree does not find work in the current period, she has to search for work again in the next period. Once she finds a job, she remains employed forever. The insurer offers a consumption schedule $\{(c_l^u, c_l^e)\}_l$ determining consumption during unemployment c_l^u and upon employment c_l^e as a function of the length of the unemployment spell l. Since there is no moral hazard once the insuree is employed, it is optimal to keep consumption constant at c_l^e after having experienced an unemployment spell of length l. The length of the spell is a sufficient statistic for the unemployment history.

I abstract from several features that are important in a dynamic context. I do this to keep the analysis simple and focused on the trade-off between providing insurance and incentives for search. I assume that job seekers do not learn about their bias during unemployment; both the true probability function of effort $\pi(e)$ and the perceived probability function of effort $\hat{\pi}(e)$ remain unchanged during unemployment. In Section 5.4, I discuss empirical evidence suggesting that the optimistic baseline bias does not decrease during unemployment. I also assume that agents cannot save or borrow. Like the search decision, the savings decision would be distorted when beliefs are biased. Job seekers who underestimate the duration of unemployment consume their savings more rapidly, which affects the insurer's response to biases in beliefs. When savings are not allowed, the optimal consumption allocation can be implemented by a schedule of unemployment benefits and taxes $\{(b_l, \tau_l^u)\}_l$ such that $b_l = c_l^u$ and $w - \tau_l^u = c_l^e$. The issue of implementing consumption allocations when savings are unobservable is studied by Werning (2002) and Shimer and Werning (2008).[37] Relaxing these assumptions would further improve the understanding of the role of biases in beliefs for insurance design and is an interesting topic for further research.

A.II. Linear Unemployment Insurance

I consider CARA preferences and restrict the analysis to unemployment schemes for which consumption depends linearly on the length of the unemployment spell. In the next section, I show that such contracts are optimal for private insurers, regardless of the beliefs of the unemployed, and for the social planner, only when these beliefs are unbiased. Linear contracts are ideal for analyzing

[37] Shimer and Werning (2008) show that with CARA preferences, as considered here, the optimal consumption allocation can still be implemented with unobservable savings.

the extent to which dynamic incentives are used, but imply that consumption may become negative for long unemployment spells.

Assumption 1 *Contracts are linear, i.e.* $b_l = \bar{b} - \Delta l$ *and* $\tau_l^u = \bar{\tau} + \Delta(l-1)$*.*

A linear contract reduces the insurer's problem to the choice of a vector of three variables $z = (b, w - \bar{\tau}, \Delta)$: the unemployment benefit $\bar{b}$ at the start of unemployment, the after-tax wage $w - \bar{\tau}$ if the insuree finds work after one period of unemployment and the reduction Δ in benefit and the after-tax wage for each additional period that the unemployment spell takes.

Assumption 2 *The insuree has CARA preferences with monetary costs of effort e,* $u(c-e) = -\exp(-\sigma(c-e))$*.*

An insuree with CARA preferences makes her search decision only based on the differences in consumption levels across states. With a linear contract, an equal shift in all consumption levels is the only difference between the continuing contracts when short-term unemployed and long-term unemployed. Hence, the insuree exerts the same search effort throughout the unemployment spell. This makes it possible to write the lifetime utility explicitly, rather than rewriting the problem recursively. Using the property for CARA preferences that $u(c-\Delta) = -u(-\Delta)\,u(c)$, the true and perceived expected utility of a contract for an insuree who starts unemployed simplify to

$$U(z,e) = \frac{u\left(\bar{b}-e\right) + \beta\pi(e)\frac{u(w-\bar{\tau})}{1-\beta}}{1-\beta(1-\pi(e))(-u(-\Delta))} \text{ and } \hat{U}(z,e) = \frac{u\left(\bar{b}-e\right) + \beta\hat{\pi}(e)\frac{u(w-\bar{\tau})}{1-\beta}}{1-\beta(1-\hat{\pi}(e))(-u(-\Delta))},$$

with β denoting the discount factor. The insuree exerts effort e and consumes $\bar{b}$ during the first period of unemployment and finds employment the next period at the after-tax wage $w - \bar{\tau}$ with probability $\pi(e)$. With probability $1 - \pi(e)$, the insuree is still unemployed the next period and faces the exact same prospects as the period before, except that all payments are Δ lower. As before, the insuree's effort choice $\hat{e}(z)$ maximizes her perceived expected utility $\hat{U}(z,e)$, rather than her true expected utility $U(z,e)$. With $\bar{c} \equiv \left(\bar{b}, w - \bar{\tau}\right)$, the initial levels of unemployment benefit and after-tax wage, the effort level $\hat{e}(z)$ solves

$$\beta\hat{\pi}'(\hat{e}(z))\left[\frac{u(w-\bar{\tau})}{1-\beta} - \hat{U}(\bar{c}\text{-}\Delta, \Delta, \hat{e}(z))\right] = u'\left(\bar{b} - \hat{e}(z)\right).$$

