Unemployed but Optimistic: Optimal Insurance Design with Biased Beliefs

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Abstract

This paper analyzes how biased beliefs about employment prospects affect the optimal design of unemployment insurance. Empirically, I find that the unemployed greatly overestimate how quickly they will find work. As a consequence, they would search too little for work, save too little for unemployment and deplete their savings too rapidly when unemployed. I analyze the use of "sufficient-statistics" formula to characterize the optimal unemployment policy when beliefs are biased and revisit the desirability of providing liquidity to the unemployed. I also find that the optimal unemployment policy may involve increasing benefits during the unemployment spell.

Keywords: Biased Beliefs, Unemployment, Optimal Insurance, Moral Hazard
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1 Introduction

Policy makers and insurers face the trade-off between providing insurance against risks and providing incentives to avoid these risks. This trade-off is central in the design of unemployment policies (Baily 1978, Chetty 2006). Unemployment insurance aims to protect workers against the loss of their earnings when unemployed, but also to preserve their incentives to leave unemployment again. The workers' perceptions regarding their employment prospects should play a crucial role for this trade-off. They determine how much workers are willing to protect themselves against unemployment and how much effort displaced workers are willing to invest to find new employment. However, comparing the reported expectations of unemployed job seekers to the actual outcomes of their job search reveals a striking optimistic bias. Based on a survey by Price et al. (1998), I find that on average unemployed job seekers expect to remain unemployed for an additional 6.8 weeks.[1] Only one out of ten job seekers expect that he or she will need more than three additional months to find employment. In follow-up interviews, subjects are asked when they actually started working. Accounting for censored unemployment spells, the average remaining duration for the same sample of job seekers exceeded 23.0 weeks. This is more than three times longer than expected. One out of two job seekers needed more than three additional months to find employment. This remarkable optimistic bias is also illustrated in Figure 1 showing the distribution of the difference between the actual and expected remaining duration of unemployment for the different job seekers: more than 80% of the job seekers have underestimated rather than overestimated the length of their unemployment spell and their forecast errors are much more pronounced. This evidence complements a large empirical literature in psychology and economics documenting systematic biases in risk perceptions and motivates analyzing the role of biased beliefs for the optimal design of unemployment insurance. The analysis in this paper shows that the presence of biased beliefs affects the conclusions regarding two prominent topics in the recent literature: the first regards the identification of "sufficient statistics" capturing the optimal trade-off between insurance and incentives, the second regards the optimal timing of unemployment benefits and the optimal provision of liquidity.

I first consider a stylized model of unemployment (Baily 1978, Chetty 2006) in which an employed agent decides how much to save for unemployment and how much to search when unemployed. In contrast with previous work, I allow the agent to have biased beliefs about her employment prospects and to maximize her *perceived* expected utility. A paternalistic social planner, however, designs the unemployment policy to maximize the agent's *true* expected utility. When determining the optimal generosity of the unemployment policy, the social planner trades off the value of additional insurance and the cost of reduced incentives. This trade-off depends critically on how beliefs are biased in two particular dimensions. The *baseline beliefs* - the beliefs about the baseline job finding probability for given search efforts - affect the perceived value of insurance and

[1] The results are based on a sample of 1,487 job seekers in Michigan and Maryland surveyed repeatedly between 1996 and 1998 by Price et al. (1998). Subjects were 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 as week." I provide more details about the survey, the empirical results and the robustness of the optimistic bias in the appendix.

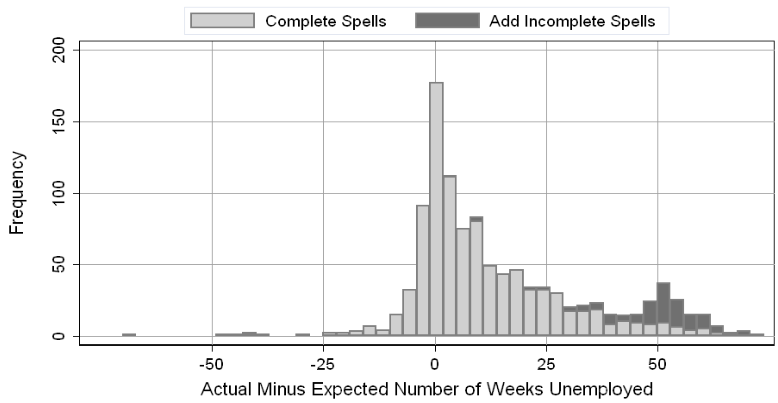

Figure 1: Histogram of differences between actual and expected unemployment durations. Calculations are based on a survey by Price et al. (1998).

thus the agent's willingness to save for unemployment. The *control beliefs* - the beliefs about the increase in the job finding probability when searching more intensively - affect the agent's willingness to exert search effort in order to leave unemployment.

I characterize the impact of these biases on the optimal unemployment policy by building on a canonical result known as the Baily formula. In its standard formulation, this formula states that at the optimum the consumption smoothing benefit from an increase in unemployment benefits should be equal to the incentive (or moral hazard) cost. The consumption smoothing benefit depends on the wedge between employment and unemployment consumption, while the incentive cost is captured by the elasticity of the unemployment probability. Several recent studies have analyzed the implementation of the Baily formula as it identifies two simple sufficient statistics for unemployment policy that can be estimated using reduced-form methods (see Gruber 1997, Chetty 2006, 2008, 2009, Shimer and Werning 2007, Landais 2013). A key insight of the sufficient-statistics analysis is that the agent's behavioral responses to policy only matter to the extent that they affect the policy maker's budget. This is no longer true when an agent's behavior is distorted due to biased beliefs. Biased beliefs do not only change the consumption wedge and the elasticity of the unemployment probability that we would estimate empirically, but also make that corrections of these respective statistics are required to characterize the optimal policy. While the moral hazard cost needs to be corrected for the distortion in search efforts, the consumption smoothing benefit needs to be corrected for the distortion in precautionary savings. The analysis reveals the potential value of active labor market policies affecting search efforts directly and the potential cost of policies relying on the individuals' own savings to protect themselves against unemployment (e.g., Altman and Feldstein 2006).

I then consider a standard dynamic model of the unemployment spell (Shavell and Weiss 1979, Hopenhayn and Nicolini 1997) to analyze the dynamics of the unemployment policy. I explicitly allow for unobservable savings and focus on CARA preferences like in Werning (2002) and Shimer and Werning (2008). I first use the model to show that the Baily decomposition into consumption smoothing benefits and incentive costs again leads to an intuitive characterization of the optimal static unemployment policy and the corrections required for biased beliefs in this dynamic model. I then use the model to analyze the optimal timing of benefits and the desirability of allowing borrowing and savings. In particular, I revisit the powerful result in Shimer and Werning (2008) that the optimal unemployment policy can be implemented with a simple policy that keeps unemployment benefits and taxes constant and gives the unemployed access to savings. This result assumes unbiased beliefs. A baseline-optimistic agent, however, underestimates how long she will remain unemployed and will deplete her assets too rapidly given the expected duration of her unemployment spell. In theory, this increases the value of controlling the unemployed's savings and puts into question the (uncontrolled) provision of liquidity to the unemployed. A calibration of the dynamic model suggests that access to savings substantially increases the value of the static unemployment policy. This increase hardly depends on whether the access to savings is controlled or not provided that the static policy is optimally adjusted. Finally, by underestimating the probability to be long-term unemployed a baseline-optimistic job seeker is also less responsive to future incentives. As a consequence, the social planner can provide more insurance to the long-term unemployed at a low incentive cost for the short-term unemployed. I show how this can result in increasing unemployment benefits during the unemployment spell.

Related Literature A vast literature in psychology starting with the seminal work by Tversky and Kahneman (1974) and a growing literature in economics find that risk perceptions are subject to systematic biases. By now there is broad evidence that people tend to overestimate the probability of positive events and underestimate the probability of negative events.[2] This has also lead to a theoretical literature proposing explanations for the biases in beliefs and finding that optimistic beliefs are more likely to arise and persist.[3] In the context of unemployment, some previous work has analyzed perceptions about employment prospects, but without linking the perceptions and outcomes of the same individuals (see Manski 2004). A recent poll by Gallup in the US finds that 4 in 10 unemployed job seekers expect to find employment within a month. The average job finding rate in the US is, however, much lower, which is again suggestive of a substantial optimistic bias.[4] In ongoing work, Mueller and Spinnewijn analyze how perceptions evolve during the unemployment spell using a survey of job seekers in New Jersey during the most recent recession. They find an optimistic bias that is as extreme in magnitude and persists during the unemployment spell.

The analysis in this paper fits well in the behavioral public economics literature, studying optimal policies with non-standard decision makers.[5] First, behavioral biases like biases in beliefs

[2] Moore and Healy (2008) provide an excellent overview. For seminal contributions, see for example Weinstein (1980) and Slovic (2000). De Bondt and Thaler (1995) conclude: "Perhaps the most robust finding in the psychology of judgment is that people are overconfident." In this literature, overconfidence is often interpreted as over-estimation of a probability relative to the true probability, which relates to my definition of baseline-optimism. However, it can also refer to over-placement (i.e., the belief that one performs better than others) and over-precision (i.e., the belief that one's information is more precise than it actually is).

[3] Examples are Gervais and Odean (2001), Bénabou and Tirole (2002 and 2006), Compte and Postlewaite (2004), Van den Steen (2004), Brunnermeier and Parker (2005), Gollier (2005) and Köszegi (2006).

[4] See http://www.gallup.com/poll/145817/Unemployed-Americans-Face-Challenging-Job-Search.aspx.

[5] For reviews, see Kanbur et al. (2006), Bernheim and Rangel (2007) and Mullainathan et al. (2012).

distort behavior and thus affect the need for public policies and their impact. In the context of unemployment, DellaVigna and Paserman (2005) have analyzed theoretically how impatience distorts job search behavior. 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 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). Finally, behavioral biases may justify government intervention in 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. In other contexts, previous work has focused on the response by private firms to behavioral biases and the potential welfare consequences (see Ellison 2006, DellaVigna 2009). In particular, Santos-Pinto (2008) and De la Rosa (2011) analyze the change in incentive contracts proposed by a profit-maximizing principal in response to specific optimistic biases.[6]

The paper is organized as follows. Section 2 sets up a stylized two-period model and defines the baseline and control beliefs. Section 3 derives an adjustment of the Baily formula characterizing the optimal policy in the presence of biased beliefs. Section 4 introduces a dynamic model of the unemployment spell and analyzes the features of the optimal policy in a dynamic context. Section 5 calibrates this dynamic model and provides some numerical explorations of the optimal policy features and its welfare consequences. Section 6 concludes. All proofs are presented in appendix.

2 Stylized Model

I first consider a two-period model that closely follows the seminal model of unemployment by Baily (1978). A risk-averse agent is employed in the first period, but faces the risk to be unemployed in the second period. In the first period, the agent decides how much to save to protect herself against the loss of earnings when unemployed. In the second period, the agent decides how hard to search for employment.

In each period, the agent earns a wage w when employed and 0 when unemployed. In the first period, the agent can save $s \in [0, w]$ to increase her consumption in the second period by $(1 + r)\, s$, regardless of her employment status. In the second period, the agent finds work with probability $\pi(e) \in [0, 1]$ when exerting search effort at utility utility cost $e \geq 0$. The job finding probability is increasing, but concave in the search cost, $\pi'(e) \geq 0$, $\pi''(e) < 0$. For notational convenience, I assume that the agent is certain to lose her job after the first period and is thus obliged to search

[6] A different set of papers focuses on the impact of heterogeneity in risk perceptions on the design of insurance or other contracts. See for example Sandroni and Squintani (2007), Eliaz and Spiegler (2008), Grubb (2009) and Spinnewijn (2012, 2013).

for a new job in the second period.[7]

The social planner provides mandatory insurance against the unemployment risk. The agent receives a benefit b when unemployed, but pays a tax τ when employed. The insurance reduces the wedge between employment and unemployment consumption. The policy cannot be made conditional on the agent's behavior, but affects how much she saves when employed in the first period and how much search effort she exerts after being displaced in the second period. The expected utility of an unemployment policy (b, τ) for an agent with Bernouilli-utility function $u(\cdot)$ and discount factor β who saves s and exerts effort e equals

$$u(w-\tau-s)+\beta\left[\pi(e)\,u(w-\tau+(1+r)\,s)+(1-\pi(e))\,u(b+(1+r)\,s)-e\right].$$

I will use c_0, c_e and c_u as short-hands of the consumption levels in the first period of employment, the second period when employed and the second period when unemployed respectively.

2.1 Biased Beliefs

The agent's behavior depends on her perceived employment prospects. I allow the agent's belief regarding her job finding probability to be different from the true probability. I denote by $\hat{\pi}(e) \in [0,1]$ the agent's belief when exerting effort e. Like the true probability $\pi(e)$, the perceived probability $\hat{\pi}(e)$ is 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 $\hat{\pi}(e)-\pi(e)$, the *baseline bias,* and the difference in margins $\hat{\pi}'(e)-\pi'(e)$, the *control bias.*

Definition 1 *An agent is baseline-optimistic (-pessimistic) if $\hat{\pi}(e) \geq (\leq)\ \pi(e)$for all $e \geq 0$.*

Definition 2 *An agent is control-optimistic (-pessimistic) if $\hat{\pi}'(e) \geq (\leq)\ \pi'(e)$ for all $e \geq 0$.*

Baseline and control beliefs are interdependent. Whether baseline-optimistic agents are also more optimistic about their control may depend on the context, as illustrated by the following two examples constructed by using an increasing, but concave function $\rho(e)$.[8]

Example 1: *$\pi(e) = \theta \times \rho(e)$ and $\hat{\pi}(e) = \hat{\theta} \times \rho(e)$;* the probability of finding work is complementary in the job seeker's ability θ and effort e. A job seeker who overestimates her ability (i.e., $\hat{\theta} > \theta$) is at the same time baseline-optimistic and control-optimistic.

