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Assessing the Welfare Effects of Unemployment Benefits Using the Regression Kink Design

By Camille Landais*

I show how, in the tradition of the dynamic labor supply literature, one can identify the moral hazard effects and liquidity effects of unemployment insurance (UI) using variations along the time profile of unemployment benefits. I use this strategy to investigate the anatomy of labor supply responses to UI. I identify the effect of benefit level and potential duration in the regression kink design using kinks in the schedule of benefits in the US. My results suggest that the response of search effort to UI benefits is driven as much by liquidity effects as by moral hazard effects. *Keywords: Unemployment insurance, Regression Kink Design*

Most social insurance and transfer programs have time-varying benefits, in the sense that the benefits received are a function of time spent in the program. Changing the generosity of these programs therefore involves affecting the time profile of benefits. It is now well-understood, in particular in the context of unemployment insurance (UI), that labor supply responses to such variations in the time profile of benefits consist of a combination of liquidity effects and "moral hazard" effects. And that the dichotomy between the moral hazard effect and the liquidity effect of benefits is critical to assess the welfare impact of such social insurance and transfer programs (Shimer and Werning [2008], Chetty [2008]). But, to date, the dichotomy has been of little practical interest because of the difficulty to disentangle these two effects empirically[1].

The contribution of this paper is to propose a new strategy to estimate liquidity and moral hazard effects in the context of unemployment insurance. I show how the dichotomy between liquidity effects and moral hazard effects can be reinterpreted in light of the more traditional literature on dynamic labor supply, and how the moral hazard effect of UI on search effort can be related to the Frisch elasticity concept (*i.e.* the response of search effort to a change in benefits keeping marginal utility of wealth constant). Following the methodology

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[1] Apart from Chetty [2008], using variations in severance payments, and also LaLumia [2013], using variations in the timing of EITC refunds, there has been very few attempts to empirically estimate the magnitude of liquidity effects of social insurance programs.

of MaCurdy [1981], which relies on exploiting (exogenous) variations in the wage profile, keeping marginal utility of wealth constant, I propose a similar method to identify the moral hazard effects of UI using variations along the time profile of benefits brought about by exogenous variations in the benefit level as well as the benefit duration. Importantly, this strategy only relies on exploiting individuals' first order conditions and variations in the time profile of benefits. It is, in this sense, very general, and can be applied to any other transfer program with time-dependent benefits.

I implement empirically this identification strategy, identifying the effect of both benefit level and potential duration in the regression kink (RK) design, using kinks in the schedule of UI benefits, following Card et al. [2012]. I use administrative data from the Continuous Wage and Benefit History Project (CWBH) on the universe of unemployment spells in five states in the US from the late 1970s to 1984[2]. Since identification in the regression kink design relies on estimating changes in the slope of the relationship between an assignment variable and some outcomes of interest, the granularity of the CWBH data is a key advantage and smaller samples of UI recipients would in general not exhibit enough statistical power to detect any effect in a RK design. I provide compelling graphical evidence and find significant responses of unemployment and non-employment duration with respect to both benefit level and potential duration for all states and periods in the CWBH data. I provide various tests for the robustness of the RK design, and assess its validity to overcome the traditional issue of endogeneity in UI benefit variations on US data. These tests include graphical and regression based tests of the identifying assumptions as well as placebo tests and kink-detection and kink-location tests. I also use variations in the location of the kink over time to implement a difference-in-difference RK strategy to check the robustness of the results.

Overall, replicating the RK design for all states and periods, my results suggest that a 10% increase in the benefit level increases the duration of UI claims by about 4% on average, and that increasing the potential duration of benefit by a week increases the duration of UI claims by about .3 to .4 week on average. These estimates are higher than estimates found in European countries using sharp RD designs but are still lower than previous estimates on US data. My results also suggest that the ratio of liquidity to moral hazard effects in the response of labor supply to a variation in unemployment benefits is around .9. This confirms the existence of significant liquidity effects as found in Chetty [2008]. But interestingly, the identification strategy for moral hazard and liquidity effects proposed in this paper only uses administrative UI data and the RK design, and can therefore deliver timely estimates of liquidity effects without the need for data on consumption or on assets. I finally use these estimates to calibrate the welfare benefits of UI.

[2]Records begin in January 1976 for Idaho, in January 1979 for Louisiana, January 1978 for Missouri, April 1980 for New Mexico and July 1979 for Washington

The remainder of the paper is organised as follows. In section I, I present a simple dynamic model to show how the moral hazard effect can be identified using variations in the time profile of UI benefits, that, in practice, come from variations in both benefit level and potential duration. In section II, I present the RKD strategy, the data and provide with institutional background on the functioning of UI rules. In section III, I present the results of the labor supply effects of benefit level and potential duration, and I present various tests for the robustness of the RKD estimates. Finally, in section IV, I estimate the liquidity to moral hazard ratio of the effect of UI, and calibrate the welfare benefits of UI using my RKD estimates.

I. Relating moral hazard to estimable behavioral responses

I show in this section how the dichotomy between liquidity effects and moral hazard effects can be reinterpreted in light of the more traditional literature on dynamic labor supply and how one can use the insights from this literature to back out moral hazard effects from comparing the behavioral response of current search effort to variations in benefits at different points in time.

In a standard dynamic labor supply model, with time-separability, a change in the net return to work today has two effects on current labor supply. First, there is an effect due to the manipulation of the current return to work keeping marginal utility of wealth constant: this effect relates to the concept of Frisch elasticity. Second, there is a wealth effect due to the change in the marginal utility of wealth[3]. The "Macurdy critique" (MaCurdy [1981]) formulated against static reduced-form labor supply studies using tax reform variation builds on this simple argument. A permanent tax change dt will shift the whole net-of-tax wage profile as shown on the left hand side of figure 1 panel A, and the effect of such a tax change on labour supply should therefore be interpreted as a mix of wealth effect and "Frisch" effects.

Another important point of the standard dynamic labor supply literature is that any variation in the future returns to work only affects current labor supply through the marginal utility of wealth. An obvious corollary is that you can back out the wealth effects and the Frisch elasticity component by comparing the effect on current labor supply of a marginal change in the return to effort today versus that of an equivalent marginal change in return to effort in the future. This is the principle of the methodology used in MaCurdy [1981], which relies on exploiting (exogenous) variations in the wage profile, keeping marginal utility of wealth constant as shown on the right hand side of figure 1 panel A.

In the context of unemployment benefits, most countries have two-tiers UI benefits systems, giving benefits b for a maximum period of B weeks, at which point

[3]See online appendix C.1 for a simple exposition of a standard dynamic labor supply model without state dependence, and how Frisch elasticities can be identified using variations in the wage profiles.

UI benefit exhaust, and UI benefits are zero afterwards. A change in the benefit level db received by the unemployed for the first B periods can be interpreted as a full shift of the profile of the returns to search effort, as in the left hand side of figure 1 panel B. Most studies exploiting variations in the benefit level b across individuals to analyze the effect of UI benefits on search effort therefore estimate a mix of wealth effects and of distortionary "Frisch" effects (moral hazard effects). This is the point explicitly made by Chetty [2008]. The idea developed here is that one can use, as has been traditionally done in the dynamic labor supply literature, variations in the net return to search effort at different points in time in order to disentangle wealth effects from the moral hazard effects[4] . Such variation is brought about by variations in benefit level and in the potential duration of benefits as shown in the right hand side of figure 1 panel B. The only notable difference in the context of unemployment benefits is the presence of state-dependence: search effort today affects in which state one ends up tomorrow. In other words, when increasing future benefits (through an increase in the potential duration B for instance), one only gets the higher benefits if still unemployed after B periods. Because of this, variations in future benefits do not only have an effect on current job search effort through the marginal utility of wealth, but also through the net return to search effort today.