In the dynamic model, both baseline and control beliefs change the insuree's effort choice. If an unemployed insuree is baseline-optimistic, she overestimates the continuation value of remaining unemployed $\hat{U}(\bar{c}\text{-}\Delta, \Delta, \hat{e}) > U(\bar{c}\text{-}\Delta, \Delta, \hat{e})$ and therefore exerts too little effort.

The expected cost for the insurer when facing an insuree who starts unemployed simplifies to

$$C(z,e) = \frac{\bar{b} - \beta\left\{\pi(e)\frac{\bar{\tau}}{1-\beta} + (1-\pi(e))\frac{\Delta}{1-\beta}\right\}}{1-\beta(1-\pi(e))}.$$

If the insuree finds work immediately, the insurer starts receiving $\bar{\tau}$ from the next period on. If the insuree does not find work, the insurer has to pay unemployment benefits again in the next period, but all future consumption levels are reduced by Δ. For the insurer's budget to be balanced, these expected costs when the insuree starts unemployed need to be funded with the tax paid when the insuree starts employed, as analyzed in the static model.[38]

I characterize the optimal linear contract for an insuree who starts unemployed considering two revenue-neutral changes. First, an increase in the unemployment benefit level accompanied with a decrease in the after-tax wage upon employment. Second, an increase in the starting consumption levels accompanied with a faster decrease in the consumption levels throughout unemployment. Again, for the insurance contract to be optimal, the marginal consumption smoothing benefits and the moral hazard cost of such changes have to be equal.

Static Wedge I first consider an increase in the starting level of the unemployment benefit $\bar{b}$, accompanied by a decrease in the starting level of the after-tax wage $w - \bar{\tau}$. Keeping the reduction Δ constant, this implies an equal increase in all consumption levels during unemployment and an equal decrease in all consumption levels upon employment, regardless of the length of the unemployment spell. The Baily formula derived from this static change in the dynamic contract and the adjustments for biased beliefs are very similar to the Baily formula and the required adjustments in the static model. To emphasize the similarity with the static contracts, I introduce the functions

$$I^{\tau}\left(\tfrac{\pi'(\hat{e})-\hat{\pi}'(\hat{e})}{\pi'(\hat{e})}, \tfrac{\hat{\pi}(\hat{e})-\pi(\hat{e})}{\pi(\hat{e})}, z\right) = \frac{U_e(z,\hat{e})}{-\frac{(1-\beta)\left(\bar{b}+\bar{\tau}\right)-\Delta}{1-\beta(1-\pi(\hat{e}))}\frac{\partial U(z,\hat{e})}{\partial \bar{\tau}}},$$

$$J^{\tau}(z) = \frac{\beta\pi\left(\hat{e}(z)\right)\left[\bar{b}+\bar{\tau}-\frac{\Delta}{1-\beta}\right]}{\left[1-\beta\left(1-\pi\left(\hat{e}(z)\right)\right)\right]}.$$

Proposition 7 *The unemployment contracts in the social optimum and the competitive equilibrium are characterized by respectively*

$$\frac{u'\left(\bar{b}-\hat{e}\right)-u'\left(w-\bar{\tau}\right)}{u'\left(w-\bar{\tau}\right)} = J^{\tau}(z)\times\varepsilon_{\frac{1}{\pi(\hat{e})},\left(\bar{b},\bar{\tau}\right)}\left[1+I^{\tau}\left(\tfrac{\pi'(\hat{e})-\hat{\pi}'(\hat{e})}{\pi'(\hat{e})}, \tfrac{\hat{\pi}(\hat{e})-\pi(\hat{e})}{\pi(\hat{e})}, z\right)\right]$$

and

$$\frac{\frac{\pi(\hat{e}(z))}{\hat{\pi}(\hat{e}(z))}u'\left(\bar{b}-\hat{e}\right)-u'\left(w-\bar{\tau}\right)}{u'\left(w-\bar{\tau}\right)} = J^{\tau}(z)\times\varepsilon_{\frac{1}{\pi(\hat{e})},\left(\bar{b},\bar{\tau}\right)},$$

with $I_1^{\tau}>0, I_2^{\tau}>0$ *and* $I^{\tau}(0,0,z)=0$.