Example 2: $1-\pi(e) = \phi \times [1-\rho(e)]$ *and* $1-\hat{\pi}(e) = \hat{\phi} \times [1-\rho(e)]$; a job seeker who underestimates the probability to remain unemployed when exerting no search effort (i.e., $\hat{\phi} < \phi$) will be baseline-optimistic, but will also underestimate the return to reducing this probability by searching and thus be control-pessimistic.

[7] For notational convenience, I do not consider the possibility that the worker retains her job, which would introduce an additional state. Still, an alternative interpretation of the model is that the agent exerts effort to keep her job in order to capture moral hazard on-the-job.

[8] Note that the theoretical results apply for any baseline and control bias. For expositional purposes, I do restrict attention to biases in beliefs that are the same for all effort levels, although only the bias in beliefs evaluated at the chosen effort level will matter.

2.2 Agent's Problem

The agent chooses an effort level e and savings level s to maximize her *perceived* expected utility taking the unemployment policy (b, τ) as given,

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

At an interior solution, the levels equalize the respective perceived individual benefit and cost at the margin,

$$\hat{\pi}'(e)\left[u(c_e) - u(c_u)\right] - 1 = 0, \qquad (IC_e)$$

$$-u'(c_0) + \beta(1+r)\left\{\hat{\pi}(e)\left[u'(c_e) - u'(c_u)\right] + u'(c_u)\right\} = 0. \qquad (IC_s)$$

From IC_e, it follows that the agent exerts more effort the higher she perceives the marginal return to effort to be. As a consequence, her effort and thus her probability of finding work is higher when she is control-optimistic than when she is control-pessimistic. This is true as long as the consumption wedge $c_e - c_u$ is positive. The more insurance the unemployment policy provides, the smaller the consumption wedge. The agent responds by decreasing her search effort and more so if she is control-optimistic.

From IC_s, it follows that the agent saves less the higher she perceives the job finding probability to be. This is true as long as the consumption wedge $c_e - c_u$ is positive by concavity of the Bernouilli utility. In contrast with the effort choice, the consumption choice depends on the baseline beliefs. A baseline-optimistic agent underestimates the value of unemployment insurance and protects herself less against the unemployment risk through precautionary savings. The less the unemployment policy insures the agent against the loss of earnings, the larger her incentive to save.[9]

3 Optimal Unemployment Policy

The social planner faces the trade-off between providing insurance and maintaining incentives for search. The agent's perception of her employment prospects is central to this trade-off.

3.1 Social Planner's Problem

The expected expenditures and revenues for the social planner depend on the agent's true employment probabilities. I assume that the social planner is paternalistic and also uses these true probabilities to weight the different states when calculating the agent's expected utility.[10] While

[9] Since the earnings distribution in the second period is first-order stochastically dominated by the earnings in the first period, $u''' > 0$ is not necessary to explain precautionary savings for the unemployment risk. By implicit differentation of IC_s, it follows that the savings level increases in response to a decrease in b (i.e., $\frac{ds}{db} < 0$) regardless of the sign of u'''. For the savings level to increase in response to a decrease in τ, $u''' > 0$ is not necessary either, but sufficient.

[10] The insights generalize for welfare concepts putting some positive weight on the agent's perceived expected utility. In the web-appendix, I contrast the optimal policy under this extreme welfare criterion with the policy implemented

only the true probabilities enter the social planner's problem directly, they still depend on the agent's behavior and thus on the agent's beliefs. I assume that the social planner knows the agent's beliefs, which cannot be manipulated, nor changed in response to the unemployment policy.[11] Hence, the social planner solves

$$\max_{b,\tau} u(w-\tau-s)+\beta\left[\pi\left(e\right)u(w-\tau+\left(1+r\right)s)+\left(1-\pi\left(e\right)\right)u(b+\left(1+r\right)s)-e\right]$$

subject to IC_e, IC_s and

$$\tau+\frac{1}{1+r}\left[\pi\left(e\right)\tau-\left(1-\pi\left(e\right)\right)b\right]=0. \tag{BC}$$

I denote the agent's *true* expected utility by $U\left(b,\tau\right)$ and the social planner's profit by $P\left(b,\tau\right)$. For any unemployment benefit level b, the incentive compatibility constraints and the budget constraint implicitly determine a tax level $\tilde{\tau}\left(b\right)$, an effort choice $\tilde{e}\left(b\right)$ and a savings choice $\tilde{s}\left(b\right)$. I assume that these functions are well-behaved for the relevant range of values for b with $\tilde{\tau}'\left(b\right)>0$, $\tilde{e}'\left(b\right)\leq 0$ and $\tilde{s}'\left(b\right)\leq 0$ and drop the argument when it is clear.

For the unemployment policy to be optimal, a budget-balanced increase in the unemployment benefit b cannot increase the agent's welfare,

$$\frac{dU}{db}=0 \;\Leftrightarrow\; \frac{\partial U}{\partial b}+\frac{\partial U}{\partial \tau}\tilde{\tau}'\left(b\right)+\frac{\partial U}{\partial e}\tilde{e}'\left(b\right)+\frac{\partial U}{\partial s}\tilde{s}'\left(b\right)=0. \tag{1}$$

An increase in the unemployment benefit b has three types of effects. First, it directly increases the agent's utility when unemployed. Second, it requires an increase in the tax to keep the budget balanced and thus affects the agent's utility when employed. Third, it changes the agent's behavior: the agent reduces her search effort e and her savings s. With unbiased beliefs, these behavioral responses have only a second-order impact on the agent's expected utility by the envelope condition. That is, if the agent were to maximize her true expected utility, the last two terms in equation (1) would drop and the social planner could ignore the utility impact of any behavioral response. This is a key force in the analysis by Baily (1978) and the sufficient statistic literature in public economics (see Chetty 2006, 2009). However, this no longer applies when an agent has biased beliefs and maximizes her perceived rather than her true expected utility.

I relate the first-order utility impact of these behavioral responses when beliefs are biased to the standard moral hazard cost and consumption smoothing benefit from an increase in unemployment benefits.

Moral Hazard: Perceived Returns to Search Higher unemployment benefits lower the incentives for an unemployed agent to search for work. Moral hazard arises as the agent does not internalize the impact of her effort on the social planner's expected revenues and expenditures.

by a populist government catering to its voters' beliefs. Such government would propose the same policy as profit-maximizing insurers in a competitive equilibrium. I briefly discuss this in Section 3.3.

[11] These assumptions correspond to a setting with different priors where the social planner and the agent 'agree to disagree'.

The tax increase required to balance the budget is larger the more responsive the agent's search effort. The impact of this behavioral response on the social planner's budget is fully captured by the elasticity of the unemployment probability with respect to a budget-balanced increase in the unemployment benefit. That is, the required tax increase equals

$$\tilde{\tau}'(b) = \frac{\tilde{\tau}(b)}{b}\left[1 + \varepsilon_{1-\pi(\tilde{e}),b}\right], \text{ with } \varepsilon_{1-\pi(\tilde{e}),b} \equiv \frac{d\left(1-\pi\left(\tilde{e}\left(b\right)\right)\right)}{db}\frac{b}{1-\pi\left(\tilde{e}\left(b\right)\right)}. \tag{2}$$

The higher the elasticity, the worse the rate at which the social planner can transfer consumption from employment to unemployment and thus the more costly it is to provide insurance against unemployment.

The agent's biased beliefs introduce a second externality related to her effort choice, which I refer to as a *search internality*. If the perceived and true marginal return to search differ, the agent does not correctly internalize the effect of her search effort on her true expected utility. The social planner affects this search internality when changing the unemployment policy. Using IC_e, I find

$$\frac{\partial U}{\partial e}\tilde{e}'(b) = \beta\left[\pi'(\tilde{e}) - \hat{\pi}'(\tilde{e})\right]\left[u(c_e) - u(c_u)\right]\tilde{e}'(b). \tag{3}$$

With unbiased control beliefs, this effect is of second order. However, when the agent is control-pessimistic, $\pi'(\cdot) > \hat{\pi}'(\cdot)$, she underestimates the marginal return to effort and exerts too little effort given the true return. A decrease in her effort choice in response to an increase in unemployment benefits now causes a first-order decrease in welfare. When the agent is control-optimistic, the opposite happens. In fact, the positive search internality due to her control-optimistic beliefs may offset the negative externality due to moral hazard and thus reduce the incentive cost from providing unemployment insurance.

Consumption Smoothing: Perceived Value of Insurance Unemployment benefits provide insurance by reducing the wedge between employment and unemployment consumption. The welfare gain from a budget-balanced increase in the unemployment benefit is increasing in the wedge between the marginal utility of consumption when employed and unemployed. Ignoring behavioral responses, the normalized utility gain equals

$$\left[\frac{\partial U}{\partial b} + \frac{\partial U}{\partial \tau}\frac{\tilde{\tau}(b)}{b}\right] / \left[-\frac{\partial U}{\partial \tau}\frac{\tilde{\tau}(b)}{b}\right] = \frac{u'(c_u) - \bar{u}'(c_e)}{\bar{u}'(c_e)}, \tag{4}$$

for $\beta(1+r) = 1$ and $\bar{u}'(c_e) \equiv \left[u'(c_0) + \beta\pi(\tilde{e})\,u'(c_e)\right] / \left[1 + \beta\pi(\tilde{e})\right]$ denoting the average (discounted) marginal utility when employed. The relative difference in marginal utilities and thus the consumption smoothing benefit of the unemployment policy is decreasing in the benefit b and tax τ.

Higher unemployment benefits also reduce the gains from self-protection against the unemployment risk. The social planner's unemployment policy crowds out the agent's precautionary savings. The welfare impact of the crowd-out response when considering a marginal change in the unemployment policy is again of second order if agents have unbiased beliefs. Using IC_x, I find

$$\frac{\partial U}{\partial s}\tilde{s}'(b) = \beta(1+r)\left[\hat{\pi}(\tilde{e}) - \pi(\tilde{e})\right]\left[u'(c_u) - u'(c_e)\right]\tilde{s}'(b). \tag{5}$$

When the agent is baseline-optimistic about her employment prospects, $\hat{\pi}(e) > \pi(e)$, she saves too little to protect herself against unemployment. A further decrease in her precautionary savings in response to an increase in the unemployment benefit thus causes a first-order decrease in her expected utility.

3.2 Adjusted Baily Formula

Using the above expressions, the optimality condition (1) can be rewritten to find a Baily formula adjusted for biased beliefs. The formula states that when setting unemployment benefits the gain from providing insurance and the cost from reducing the search incentives have to be equalized at the margin.

Proposition 1 *The optimal unemployment policy is characterized by*

$$\frac{u'(c_u) - \bar{u}'(c_e)}{\bar{u}'(c_e)}\left[1 - \frac{\hat{\pi}(\tilde{e}) - \pi(\tilde{e})}{1-\pi(\tilde{e})}I(b)\right] = \varepsilon_{1-\pi(\tilde{e}),b}\left[1 - \frac{\hat{\pi}'(\tilde{e}) - \pi'(\tilde{e})}{\pi'(\tilde{e})}J(b)\right], \tag{6}$$

for $I(b) = -\frac{u'(c_u)-u'(c_e)}{u'(c_u)-\bar{u}'(c_e)}\frac{\tilde{s}'(b)}{\beta} \geq 0,\ J(b) = \frac{u(c_e)-u(c_u)}{b\bar{u}'(c_e)} \geq 0$ *and* $\beta(1+r) = 1$.

When beliefs are unbiased, condition (6) simplifies to the standard Baily formula[12],

$$\frac{u'(c_u) - \bar{u}'(c_e)}{\bar{u}'(c_e)} = \varepsilon_{1-\pi(\tilde{e}),b}. \tag{7}$$

This formulation by Baily (1978) is central in the recent literature in public finance developing and implementing "sufficient statistic formulas" for social insurance (Chetty 2009). The Baily formula suggests that the identification of two moments is sufficient to guide policy design. If the relative difference in marginal utilities exceeds the elasticity $\varepsilon_{1-\pi(\tilde{e}),b}$, an increase in the unemployment benefit increases welfare. The larger the difference in marginal utilities or the smaller the elasticity, the higher the expected welfare gain. Identifying the primitives underlying the agent's search and savings decision is not necessary. The appeal of this approach is thus that policy recommendations can be based on a small set of high-level empirical moments, which have been credibly estimated in the empirical literature.[13] However, when biased beliefs distort a job seeker's behavior, the Baily formula prescribes an unemployment benefit level that is generally suboptimal. The direction

[12] Note that the second order condition of the social planner's maximization problem requires that $\frac{u'(c_u)-\bar{u}'(c_e)}{\bar{u}'(c_e)}$ decreases more in b than $\varepsilon_{1-\pi(\tilde{e}),b}$.

[13] A large literature has analyzed the unemployment responses to unemployment benefits (see Krueger and Meyer (2002) for a review). Gruber (1997) estimates the relative difference in consumption when employed and unemployed to approximate the relative difference in marginal utilities, i.e., $\left[u'(c_u) - \bar{u}'(c_e)\right]/\bar{u}'(c_e) \cong \gamma\frac{\Delta c}{c}$ for relative risk aversion parameter γ. See Shimer and Werning (2007) and Chetty (2008) for alternative implementations.

in which the benefit level should be adjusted depends only on the belief biases as illustrated in Corollary 1 and 2.