To make the point across and explain the intuition of the main results, I only present a simplified two-period version of a partial equilibrium dynamic search model, a class of models that has been used extensively to analyze the welfare implications of UI benefits (Chetty [2008], Schmieder, von Wachter and Bender [2012]). Proofs and discussion for the multi-period model are in online appendix C. The model describes the behavior of a worker who is laid-off and therefore becomes unemployed before the start of period zero. If the worker is unemployed at the start of period i, he exerts (endogenous) search effort s_i, which has a utility cost $\psi(s_i)$, with $\psi' \geq 0$ and $\psi'' \geq 0$. Search effort s_i translates into a probability to find a job[5] that I normalize to s_i to simplify presentation[6]. If employed in period 0, the worker gets utility $u(c_0^e) = u(A_0 - A_1 + w_0 - \tau)$, where A_0 is the initial level of wealth and $u' \geq 0$; $u'' \leq 0$. w_0 is the wage rate (assumed exogenous) and τ is the payroll tax paid to finance UI benefits. If employed in period 1, the worker gets utility $u(c_1^e) = u(A_1 - \bar{A} + w_1 - \tau)$ where $\bar{A}$ is asset level at the end of period 1, subject to the non-Ponzi condition $\bar{A} \geq 0$. We can also introduce liquidity constraints of the form $A_1 \geq L, \bar{A} \geq L$. If unemployed in period 0, the worker gets utility $u(c_0^u) = u(A_0 - A_1 + b_0)$, where b_0 are UI benefits in period 0. And if unemployed in period 1, the worker gets utility: $u(c_1^u) = u(A_1 - \bar{A} + b_1)$.

[4]Note also that if agents are totally credit constrained, or totally myopic, the dynamic dimension of the problem is irrelevant, and the effect of UI benefits is a mix of contemporaneous income effects and substitution effects, as in the static case. Identification of distortionary effects of UI would then simply require the use of contemporaneous income shocks to control for income effects.

[5]This captures the presence of search frictions in the labor market.

[6]We also assume that search effort is not observable from the social planner, and this is why we describe as "moral hazard" the distortions in search effort induced by UI benefits.

Lifetime utility at the start of period 0 is given by:

$$\mathcal{U} = s_0 u(c_0^e) + (1-s_0)u(c_0^u) - \psi(s_0) + \beta\Big(s_0 u(c_1^e) + (1-s_0)\Big(s_1 u(c_1^e) + (1-s_1)u(c_1^u) - \psi(s_1)\Big)\Big)$$

where β is the discount factor, and we assume interest rates to be zero for simplicity. Maximizing utility with respect to search effort in period 0, s_0, yields the following first-order condition:

(1)

$$\psi'(s_0) = \underbrace{u(c_0^e) + \beta u(c_1^e)}_{\text{Lifetime utility if employed in period 0}} - \underbrace{\Big(u(c_0^u) + \beta\Big(s_1 u(c_1^e) + (1-s_1)u(c_1^u) - \psi(s_1)\Big)\Big)}_{\text{Lifetime utility if unemployed in period 0}}$$

This is the standard optimal intratemporal allocation rule where the marginal disutility of effort in period 0 equals the marginal return to effort in period 0, *i.e.* the lifetime utility of getting employment starting in period 0 minus the lifetime utility of staying unemployed in period 0[7]. From this intratemporal allocation rule we get that:

$$\frac{\partial s_0}{\partial b_0} = -\frac{u'(c_0^u)}{\psi''(s_0)} = \frac{\partial s_0}{\partial A_0} - \frac{\partial s_0}{\partial w_0} \tag{2}$$

This decomposition, at the centre of the argument in Chetty [2008] can be thought of as a standard dynamic decomposition of the effect of current returns to effort between a Frisch elasticity concept keeping marginal utility of wealth constant ($\frac{\partial s_0}{\partial w_0}$), that from now on will be referred to as the moral hazard effect of UI benefits, and a wealth effect $\frac{\partial s_0}{\partial A_0}$ [8].

Individuals choose their consumption level every period once the result of the search process is realised. From their optimal choice we get the standard Euler conditions determining the optimal inter temporal allocation of consumption:

$$u'(c_0^e) = \beta u'(c_1^e) \tag{3}$$

$$u'(c_0^u) = \beta\big(s_1 u'(c_1^e) + (1-s_1)u'(c_1^u)\big) \tag{4}$$

Using (1), (3) and (4), we can retrieve the simple relationship between the effect of current and future wages on current effort:

[7]In the absence of state-dependence (or in a static model), only $u(c_0^e)$ and $u(c_0^u)$ would appear in this first-order condition, and future wages would only affect current effort through the marginal utility of wealth (wealth effect). See online appendix C for a simple example of a two-period labor supply model without state-dependence.

[8]I explain more in depth in online appendix C.1 the comparison between this decomposition and the one obtained in a standard model without state dependence.

$$\frac{\partial s_0}{\partial w_1} = (1 - s_1) \cdot \frac{\partial s_0}{\partial w_0} \tag{5}$$

The intuition for this relationship, which stems directly from the presence of state dependence, is simply that increasing wages tomorrow induces me to search more today to benefit from the extra consumption tomorrow if I am employed at the start of the period, but at the same time, I can delay search until tomorrow and find a job tomorrow with probability s_1 to benefit from the extra wages tomorrow. The effect of increasing the net reward from work tomorrow on search effort today is therefore $s_1\%$ smaller than the effect of increasing wages today on search effort today[9]. And if $s_1 = 1$, then I will be employed with certainty in period 1, irrespective of my search effort in period 0, therefore changes in the wage rate in period 1 will have no effect on my search effort in period 0 in this case.

Using 5, and Euler conditions 3 and 4, a change in b_1 can therefore be decomposed as:

$$\frac{\partial s_0}{\partial b_1} = -\beta \frac{(1 - s_1)u'(c_1^u)}{\psi''(s_0)} = \frac{\partial s_0}{\partial A_0} - (1 - s_1)\frac{\partial s_0}{\partial w_0} \tag{6}$$

And therefore we have that:

$$\frac{\partial s_0}{\partial b_0} - \frac{\partial s_0}{\partial b_1} = -s_1 \cdot \frac{\partial s_0}{\partial w_0} \tag{7}$$

In a model with no state dependence, the effect of future benefits would give us the wealth effect directly but here, because of state dependence, the effect of future benefits on current search effort is larger in absolute value than the pure wealth effect, as shown in equation (6), since the change in future benefits also affects the net return to effort in the current period. Then the difference between the effect of current and future returns, which would give us the Frisch elasticity directly

[9]The best way to understand this result is to rewrite lifetime budget constraint:

$$\begin{aligned} A_0 + s_0(w_0 - \tau) + (1 - s_0)b_0 + s_0(w_1 - \tau) + (1 - s_1)s_0(w_1 - \tau) + (1 - s_0)(1 - s_1)b_1 \quad &\geq \quad \mathcal{C}_0 + \mathcal{C}_1 \\ A_0 + b_0 + b_1 + s_0 \underbrace{[\Delta c_0 + (1 - s_1)\Delta c_1]}_{\text{Price of effort at time 0}} + s_1 \underbrace{[\Delta c_1]}_{\text{Price of effort at time 1}} \quad &\geq \quad \mathcal{C}_0 + \mathcal{C}_1 \end{aligned}$$

where $\Delta c_0 = (w_0 - \tau - b_0)$ and $\Delta c_1 = (w_1 - \tau - b_1)$. In other words, by exerting effort at time 0, your reward is the extra money Δc_0 you gain in period 0 compared to remaining unemployed plus the extra money you earn tomorrow $(1 - s_1)\Delta c_1$ because you will enter period 1 as employed. The reason your return for tomorrow is $(1 - s_1)\Delta c_1$ and not simply Δc_1 is because you could also have had Δc_1 by exerting effort tomorrow instead and therefore get Δc_1 with probability s_1. In other words, altering the total price of effort at time 0 by dw_0 or by $(1 - s_1)dw_1$ is equivalent, and should have the same effect on effort at time 0. Hence the result that $\frac{\partial s_0}{\partial w_1} = (1 - s_1) \cdot \frac{\partial s_0}{\partial w_0}$.