Proof.

[38] Since the starting consumption levels $\bar{c}=\left(\bar{b}, w-\bar{\tau}\right)$ when unemployed do not change the search effort level with CARA preferences, the characterisation of the consumption allocation between the insurees who start unemployed and who start employed simplifies to $\frac{u'(w-\tau)}{1-\beta}=U_{\bar{c}}(z,\hat{e})$ and $\frac{u'(w-\tau)}{1-\beta}=\hat{U}_{\bar{c}}(z,\hat{e})$ in the social optimum and the competitive equilibrium respectively.

I consider an increase in $\bar{b}$ together with an increase in $\bar{\tau}$ such that the budget constraint, accounting for the changes in $\hat{e}(z)$, is still satisfied. That is,

$$\frac{-d\bar{b}+\beta\pi(\hat{e}(z))\frac{d\bar{\tau}}{1-\beta}}{1-\beta(1-\pi(e))} - C_e(z,e)\left\{\frac{\partial\hat{e}(z)}{\partial\bar{b}}d\bar{b}+\frac{\partial\hat{e}(z)}{\partial\bar{\tau}}d\bar{\tau}\right\}=0,$$

with

$$C_e(z,e) = -\frac{\beta\pi'(e)}{[1-\beta(1-\pi(e))]^2}\left\{\bar{b}+\bar{\tau}-\frac{\Delta}{1-\beta}\right\},$$

the decrease in the expected cost of the contract for the insurer when e increases. Denote the elasticity of unemployment duration $\frac{1}{\pi(\hat{e})}$ with respect to an increase in $\bar{b}$, balanced by an increase in $\bar{\tau}$, by

$$\varepsilon_{\frac{1}{\pi(\hat{e})},(\bar{b},\bar{\tau})} = -\frac{\pi'(\hat{e}(z))}{\pi(\hat{e}(z))}\left\{\frac{\partial\hat{e}(z)}{\partial\bar{b}}+\frac{\partial\hat{e}(z)}{\partial\bar{\tau}}\frac{d\bar{\tau}}{d\bar{b}}\right\}\bar{b}>0,$$

then the revenue-neutral change implies

$$\frac{d\bar{\tau}}{d\bar{b}} = \frac{1-\beta}{\beta\pi(\hat{e}(z))}\left\{1+\frac{\beta\pi(\hat{e}(z))}{1-\beta(1-\pi(\hat{e}(z)))}\frac{\bar{b}+\bar{\tau}-\frac{\Delta}{1-\beta}}{\bar{b}}\varepsilon_{\frac{1}{\pi(\hat{e})},(\bar{b},\bar{\tau})}\right\}.$$

The gain in true expected utility from an increase in $\bar{b}$, balanced by an increase in $\bar{\tau}$ equals zero if

$$U_{\bar{b}}(z,\hat{e}(z))+\hat{U}_{\bar{\tau}}(z,\hat{e}(z))\frac{d\bar{\tau}}{d\bar{b}}+U_e(z,\hat{e}(z))\left\{\frac{\partial\hat{e}(z)}{\partial\bar{b}}d\bar{b}+\frac{\partial\hat{e}(z)}{\partial\bar{\tau}}d\bar{\tau}\right\}=0,$$

with

$$\begin{aligned} U_{\bar{b}}(z,\hat{e}) &= \frac{u'(\bar{b}-\hat{e})}{1-\beta(1-\pi(\hat{e}))\exp(\sigma\Delta)}, \\ \hat{U}_{\bar{\tau}}(z,\hat{e}) &= \frac{-\beta\pi(\hat{e})\frac{u'(w-\bar{\tau})}{1-\beta}}{1-\beta(1-\pi(\hat{e}))\exp(\sigma\Delta)}. \end{aligned}$$

Using the same algebraic manipulations as in the proof of Proposition 4, I find the first result in the proposition with the correction for the search internality

$$I^{\tau}\left(\frac{\pi'(\hat{e})-\hat{\pi}'(\hat{e})}{\pi'(\hat{e})},\frac{\hat{\pi}(\hat{e})-\pi(\hat{e})}{\pi(\hat{e})},z\right)\equiv\frac{U_e(z,\hat{e})}{-\frac{(1-\beta)(\bar{b}+\bar{\tau})-\Delta}{1-\beta(1-\pi(\hat{e}))}\frac{\partial U(z,\hat{e})}{\partial\bar{\tau}}}.$$

The function depends on the baseline bias and control bias through $U_e(z,\hat{e})$. We find $I^{\tau}(0,0,z)=0$ and $I_1^{\tau}>0$ and $I_2^{\tau}>0$.