Corollary 1 *The elasticity $\varepsilon_{1-\pi(\tilde{e}),b}$ overestimates (underestimates) the cost from reducing incentives when agent's have control-optimistic (-pessimistic) beliefs.*

The cost from reduced incentives depends on both the moral hazard cost and the search internality. The search internality appears as a correction of the elasticity in the adjusted Baily formula (6), which depends on the control bias. Ignoring this correction would lead the social planner to set the unemployment benefit suboptimally high for control-pessimistic agents and suboptimally low for control-optimistic agents. Note that the social planner can correct the search internality only to the extent that the agent is responsive to its policy. In case of a zero elasticity, for example when the job seeker believes she has no control over her situation, she will not respond to changes in the unemployment benefits. This indicates the potential importance of other unemployment policies to encourage search directly, like job search monitoring and job search assistance. The impact of biased control beliefs on the optimal benefit level itself is also ambiguous despite the unambiguous correction in the formula. The reason is that control beliefs also affect the standard moral hazard cost (by changing the responsiveness and thus the elasticity $\varepsilon_{1-\pi(\tilde{e}),b}$) and consumption smoothing benefits (by changing effort and thus the required tax $\tilde{\tau}(b)$) with potentially opposite effects on the optimal benefit level. This can be easily seen when the control beliefs are either extremely pessimistic or optimistic, since in both cases the optimal policy converges to full insurance (i.e., $c_e - c_u \rightarrow 0$).[14]

Corollary 2 *The relative difference $[u'(c_u) - \bar{u}'(c_e)]/\bar{u}'(c_e)$ overestimates (underestimates) the gain from providing insurance when agents have baseline-optimistic (-pessimistic) beliefs.*

The gain from providing additional insurance depends on the relative difference in marginal utilities, but needs to be corrected for the crowd-out of savings when beliefs are biased. The correction depends on the baseline bias. Note that baseline-optimistic agents save less to protect themselves against the unemployment risk and thus gain more from higher unemployment benefits. This is reflected by the higher relative difference in marginal utilities due to the lower savings. However, this relative difference overstates the welfare gain from increasing unemployment benefits. This is due to the reduction in savings in response to the benefit increase, although the savings are already insufficient. Similarly, baseline-pessimistic agent smooth their consumption more and thus gain less from higher unemployment benefits, but this gain is larger than indicated by the relative difference in marginal utilities.

[14] When the agent is extremely pessimistic about her control, the increase in search efforts when introducing a (costly) wedge between employment and unemployment consumption is too low. When the agent is extremely optimistic about her control, a small wedge would suffice to induce her to exert the efficient level of search.

3.3 Self-Protection against Unemployment

The analysis highlights that workers who overestimate their job finding probability (or underestimate their job loss probability) are expected to save too little and to be unprepared for the loss of earnings when unemployed. The optimism about employment prospects might explain why many unemployed individuals have limited liquidity (Chetty 2008) and raises doubts regarding the desirability of individual unemployment savings accounts to provide protection against unemployment as proposed by Altman and Feldstein (2006). The under-investment and its consequences for optimal policy extend to any type of self-insurance against the unemployment risk that workers could invest in. As such, the optimistic bias may provide an alternative explanation for the puzzle why unemployment insurance is almost always publicly provided (Acemoglu and Shimer 2000). This can be illustrated in an extended model with private insurance. The desirability of social insurance depends on whether or not the equilibrium coverage provided by private insurers is socially optimal. Like a social planner, private insurers are constrained by the true employment probabilities when designing their policies. However, in order to attract agents with biased beliefs, they would offer policies that maximize the agents' perceived rather than true expected utility. In particular, private insurers would offer less insurance than is socially optimal in response to the low valuation implied by baseline-optimistic beliefs. In addition, they would not adjust the coverage to correct for the distortions in the agent's search behavior driven by her biased control beliefs. Both effects illustrate why the well-known result that moral hazard, in contrast with adverse selection, does not raise the need for government intervention (e.g., Chetty and Saez 2010) holds only if the agent's beliefs are unbiased. In the web-appendix to this paper, I show these insights formally by characterizing the insurance policy provided by private insurers in a competitive equilibrium, which would coincide with the optimal policy when beliefs are unbiased.[15]

4 Dynamic Model of the Unemployment Spell

The previous section characterized the optimal generosity of the unemployment policy focusing on the role of biased beliefs for the incentives for workers to save for unemployment and for displaced workers to leave unemployment. This section provides a complementary analysis of the role of biased beliefs for the search and consumption choices of unemployed job seekers during the unemployment spell and also studies the consequence for the optimal dynamics of the unemployment policy. I consider a standard dynamic model of the unemployment spell in which a job seeker starts unemployed and decides how much to search for employment as long as she has not found employment (see Shavell and Weiss 1979, Hopenhayn and Nicolini 1997, Shimer and Werning 2008, etc.). The job seeker has also access to assets which can be used to increase unemployment consumption at the expense of future consumption and thus make consumption levels dependent on the length of the unemployment spell.

[15] Note that this is also the policy that a non-paternalistic policy maker would propose when trying to gain the agent's vote in elections.

I consider the case of CARA preferences for which Werning (2002) and Shimer and Werning (2008) show that the social optimum is achieved with constant unemployment benefits and taxes when job seekers are not liquidity constrained. First, I show how the optimal characterization of this constant policy generalizes the previous insights of the adjusted Baily formula to this dynamic setting. Note that both the effort and savings decision will now depend on the perceived length of the unemployment spell. Baseline-optimistic job seekers search too little and draw down their assets too quickly given the true expected duration. The latter implies that access to liquidity is no longer sufficient to achieve the social optimum. Finally, I also show how the social planner could increase the welfare of baseline-optimistic agents by increasing the unemployment benefits and taxes with the length of the unemployment spell.

4.1 Setup

The agent now starts unemployed and exerts effort at cost e to find work. She finds a job with probability $\pi(e)$ in a given period, but she believes this probability to be equal to $\hat{\pi}(e)$. If the agent does not find work in a given period, she has to search again in the next period. Once she finds a job, she remains employed forever.[16,17] I assume CARA preferences with the cost of effort expressed in monetary terms, $u(c-e) = -\exp(-\sigma(c-e))$. Next to the unemployment benefits and taxes, the agent has also access to a risk-free asset a with interest rate r to smooth her consumption. The agent's discount factor equals β with $\beta(1+r) = 1$.

I consider the constant policy (b, τ) specifying the constant benefit b received when unemployed and the constant tax τ paid when re-employed. An agent with CARA preferences makes her search and consumption decision based only on differences in income levels. With a constant policy, these differences remain the same throughout the unemployment spell.

Lemma 1 *An agent with CARA preferences facing a constant policy (b, τ) exerts a stationary effort level $\hat{e}$ and depletes her asset holdings by a stationary amount $\hat{x}$. The perceived continuation value in unemployment equals*

$$\hat{U}(b, \tau | a) = \frac{u(c_u(a) - \hat{e}) + \frac{\beta}{1-\beta}\hat{\pi}(\hat{e})\, u(c_e(a) - r\hat{x})}{1 - \hat{\beta}(\hat{e}, \hat{x})}, \tag{8}$$

with $\hat{\beta}(\hat{e}, \hat{x}) \equiv \beta(1 - \hat{\pi}(\hat{e}))\exp(\sigma r \hat{x})$.

The stationarity makes the problem particularly tractable and allows for a closed-form expression for the continuation value in unemployment with a simple interpretation: each period that

[16] It is possible to introduce a spell of employment at the start in the spirit of the stylized two-period model. This would confirm the earlier insights and not affect the dynamic results. Note that in the dynamic model effort exerted in a given period of unemployment affects employment in the next period, which is different from the stylized model.

[17] 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 the web-appendix, I discuss empirical evidence suggesting that the optimistic baseline bias does not decrease during unemployment.

the job seeker starts unemployed she receives a utility flow that depends on her unemployment utility and the expected utility from potentially becoming employed. This utility flow is discounted by $\hat{\beta}(e,x)$ which in addition to the discount factor β depends on the perceived probability of unemployment and the rate at which the utility flow decreases through asset depletion.

The agent's effort level solves

$$\beta\hat{\pi}'(e)\exp(\sigma r x)\left[\frac{u(c_e(a))}{1-\beta}-\hat{U}(b,\tau|a)\right]=u'(c_u(a)-e). \tag{IC_e'}$$

Her effort now depends on her baseline beliefs as well. A baseline-optimistic job seeker overestimates the probability of leaving unemployment and thus the continuation value in unemployment $\hat{U}(b,\tau|a)$. As a consequence, she exerts less effort to leave unemployment. The agent's consumption levels during unemployment and upon re-employment equal respectively,

$$\begin{aligned} c_u(a) &= \frac{r}{1+r}a+b+x, \\ c_e(a) &= \frac{r}{1+r}a+(w-\tau). \end{aligned}$$

The static wedge between employment and unemployment consumption is decreasing in the unemployment benefit and the tax as in the two-period model. A job seeker can now decrease this static wedge by running down her savings at the expense of future consumption. That is, when increasing today's unemployment consumption by x, it is optimal to reduce all future consumption levels by rx, whether employed or unemployed. The reduction of the static wedge by x thus introduces a dynamic wedge rx measuring the slope of the decreasing profile of unemployment consumption. The job seeker trades off this static and dynamic wedge and sets x to solve

$$\frac{u'(c_u-e)-u'(c_e)}{u'(c_u-e)}=\frac{1}{\hat{\pi}(e)}\left(1-\frac{1}{\exp(\sigma r x)}\right), \tag{IC_x}$$

where $1/\hat{\pi}(e)$ equals the job seeker's belief regarding the expected duration of her unemployment spell. The left-hand side captures the value of a reduction in the static wedge, while the right-hand side captures the cost from an increase in the dynamic wedge. The shorter a job seeker expects to remain unemployed, the more willing she is to run down her savings during unemployment in order to reduce the static wedge.

4.2 Adjusted Baily Formula

The social planner again sets the benefit level of a budget-balanced policy to maximize the agent's true expected utility, constrained by the agent's effort and consumption choices. Budget balance for a constant policy simplifies to $\tau = rb/\pi(e)$. The required tax to balance the budget is higher the longer the true expected duration of the unemployment spell $1/\pi(e)$. Like in the two-period model, the constraints implicitly define three functions $\tilde{\tau}(b)$, $\tilde{e}(b)$ and $\tilde{x}(b)$ and the optimal benefit level b satisfies

$$\frac{dU}{db}=0 \;\Leftrightarrow\; \frac{\partial U}{\partial b}+\frac{\partial U}{\partial \tau}\tilde{\tau}'(b)+\frac{\partial U}{\partial e}\tilde{e}'(b)+\frac{\partial U}{\partial x}\tilde{x}'(b)=0. \tag{9}$$

This condition allows for a Baily-type characterization of the optimal constant policy in this dynamic setting. Note that at the optimum both the search effort and the depletion level are decreasing in response to a budget-balanced increase in the unemployment benefit, i.e. $\tilde{e}'(b)\leq 0$ and $\tilde{x}'(b)\leq 0$.

Proposition 2 *With CARA preferences, the optimal constant policy is characterized by*

$$\frac{u'(c_u-\tilde{e})-u'(c_e-r\tilde{x})}{u'(c_e-r\tilde{x})}\left\{1+\frac{\hat{\pi}(\tilde{e})-\pi(\tilde{e})}{1-\hat{\pi}(\tilde{e})}K(b)\right\}=\varepsilon_{1/\pi(\tilde{e}),b}\left\{1-(1-\frac{\pi'(\tilde{e})}{\hat{\pi}'(\tilde{e})}\frac{1-\hat{\beta}(\tilde{e},\tilde{x})}{1-\beta(\tilde{e},\tilde{x})})L(b)\right\},$$

where $K(b)=\frac{-\tilde{x}'(b)}{1-\hat{\beta}(\tilde{e},\tilde{x})}\geq 0$ *and* $L(b)=\frac{u'(c_u-\tilde{e})}{u'(c_e)b}\frac{\pi(\tilde{e})}{\pi'(\tilde{e})}\geq 0.$

The Proposition shows how the Baily formula and the adjustment for biased beliefs generalize in this dynamic setting. The insurance gain is simply captured by the drop in the marginal utility of consumption for an agent exiting unemployment, i.e., $[u'(c^u-e)-u'(c^e-r\tilde{x})]/u'(c^e-rx)$. Note that this drop depends on both the static and dynamic consumption wedge, which are related through the job seeker's savings choice in IC_x. The incentive cost is simply captured by the elasticity of the expected unemployment duration with respect to a budget-balanced increase in the benefit, $\varepsilon_{1/\pi(\tilde{e}),b}\equiv d\ln(1/\pi(\tilde{e}))/d\ln b$.