as in MaCurdy [1981] in the absence of state dependence, here gives us s_1 times the moral hazard, because the effect of benefits tomorrow also contains a moral hazard dimension; but we know that this moral hazard component is $s_1\%$ smaller than the moral hazard component of today's benefits. In other words, variations in search effort brought about by changes in the profile of benefits contains a lot of information, but one needs to take explicitly the state-dependence dimension of the dynamic problem to retrieve parameters that are meaningful for welfare analysis.

The strategy used in this paper to identify the moral hazard effects of UI relies on the use of variations along the time profile of benefits brought about by exogenous variations on both benefit levels and potential benefit duration in the UI system. Proposition 1 generalizes the insight of (7) to a multi period case where variations in b_0 and b_1 from the two period model are now replaced by variations in benefit level b and potential duration B. As in the two-period model, a change in benefits today due to an increase in the benefit level b affects search effort today through a liquidity and a moral hazard effect. A change in benefits tomorrow because of a benefit extension also affects search effort today through a liquidity effect and through a moral hazard effect because of state dependence. As shown in figure 1 panel B, a benefit level increase or a benefit extension will give the same dollar increment in liquidity to unemployed individuals when $B\partial b = b\partial B$. This explains why, compared to (7), $\frac{\partial s_0}{\partial b_0}$ now becomes $\frac{1}{B}\frac{\partial s_0}{\partial b}$ in proposition 1, and $\frac{\partial s_0}{\partial b_1}$ becomes $\frac{1}{b}\frac{\partial s_0}{\partial B}$. Proposition 1 simply uses the fact that the liquidity effects of the same dollar increment in a benefit level increase and in a benefit extension are equal, so that the difference in the effects on search effort at time 0 of a benefit level increase and of a benefit extension can identify the moral hazard effect.

PROPOSITION 1. *If the borrowing constraint does not bind after B periods, the moral hazard effect Θ_1 of providing UI benefits b for B periods is a linear combination of the effects on exit rate at the start of a spell of an increase in benefit duration ($\frac{\partial s_0}{\partial B}$) and of an increase in benefit level ($\left.\frac{\partial s_0}{\partial b}\right|_B$)*

$$\frac{1}{B}\left.\frac{\partial s_0}{\partial b}\right|_B - \frac{1}{b}\frac{\partial s_0}{\partial B} = -\frac{\overline{S_1^B} - S_1(B)}{D_1^B} \cdot \Theta_1 \tag{8}$$

where $S_1(B)$ is the survival rate at time B conditional on being unemployed at period 1, $\overline{S_1^B}$ is the average survival rate between time 1 and time B conditional on being unemployed at period 1, and D_1^B is the average duration of covered UI spells conditional on being unemployed at time 1.

Proof: see online appendix C.

To understand the intuition behind proposition 1 it is useful to compare it to the standard dynamic labor supply. In this case, there is no state-dependence, and giving one extra dollar of wealth today or tomorrow through an increase in the wage rate has the same wealth effect on labor supply today, so that the difference in the behavioral response of search effort today to a change in the wage rate today and tomorrow washes out the wealth effect, and only the moral hazard or Frisch effect remains. In the presence of state-dependence, search effort today affects in which state one will be tomorrow. In other words, when increasing potential duration dB, one only gets the higher benefits if still unemployed after B periods. In this case, the difference in the effect of current and future benefits on search effort today only identifies the moral hazard effect up to a term that depends on the ex-ante survival function, as shown in proposition 1.

Heterogeneity:
An interesting aspect of proposition 1 is that it can be generalized to allow for the presence of heterogeneity. The reason for this generalizability is that proposition 1 is only making use of individual optimality conditions. Suppose the economy has N individuals, indexed by i and for simplicity, let us focus back on the two-period case. Denote $\mathbb{E}[\frac{\partial s_0}{\partial b_0}] = \frac{1}{N}\sum_{i=1}^{N}\frac{\partial s_0^i}{\partial b_0}$ the mean response of search effort in period 0 to a change in benefit at time 0 and $\mathbb{E}[\frac{\partial s_0}{\partial b_1}] = \frac{1}{N}\sum_{i=1}^{N}\frac{\partial s_0^i}{\partial b_1}$ the mean response of search effort in period 0 to a change in benefit at time 1. Then $\mathbb{E}[\frac{\partial s_0}{\partial b_0}] - \mathbb{E}[\frac{\partial s_0}{\partial b_1}] = \mathbb{E}[\frac{\partial s_0}{\partial b_0} - \frac{\partial s_0}{\partial b_1}] = \mathbb{E}[s_1\frac{\partial s_0}{\partial w_0}]$ where we only use individual first order conditions regarding consumption and search effort. If heterogeneity is such that the distribution of optimal effort s^i and $\frac{\partial s_0^i}{\partial w_0}$ are independent, then we have $\mathbb{E}[\frac{\partial s_0}{\partial b_0}]-\mathbb{E}[\frac{\partial s_0}{\partial b_1}] = \bar{s_1}\cdot\mathbb{E}[\frac{\partial s_0}{\partial w_0}]$, where $\bar{s_1} = \sum_{i=1}^{N}\frac{s_1^i}{N}$ is the average hazard rate in period 1. Note however that the independence of the optimal effort level and the marginal effect of w_0 on optimal effort can actually be a fairly strong assumption depending on the type of heterogeneity one considers. If heterogeneity was in parameters related to risk preferences, for example, this would most certainly not be true and a covariance term would kick in that would also need to be estimated[10].

Empirically, this means that the difference between the average behavioral response of search effort of the unemployed in period 0 to a change in benefits in period 0 versus a change in benefits in period 1 can be related to the average moral hazard effect of UI benefits in period 0 $\mathbb{E}[\frac{\partial s_0}{\partial w_0}]$, and by extension, to the average liquidity effect of UI benefits $\mathbb{E}[\frac{\partial s_0}{\partial A_0}]$. And as shown in Chetty [2008], the ratio of the average moral hazard effect to the average liquidity effect is a sufficient statistic for the optimal level of UI benefit in the presence of heterogeneity. In other words, even in the presence of heterogeneity, the difference between the average behavioral responses of search effort to variations in UI benefits at different point in time reveals all the relevant information for the Baily formula.

Stochastic wage offers:

[10]Note that Andrews and Miller [2014] have a similar discussion on heterogeneity and sufficient statistics in the context of UI.