The gain in perceived expected utility from an increase in $\bar{b}$, balanced by an increase in $\bar{\tau}$ equals zero if

$$\hat{U}_{\bar{b}}(z,\hat{e}(z))+\hat{U}_{\bar{\tau}}(z,\hat{e}(z))\frac{d\bar{\tau}}{d\bar{b}}=0,$$

with

$$\hat{U}_{\bar{b}}(z,\hat{e}) = \frac{u'(\bar{b}-\hat{e})}{1-\beta(1-\hat{\pi}(\hat{e}))\exp(\sigma\Delta)} \text{ and } \hat{U}_{\bar{\tau}}(z,\hat{e}(z)) = \frac{-\beta\hat{\pi}(\hat{e})\frac{u'(w-\bar{\tau})}{1-\beta}}{1-\beta(1-\hat{\pi}(\hat{e}))\exp(\sigma\Delta)}.$$

The effect through effort on the perceived utility is of second order by the envelope condition. Using the same algebraic manipulations as in the proof of Proposition 3, I find the second result in the Proposition. ■

The consumption smoothing gain, on the left-hand side of the equation, is again determined by the relative difference in the marginal utility of consumption during unemployment and upon employment. The moral hazard cost, on the right-hand side, is determined by the elasticity $\varepsilon_{\frac{1}{\pi(\hat{e})},(\bar{b},\bar{\tau})}$, capturing the responsiveness of the expected unemployment duration $\frac{1}{\pi(\hat{e}(z))}$ to the considered change in benefit and tax, and by $J^{\tau}(z)$, which reflects the increase in expected costs for the insurer $C(z, \hat{e}(z))$ from an increase in the unemployment duration.[39]

When beliefs are unbiased, the corrections in both formulas in the Proposition drop, $I^{\tau}(0,0,z) = 0$ and $\frac{\pi(\hat{e}(z))}{\hat{\pi}(\hat{e}(z))} = 1$, such that the insurance contracts in the social optimum and the competitive equilibrium coincide. The control beliefs play the same role as in the static model. The baseline beliefs, however, do not only change the perceived value of insurance, to which private insurers respond, but also change the perceived returns to search. Baseline optimism distorts the insuree's effort choice downward and thus affects the search internality in the same way as control pessimism. Both biases make the social planner revise the moral hazard cost upward and therefore decrease the optimal benefit level, i.e. $I^{\tau} > 0$ if $\frac{\pi'(\hat{e})-\hat{\pi}'(\hat{e})}{\pi'(\hat{e})} > 0$ and $\frac{\hat{\pi}(\hat{e})-\pi(\hat{e})}{\pi(\hat{e})} > 0$.[40]

Dynamic Wedge In the text, I also consider an equal decrease in the starting level of the unemployment benefit $\bar{b}$ and the after-tax wage $w - \bar{\tau}$, accompanied with a slower reduction Δ in consumption during unemployment. The slower reduction smooths the risk-averse insuree's consumption profile, but discourages her from searching for a job. In the optimum, the marginal consumption smoothing gain and moral hazard cost of this change has to be equal. The social planner corrects for the search internality, whereas the private insurers focus on the perceived smoothing cost in the presence of biased beliefs. This leads to Proposition 4, using the functions

$$\begin{aligned} I^{\Delta}\left(\frac{\pi'(\hat{e})-\hat{\pi}'(\hat{e})}{\pi'(\hat{e})}, \frac{\hat{\pi}(\hat{e})-\pi(\hat{e})}{\pi(\hat{e})}\right) &= \frac{1}{\frac{\left(\bar{b}+\bar{\tau}\right)(1-\beta)-\Delta}{[1-\beta(1-\pi(e))]}\frac{\pi'(e)}{(1-\pi(\hat{e}))}}\frac{U_e(z,\hat{e})}{-U_{\Delta}(z,\hat{e})}, \\ J^{\Delta}(z) &= \frac{\beta\pi(e)}{[1-\beta(1-\pi(e))]^2}\frac{\left(\bar{b}+\bar{\tau}\right)(1-\beta)-\Delta}{\Delta}. \end{aligned}$$