Both sides of the Baily-type expression are again corrected for the first-order welfare impact of the job seeker's behavioral responses to the policy change. The correction for the search internality now depends on both the baseline and control bias. If the job seeker is either control-pessimistic or baseline-optimistic such that the ratio $\pi'(e)[1-\hat{\beta}(e,x)]/\{\hat{\pi}'(e)[1-\beta(e,x)]\}>1$, the job seeker's reduced search effort in response to an increase in unemployment benefits has a negative first-order impact on welfare. The elasticity $\varepsilon_{1/\pi(\tilde{e}),b}$ would underestimate the incentive cost like in Corollary 1. The correction for the job seeker's savings response depends on the bias in the baseline beliefs. A baseline-optimistic job seeker depletes her assets too quickly to increase her unemployment consumption. By slowing down this rate, an increase in the unemployment benefits now implies a positive, first-order effect on welfare. This contrasts with the effect on precautionary savings during employment in the two-period model. A baseline-optimistic worker saves too little for unemployment. An increase in unemployment benefits further reduces her precautionary savings and thus decreases welfare in the two-period model.[18]

4.3 Insurance vs. Liquidity

The distortion in the consumption choice during the unemployment spell when beliefs are biased raises questions concerning the use of unemployment policies that rely on an agent's discretionary

[18] More formally, in the respective models $\tilde{s}'(b)\leq 0$ and $\tilde{x}'(b)\leq 0$, but $\frac{\partial U}{\partial s}\geq 0$ in the two-period stylized model and $\frac{\partial U}{\partial x}\leq 0$ in the dynamic unemployment model for baseline-optimistic agents.

use of her assets to protect herself against unemployment. In the spirit of individual unemployment savings accounts, Shimer and Werning (2008) argue that when workers have access to liquidity to smooth their consumption during the unemployment spell, the unemployment policy should primarily focus on the provision of insurance. In particular, they show that in a McCall (1970) search model with CARA preferences, the optimal unemployment policy is implemented with constant benefits and taxes as long as job seekers can freely borrow and save. The dynamic wedge implied by a job seeker's asset depletion is thus exactly optimal from the social planner's perspective. This, however, does no longer hold when a job seeker underestimates the expected duration of her unemployment spell.

I study this issue in a model with costly search. I contrast the job seeker's depletion rate with the rate the social planner would set when controlling the job seeker's savings at zero cost. For the asset depletion to be socially optimal, a budget-balanced increase in x should not increase welfare accounting for the agent's behavioral responses. In particular, if x increases, the job seeker will search harder which relaxes the planner's budget constraint so that the unemployment benefit could be increased. Denoting by $\check{b}(x)$ and $\check{e}(x)$ the benefit and effort level implied by IC_e' and the budget constraint at x, I find

$$\frac{dU}{dx} = 0 \;\Leftrightarrow\; \frac{\partial U}{\partial x} + \frac{\partial U}{\partial b}\check{b}'(x) + \frac{\partial U}{\partial e}\check{e}'(x) = 0, \tag{10}$$

with $\check{e}'(x) \geq 0$ and $\check{b}'(x) \geq 0$. The condition allows for a Baily-type characterization of the optimal dynamics.

Proposition 3 *With CARA preferences and controlled savings, the unemployment policy satisfies*

$$\frac{u'(c_u - \check{e}) - u'(c_e)}{u'(c_u - \check{e})} = \frac{1}{\pi(\check{e})}\left(1 - \frac{1}{\exp(\sigma r x)}\right) - \left\{b - \left(1 - \frac{\pi'(\check{e})}{\hat{\pi}'(\check{e})}\frac{1-\hat{\beta}(\check{e},x)}{1-\beta(\check{e},x)}\right)\frac{\pi(\check{e})}{\pi'(\check{e})}\right\}\frac{1-\beta(\check{e},x)}{\pi(\check{e})\,x\exp(\sigma r x)}\varepsilon_{1/\pi(\check{e}),x}.$$

Like the agent, the social planner trades off the static and dynamic wedge when determining the asset depletion rate x. The trade-off in the Proposition is directly comparable to the agent's trade-off expressed in IC_x. In contrast with the agent, the social planner uses the true rather than the perceived expected unemployment duration in the first term on the right-hand side to evaluate this trade-off. This would lead the social planner to set x lower than a baseline-optimistic job seeker. Hence, reducing the job seeker's excessive asset depletion for example by restricting her access to savings or by taxing her withdrawals during unemployment would increase welfare.[19] However, the social planner must also account for the positive effect on search when increasing x, as captured by the second term on the right-hand side. Higher x yields higher welfare by making

[19] Note that decreasing the unemployment benefits and increasing taxes upon re-employment at the same rate with the length of the unemployment spell like in Hopenhayn and Nicolini (1997) would not be effective in changing the consumption profile since job seekers would adjust their savings to undo such policy.

an increase in unemployment benefits feasible and by correcting a negative search internality (if $\pi'(e)[1-\hat{\beta}(e,x)]/\{\hat{\pi}'(e)[1-\beta(e,x)]\} > 1$). The two latter effects would lead the social planner to set x higher than the job seeker. The welfare gain from restricting the access to savings might thus disappear in a costly search model due to its negative effect on search.[20]

4.4 Timing of Incentives

An important aspect for the design of unemployment policies is that the treatment of the long-term unemployed affects the incentives for the short-term unemployed: both the search incentives in order to avoid being long-term unemployed and the saving incentives in order to prepare for long-term unemployment. In particular, the threat to receive low benefits when long-term unemployed increases the incentives to search already when short-term unemployed. The effectiveness of this threat, however, depends on the perceived probability to be long-term unemployed. The above analysis considered a policy which keeps the subsidy to unemployment $b+\tau$ constant and provides the same incentives throughout the unemployment spell. This constant subsidy provides a lower bound on the attainable welfare of unemployment policies, which is tight in case of a McCall search model with CARA preferences and unbiased beliefs (Shimer and Werning 2008). This is no longer true when job seekers have biased beliefs. The reason is exactly that biased beliefs cause policies for the long-term unemployed to have a differential impact on the true and perceived continuation value of unemployment. However, only the impact of the future policy on the perceived continuation value affects an unemployed job seeker's behavior today.

Consider the same budget-balanced increase in the constant benefit and tax considered in section 4.2, but only implemented after one period of unemployment, which I denote by db_1. This affects the true and perceived continuation of unemployment after one period of unemployment denoted by U_1 and $\hat{U}_1$ respectively. If the perceived continuation value changes, this policy change also affects behavior at the start of the unemployment spell, which I denoted by e_0 and x_0. The impact on welfare at the start of the spell therefore equals

$$\frac{dU}{db_1} = \left[\left[\frac{\partial U}{\partial e_0} + \frac{\partial U}{\partial P}\frac{\partial P}{\partial e_0}\right]\frac{\partial e_0}{\partial \hat{U}_1} + \frac{\partial U_0}{\partial x_0}\frac{\partial x_0}{\partial \hat{U}_1}\right]\frac{d\hat{U}_1}{db_1} + \beta\left(1-\pi\left(e_0\right)\right)\frac{dU_1}{db_1}. \tag{11}$$

Starting from the optimal constant policy, the marginal change has no first-order impact on the continuation value of unemployment after one period of unemployment (i.e., $dU_1/db_1 = 0$). Since the baseline-optimistic agent tends to prefer an unemployment policy with lower benefits and taxes, the budget-balanced increase lowers her perceived utility (i.e., $d\hat{U}_1/db_1 < 0$). This holds, unless the social planner sets the unemployment benefit very low relative to the standard Baily formula to correct for a negative search internality.[21] Hence, the decrease in perceived utility induces the job

[20] Note that the positive effect of x on search and thus the exit rate out of unemployment is not present in a McCall search model considered by Shimer and Werning (2008). In that model, agents who overestimate the arrival rate of job offers would set their reservation wage too high and thus leave unemployment too slowly, but this is not affected by the rate at which assets are depleted.

[21] There exists a positive upper bound ζ, explicitly characterized in the proof and increasing in the baseline bias,

seeker to increase her search effort e_0 and to reduce her consumption from savings x_0 in the first period of unemployment. Both behavioral responses increase her true expected utility U when she is baseline-optimistic. Moreover, the increase in search effort relaxes the social planner's budget P, which allows for a further increase in the agent's welfare.

Proposition 4 *With unbiased beliefs and unobservable savings, the optimal unemployment policy is constant. If beliefs are baseline-optimistic and the search internality is relatively small, welfare is increased by increasing benefits and taxes for the long-term unemployed.*

Limiting or reducing unemployment benefits in time has been a central topic in the policy debate and the literature on optimal unemployment insurance. The papers by Shavell and Weiss (1979) and Hopenhayn and Nicolini (1997) have argued that this results from the optimal trade-off between smoothing consumption and providing incentives. Shimer and Werning (2008) show that by providing liquidity to the unemployed, the negative duration-dependence of consumption can be optimally implemented with constant benefits. The Proposition takes this result one step further suggesting that when job seekers are baseline-optimistic, unemployment benefits could be increasing during the unemployment spell. Insurance can be provided to the long-term unemployed at a relatively low incentive cost for the short-term unemployed.

5 Numerical Analysis

In this section, I calibrate the dynamic model of the unemployment spell. I calculate the optimal unemployment policy for different specifications of the underlying beliefs under different saving scenario's.

Calibration. The true probability function and perceived probability function in this numerical exercise are of the form $\pi(e) = \pi_0 + \pi_1 e^{\rho}$ and $\hat{\pi}(e) = \hat{\pi}_0 + \hat{\pi}_1 e^{\rho}$. I use the reported search intensity in Price et al. (1998) and its relation with the actual and expected unemployment duration to calibrate these functions. The monetary cost of search effort $\psi_u(e) = \psi_0 e^{\psi_1}$ and the constant cost of work ψ_e are calibrated to match an elasticity of the unemployment duration to unemployment benefits of -0.5 and a monthly exit rate of 0.188. These values correspond to respectively the empirical estimates of duration elasticities reviewed in Krueger and Meyer (2002) and the average exit rate in the sample of a survey of unemployed job seekers in the US by Price et al. (1998). I calculate the optimal policy for different values of the baseline and control bias. The elicited expectations of the unemployment duration in Price et al. (1998) suggest an optimistic baseline bias $[\hat{\pi}(e) - \pi(e)]/\pi(e) = [\hat{\pi}_0 - \pi_0 + (\hat{\pi}_1 - \pi_1)e^{\rho}]/\pi(e)$ of around 200%. To evaluate the importance of the baseline bias, I consider a range of values for $\hat{\pi}_0$ implying a baseline bias between $0\% - 200\%$ (keeping $\hat{\pi}_1 = \pi_1$). In the sample, the baseline bias is negatively related to the reported search effort across job seekers. Controlling for other observable characteristics, I find that the actual unemployment spell is on average 3.4 weeks shorter for subjects who report to search at double the

such that $\frac{\pi'(\tilde{e})}{\hat{\pi}'(\tilde{e})}\frac{1-\hat{\beta}(\tilde{e},\tilde{x})}{1-\beta(\tilde{e},\tilde{x})} \leq 1+\zeta$ is sufficient for $\frac{d\hat{U}_1}{db_1} < 0$.

frequency, but the expected unemployment spell is only 2.0 weeks shorter (see Table B.2). Taken at face value, this would suggest a pessimistic control bias $\left[\hat{\pi}'(e) - \pi'(e)\right]/\pi'(e) = [\hat{\pi}_1 - \pi_1]/\pi_1$ of -67%, but this result could also be driven by reversed causality or unobserved heterogeneity. To evaluate the importance of the control bias, I consider a range of values for $\hat{\pi}_1$ implying a control bias between -100 and 100% (keeping $\hat{\pi}_0 = \pi_0$). Note that changes in $\hat{\pi}_1$ will also affect the baseline bias. The details of the regression specifications and the calibration are in the appendix.

Optimal Static Policy (No savings). I first consider first the optimal 'static' policy. That is, the optimal constant policy (b, τ) when the unemployed agent has no access to any assets such that consumption is independent of the length of unemployment. The left panels of Figures C.1 and C.2 in appendix show the net unemployment subsidy $b + \tau - \Delta\psi$ for different belief parameters with $\Delta\psi = \psi_u(e) - \psi_e$. Given that the costs of effort are expressed in monetary terms, the subsidy is presented net of these costs. In the absence of savings, the *static wedge* between the marginal utility of consumption when employed and unemployed is determined by the wage minus this net subsidy, $w - [b + \tau - \Delta\psi]$. I scaled the wage to 1 such that the results can be interpreted in percentage terms relative to output. The right panels show the monthly exit probability out of unemployment. Both baseline-optimistic beliefs and control-pessimistic beliefs increase the cost of providing incentives and thus reduce the exit rate implied by the optimal policy. The monthly exit probability decreases from .20 to .18 for the range of baseline beliefs and increases from .14 to .21 for the range of control beliefs. As discussed before, the impact of biased beliefs on the optimal policy itself is ambiguous and, in the absence of savings, the beliefs only affect the search effort. For different values of the baseline beliefs, the optimal unemployment subsidy remains around .88, implying a static wedge of around .12. The changes are more pronounced for different control beliefs. In particular, the unemployment subsidy increases to 1 when the control beliefs become extremely pessimistic. The static wedge disappears as providing incentives becomes useless. As discussed in Section 3.3, private insurers would accommodate the job seekers' changing perception of the value of insurance and thus lower the unemployment subsidy when the job seekers are baseline-optimistic. I calculate the unemployment subsidy that they would provide in a competitive equilibrium as a natural benchmark for the unemployment policy.[22] When the optimistic baseline bias increases to 200%, the net unemployment subsidy decreases to about 0.5. This approximately equals the cost differential $-\Delta\psi$ implying that the underlying unemployment benefit level is close to 0. At 200%, the baseline bias makes it unprofitable for private insurers to provide positive unemployment benefits in this model.[23]

Optimal Dynamic Policy (With Savings). I now consider the optimal 'dynamic' policy. That is, the optimal constant policy (b, τ) when the agent has free access to a riskless asset such that the agent's consumption decreases linearly with the length of the unemployment spell at rate rx. The left panel in Figure C.3 contrasts this *dynamic* wedge with the *static* wedge which is now

[22] The characterization of the competitive equilibrium discussed in section 3.3 and derived in the web appendix naturally generalizes for the dynamic model.