The result of proposition 1 can also be extended to the presence of stochastic wage offers, whereby an agent's hazard rate out of unemployment would depend both on her search effort and her reservation wage. Suppose that in period t with probability s_t (controlled by search intensity) the agent is offered a wage $w \sim \hat{w} + F(w)$ and assume i.i.d. wage draws across periods. In such a framework (McCall [1970]), the agent follows a reservation-wage policy: in each period, there is a cutoff R_t such that the agent accepts a job only if the wage $w > R_t$. I show in online appendix C.6 that the result of proposition 1 remains unchanged in this context, because the agent is setting her reservation wage profile optimally, so that the envelope theorem applies and there is no first-order effect of a change in reservation-wage policy on the agent's expected utility. In the two-period case, formula (7) becomes

$$\frac{\partial s_0}{\partial b_0} - \frac{\partial s_0}{\partial b_1} = -h_1 \frac{\partial s_0}{\partial w_0} \tag{9}$$

where $h_1 = s_1 P[w \geq R_1]$ is the hazard rate out of unemployment[11] in period 1, and $P[w \geq R_1]$ is the probability that the wage offered in period 1 is larger than the reservation wage in period 1 R_1.

Relationship with optimal UI formula:
The importance of isolating moral hazard from liquidity effects lies in the fact that they reveal critical information about the consumption smoothing benefits of UI, and as a consequence about the welfare effects of UI. The ratio of moral hazard to liquidity effects is actually directly proportional to the risk aversion parameter $(c \cdot \frac{u''}{u'})$ and therefore to the consumption smoothing benefits of UI. The intuition for this is the following. First, the moral hazard effect of UI (ds/dw) is proportional to u': the larger the marginal benefit of a dollar, the more the agent's search effort will react to a one dollar increase in her wage rate. Second, the liquidity effects (ds/dA) is proportional to u'': when u'' is large, if wealth falls, u' rises sharply, and individuals will exert a lot of effort to find a job. Therefore, the consumption smoothing benefits of UI, which constitute the left-hand side of the traditional Baily formula can be recast in terms of the ratio of moral hazard to liquidity effects. Chetty [2008] shows how to obtain this modified Baily formula to calibrate the optimal benefit level for a constant duration, and I show in online appendix C that a similar formula can be obtained to calibrate the optimal duration of benefit for a given benefit level. Armed with these modified formulas for the optimal benefit level and optimal benefit duration, and using proposition 1, it becomes possible to evaluate the welfare impact of local policy reforms using only responses of search effort to variations in the time profile of unemployment benefits, and without estimation of the full underlying structural

[11]The only difficulty lies in defining the empirical counterparts for the implementation of formula 9, as changes in empirically observed job finding hazards cannot be directly used to infer the relevant changes in search intensity because part of the change in job finding hazards comes from changes in the reservation wage. I give two options for empirical implementation in online appendix C.6.

model.

To fully implement the proposed strategy, and calibrate optimal formula for UI level (resp. benefit duration) I need to estimate three statistics: the elasticity of the duration of paid unemployment spell with respect to benefit level (resp. benefit duration), the elasticity of the duration of total non-employment spell with respect to benefit level (resp. benefit duration), and the ratio of liquidity effect to moral hazard effect of an increase in benefit level (resp. benefit duration). In the empirical implementation, I begin by estimating the two elasticities. To estimate the ratio of moral hazard to liquidity effects, I estimate the effect of a change in benefit level on the hazard rate at the start of the spell $\frac{\partial s_0}{\partial b}\Big|_B$ and the effect of a change in potential duration on the hazard rate at the start of the spell $\frac{\partial s_0}{\partial B}\Big|_b$. I then use proposition 1 to get the moral hazard effect Θ_1 of providing UI benefits b for B periods. Finally, I use the fact that the behavioral response $\frac{\partial s_0}{\partial b}\Big|_B$ is the sum of the liquidity effect ($\frac{\partial s_0}{\partial a}\Big|_B$) and of the moral hazard effect Θ_1 (see online appendix C for details) to back out the liquidity effect and compute the ratio of liquidity to moral hazard effects.

Pros and cons of the proposed method:
The obvious advantage of the proposed method to estimate moral hazard and liquidity effects is that it can be done from estimation of search responses only. Proposition 1 relates the structural approach of dynamic models to behavioral responses of search effort that can be estimated in reduced-form using credibly exogenous variations in both benefit levels and potential durations for the same individuals. And as a consequence, welfare effects of UI can be assessed without any direct estimation of the consumption smoothing benefits of UI from consumption data, which can prove arduous. Given the "local"[12] nature of the Baily-Chetty formula, the components of the welfare formula need to be statistics that can be easily estimable, and preferably at high frequency, to be able to make readily available policy recommendation. The interest of the proposed method is that, as will become apparent in the empirical sections of the paper, all the relevant statistics for welfare analysis are estimable with administrative UI data at high frequency using the regression kink design.

The method of proposition 1 to uncover the moral hazard component of behavioral responses relies on individuals' optimality conditions, and in particular on the Euler equations. A key advantage of this approach is that it does not require any knowledge about individuals' risk aversion or discount factors. In practice though, it is therefore important to test the assumption that the credit constraint is not yet binding after B periods so that the Euler equations actually hold. In section A.8, I provide a simple test of this assumption using post-exhaustion behavior with administrative data. More fundamentally, the method proposed here to identify moral hazard and liquidity effects relies on the assumption that

[12]Local here means in the neighborhood of the actual policy parameters, where the statistics entering the formula are estimated.

the unemployed are rational and forward-looking. If individuals were perfectly myopic for instance, the Euler equation would not hold. The test about the slackness of the liquidity constraint seems to indicate a certain degree of consumption smoothing over time, ruling out perfect myopia. But evidence in the labor market (see for instance DellaVigna and Paserman [2005]) indicates that job seekers may exhibit a lot of impatience. Even though our identification strategy is valid independently of the value of the discount factor, it rules out the possibility of forms of impatience such as hyperbolic (beta-delta) discounting.

My identification strategy also necessitates that individuals have very precise information about their benefit level and potential duration of UI. This seems to be the case nowadays, unemployed individuals receiving in most states at the beginning of their claim a summary of their rights, with the amount of their weekly benefits and total duration of benefits in weeks[13]. Finally, my identification strategy postulates that unemployed individuals are able to form rational expectations about their survival rates and expected duration of unemployment at the start of a spell. Evidence in the labor market also suggests that unemployed individuals may actually exhibit biased perceptions about their unemployment risks (Spinnewijn [2010]). It is unfortunately difficult to know to what extent such biased beliefs are likely to affect my estimates, since the moral hazard estimate is at the same time an increasing function of the expected duration of unemployment and a decreasing function of the expected survival rate at exhaustion. In other words, biased beliefs would not affect my estimate if the bias is a simple shifter of the survival curve. If this is not the case, one would need to compare the full (biased) expected survival curve to the true survival curve to know how these biased perceptions affect the moral hazard and liquidity estimates.

II. Empirical implementation

The empirical challenge in applying the formula of proposition 1 lies in the difficulty to find credibly exogenous and time invariant sources of variations in UI benefits. Most sources of variations used in the literature on US data come from changes in state legislation over time[14], with the issue that these changes might be endogenous to labor market conditions. In this paper, I use the presence in most US states of kinked schedules in the relationship between previous earnings and both benefit level and benefit duration to estimate the responses of labor supply to UI benefits using administrative data on UI recipients. This strategy has several important advantages. First, in contrast to studies using regional or time variation in UI benefits, the RK design holds market-level factors constant, such that I identify changes in the actual behavioral response, net of any market level factors that may change over time or across regions. Second, the RK design

[13]Unfortunately, I was not able to find a copy of UI benefit summary for the period covered by the CWBH, and could not confirm that such information was already present at the time.

[14]See for instance Meyer [1990] or Card and Levine [2000].

allows me to identify behavioral responses with respect to both benefit level and potential duration for the same workers in the same labor markets. Finally, my empirical strategy, based on the use of administrative data, delivers high frequency estimates of behavioral responses without the need for quasi-experimental policy reforms, which is critical for welfare recommendations based on sufficient statistics formula.