The moral hazard cost is again similar in nature; $J^{\Delta}(z)$ depends on the increase in the expected costs for the insurer if the unemployment duration increases and the elasticity $\varepsilon_{\frac{1}{\pi(\hat{e})},(\bar{c},\Delta)}$ depends on the responsiveness of the unemployment duration with respect to the considered change. Given the CARA preferences, the starting level of consumption $\bar{c}$ has no impact on search, whereas an increase in the reduction Δ increases search and thus decreases the expected unemployment duration.

The consumption smoothing gain from the dynamic change evaluated at the contract $(\bar{c}, \Delta)$ has a simple interpretation as well. This depends on the difference in expected utility gains from an increase in the initial consumption level $\bar{c}$, denoted by $U_{\bar{c}}$, starting from a contract $(\bar{c}, 0)$ for which the consumption levels remain fixed at the initial level $\bar{c}$ and from a contract $(\bar{c}\text{-}\Delta, \Delta)$ for which the initial consumption level is reduced by Δ. If $\Delta > 0$, the marginal utility of consumption is higher for the second contract, $U_{\bar{c}}(\bar{c}\text{-}\Delta, \Delta, \hat{e}) > U_{\bar{c}}(\bar{c}, 0, \hat{e})$. This consumption smoothing gain is decreasing in Δ. If $\Delta = 0$, the first and the second scheme coincide. At that point, the consumption

[39] In the static model, effort did not depend on the change in taxes. Here, the taxes changes the effort level as well. The response in effort captured by the elasticity $\varepsilon_{\frac{1}{\pi(\hat{e})},(\bar{b},\bar{\tau})}$ is both to the change in the unemployment benefit and the change in the tax that keeps the revenues constant.

[40] As with control pessimism, the effect of baseline optimism on the optimal wedge between unemployment and employment consumption is ambiguous. Both biases decrease search and increase the required tax change, but may also decrease the responsiveness to insurance coverage. The first effect decreases the smoothing benefit. The second effect decreases the moral hazard cost. The effect on the optimal starting levels $\bar{b}$ and $w - \bar{\tau}$ is ambiguous.

smoothing gain of changing Δ is of second order, but an increase in Δ also increases the induced effort level and thus has a first-order impact on the insurer's budget constraint. Hence, Δ needs to be positive to be optimal. This confirms the well-known result by Shavell and Weiss (1979) and Hopenhayn and Nicolini (1997) that with unbiased beliefs consumption should be decreasing with the length of the unemployment spell.

Biased beliefs change the induced effort level and the responsiveness to Δ. The impact on the optimal level of Δ is again ambiguous. However, insurees who overestimate the probability to leave unemployment clearly underestimate the utility cost of a fast decrease in benefits or a fast increase in taxes for longer unemployment spells. This effect on the perceived consumption smoothing tends to increase the equilibrium level of the Δ. The social planner, however, wants to correct for the search internality. This tends to increase the socially optimal level of Δ if insurees are more baseline-optimistic or control-pessimistic. If the perceived consumption smoothing effect dominates the search internality effect, equilibrium consumption decreases suboptimally fast during unemployment.

A.III. Optimal Unemployment Insurance

As in the static model, the social optimum and competitive equilibrium coincide for unbiased beliefs. Werning (2002) shows that with CARA preferences the optimal unemployment schedule is linear of the form $z = \left(\bar{b}, w\text{-}\bar{\tau}, \Delta\right)$ using recursive techniques. The dual problem that minimizes the expected cost of an insurance scheme providing a given level of expected lifetime utility V can be written recursively. The lifetime utilities promised last period to the insuree conditional on unemployment or employment summarizes all relevant aspects of the insuree's unemployment history. The promised utility V is therefore the unique state variable during unemployment. Moreover, starting from an optimal contract which assigns expected utility V, the optimal response to an increase in V is to increase all consumption levels by the same amount today and in the future, while employed and unemployed. The reason is that with CARA preferences search effort only depends on differences in consumption across different states. The provision of search incentives and utility becomes separable. Once the differences in consumption levels are chosen to induce the optimal levels of search effort, the consumption levels can be set to assign the required utility level. Hence, two consecutive periods of unemployment only differ by an equal shift in all expected consumption levels. This implies that the ratio of promised utilities in two consecutive periods of unemployment remains unchanged. The optimal contract is therefore linear with the shift in consumption for an additional period of unemployment being constant throughout the unemployment spell.