[23] The lower subsidy relative to the optimal policy induces more search as well. The monthly exit rates are up to 2 percentage points larger than in the social optimum.

reduced by x (i.e., $w - [b + \tau - \Delta\psi] - x$). Both wedges are evaluated given the optimal policy for different baseline beliefs. The first thing to notice is that the optimal static wedge falls below .01 when the job seeker has access to savings (from about .12 in the absence of savings). The assets allow using all future periods in this infinite-horizon model to smooth the loss of income during unemployment. With unbiased beliefs, the static wedge equals .009 for the optimal policy, while the dynamic wedge equals just above .002. This dynamic wedge increases substantially when the agent underestimates how long she will remain unemployed. For a baseline bias of 200%, the dynamic wedge has increased above .004 while the static wedge has decreased to below .007. In other words, while the consumption of someone who finds work immediately is hardly 1% higher than the net consumption of an unemployed job seeker at the start of spell, this difference increases by almost 1% for any additional two months in unemployment. A job seeker who finds work only after two years consumes almost 10% less (in each remaining period of her infinite life). The right panel shows the unemployment subsidy $b + \tau - \Delta\psi$ and the asset depletion x underlying the static and dynamic wedge. The optimal policy involves a lower unemployment subsidy for baseline-optimistic agents, but the static wedge between employment and unemployment consumption is still smaller since the baseline-optimistic agent uses more of her assets to increase her unemployment consumption. I also calculate the optimal policy when the social planner can directly control savings and thus effectively determine the (linear) rate at which consumption decreases with the length of unemployment as in Proposition 3. Surprisingly, this rate is hardly different, even for optimistic baseline beliefs, which indicates that the static unemployment subsidy adjusts to induce a similar dynamic wedge.[24]

Welfare. Figure C.4 compares the welfare impact of the above policies by showing compensating variations that make an unemployed job seeker without the policy as well of as with the policy. The compensating variation is expressed as the present value of a constant consumption flow, which is between one and two months worth of output in this numerical exercise. Providing access to savings (i.e., switching from a static to a dynamic unemployment policy) substantially increases the value of the unemployment policy as this allows to spread the unemployment risk over all future periods. The value-added hardly depends on whether the access to savings can be controlled or not. The adjustment of the unemployment subsidy to induce the unemployed to deplete their savings at a desirable rate thus comes at a small cost, even when they are optimistic about the duration of their unemployment spell. As a consequence, the value of the optimal policy is fairly constant for different baseline beliefs. Note that the dynamic model allows biased beliefs to distort the agent's behavior only during the unemployment spell. In a more general model, baseline beliefs would also affect the agent's willingness to protect against unemployment through precautionary savings (or other self-insurance). The welfare of the policy provided in a competitive equilibrium illustrates the potential magnitude of these effects within this dynamic model. Private insurers cater to the low value baseline-optimistic workers attach to unemployment protection by

[24] As discussed before, a baseline-optimistic agent may choose a higher depletion rate for a given unemployment subsidy than is socially optimal. In this case of unobservable savings, the simulation finds a lower subsidy, but a similar depletion rate. This indicates the importance of the positive incentive effect of faster depletion during the unemployment spell, which the agent does not account for.

reducing the unemployment subsidy. Figure C.4 shows that the welfare of this policy is in fact strongly decreasing in the baseline-optimistic bias and reaches zero for a bias of 200%.

6 Conclusion

This paper argues that perceptions of employment prospects should be at the heart of the design of unemployment policies. New evidence reveals a striking optimistic bias suggesting that workers underestimate the unemployment risk and the risk of long unemployment spells in particular. Optimistic workers invest too little to protect themselves against the loss of earnings. Optimistic job seekers do too little to leave unemployment and will be unprepared for long unemployment spells. A natural way to reduce the negative impact of optimistic beliefs is to provide better information. Information policies have been successful in other areas (e.g. health risks), but may be challenging in the context of unemployment. As long as the bias persists, the analysis in this paper shows that the use of future incentives (e.g., time limits on unemployment benefits) is particularly ineffective in encouraging displaced workers to search harder or accept job offers earlier on. Moreover, empirical estimates of standard behavioral responses like the policy elasticity of unemployment become an inaccurate guide for policy design since they get a different interpretation when affected by biased beliefs. This insight naturally extends to the design of other government policies based on so-called "sufficient statistics". More generally, policy makers should be cautious when relying on individuals' actions to avoid risks or to protect themselves against their consequences. The strong optimistic bias suggests that the use of private savings accounts or the reliance on the private provision of insurance would be problematic. Competition would discipline private insurers to charge actuarially fair prices, but not to correct the agents' distorted choices. In fact, the low perceived value of unemployment protection may help explain the puzzle why unemployment insurance is publicly provided in almost all countries (Acemoglu and Shimer 2000).

The analysis highlights the importance of the control beliefs next to the beliefs about the baseline risk. The empirical evidence on control beliefs is lagging and credible identification seems particularly challenging. The experimental evidence on the *illusion of control* (see Langer 1975) would suggest that job seekers are optimistic about the returns to their search efforts, but the many unemployed who are not currently looking for employment because they are *discouraged* over job prospects may well be underestimating these returns. For the job seekers in the study by Price et al. (1998), I find that those who report to search more frequently expect shorter unemployment spells, but the reduction in the experienced unemployment spells is even larger. This result could indicate that job seekers are control-pessimistic next to being baseline-optimistic. Both biases slow down the exit out of unemployment and contribute to its persistence. Further research should shed more light on this and investigate the role of job seekers' perceptions for other unemployment features. For example, the high incidence of long-term unemployment, in particular during the Great Recession (Kroft et al., 2013), could be the result of beliefs adjusting slowly to deteriorating employment prospects during the unemployment spell and during recessions.

Appendix A: Proofs

Proof of Proposition 1

The social planner solves

$$\max_b u(w-\tilde{\tau}(b)-\tilde{s}(b))+ \beta\left[\pi(\tilde{e}(b))\,u(w-\tilde{\tau}(b)+(1+r)\,\tilde{s}(b))+(1-\pi(\tilde{e}(b)))\,u(b+(1+r)\,\tilde{s}(b))-\tilde{e}(b)\right],$$

where $\tilde{\tau}(b)$, $\tilde{s}(b)$ and $\tilde{e}(b)$ are implicitly defined by the incentive compatibility constraints IC_e, IC_s and the budget constraint BC. The implicit functions are assumed to be well-behaved such that the optimal benefit level is characterized by the first-order condition

$$\frac{dU}{db}=0\Leftrightarrow\frac{\partial U}{\partial b}+\frac{\partial U}{\partial\tau}\tilde{\tau}'(b)+\frac{\partial U}{\partial e}\tilde{e}'(b)+\frac{\partial U}{\partial s}\tilde{s}'(b)=0,\text{ with}$$

$$\begin{aligned}
\frac{\partial U}{\partial b} &= \beta\,(1-\pi(\tilde{e}))\,u'(c_u),\ \frac{\partial U}{\partial\tau}=-u'(c_0)-\beta\pi(\tilde{e})\,u'(c_e)\equiv-(1+\beta\pi(\tilde{e}))\,\bar{u}'(c_e),\\
\tilde{\tau}'(b) &= \frac{\frac{1}{1+r}(1-\pi(\tilde{e}))}{1+\frac{1}{1+r}\pi(\tilde{e})}\left[1+\varepsilon_{1-\pi(\tilde{e}),b}\right],\ \frac{\partial U}{\partial e}=-\beta\left[\hat{\pi}'(\tilde{e})-\pi'(\tilde{e})\right][u(c_e)-u(c_u)]\text{ and}\\
\frac{\partial U}{\partial s} &= \beta\,(1+r)\,[\hat{\pi}(\tilde{e})-\pi(\tilde{e})]\left[u'(c_u)-u'(c_e)\right],
\end{aligned}$$

where the last two expressions use IC_e and IC_s respectively. For $\varepsilon_{1-\pi(\tilde{e}),b}=-\pi'(\tilde{e})\,b\tilde{e}'(b)\,/\,[1-\pi(\tilde{e})]$ and $\beta(1+r)=1$, we find

$$\begin{aligned}
\frac{dU}{db}/\beta\,(1-\pi(\tilde{e}))=u'(c_u)-\bar{u}'(c_e)\left[1+\varepsilon_{1-\pi(\tilde{e}),b}\right]&+\frac{\hat{\pi}'(\tilde{e})-\pi'(\tilde{e})}{\pi'(\tilde{e})}\frac{u(c_e)-u(c_u)}{b}\varepsilon_{1-\pi(\tilde{e}),b}\\
&+\frac{\hat{\pi}(\tilde{e})-\pi(\tilde{e})}{\beta\,(1-\pi(\tilde{e}))}\left[u'(c_u)-u'(c_e)\right]\tilde{s}'(b)=0\Leftrightarrow
\end{aligned}$$

$$\begin{aligned}
\frac{u'(c_u)-\bar{u}'(c_e)}{\bar{u}'(c_e)}&\left[1-\frac{\hat{\pi}(\tilde{e})-\pi(\tilde{e})}{1-\pi(\tilde{e})}\frac{1}{\beta}\frac{u'(c_u)-u'(c_e)}{u'(c_u)-\bar{u}'(c_e)}\left(-\tilde{s}'(b)\right)\right]\\
&=\varepsilon_{1-\pi(\tilde{e}),b}\left[1-\frac{\hat{\pi}'(\tilde{e})-\pi'(\tilde{e})}{\pi'(\tilde{e})}\frac{u(c_e)-u(c_u)}{b\bar{u}'(c_e)}\right].
\end{aligned}$$

The adjusted Baily formula (6) for the social optimum directly follows from this expression.□

Proof of Lemma 1

Denote the perceived expected utility of unemployed agent with assets a for an unemployment policy z by $\hat{U}(z|a)$. The assets are used by an agent with CARA preferences to increase consumption in all states by the same amount $\frac{r}{1+r}a$. For CARA utility, we have $u(x+y)=u(x)\exp(\sigma y)$ and $u'(x+y)=u'(x)\exp(\sigma y)$. The marginal utilities determining the agent's optimal consumption allocation and effort choice are thus all rescaled by the same amount $\exp\left(\sigma r/\left(1+r\right)a\right)$.

Facing a constant policy $z = (b, \tau)$, an employed agent with assets a and CARA preferences consumes her after-tax wage plus the interest on her asset level, $c_e(a) = r/(1+r)a + w - \tau$. I denote her consumption level when unemployed by $c_u(a) = r/(1+r)a + b + x$. When consuming x more than her current income, her asset level decreases to $a - (1+r)x$ by the next period. This decreases all her future consumption levels by rx. Her perceived expected utility when unemployed can be written recursively with her assets a as the single state variable,

$$\hat{U}(b,\tau|a) = \max_{e,x} u\left(c_u(a) - e\right) + \beta\hat{\pi}(e)\frac{u\left(c_e(a) - rx\right)}{1-\beta} + \beta\left(1-\hat{\pi}(e)\right)\hat{U}\left(b,\tau|a-(1+r)x\right).$$

Using the property of CARA preferences, this can be rewritten as $\hat{U}(b,\tau|a) = \exp\left(\sigma r/(1+r)a\right)\hat{U}(b,\tau|0)$. Hence, the agent's problem is stationary and she chooses the same effort $\hat{e}$ and increase in consumption $\hat{x}$ throughout the unemployment spell. From the recursive formulation, it then follows that

$$\hat{U}(b,\tau|0) = \frac{u\left(b+\hat{x}-\hat{e}\right) + \beta\hat{\pi}(\hat{e})\frac{u(w-\tau-r\hat{x})}{1-\beta}}{1-\hat{\beta}(\hat{e},\hat{x})},$$

with $\hat{\beta}(e,x) = \beta\left(1-\hat{\pi}(e)\right)\exp(\sigma r x)$.□

Proof of Proposition 2

The social planner maximizes the agent's true expected utility given the implicit functions $\tilde{\tau}(b), \tilde{e}(b)$ and $\tilde{x}(b)$ defined by IC_e', IC_x and the budget constraint $\tau = rb/\pi(e)$. That is

$$\max_b \frac{u\left(\frac{r}{1+r}a + b + \tilde{x}(b) - \tilde{e}(b)\right) + \frac{\beta}{1-\beta}\pi\left(\tilde{e}(b)\right)u\left(\frac{r}{1+r}a + \left(w - \tilde{\tau}(b)\right) - r\tilde{x}(b)\right)}{1-\beta\left(\tilde{e}(b),\tilde{x}(b)\right)}.$$

with $\beta(e,x) = \beta\left(1-\pi(e)\right)\exp(\sigma r x)$. The first-order condition equals

$$\frac{\partial U}{\partial b} + \frac{\partial U}{\partial \tau}\tilde{\tau}'(b) + \frac{\partial U}{\partial e}\tilde{e}'(b) + \frac{\partial U}{\partial x}\tilde{x}'(b) = 0, \text{ with}$$

$$\frac{\partial U}{\partial b} + \frac{\partial U}{\partial \tau}\tilde{\tau}'(b) = \left[u'(c_u - \tilde{e}) - u'(c_e - r\tilde{x})\left(1+\varepsilon_{1/\pi(\tilde{e}),b}\right)\right]/\left[1-\beta(\tilde{e},\tilde{x})\right], \text{ since}$$