A. Institutional Background: Kinks in UI Schedules

In all US states, the weekly benefit amount b received by a compensated unemployed is a fixed fraction τ_1 of her highest-earning quarter (hqw) in the base period (the last four completed calendar quarters immediately preceding the start of the claim)[15] up to a maximum benefit amount b_{max}:

$$b = \begin{cases} \tau_1 \cdot hqw & \\ b_{max} & \text{if} \quad \tau_1 \cdot hqw > b_{max} \end{cases}$$

Figure 2 plots the evolution of the weekly benefit amount schedule in Louisiana for the time period available in the CWBH data used in this paper. Note that the maximum benefit amount has been increased several times in Louisiana, partly to adjust to high inflation rates during the period[16]. The schedule applies based on the date the UI claim was filed, so that a change in the maximum weekly benefit amount does not affect the weekly benefit amount of ongoing spells. In Louisiana, τ_1 is equal to 1/25 which guarantees a constant replacement ratio of 52% of the highest-earning quarter up to the kink, where the replacement ratio decreases.

The potential duration of benefits (number of weeks a claimant can collect UI benefits) is determined by two rules. First, there is a maximum duration D_{max} that cannot be exceeded, usually 26 weeks. But the total amount of benefits that a claimant is able to collect for a given benefit year is also subject to a ceiling, which is usually determined as a fraction τ_2 of total earnings in the base period bpw. So the total amount of benefits collected is defined as:

$$B = min(D_{max} \cdot b, \tau_2 \cdot bpw)$$

This ceiling in the total amount of benefits determines the duration of benefits, since duration $D = \frac{B}{b}$ is simply the total amount of benefits divided by the weekly

[15]Some states, such as Washington, use the average of the two highest-earning quarters in the base period.

[16]Inflation was 13.3 percent in 1979, 12.5% in 1980, 8.9% in 1981, 3.8% in 1982 (source: BLS CPI data).

benefit amount. Duration of benefits can therefore be summarized as[17]:

$$D = \begin{cases} D_{max} \\ \tau_2 \cdot \frac{bpw}{min(\tau_1.hqw, b_{max})} & \text{if} \quad \tau_2 \cdot \frac{bpw}{min(\tau_1 \cdot hqw, b_{max})} \leq D_{max} \end{cases}$$

Duration is thus also a deterministic kinked function of previous earnings[18], as shown in Figure 3. All the details on the rules pertaining to the kinks in potential duration are described in online appendix D.7. The rules for the determination of benefit duration discussed above constitute the basis of the UI benefit system (Tier I) that applies in each state. During recessions, and depending on state labor market conditions, two additional programs superimpose on Tier I to extend the potential duration of UI benefits. The first program is the permanent standby Extended Benefit (EB) program, federally mandated but administered at the state level (Tier II). On top of the EB program, federal extensions are usually enacted during recessions (Tier III). These extensions may change the location and size of the kink in the relationship between previous earnings and benefit duration as shown in figure 3 in the case of Louisinia. Most importantly, benefit extensions create non-stationarity in the potential duration of benefits over the duration of a spell, which create an additional challenge for inference in the RK design, as I discuss in section III.B.

B. Data

The data used is from Continuous Wage and Benefit History (CWBH) UI records[19]. This is the most comprehensive, publicly available administrative UI data set for the US. CWBH data contains the universe of unemployment spells and wage records for five US states from the late 1970s to 1984. Records begin in January 1976 for Idaho, in January 1979 for Louisiana, January 1978 for Missouri,

[17]Idaho is the only state in the CWBH data with different rules for the determination of benefit duration.

[18]To give a concrete example, an unemployed individual in Louisiana during the period 1979 to 1983 will hit the maximum duration whenever her ratio of base period earnings to highest quarter of earnings is larger than 2.8. An individual with a highest quarter of earnings of \$3725 in 1979 for instance, who is therefore hitting the maximum benefit amount ceiling will see her potential duration increase by roughly .25 week for each additional \$100 of base period earnings, up to the point where her base period earnings is larger than \$10430, at which point she will be hitting the maximum duration ceiling of 28 weeks. Note also that the schedule of benefit level and benefit duration are related. In particular, if $\frac{bpw}{min(hqw, \frac{b_{max}}{\tau_1})} \leq D_{max} \cdot \frac{\tau_1}{\tau_2}$, then $D = \tau_2 \cdot \frac{bpw}{min(\tau_1.hqw, b_{max})}$, so that potential duration is always inferior to the maximum duration D_{max}, but the relationship between duration and highest quarter earnings hqw exhibits an upward kink at $hqw = \frac{b_{max}}{\tau_1}$, which is also the point where the relationship between the weekly benefit amount b and hqw is kinked. To deal with the issue, I always get rid of all individuals with $\frac{bpw}{min(hqw, \frac{b_{max}}{\tau_1})} \leq D_{max} \cdot \frac{\tau_1}{\tau_2}$ when estimating the effect of benefit level, to avoid the correlation between the location of the two kinks. I explain in detail in appendix D.7 how to deal with the correlation between the two schedules, for all the various subcases.

[19]I am especially grateful to Bruce Meyer and Patricia M. Anderson for letting me access the CWBH data.

April 1980 for New Mexico and July 1979 for Washington[20]. This enables me to replicate and successfully test for the validity of the RK design in many different settings and labor market conditions. Two important advantages of the data are worth noting. First, CWBH data provides accurate information on the level of benefits, potential duration, previous earnings and work history over time. Given the large degree of measurement error found in survey data, administrative data like the CWBH are the only reliable source to implement identification strategies such as the regression kink design [21]. Second, the granularity of the CWBH data is a key advantage and smaller samples of UI recipients would in general not exhibit enough statistical power to detect any effect in a RK design.

I report in table 1 descriptive statistics for the CWBH sample used in my RKD strategy for all five states. In terms of duration outcomes[22], I focus on four main outcomes: the duration of paid unemployment, the duration of claimed unemployment, the duration of the initial spell as defined in Spiegelman, O'Leary and Kline [1992] [23] and the duration of total non-employment. Note that the latter can only be properly computed in Washington, which is the only state where the wage records, matched to the UI records, contain information about reemployment dates.

Table 1 also reveals large variation in the generosity of UI benefits across states. The average weekly benefit level (in $2010) varies from $225 in Missouri to $305 in Louisiana, while the average potential duration varies from 20 weeks in Idaho to 27 weeks in Washington. These differences are due to variations in the parameters of the schedule (the maximum benefit amount, τ_1, etc.). For the purpose of the RKD estimation, this has the advantage of creating substantial variation in the location of the kink (relative to the distribution of earnings) across states: the ratio of the kink point to the average hqw varies from .98 in Missouri to 1.65 in Louisiana, with a fraction of unemployed at the maximum benefit amount varying from .64 to .35. This mitigates the concern that RKD estimates are just picking a functional form dependence between the outcome of interest and the running variable that would be consistent across states.

In terms of external validity, it is interesting to note that the overall structure of the UI system has remained almost unchanged since the period covered by the CWBH. The slope of the UI schedule has remained the same in almost all

[20]For all details on the CWBH dataset, see for instance Moffitt [1985*a*]

[21]Administrative data was also supplemented by a questionnaire given to new claimants in most states participating to the CWBH project, which gives additional information on socio-demographic characteristics of the claimants such as ethnicity, education, spouse's and dependents' incomes, capital income of the household, etc

[22]Unemployment Insurance claims are observed at weekly frequencies in the administrative data so that all duration outcomes are measured and expressed in weeks

[23]The duration of claimed unemployment corresponds to the number of weeks a claimant is observed in the administrative data for a given unemployment spell. This duration differs from the duration of paid unemployment. First, because most states have instated waiting periods, and second, because a lot of spells exhibit interruptions in payment with the claimant not collecting any check for a certain number of weeks without being observed in the wage records. The initial spell, as defined in Spiegelman, O'Leary and Kline [1992], starts at the date the claim is filed and ends when there is a gap of at least two weeks in the receipt of UI benefits.