It is important that this argument continues to hold for private insurers, but not for the social planner in the presence of biased beliefs. With biased beliefs, the unemployed's search behavior is determined by the perceived expected lifetime utility $\hat{V}$. Since a private insurer does not care about the true expected utility, the recursive problem has still a unique state variable, i.e. the perceived expected lifetime utility $\hat{V}$. The same argument holds as with unbiased beliefs, but now in terms of $\hat{V}$. Linear contracts are still optimal, as stated in Proposition 6.

In contrast to private insurers, the social planner cares about the insuree's true expected utility. However, the perceived expected utility still determines search behavior. The optimal contract is not linear anymore. If the unemployed worker overestimates the probability of leaving unemployment, decreasing future benefits become an ineffective instrument for inducing effort. Starting from the optimal linear contract, the social planner improves the trade-off between consumption smoothing and inducing effort by making the consumption steeper at the beginning of the unemployment spell and flatter afterwards. Such a variation induces more effort at the start of the unemployment spell, but less effort in any later period. This may increase or decrease the search internality. The considered deviation from the optimal linear contract increases the insuree's welfare if the effect on the search internality is either negative and small or positive. Proposition 5 states that this variation can increase welfare. If similar variations for longer unemployment spells lead to the optimal contract, this suggests that the long-term unemployed should be incentivized less than the short-term unemployed. For private insurers this effect of improved incentives is offset by the fact that insurees need to be compensated less in terms of current consumption for decreases in future consumption the further these decreases are in the future. This shows that the timing of incentives during unemployment is therefore another dimension along which privatizing insurance may decrease welfare in the presence of biased beliefs.

Appendix B: Calibration of the Dynamic Model

The unit of time is one month. The monthly discount factor equals $\beta = 0.9956$, which corresponds to a yearly discount factor equal to 0.95. I assume that the monthly output equals 1 when employed and 0 when unemployed. I consider the probability of starting employed $p = 1/2$.[41] The agents have CARA preferences with monetary costs of efforts and absolute risk aversion $\sigma = 2$. Both the true and perceived monthly probability of finding work are assumed not to change throughout the unemployment spell, other than through changes in effort.

True Probability of Finding Work I assume that effort e is linear in the number of times a job seeker reports to have engaged in any of the search activities discussed in section 4.3. I rescale this effort variable such that $e = 0$ corresponds to not having searched in any dimension during the entire month and $e = 1$ corresponds to having searched every day in every dimension, averaged over the entire month. In this interpretation, $e = 0.15$ corresponds to the sample average of search effort (i.e. search in all dimensions between 'once every couple of weeks' and 'every week'). For

[41] The simplication that employment is an absorbent state and the horizon is infinite makes a calibrated choice of p difficult. The NLSY 1979 shows that only 10.1 percent of the individuals does not experience any unemployment spell between age 18 and 40. However, many of the individuals who are unemployed at some point, are unemployed when they are young. Between age 36 and 40, 74.7 percent of the individuals do not experience any unemployment spell.

these three values of search effort, the probability function

$$\pi(e) = \pi_0 + \pi_1 \times e^{0.662} \text{ with } \pi_0 = 0.140 \text{ and } \pi_1 = 0.170$$

approximates the average duration of unemployment, estimated using ordinary least squares (Table 2).

Perceived Probability of Finding Work The empirical section suggests baseline optimism, but control pessimism. I assume that the perceived monthly probability of finding work as a function of effort equals

$$\hat{\pi}(e) = \hat{\pi}_0 + \hat{\pi}_1 \times e^{0.662} \text{ with } \hat{\pi}_0 = 0.361 \text{ and } \hat{\pi}_1 = 0.056.$$

This implies an optimistic relative baseline bias $\frac{\hat{\pi}(e)-\pi(e)}{\pi(e)}$ equal to 100 percent (at the average effort level $e = 0.15$) and a pessimistic relative control bias $\frac{\hat{\pi}'(e)-\pi'(e)}{\pi'(e)}$ equal to -67 percent. Notice that the baseline bias is more modest than the average baseline bias in the sample of about 200 percent. The control bias corresponds to the relative ratio of the least squares estimates of the actual and perceived impact of search (Table 2).