$$\begin{aligned}\frac{\partial U}{\partial b} &= u'(c_u - \tilde{e})/\left[1-\beta(\tilde{e},\tilde{x})\right], \ \frac{\partial U}{\partial \tau} = -\frac{\beta}{1-\beta}\pi(\tilde{e})\,u'(c_e - r\tilde{x})/\left[1-\beta(\tilde{e},\tilde{x})\right] \text{ and} \\ \tilde{\tau}'(b) &= \frac{r}{\pi(\tilde{e})}\left[1+\varepsilon_{1/\pi(\tilde{e}),b}\right], \text{ and with,}\end{aligned}$$

$$\frac{\partial U}{\partial e} = -\left\{1 - \frac{\pi'(\tilde{e})}{\hat{\pi}'(\tilde{e})}\frac{1-\hat{\beta}(\tilde{e},\tilde{x})}{1-\beta(\tilde{e},\tilde{x})}\right\}\frac{u'(c_u - e)}{1-\beta(\tilde{e},\tilde{x})}, \tag{12}$$

$$\frac{\partial U}{\partial x} = -\left[\hat{\pi}(\tilde{e}) - \pi(\tilde{e})\right]\frac{\exp(\sigma r x)\left[u'(c_u - \tilde{e}) - u'(c_e)\right]}{\left[1-\beta(\tilde{e},\tilde{x})\right]^2}, \tag{13}$$

using IC_e' and IC_x for the last two expressions. Using the above expressions in the FOC with $\varepsilon_{1/\pi(\tilde{e}),b} = \pi'(\tilde{e})\, b\tilde{e}'(b)/\pi(\tilde{e})$ and $[u'(c_u - \tilde{e}) - u'(c_e)] / [u'(c_u - \tilde{e}) - u'(c_e - r\tilde{x})] = [\exp(\sigma r x)(1 - \hat{\pi}(\tilde{e}))]^{-1}$ from IC_x, I find

$$\frac{dU}{db} = 0 \Leftrightarrow \frac{u'(c_u - \tilde{e}) - u'(c_e - r\tilde{x})}{u'(c_e - r\tilde{x})} \left[1 + \frac{\hat{\pi}(\tilde{e}) - \pi(\tilde{e})}{1 - \hat{\pi}(\tilde{e})} \frac{(-\tilde{x}'(b))}{1 - \beta(\tilde{e}, \tilde{x})}\right]$$
$$= \varepsilon_{1/\pi(\tilde{e}),b} \left[1 - \left\{1 - \frac{\pi'(\tilde{e})}{\hat{\pi}'(\tilde{e})} \frac{1 - \hat{\beta}(\tilde{e}, \tilde{x})}{1 - \beta(\tilde{e}, \tilde{x})}\right\} \frac{u'(c_u - \tilde{e})}{u'(c_e) b} \frac{\pi(\tilde{e})}{\pi'(\tilde{e})}\right].$$

The adjusted Baily formula for the constant policy immediately follows. Note that for

$$Q(b) = \left(\frac{-\hat{\pi}''(\tilde{e})}{r\sigma\hat{\pi}'(\tilde{e})} - 1\right)\left(r + \frac{u'(c_e)}{u'(c_u - \tilde{e})}\hat{\pi}(\tilde{e})\exp(\sigma r x)\right)\frac{u'(c_u - \tilde{e}) - u'(c_e)}{u'(c_e)} - \exp(\sigma r \tilde{x})\,\tilde{\tau}\frac{\pi'(\tilde{e})}{\pi(\tilde{e})},$$

total differentiation of the agent's FOC's (IC_e' and IC_x) yields

$$\tilde{e}'(b) = -\frac{\exp(\sigma r \tilde{x})}{Q(b)} \text{ and } \tilde{x}'(b) = -\frac{(\exp(\sigma r \tilde{x}) - 1)\left(\frac{-\hat{\pi}''(\tilde{e})}{r\sigma\hat{\pi}'(\tilde{e})} - 1\right) + \exp(\sigma r \tilde{x})}{Q(b)}.$$

Hence, since $\tilde{e}'(b) < 0$ for the optimal benefit level, $Q(b) > 0$. This implies that $-\hat{\pi}''(\tilde{e}) / \left[r\sigma\hat{\pi}'(\tilde{e})\right] - 1 > 0$ from the above expression for $Q(b)$. Hence, $\tilde{x}'(b) < 0$.□

Proof of Proposition 3

When the social planner can set x at zero cost, he maximizes the agent's true expected utility with respect to (b, τ, x) such that IC_e' and the budget constraint $\tau = rb/\pi(e)$ are satisfied. At the optimum, a budget-balanced increase in x cannot increase the agent's welfare. Consider the case where b is adjusted to keep the budget balanced. That is, IC_e' and the budget constraint implicitly define $\check{e}(x)$ and $\check{b}(x)$ when keeping τ fixed. Hence,

$$\frac{dU}{dx} = 0 \Leftrightarrow \frac{\partial U}{\partial x} + \frac{\partial U}{\partial b}\check{b}'(x) + \frac{\partial U}{\partial e}\check{e}'(x) = 0, \text{ with}$$

$$\frac{\partial U}{\partial x} = \frac{\pi(\check{e})\exp(\sigma r x)\, u'(c_u - \check{e})}{[1 - \beta(\check{e}, x)]^2}\left[\frac{u'(c_u - \check{e}) - u'(c_e)}{u'(c_u - \check{e})} - \frac{1}{\pi(\check{e})}\left(1 - \frac{1}{\exp(\sigma r x)}\right)\right],$$
$$\frac{\partial U}{\partial b} = \frac{u'(c_u - \check{e})}{1 - \beta(\check{e}, x)} \text{ and } \frac{\partial U}{\partial e} = -\left\{1 - \frac{\pi'(\check{e})}{\hat{\pi}'(\check{e})}\frac{1 - \hat{\beta}(\check{e}, x)}{1 - \beta(\check{e}, x)}\right\}\frac{u'(c_u - \check{e})}{1 - \beta(\check{e}, x)}.$$

From total differentiation of the incentive compatibility and budget constraint defining the implicit functions, I find

$$\check{b}'(x) = \frac{\pi'(\check{e})}{\pi(\check{e})} b\check{e}'(x) \text{ and } \check{e}'(x) = \frac{r + \frac{u'(c_e - rx)}{u'(c_u - \check{e})}\frac{\hat{\pi}'(\check{e})}{\sigma r}(\exp(\sigma r x) - 1)}{\left(\frac{-\hat{\pi}''(\check{e})}{\sigma\hat{\pi}'(\check{e})} + 1\right)\left(1 - \hat{\beta}(e, x)\right)},$$

implying $\check{e}'(x) > 0$ and $\check{b}'(x) > 0$. Using the expression for $\check{b}'(x)$ and $\varepsilon_{1/\pi(\check{e}),x} = \pi'(\check{e})\, x\check{e}'(x)/\pi(\check{e})$,

$$\begin{aligned}\frac{dU}{dx} &= 0 \Leftrightarrow \left[\frac{u'(c_u - \check{e}) - u'(c_e)}{u'(c_u - \check{e})} - \frac{1}{\pi(\check{e})}\left(1 - \frac{1}{\exp(\sigma r x)}\right)\right] \\ &+ \left[b - \left\{1 - \frac{\pi'(\check{e})}{\hat{\pi}'(\check{e})}\frac{1-\hat{\beta}(\check{e},x)}{1-\beta(\check{e},x)}\right\}\frac{\pi(\check{e})}{\pi'(\check{e})}\right]\frac{1-\beta(\check{e},x)}{\pi(\check{e})\, x\exp(\sigma r x)}\varepsilon_{1/\pi(\check{e}),x} = 0.\end{aligned}$$

The characterization of the optimal dynamic policy immediately follows.□

Proof of Proposition 4

I use subindex 0 to denote the variables values in the first period of the unemployment spell and subindex 1 to denote the variable values in all subsequent periods. The agent's perceived expected utility can be written recursively as

$$\begin{aligned}\hat{U}(b,\tau) = \max_{x_0,e_0} u&\left(\frac{r}{1+r}a + b_0 + x_0 - e_0\right) \\ &+ \beta\hat{\pi}(e_0)\left[\frac{u\left(\frac{r}{1+r}a + w - \tau_0 - r x_0\right)}{1-\beta} + (1-\hat{\pi}(e_0))\exp(\sigma r x_0)\,\hat{U}(b_1,\tau_1)\right]\end{aligned}$$

The lower the agent perceives her expected utility when still unemployed in the next period $\hat{U}(b_1,\tau_1)$, the lower her effort e_0 and the higher her depletion x_0 in the first period of unemployment, i.e., $\partial e_0/\partial\hat{U}_1 < 0, \partial x_0/\partial\hat{U}_1 > 0$. With CARA preferences, her behavior in the first period does not affect her future behavior.

Now start from the optimal constant policy (b,τ) and consider a budget-balanced increase in b and τ like in Proposition 2, but only implemented after the first period of unemployment. The impact on the agent's true expected utility equals

$$\frac{dU}{db_1} = \underbrace{\left[\left[\frac{\partial U}{\partial e_0} + \frac{\partial U}{\partial P}\frac{\partial P}{\partial e_0}\right]\frac{\partial e_0}{\partial\hat{U}_1} + \frac{\partial U}{\partial x_0}\frac{\partial x_0}{\partial\hat{U}_1}\right]\frac{d\hat{U}_1}{db_1}}_{\equiv A} + \beta(1-\pi(e_0))\frac{dU_1}{db_1}, \tag{14}$$

where U_1 and $\hat{U}_1$ denote the true and perceived unemployment continuation values after the first period of unemployment. Starting from the optimal contract, the budget-balanced increase in b_1 after the first period of unemployment has only a second-order impact on the true continuation value by Proposition 2, i.e., $dU_1/db_1 = 0$. Hence, the second of the two terms in (14) equals zero. The agent's change in behavior at the start of the spell, however, affects both her true expected utility U and the social planner's budget P. If the agent is baseline-optimistic, increasing e and decreasing x in every period would increase her true expected utility by (12) and (13) respectively and therefore also when changing behavior only in the first period, so that $\partial U/\partial e_0 > 0, \partial U/\partial x_0 < 0$. The increase in e_0 also improves the planner's budget, which can be used to increase the agent's welfare. Hence, the term A, the first of the two terms in (14), is positive if $d\hat{U}_1/db_1 < 0$. I now show that $d\hat{U}_1/db_1 < 0$ if $dU_1/db_1 = 0$ for a baseline optimistic agent if in an optimal policy with constant benefits

$$1 + \tfrac{\hat{\pi}(\tilde{e})-\pi(\tilde{e})}{1-\hat{\beta}(\tilde{e},\tilde{x})} \tfrac{u'(c_u-\tilde{e})-u'(c_e)}{u'(c_u-\tilde{e})} \left(\tfrac{-\hat{\pi}''(\tilde{e})}{r\sigma\hat{\pi}'(\tilde{e})} \left(\exp\left(\sigma r \tilde{x}\right) - 1\right) + 1 \right) \geq \tfrac{1-\hat{\beta}(\tilde{e},\tilde{x})}{1-\beta(\tilde{e},\tilde{x})} \tfrac{\pi'(\tilde{e})}{\hat{\pi}'(\tilde{e})}. \tag{15}$$

That is, at the optimal policy,

$$\frac{dU_1}{db_1} = \underbrace{\frac{\partial U_1}{\partial b_1} + \frac{\partial U_1}{\partial \tau_1}\tilde{\tau}_1'\left(b_1\right)}_{\equiv B} + \underbrace{\frac{\partial U_1}{\partial e_1}\tilde{e}_1'\left(b_1\right) + \frac{\partial U_1}{\partial x_1}\tilde{x}_1'\left(b_1\right)}_{\equiv C} = 0, \text{ with}$$

$$B = \frac{u'(c_u - \tilde{e}) - u'(c_e - r\tilde{x})\left[1 + \varepsilon_{1/\pi(\tilde{e}),b}\right]}{1 - \beta\left(\tilde{e}, \tilde{x}\right)},$$

$$C = \frac{u'(c_u - \tilde{e})}{1 - \beta\left(\tilde{e}, \tilde{x}\right)} \frac{\exp\left(\sigma r \tilde{x}\right)}{Q\left(b\right)} \left(\begin{array}{c} \left(1 - \frac{1-\hat{\beta}(\tilde{e},\tilde{x})}{1-\beta(\tilde{e},\tilde{x})} \frac{\pi'(\tilde{e})}{\hat{\pi}'(\tilde{e})}\right) + \\ \frac{\hat{\pi}(\tilde{e})-\pi(\tilde{e})}{1-\hat{\beta}(\tilde{e},\tilde{x})} \frac{u'(c_u-\tilde{e})-u'(c_e)}{u'(c_u-\tilde{e})} \exp\left(\sigma r \tilde{x}\right) \left(\frac{\exp(\sigma r \tilde{x})-1}{\exp(\sigma r \tilde{x})} \left(\frac{-\hat{\pi}''(\tilde{e})}{r\sigma\hat{\pi}'(\tilde{e})} - 1 \right) + 1 \right) \end{array} \right).$$

Evaluated at the same policy,

$$\frac{d\hat{U}_1}{db_1} = \frac{\partial \hat{U}_1}{\partial b_1} + \frac{\partial \hat{U}_1}{\partial \tau_1}\tilde{\tau}_1'\left(b_1\right) = B - \frac{\hat{\pi}\left(\tilde{e}\right) - \pi\left(\tilde{e}\right)}{\pi\left(\tilde{e}\right)} \frac{u'(c_e - r\tilde{x})\left[1 + \varepsilon_{1/\pi(\tilde{e}),b}\right]}{1 - \hat{\beta}\left(\tilde{e}, \tilde{x}\right)}$$

Since $B + C = 0$, $B < 0$ if $C > 0$. For a baseline-optimistic agent, $B < 0$ implies $d\hat{U}_1/db_1 < 0$ and thus $dU_1/db_1 = A d\hat{U}_1/db_1 < 0$. Now I establish when $C > 0$. As argued in the proof of Proposition 2, $\tilde{e}'\left(b\right) < 0$ implies $Q\left(b\right) > 0$ and $-\hat{\pi}''\left(\tilde{e}\right) / \left[r\sigma\hat{\pi}'\left(\tilde{e}\right)\right] - 1 > 0$. Hence, $C > 0$ if condition (15) is satisfied. Since the second term in the left-hand side of (15) is positive, there exists a positive upper bound ζ such that $(1 - \hat{\beta}\left(\tilde{e}, \tilde{x}\right))\pi'\left(\tilde{e}\right) / \left[(1 - \beta\left(\tilde{e}, \tilde{x}\right))\hat{\pi}'\left(\tilde{e}\right)\right] \leq 1 + \zeta$ is sufficient for the condition to be satisfied. Hence, it is sufficient for the search internality to be small relative to the baseline bias.$\square$

Appendix B: Empirical Analysis and Calibration

Price et al. (1998) organized a survey to study the prevention of 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 B.1, 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.