US states over the past thirty years. The generosity of the UI system has only been affected by the evolution of the other parameters of the schedule, and in particular of the maximum benefit amount. Some states, such as Louisiana, are less generous today than they are in the CWBH data: the average replacement rate is .47 in the CWBH data, while it is around .395 in 2012[24]. But overall, with average replacement rates ranging between .43 and .47 across states, the generosity of UI benefits in the CWBH data is very similar to today's, with an average replacement rate of .466 in the US in 2012. This means that the location of the kink in the distribution of earnings is roughly similar today to that in the CWBH data. The only notable difference concerns the tax status of UI benefits. Prior to 1979, UI benefits were not subject to Federal income taxation, but in 1979 they became taxable for high income individuals and in 1987 benefits became taxable for all recipients. It is finally interesting to note that the composition of the UI recipients in the CWBH is relatively close to that of UI recipients during the Great Recession as can be seen for instance from Table 2.1 in Krueger and Mueller [2011].

C. Regression Kink Design

To identify the effect of UI benefit level and UI potential duration on search outcomes, I use the kinks in the schedule of UI benefits following a *sharp* RK design[25]. Identification relies on two assumptions. First, the direct marginal effect of the assignment variable on the outcome should be smooth. Second, density of the unobserved heterogeneity should evolve smoothly with the assignment variable at the kink. This local random assignment condition seems credible in the context of UI as few people may know the schedule of UI benefits while still employed[26]. Moreover, to be able to perfectly manipulate ex ante one's position in the schedule of both benefit level and potential duration, it is necessary to know continuously one year in advance the date at which one gets fired and the schedule that shall apply then[27] and to optimize continuously not only one's highest-earning quarter but also the ratio of base period earnings to the highest-earning quarter. I provide in the next section further empirical evidence in support of the RKD assumptions.

As explained in Card et al. [2012], the denominator of the RKD estimand is deterministic[28], so that RKD estimation only relies on the estimation of the numerator of the estimand which is the change in the slope of the conditional

[24]The replacement rate is defined as the weekly benefit amount divided by the weekly wage in the highest quarter of earnings. The figures for recent state UI replacement rates come from the Department of Labor and can be found at `http://workforcesecurity.doleta.gov/unemploy/ui_replacement_rates.asp`

[25]There has been recently a considerable interest for RK designs in the applied economics literature. References include Nielsen, Sandoslash;rensen and Taber [2010], Card et al. [2012], Dong [2010] or Simonsen, Skipper and Skipper [2010]. The term *sharp* RK design means that everyone is a complier and obeys the same treatment assignment rule.

[26]Unfortunately, apart from anecdotal evidence, there is very little data on individuals' information on UI schedules in order to fully substantiate this point.

[27]As shown in figures 2 and 3, the schedule changes rather frequently.

[28]It is the change in the slope of the schedule at the kink.

expectation function of the outcome given the assignment variable at the kink. This can be done by running parametric polynomial models of the form:

$$(10)\quad E[Y|W=w] = \mu_0 + [\sum_{p=1}^{\bar{p}} \gamma_p (w-k)^p + \nu_p (w-k)^p \cdot D] \quad \text{where } |w-k| \leq h$$

where W is the assignment variable, $D = \mathbb{1}[W \geq k]$ is an indicator for being above the kink threshold, h is the bandwidth size, and the change in the slope of the conditional expectation function is given by ν_1.

Note that the US is characterized by relatively low take-up rates of UI. Incomplete take-up may affect the validity of RK design if it causes the random local assignment assumption to be violated. The RKD requires that the presence of incomplete take-up does not generate a non-smooth relationship between the assignment variable and unobserved heterogeneity at the kink point. This requirement is more likely to be met if some components of take-up are orthogonal to the assignment variable. Empirical evidence from the CWBH period partly supports this assumption. Blank and Card [1991] for instance show that unionization had a large impact on take-up, which suggests that lack of information/ignorance stories played an important role in take-up behaviors in the 1980s. Note also that because we only observe individuals who take-up UI in the CWBH data, the RKD estimates should be interpreted as a treatment effect on the treated and not as an Intention-To-Treat effect, in the sense that a change in the generosity of the schedule may affect the selection of individuals in the CWBH sample.

III. Effect of UI benefits on unemployment duration

I present in this section results of the estimation of the effect on unemployment duration of both UI benefit level and UI potential duration. The objective of this section is also to assess the validity of the RK design to estimate these elasticities. I propose and run several tests aimed at assessing both the validity of the identifying assumptions, and the robustness of the RK estimates.

A. Benefit level

In the baseline analysis, I divide for each state all the unemployment spells in subperiods corresponding to stable UI schedules. In figures 4, 5 and 6 and in the robustness analysis of table A1 though, I group unemployment spells over all periods, which has the advantage of providing with a larger number of observations at the kink for statistical power. For exposition purposes, I focus mainly on the case of Louisiana but all the results for all states and periods are displayed in online appendix B.

Graphical Evidence: I begin by showing graphical evidence in support of the RKD assumptions. First, I plot the probability density function of the assignment variable in order to detect potential manipulation of the assignment variable at the kink point. Figure 4 panel A shows the number of spells observed in each bin of the highest quarter of earnings normalized by the kink point[29] in Louisiana. The graph shows no signs of discontinuity in the relationship between the number of spells and the assignment variable at the kink point. To confirm this graphical diagnosis, I also performed McCrary tests as is standard in the Regression Discontinuity Design literature. The estimate for the log change in height and its bootstrapped standard error are displayed directly on the graph and confirm that we cannot detect a lack of continuity at the kink. I also extend the spirit of the McCrary test to test the assumption of continuity of the derivative of the p.d.f, as done in Card et al. [2012]. The idea is to regress the number of observations N_i in each bin on polynomials of the average highest quarter of earnings in each bin (centered at the kink) $(w-k)$ and the interaction term $(w-k)\cdot\mathbb{1}[W\geq k]$. The coefficient on the interaction term for the first order polynomial (testing for a change in slope of the p.d.f) reported on panel A of figure 4 is insignificant which supports the assumption of a continuous derivative of the conditional density at the kink.

A key testable implication of a valid RK design is that the conditional expectation of any covariate should be twice continuously differentiable at the kink. This can be visually tested by plotting the mean values of covariates in each bin of the assignment variable as done in figure 5 in Louisiana. Panels A, B, C and D of figure 5 all suggest that the covariates evolve smoothly at the kink, in support of the identification assumptions of the RK design. In panel C., I investigate whether differences in ex-ante savings behaviors may affect the local random assignment assumption of the RK design. To do so, I exploit the information available in the CWBH survey, which contains a reported measure of capital income and interests. Although this is not a perfect measure of liquidity, this is a good proxy for the availability of savings. Figure 5 panel C. displays the relationship between the probability of having positive capital income and the assignment variable, which does not exhibit any non-linearity at the kink. Formal tests for all covariates can also be performed by running polynomial regressions of the form described in equation 10. Results are described in the next subsection.