Monetary Cost of Effort I finally calibrate the monetary cost of search function

$$\psi(e) = \psi_0 e^{\psi_1},$$

in order to match the empirical exit rate and unemployment duration elasticity. I assume that the monetary cost of effort when employed equals the monetary cost of searching daily in every dimension $\psi(1) = \psi_0$. For the standard specification of beliefs, I find $\psi_0 = 0.483$ and $\psi_1 = 2.65$. I recalibrate these parameters for the alternative beliefs specifications such that the implied exit rate and unemployment duration elasticity given the current UI system remain constant. If beliefs were to be unbiased, the calibrated parameter values are $\psi_0 = .489$ and $\psi_1 = 1.19$.

Implied Exit Rate and Search Elasticity In the US, unemployed workers are eligible for unemployment benefits for six months. The mean and median replacement rate for which the unemployed workers are eligible equal respectively 0.43 and 0.48. When implementing a contract that pays $b = 0.45$ in the first six months and $b = 0$ afterwards, the standard specification predicts an average monthly probability of finding work equal to 0.19. This equals the average monthly exit rate in the sample. Moreover, the implied elasticity of unemployment duration with respect to a constant benefit level $b = 0.45$ equals $-.5$. This corresponds to the empirical estimates reviewed in Krueger and Meyer (2002).

Appendix C: Robustness Checks

Baseline Beliefs: Probability of Finding Work The subjects are asked a second question about their expectations: "How likely is it that you will be employed more than 20 hours a week in the next two months?" The subjects have the choice among five options; 'very unlikely', 'unlikely', 'neither likely, nor unlikely', 'likely', 'very likely'. I interpret the first two and last two options as the beliefs that the probability to be employed is smaller than a half ($\hat{\pi} < 1/2$) and greater than a half ($\hat{\pi} > 1/2$) respectively. I find the following distribution of subjects who do and don't find employment within two months;

	$\hat{\pi} < 1/2$	$\hat{\pi} > 1/2$
not-employed	0.14	0.47
employed	0.05	0.34

Although the answers do not allow to quantify the bias, they suggest similar optimism about the baseline probability of finding work. Among those who believe that the probability of becoming employed within two months is strictly greater than one half, less than half actually do. Moreover, while 47 percent believe that the probability is greater than a half and do not find work, only 5 percent believe that the probability is smaller than a half, but do find work.

Control Beliefs: Search, Censoring and Instruments The search index measures the search efforts exerted in the month before the first interview. For the actual duration of unemployment starting from the first interview, the search effort actually exerted matters. For the expected duration of unemployment, the anticipated search effort matters. Unless job seekers perfectly anticipate their efforts, it is not clear whether past effort or actually exerted effort approximate the anticipated effort better. I have an imperfect measure of effort exerted after the first interview. These efforts span the month before the second interview if subjects are still unemployed and the month before they did find work if they are already employed. The measure is only available for a subsample. If the search intensity according to this later measure doubles, actual unemployment spells are on average 4.5 weeks shorter, but only expected to be 0.9 weeks shorter, as reported in Panel A of Table 4. The estimated effect on the actual duration is larger than for the earlier search variable, but the estimated effect on the expected duration is smaller. The suggested pessimistic bias in control beliefs is larger. Another issue is that low search efforts may be correlated with a lower willingness to work or accept job offers. Job seekers are asked when exactly they would like to start working, if they could choose deterministically. When controlling for this preference, the estimates of the coefficient on search reduce to respectively −2.1 and −1.2 in the actual and expected duration regressions respectively (Panel B of Table C).

Table C: OLS Estimates of the Effect of Search for Alternative Specifications. Dependent Variables: the Actual Duration of Unemployment (1), the Expected Duration of Unemployment (2) and the Difference Between the Actual and the Expected Duration of Unemployment (3)

	Actual Duration	Expected Duration	Optimism
	(1)	(2)	(3)
Panel A: Using Later Measure of Search			
Search	-4.47 [.762]**	-.878 [.309]**	-3.59 [.747]**
Obs.	852	852	852
Panel B: Include Ideal Duration under Certainty			
Search	-2.15 [.769]**	-1.16 [.353]**	-.991 [.817]
Ideal duration	.462 [.097]**	.369 [.112]**	.094 [.118]
Obs.	993	993	993
Panel C: Complete Spells Only			
Search	-1.54 [.643]*	-1.44 [.301]**	-.103 [.684]
Obs.	886	886	886
Panel D: Hazard Model with Exponential Distribution			
Search	.213 [.042]**	.258 [.038]**	
Obs.	1,007	983	

Robust standard errors are in parentheses. * denotes statistical significance at the 5 percent level, ** at the 1 percent level. Other covariates are as in Table 2.