B.1 Baseline Beliefs: Actual and Expected Duration

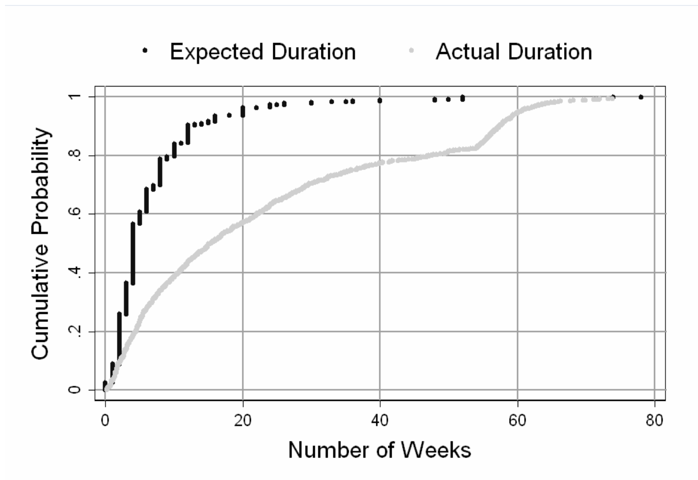

Figure B.1: Empirical cumulative distribution: actual duration vs. expected duration of remaining unemployment spell

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. In follow-up interviews, subjects are asked when they actually started working. 86% of the subjects found work for more than 20 hours a week before the last interview, about one year after the first interview. I compute the *minimum duration* of an unemployment spell, assuming that the other 14% 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.[25] The distribution of the differences between the actual and expected number of weeks of unemployment is shown in Figure 1 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 B.1, comparing the empirical distributions of the expected and actual unemployment durations. The cumulative distribution of the expected

[25] 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 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.

duration stochastically dominates the cumulative distribution of the minimum duration.[26] 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.

In the web-appendix to this paper I discuss how selection effects and alternative interpretations of the survey question are unlikely to explain this extreme optimistic bias. I also provide preliminary evidence suggesting that the bias survives during the unemployment spell.

B.2 Control Beliefs: Relation between Effort and Duration

Subjects are also 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.[27,28] The regressions of interest are

$$\begin{aligned} \textit{actual duration}_i &= \beta_1 \ \textit{search}_i + X_i\gamma_1 + \varepsilon_i, && \text{(16a)} \\ \textit{expected duration}_i &= \beta_2 \ \textit{search}_i + X_i\gamma_2 + \nu_i, && \text{(16b)} \\ \textit{act. duration}_i \text{ - } \textit{exp. duration}_i &= (\beta_1 - \beta_2) \ \textit{search}_i + X_i(\gamma_1 - \gamma_2) + \varepsilon_i - v_i && \text{(16c)} \end{aligned}$$

with the durations starting from the first interview.

Table B.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. Higher search levels correspond to lower optimism about the duration of unemployment. While the coefficients of search are significant at the 1% level in regressions (16a) and (16b), the estimate of the difference in regression (16c) is only significant at the 10% level (p -value = .08). If both effects were causal, the estimated average control bias would be -67%. This is much less pronounced and significant than the baseline bias. Unobserved heterogeneity

[26] 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.

[27] 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.

[28] 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.

affecting both the bias in beliefs and the search efforts or the reverse impact of beliefs on search effort would bias the estimate of the control bias. The estimates are similar when using candidate instrumental variables, including alternative measures of search, controlling for the willingness to work or accounting for censoring and truncation issues, as discussed in an earlier version of this paper (see Spinnewijn 2008).

B.3 Calibration of the Dynamic Model of the Unemployment Spell

The unit of time for the calibration 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. Given this rescaling, the CARA coefficient is set equal to $\sigma = 2$.

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 as discussed in the previous section. 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 these three values of search effort, the probability function $\pi(e) = \pi_0 + \pi_1 \times e^{0.662}$ with $\pi_0 = 0.140$ and $\pi_1 = 0.170$ approximates the average duration of unemployment, estimated using ordinary least squares (Table B.2). I assume that the perceived monthly probability of finding work as a function of effort equals $\hat{\pi}(e) = \hat{\pi}_0 + \hat{\pi}_1 \times e^{0.662}$ and show how the optimal policy changes for different values of $\hat{\pi}_0$ and $\hat{\pi}_1$ respectively.

Monetary Cost of Effort. I finally calibrate the monetary cost of search function $\psi_u(e) = \psi_0 e^{\psi_1}$,assuming that the monetary cost of effort when employed equals the monetary cost of searching daily in every dimension $\psi_e = \psi(1) = \psi_0$. I set $\psi_0 = 0.483$ and $\psi_1 = 2.65$ in order to match the empirical exit rate and unemployment duration 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 calibrated model predicts an average monthly probability of finding work equal to 0.19. This equals the average monthly exit rate in the sample. Moreover, the predicted 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). For the calibration of the cost function, I set the belief parameters equal to $\hat{\pi}_0 = 0.361$ and $\hat{\pi}_1 = 0.056$, which implies an optimistic relative baseline bias $[\hat{\pi}(e) - \pi(e)]/\pi(e)$ equal to 100% (at the average effort level $e = 0.15$), which is more modest than the average baseline bias in the sample of about 200%, and a pessimistic relative control bias $\left[\hat{\pi}'(e) - \pi'(e)\right]/\pi'(e)$ equal to -67%, which corresponds to the relative ratio of the least squares estimates of the actual and perceived impact of search (Table B.2).

Table B.1

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 B.2

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% level, ** at the 1% level.

Appendix C: Calibration Figures

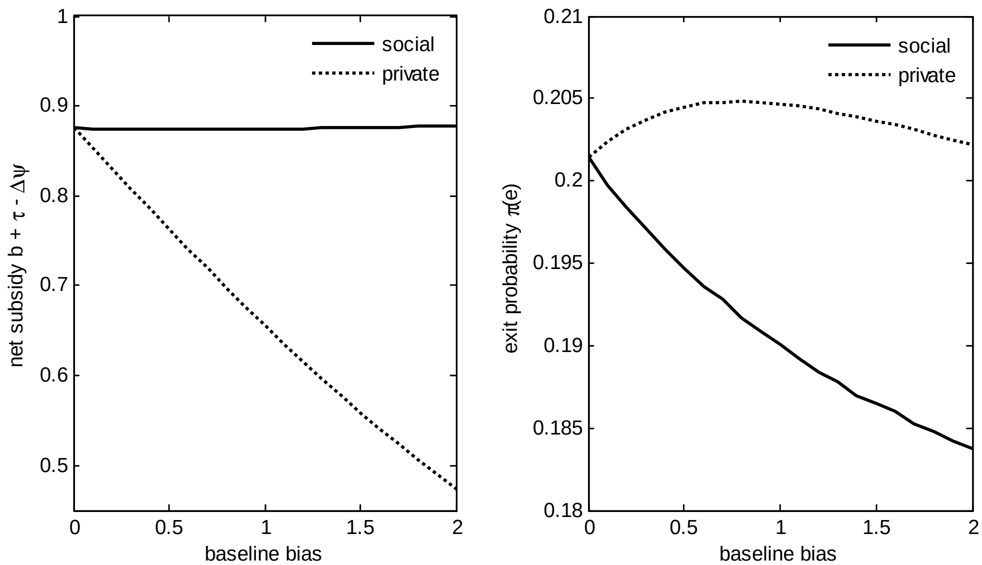

Figure C.1: Optimal Constant Policy without Savings for Biased Baseline Beliefs

The left panel shows the unemployment subsidy net of the cost differential $b + \tau - \Delta\psi$ for different values of the baseline bias when changing $\hat{\pi}_0$. The right panel shows the monthly job finding probability $\pi(e)$. The values for the competitive equilibrium with private insurers are given by the dashed lines for comparison.

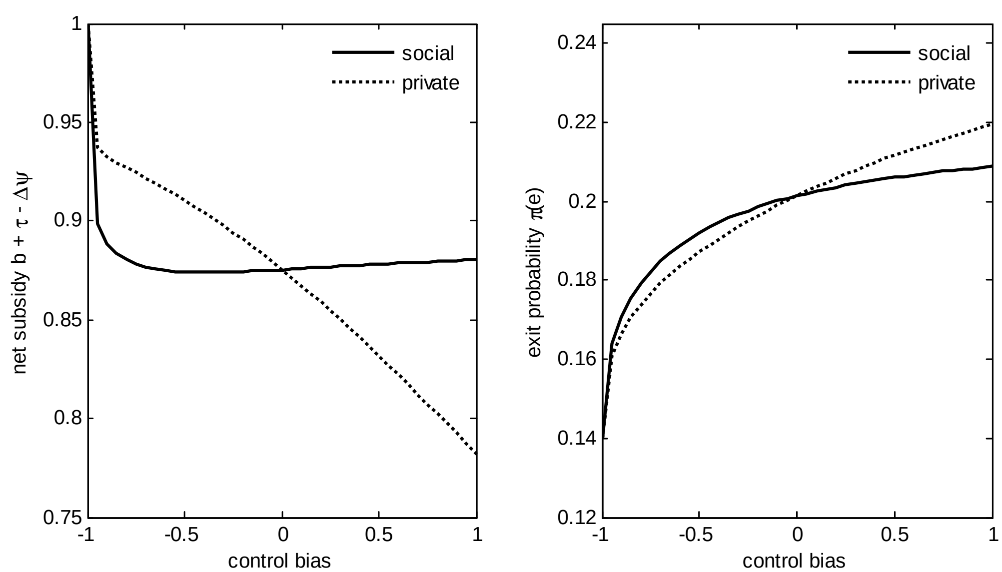

Figure C.2: Optimal Constant Policy without Savings for Biased Control Beliefs

The left panel shows the unemployment subsidy net of the cost differential $b + \tau - \Delta\psi$ for different values of the control bias when changing $\hat{\pi}_1$. The right panel shows the monthly job finding probability $\pi(e)$. The values for the competitive equilibrium with private insurers are given by the dashed lines for comparison.

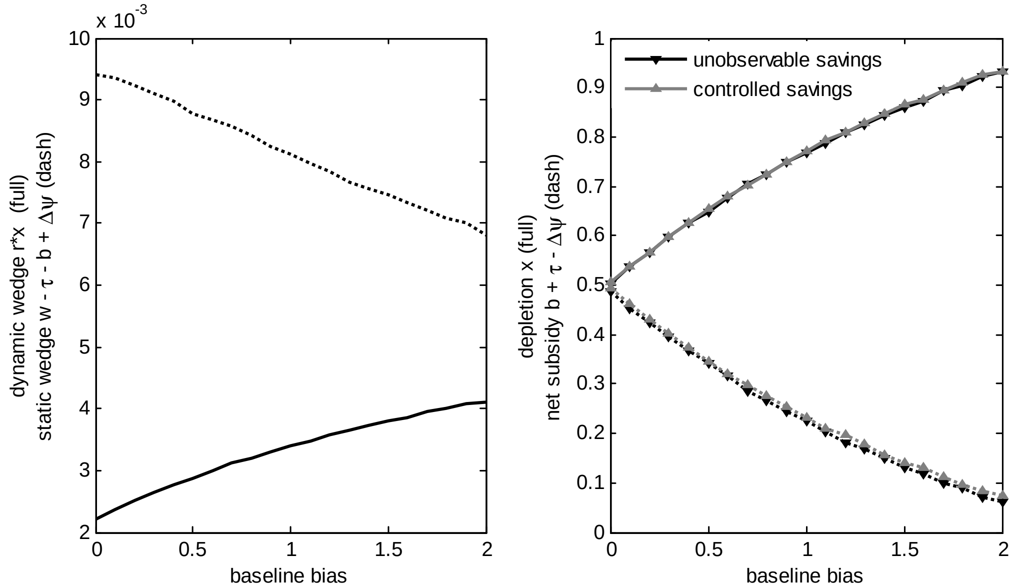

Figure C.3: Optimal Constant Policy with Savings for Biased Baseline Beliefs
The left panel shows the dynamic wedge rx (full line) and the static wedge $w - \tau - b + \Delta\psi$ (dashed line) implied by the optimal constant policy for different values of the baseline bias when changing $\hat{\pi}_0$. The right panel shows the underlying unemployment subsidy $\tau - b + \Delta\psi$ (dashed line) and depletion level x (full line). In the right panel, values are also shown for the optimal policy with controlled savings for comparison.