The pattern for the outcome variables offers a striking contrast with that of covariates, as shown in figure 6 panel A which displays the evolution of the relationship between the duration of UI claims and the assignment variable normalized at the kink. There is a sharp visible change in the slope of the relationship between the duration of UI claims and the assignment variable at the kink point of the benefit schedule. Figure 7 replicates the same graphical diagnosis for all five states [30]. This provides supportive evidence for the identification of an effect

[29]The choice of the bin size in our graphical analysis is done using the formal test of excess smoothing recommended by Lee and Lemieux [2010] in the RD setting. A bin size of .05 is the largest that passes the test for all states and outcomes of interest.

[30]Results for the other duration outcomes of interest are displayed in online appendix figures B2 and B3 and reveal the exact same patterns.

of benefit level on unemployment duration in the RK design.

Estimation Results: Table 2 shows the results for the baseline specification of equation 10 in the linear case for Louisiana for all five sub periods. In each column, I report the estimate of the weighted average treatment effect $\widehat{\alpha} = -\frac{\widehat{\nu_1}}{\tau_1}$, where $\widehat{\nu_1}$ is the estimated change in slope in the relationship between the outcome and the assignment variable at the kink point from specification (10) and τ_1 is the deterministic change in slope in the schedule of UI benefits at the kink point. Each estimate is done using nominal schedules, but the $\widehat{\alpha}$ are rescaled to 2010 dollars and they should be interpreted as the effect of an extra dollar of 2010 in weekly benefit amount on the average duration (in weeks) of the outcome[31]. The coefficient estimate of .04 (table 2 column (3), sept 1981 to sept 1982) for instance suggests that a \$1 increase in weekly benefits leads to a .04 week increase in the duration of paid unemployment.

I also report the elasticity with respect to the benefit level ($\varepsilon_b = \widehat{\alpha} \cdot \frac{b_{max}}{\overline{Y_1}}$, where $\overline{Y_1}$ is mean duration at the kink point) and its robust standard error, as well as the p-values from a Goodness-of-Fit test that consists in comparing the polynomial model to the same polynomial model plus a series of bin dummies. The results are consistent across the three duration outcomes of interest with an estimated elasticity of between .2 and .7 depending on the sub period of interest. These estimates suggest that a 10% increase in the average weekly benefit amount increases on average by 2 to 7% the duration of unemployment. In each case, the linear specification is not considered too restrictive compared to the model including bin dummies as suggested by the large p-values of the Goodness-of-Fit test. For covariates, to the contrary, I cannot detect evidence of a significant change in the slope of the conditional expectation at the kink for any of the five periods. In online appendix table B5, I display estimates of the elasticity of all duration outcomes, including the duration of total non-employment, in Washington, the only state for which we observe reemployment dates from wage records in the CWBH data. Interestingly, the marginal effect of a change in benefit level on the duration of non-employment is very similar to the effect on the duration of UI claims or on the duration of paid UI. But the duration of non-employment being usually quite longer than the duration of paid UI, the elasticity of non-employment duration is relatively lower than the elasticity of paid UI spells.

I provide various tests for the robustness of the RKD estimates. For the sake of brevity, most of the details of these tests are given in appendix A. In table A1 panel A, I begin by analyzing the sensitivity of the results to the choice of the polynomial order. The estimates for α are of very similar magnitude for the linear, the quadratic, and the cubic specification. Standard errors of the estimates

[31] The marginal effect $\widehat{\alpha}$ estimated in the RK design is of course a local estimate for individuals at the kink and might differ from the average treatment effect (ATE) for the whole population in the presence of heterogeneity. $\widehat{\alpha}$ is, to be precise, an average treatment effect weighted by the ex ante probability of being at the kink given the distribution of unobserved heterogeneity across individuals.

nevertheless increase quite substantially with higher order for the polynomial. The AIC suggest that the quadratic specification is always dominated but the linear and the cubic specification are almost equivalent, and none of them is too restrictive based on the p-values of the Goodness-of-Fit test. Table A1 panel B explores the sensitivity of the results to the choice of the bandwidth level. Results are consistent across bandwidth sizes, but the larger the bandwidth size, the less likely is the linear specification to dominate higher order polynomials. Overall though, it should be noted that the RKD does pretty poorly with small samples, and therefore is quite demanding in terms of bandwidth size compared to a regression discontinuity design.

I then provide two tests to deal with the issue of functional dependence between the forcing variable and the outcome of interest. A key identifying assumption of the RK design is that, conditional on b, this relationship is smooth at the kink. But in practice, it could be that the relationship between the forcing variable and the outcome (in the absence of a kink in the schedule of b) is either kinked or simply quadratic. Then, the RKD estimates are likely to be picking up this functional dependence between y and w_1 instead of the true effect of b on y. One way to control for this type of issue would be to compare two groups of similar individuals with different UI schedules, so that kinks would be at different points of support of the forcing variable. As shown in online appendix A.3, under the assumption that the functional dependence between y and w_1 is the same for the two groups, the average treatment effect can be identified and estimated in a "double-difference regression kink design".

To implement this strategy, the idea is to use the presence of variations in the maximum benefit amount over time, that shift the position of the kink across the distribution of the forcing variable (as shown in figure 2). The problem though is that, taken separately, each variation in max_b is too small to give enough statistical power to detect changes in slopes because the bandwidths are too small, and as previously pointed out, the drawback of the RKD is to be quite demanding in terms of bandwidth size. The idea therefore is to compare periods that are further away in time[32]. Figure A2 in online appendix A shows the relationship between the duration of paid unemployment and the forcing variable in 1979 and 1982. Interestingly, there is a kink in this relationship in 1979 at the level of the 1979-kink in the schedule, and this kink disappears in 1982, when a new kink appears right at the level of the 1982-kink. Furthermore, in the interval between the 1979 and 1982 kinks, there is a change in slope in the relationship between the duration of unemployment and the forcing variable. This evidence is strongly

[32]The obvious drawback of this option is that the identifying assumption is less likely to hold as one compares periods that are further away in time. In particular, one may worry about the high inflation rates during this period. It is important to note here that the maximum benefit amount increased in Louisiana a lot faster than inflation (40% between September 1979 and Sept 1982 and total inflation was less than 20% during that period), so that there is a clear and important change in the schedule in *real* terms. To further alleviate this concern, I also control for quadratic in *real* highest quarter of earnings in the DD-RKD specifications and find similar results.

supportive of the validity of the RK design. Table A2 reports the double-difference RKD estimates of the effect of benefit level corresponding to the evidence of figure A2. The point estimates are perfectly in line with the baseline RKD estimates of table 2. The DD-RKD strategy being a lot more demanding, the precision of the estimates is nevertheless quite reduced compared to the baseline RKD strategy.

Another way to test for the functional dependence between earnings and the outcome is to run RKD estimates using as the forcing variable a placebo, i.e. a proxy for previous earnings, that would not be too correlated with the highest quarter of earnings. In the CWBH data, the variable that is best suited for this strategy is the reemployment wage. Appendix Table A3 explores the robustness of the RKD results using the post unemployment wage as a placebo forcing variable instead of the pre-unemployment highest quarter of earnings. Results show that we cannot detect any effect in these placebo specifications[33].

I finally conduct a semi-parametric test inspired by the literature on the detection of structural breakpoints in time series analysis, following for instance Bai and Perron [2003]. The principle of the test is to try to non-parametrically detect the location of the kink by looking for the kink point that would minimize the residual sum of squares or equivalently maximize the R-squared. Details of the test are given in online appendix A.5. I report in figure A3 the evolution of the R-squared as I change the location of the kink point in specification (10). The evolution of the R-squared as one varies the location of the kink points provides evidence in support of the validity of the RKD design. The R-squared increases sharply as one moves closer to the actual kink point and then decreases sharply, supportive of the existence of a kink around 0.