When restricting the sample to the completed spells, the relation between search and the actual duration of the unemployment spell weakens. The impact of search on the baseline bias becomes insignificant (Panel C of Table C). The data set is subject to left-truncation as well. I try to control for this by including in the benchmark regression how many weeks the subject has been unemployed sofar. I also estimate the differential impact of search in a hazard model with exponential distribution, conditioning on the fact that job seekers have been unemployed for a while and that the duration for the unsuccessful job seekers goes past the last interview date. Here, the expected increase in the hazard rate for job seekers who search more intensively is slightly higher than the actual increase (Panel D of Table C). Finally, all incomplete spells can also be used without censoring when considering the binary outcome whether or not a job seeker expects to find and actually finds work within m months. The estimates in a linear probability model suggest that the actual return to search exceeds the expected return to search for $m \geq 3$, confirming that job seekers are control-pessimistic. However, the results reverse for $m \leq 2$, suggesting that job seekers are control-optimistic in the short run.

Finally, the job seeker's control pessimism is confirmed when I add alternative instruments that make the first stage stronger. A first additional instrument is the job seeker's partner's opinion about how much the job seeker ought to work as an instrument. This instrument changes the cost of searching for the job seeker. The IV estimate of search on optimism is now -7.53, with robust standard error 2.62. A second additional instrument is to use the job seeker's search as reported by the partner. This instrument does solve the endogeneity problem that arises because of measurement error in the search index variable, but does not solve the potential endogeneity problem indicated before. The IV estimate of search on optimism is now -3.73 with robust standard error 1.61. The results are also similar when considering the binary outcome whether or not a job seeker expects to find and actually finds work within m months.

Change in Beliefs during Unemployment Figure C shows the expectations of the same job seekers at different lengths of the unemployment spell. The figure suggests that the distribution of the expected remaining number of weeks of unemployment is very stable throughout the unemployment spell.

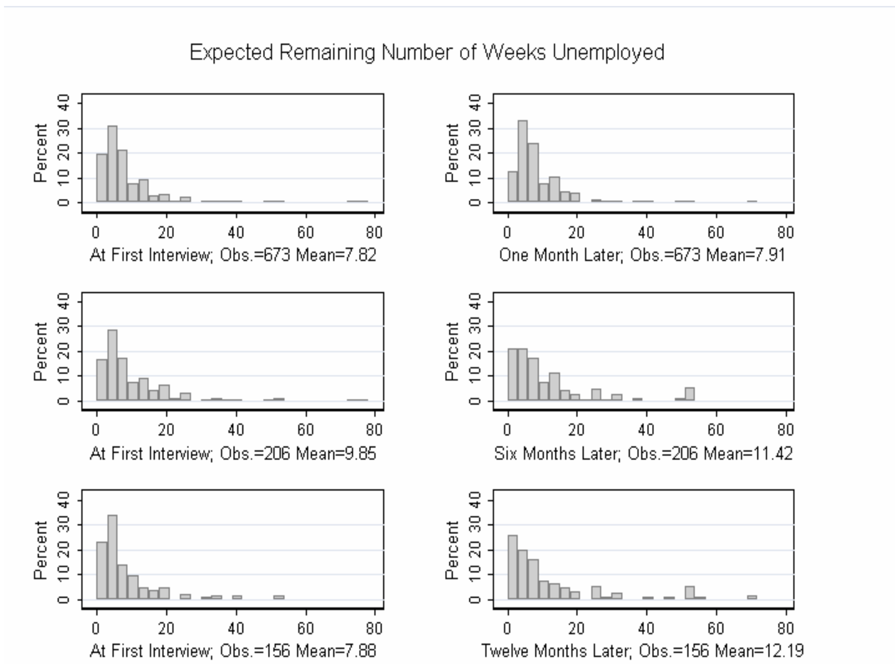

Figure C

Distribution of Expectations Regarding Remaining Duration at Different Times during the Unemployment Spell.