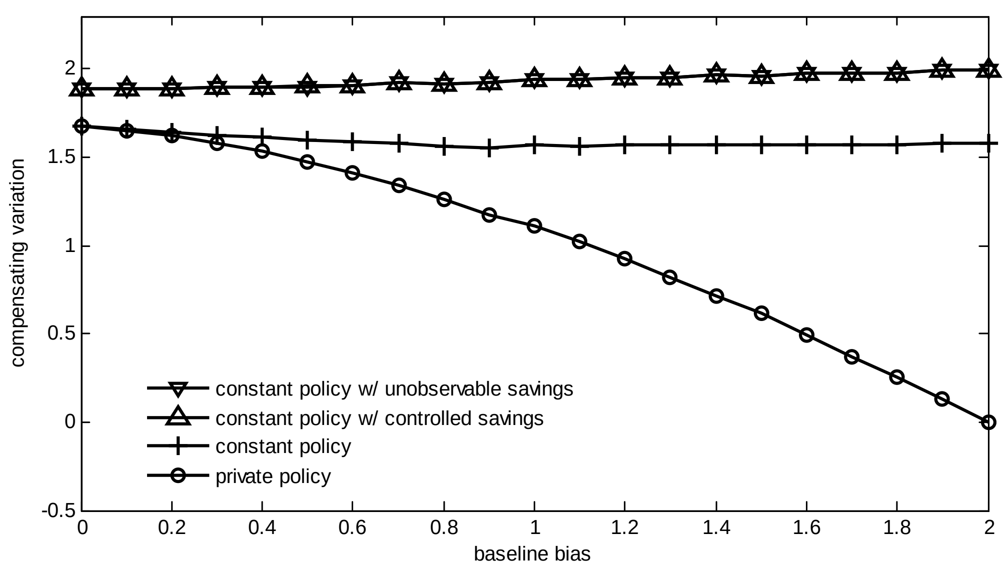

Figure C.4: Welfare Comparison of Unemployment Policies for Biased Baseline Beliefs
The figure shows the compensating variation that make an unemployed job seeker without the policy as well of as with the policy for four unemployment policies. The compensating variation is expressed as the present value of a constant consumption flow. The four policies are the optimal unemployment policy without access to savings, with unobservable savings, with controlled savings and the policy provided by private insurers in a competitive equilibrium.

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7 Web Appendix to "Unemployed but Optimistic: Optimal Insurance Design with Biased Beliefs"

This web appendix provides two pieces of complementary analysis. First, I discuss the robustness of the optimistic bias presented in the introduction and appendix of the paper. Second, I characterize the competitive equilibrium with profit-maximizing insurers discussed in Section 3.3.

7.1 Optimistic Bias

In this section I discuss how selection effects and alternative interpretations of the survey question are unlikely to explain the bias in expectations. I also provide preliminary evidence suggesting that the optimistic bias survives during the unemployment spell.

Selection Effects Selection effects seem to play a minor role in explaining the optimistic bias for the sample considered in Price et al. (1998). 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.[29] 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.[30] 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 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). Fifth, 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

[29] 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.

[30] 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.

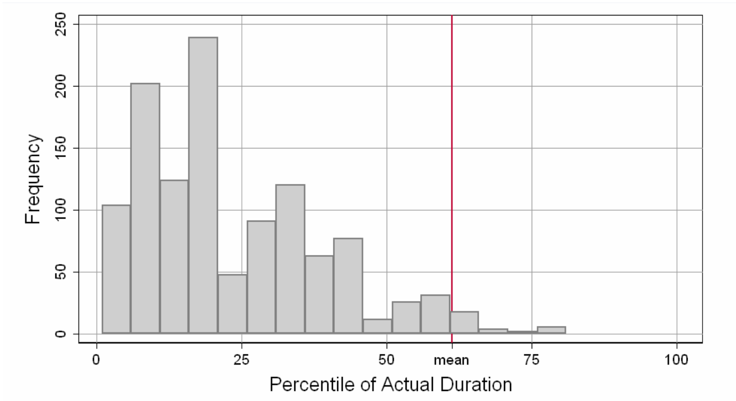

Figure 2: Histogram of the reported expectations with bins labeled by the percentiles of the actual duration

the US in 1996 (Valletta 1998). This is still twice as long as the average expectation in the sample. Finally, the US economy was expanding during the period that the survey was organized, which may affect the baseline bias. When a crisis hits, the average unemployment duration increases. 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. However, Mueller and Spinnewijn (in progress) find an optimistic baseline bias that is as extreme in magnitude based on a survey of job seekers in New Jersey, conducted during the Great Recession.

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.[31] 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.[32] The Figure suggests that it is unlikely that these alternative interpretations of the question play an important role in explaining the optimistic bias. It 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

[31] The R^2 for the first regression in Table B.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.

[32] 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.

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% 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, although it does not allow quantifying the bias.

Changes in Beliefs In the dynamic model of the unemployment spell in Section 4, 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 B.2 in the appendix to the paper. 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 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. Together these results suggest that if some learning about the bias is going on, it is very modest.[33]

7.2 Competitive Equilibrium with Profit-Maximizing Insurers

The analysis highlights the potential importance of the agent's decision to protect herself against unemployment for the design of social insurance. In the context of unemployment insurance, the role of private insurance is limited in practice. The question whether government interventions are needed depends in the first place on whether the equilibrium coverage provided by private insurers would be socially optimal. This section addresses this question by characterizing the equilibrium contract (b^p, τ^p) offered by competing private insurers in the absence of any public provision, which is a natural benchmark for the optimal policy. A well-known result in public economics is that moral hazard, in contrast with adverse selection, does not raise the need for government

[33] 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.

intervention per se (e.g., Chetty and Saez 2010). Competing private insurers would offer the socially optimal insurance contract. This is no longer true when the agent's beliefs are biased. In order to attract agents, private insurers offer contracts that maximize the agents' perceived rather than true expected utility. Notice that the wedge between private and social insurance is not sufficient to justify government interventions. A policy maker is not necessarily paternalistic, but may care about an agent's perceived welfare as when for example he would try to gain the agent's vote in elections. If a policy maker only cares about the agent's perceived welfare, he would implement the exact same policy as the competing profit-maximizing insurers.[34]

With competition driving profits down to zero, the contract (b^p, τ^p) offered in a competitive equilibrium is characterized by

$$\max_{b,\tau} u(c_0) + \beta \left[\hat{\pi}(e)\, u(c_e) + (1 - \hat{\pi}(e))\, u(c_u) - e\right] \tag{17}$$

subject to IC_e, IC_s and the balanced budget constraint

$$\tau + \frac{1}{1+r}\left[\pi(e)\,\tau - (1 - \pi(e))\, b\right] = 0. \tag{BC}$$

The single difference with the social planner's problem is that the uncertain outcomes of the agent's search effort are weighted with the perceived probabilities $\hat{\pi}(e)$ and $1 - \hat{\pi}(e)$ to calculate the perceived expected utility. In equilibrium, a budget-balanced increase in the benefit level b^p and tax level τ^p has no first-order impact on the agent's perceived expected utility,

$$\frac{d\hat{U}}{db} = 0 \;\Leftrightarrow\; \frac{\partial \hat{U}}{\partial b} + \frac{\partial \hat{U}}{\partial \tau}\tilde{\tau}'(b^p) = 0. \tag{18}$$

The equilibrium condition (18) reveals two differences with the social optimum. First, the rate at which the tax τ^p needs to be increased when increasing the benefit b^p is exactly the same as before and depends on the true probabilities. However, the perceived value of this budget-balanced increase depends on the perceived probabilities. For example, baseline-optimistic agents underestimate the insurance value relative to its cost. This induces private insurers to lower the unemployment benefit relative to the social planner. Second, the behavioral responses to a policy change have only a second-order impact on the agent's perceived expected utility. In contrast with the social planner, private insurers do not try to correct the agent's distorted effort and savings choice. For example, in the case of control-optimistic agents who exert too much effort given the true returns, this would again induce private insurers to reduce the unemployment benefit relative to the social planner. The following Proposition characterizes the competitive equilibrium in absence of social insurance.

[34] See Salanié and Treich (2009) for an analysis comparing policies by a paternalistic and populist policy maker.

Proposition 5 *The equilibrium contract offered by profit-maximizing insurers is characterized by*

$$\frac{\frac{1-\hat{\pi}(\tilde{e})}{1-\pi(\tilde{e})}u'(c_u) - \frac{1+\beta\hat{\pi}(\tilde{e})}{1+\beta\pi(\tilde{e})}\hat{u}'(c_e)}{\frac{1+\beta\hat{\pi}(\tilde{e})}{1+\beta\pi(\tilde{e})}\hat{u}'(c_e)} = \varepsilon_{1-\pi(\tilde{e}),b}, \tag{19}$$

for $\hat{u}'(c_e) \equiv \frac{u'(c_0)+\beta\hat{\pi}(\tilde{e})u'(c_e)}{1+\beta\hat{\pi}(\tilde{e})}$ *and* $\beta(1+r) = 1$.

Proof. *The competitive equilibrium solves*

$$\max_b u(w - \tilde{\tau}(b) - \tilde{s}(b)) + \beta\left[\hat{\pi}(\tilde{e}(b))\, u(w - \tilde{\tau}(b) + (1+r)\tilde{s}(b)) + (1-\hat{\pi}(\tilde{e}(b)))\, u(b + (1+r)\tilde{s}(b)) - \tilde{e}(b)\right],$$

where $\tilde{\tau}(b), \tilde{s}(b)$ *and* $\tilde{e}(b)$ *are implicitly defined by* IC_e, IC_s *and* BC*. The first-order condition of the maximization equals*

$$\frac{d\hat{U}}{db} = 0 \Leftrightarrow \frac{\partial\hat{U}}{\partial b} + \frac{\partial\hat{U}}{\partial\tau}\tilde{\tau}'(b) = 0, \text{ with}$$

$$\begin{aligned}\frac{\partial\hat{U}}{\partial b} &= \beta(1-\hat{\pi}(\tilde{e}))\, u'(c_u),\ \frac{\partial\hat{U}}{\partial\tau} = -u'(c_0) - \beta\hat{\pi}(\tilde{e})\, u'(c_e) \equiv -(1+\beta\hat{\pi}(\tilde{e}))\, \hat{u}'(c_e) \text{ and} \\ \tilde{\tau}'(b) &= \frac{\frac{1}{1+r}(1-\pi(\tilde{e}))}{1+\frac{1}{1+r}\pi(\tilde{e})}\left[1+\varepsilon_{1-\pi(\tilde{e}),b}\right].\end{aligned}$$

The first-order impact of effort and savings responses on the perceived expected utility equals zero by IC_e *and* IC_s*, i.e.,* $\partial\hat{U}/\partial e = \partial\hat{U}/\partial s = 0$*. Using the above expressions and* $\beta(1+r) = 1$*, I can rewrite the FOC as*

$$\frac{d\hat{U}}{db}/\beta(1-\pi(\tilde{e})) = \frac{1-\hat{\pi}(\tilde{e})}{1-\pi(\tilde{e})}u'(c_u) - \frac{1+\beta\hat{\pi}(\tilde{e})}{1+\beta\pi(\tilde{e})}\hat{u}'(c_e)\left[1+\varepsilon_{1-\pi(\tilde{e}),b}\right] = 0 \Leftrightarrow$$

$$\frac{\frac{1-\hat{\pi}(\tilde{e})}{1-\pi(\tilde{e})}u'(c_u) - \frac{1+\beta\hat{\pi}(\tilde{e})}{1+\beta\pi(\tilde{e})}\hat{u}'(c_e)}{\frac{1+\beta\hat{\pi}(\tilde{e})}{1+\beta\pi(\tilde{e})}\hat{u}'(c_e)} = \varepsilon_{1-\pi(\tilde{e}),b}.$$

The adjusted Baily formula (19) for the competitive equilibrium immediately follows. ■

A comparison of Proposition 1 here and Proposition 1 in the main text confirms that biases in baseline beliefs and control beliefs drive a wedge between the social optimum and the competitive equilibrium. Interestingly, competition forces private insurers to charge the actuarially fair price for insurance and thus subjects them to the same budget constraint as the social planner, but it does not force them to sell the optimal amount of insurance.[35] In particular, when agents are too optimistic about the risk of unemployment, providing insurance becomes unprofitable for private

[35] 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.

insurers. As discussed in the main text, this suggests a natural explanation for the puzzle of why unemployment insurance is mostly publicly provided.[36,37] In fact, if possible, private insurers would undo the undervalued social insurance by buying unemployment insurance from the agent. In order to increase the insurance coverage, the social planner would have to intervene by subsidizing private insurance provision or regulating the private market.

7.3 Additional References

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[36] 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. 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."

[37] Note that offering a positive benefit becomes unprofitable when $\frac{1-\hat{\pi}(\tilde{e})}{1-\pi(\tilde{e})}\frac{1+\beta\pi(\tilde{e})}{1+\beta\hat{\pi}(\tilde{e})} \leq \frac{\hat{u}'(c_e)}{u'(c_u)}\left[1+\varepsilon_{1-\pi(\tilde{e}),b}\right]$, evaluated at $b=0$.