Comparison to other studies: I replicate the RKD estimation procedure for all states and periods. All the estimates are displayed in appendix B. Overall, estimates of the elasticity of unemployment duration with respect to the benefit level are consistently between .1 and .7. The average elasticity of the duration of initial spell for all 5 states and periods is .32 (standard deviation is .2), where each period of analysis is defined as the entire period for which the benefit schedule is left unchanged and which represents a total of 26 different estimates. To get a sense of the validity of the RK design, it is useful to compare the RKD estimates to existing estimates in the literature. My estimates are on the lower end of the spectrum when compared to traditional benchmarks in the literature on US data. Estimation of the effect of UI benefit level in this literature has however always been struggling with the endogeneity issue due to the joint determination of UI benefits and previous earnings. Most empirical studies on US data therefore use

[33]Ganong and Jaeger [2014] propose a clever alternative test for curvature in the relationship between expected duration and previous earnings. The principle of the test is to use 4 part linear splines (therefore with two placebo kinks) instead of a 2 part linear spline. Using all 26 state$\times$period estimates, it is possible to look at the distribution of estimates at the true kink and at two placebo kinks (one at \$1000 and the other at -\$1000) in the 4 part linear splines. For the placebo kink at \$1000, the median point estimate is zero but not for the placebo kink at -\$1000 kink which suggest some curvature of expected duration with respect to earnings that may not be fully reflected in the conventional standard errors reported in my estimates.

proportional hazard models and add controls for previous earnings[34]. In table A4 in online appendix A.6, I report the estimates of Cox proportional hazard models on the CWBH data[35], which enables me to compare my results to the widely cited benchmark of Meyer [1990], who used a smaller sample of the same CWBH records. Appendix table A4 shows that the estimates of Meyer [1990], who found an elasticity of .56[36], can be fully replicated using his specification. The drawback of these estimates is that they may not fully address the endogeneity issue due to the joint determination of UI benefits and previous earnings. Meyer [1990] only controls for previous wages using the log of the base period earnings. Interestingly, if one adds a richer set of non parametric controls for previous earnings to mitigate the concern of endogeneity, and fully controls for variations across labor markets by adding time fixed effects interacted with state fixed effects, the results converge to the RKD estimates and the elasticity goes down to around .3. The reason is that, as one controls more efficiently for the functional dependence between unemployment duration and previous earnings, the only identifying variation in benefit level that is left comes from the kink in the benefit schedule, and the model naturally converges to the identification strategy of the RKD. Taken together, the results from these multiple robustness checks strongly support the validity of the RK design.

B. *Benefit Duration*

The existence of unemployment insurance extensions due to the EB program and the federal FSC program during the period covered by the CWBH creates frequent changes in the schedule of potential duration[37]. The schedule for potential duration applies based on the date of the week of certified unemployment so that changes in the schedule do usually affect ongoing spells. This complicates the estimation of the effect of potential duration in the CWBH sample because a fundamental requirement of the RK design is that the unemployed anticipate the stationarity of the schedule during the whole duration of their spell. Only observations for which the schedule did not change from the beginning of the spell to the end of the potential duration can be kept in the estimation sample for estimating the effect of potential duration on actual unemployment duration. In Louisiana for instance, when I restrict the sample to spells with a stationary schedule throughout the whole potential duration of the spell, I am left with only

[34]See for instance estimates in Chetty [2008], Kroft and Notowidigdo [2011] or Spinnewijn [2010], and surveys in Holmlund [1998] or Krueger and Meyer [2002]

[35]All the details of the estimation procedure are given in appendix A.6.

[36]See Meyer [1990], Table VI, column (7). Coefficient estimates for log(b) in the proportional hazard models of table A4 can be interpreted as the elasticity of the hazard rate s with respect to the weekly benefit level. However, under the assumption that the hazard rate is somewhat constant, these elasticities can be easily compared to the RKD elasticities of unemployment duration, since $D \approx 1/s$ so that $\varepsilon_D \approx -\varepsilon_s$

[37]In Louisiana for instance the schedule changed 11 times between January 1979 and December 1983.

3 sub periods[38]. Because of these constraints, the number of estimates for the effect of potential duration is more limited than for the effect of benefit level.

The ratio of base period earnings (bpw) divided by highest quarter earnings (hqw) is the assignment variable in the schedule of potential UI duration as explained in section II.A and plotted in figure 3. Figure 6 panel B plots the mean values of the duration of UI claims in each bin of bpw/hqw and centered at the kink in the schedule of potential duration. The graph provides evidence of a kink in the relationship between the assignment variable and the duration of UI claims at the kink in the schedule of potential duration. But the smaller sample size at the kink makes the relationship between the outcome and the assignment variable a little noisier visually than in the case of the kink in the benefit level schedule depicted in figure 6.

Table 3 presents the results for the average treatment effect $\widehat{\beta}$ of a one week increase in potential duration with robust standard errors for Louisiana. For each of the three sub periods with stable schedules, I report the estimates of the preferred polynomial specification based on the Aikake Information Criterion. The effect of an additional week of UI on average duration is consistently around .2 to .4 for all duration outcomes and sub-periods of interest. The linear specification is always preferred and is never rejected by the Goodness-of-Fit test as indicated by the reported p-values. For covariates in columns (4) to (8), to the contrary, the same estimation procedure does not reveal any kink in the relationship with the assignment variable, which supports the validity of the RK design. Note that the average duration of UI claims when benefit exhaust after B weeks and $S(t)$ is the survival rate at time t is: $D_B = \displaystyle\sum_{t=0}^{B-1} S(t)$. The effect of a one week increase in the potential duration of unemployment benefits dB on the average duration of UI claims is $\frac{dD_B}{dB} = \displaystyle\sum_{t=0}^{B-1} \frac{dS(t)}{dB} + S(B)$, which is the sum of a behavioral response $\sum_{t=0}^{B-1} \frac{dS(t)}{dB}$ and of the mechanical effect $S(B)$ of truncating non-employment durations one week later. The average exhaustion rate for all UI tiers $S(B)$ is between 11% and 18% as shown in table 1. This suggests that the .2 - .4 week estimated response is not entirely driven by the mechanical effect, but that only a half to two-third of the estimated response can be attributed to the behavioral response.

The estimates of an increase of .2 to .4 weeks of unemployment with each additional week of UI, which translates into an elasticity of unemployment claims with respect to potential duration of .4 to .8, are in line with previous estimates in the US such as Moffitt [1985b], Card and Levine [2000], and Katz and Meyer [1990]. They are higher than existing estimates in Europe using RD designs such

[38]The first sub period contains all spells beginning between 01/14/1979 and 01/31/1980, the second contains all spells beginning between 09/12/1981 and 05/01/1982, and finally the third sub period contains all spells beginning after 06/19/1983 to 31/12/1983.

as Schmieder, von Wachter and Bender [2012] for Germany. This could be due to much longer baseline durations in European UI systems. In Schmieder, von Wachter and Bender [2012] for instance, baseline potential durations, at which the effect of an extension of UI are estimated, are between 12 to 24 months, which is 2 to 4 times longer than in the US. They are also larger than the estimates of Rothstein [2011], who finds very small effects of UI extensions during the Great Recession. His identification strategies however might be picking up equilibrium effects in the labor market, which might be lower during recessions in the presence of negative job search externalities as suggested in Landais, Michaillat and Saez [2010].

IV. Moral hazard, liquidity and welfare calibrations

A. *Liquidity effects and calibrations*

To calibrate the welfare effects of UI following the (transformed) Baily-Chetty formula of Chetty [2008], I need estimates of the elasticities of paid unemployment duration and of total non-employment duration, as well as estimates of the liquidity to moral hazard ratio. In the CWBH data, Washington is the only state for which information on total non-employment duration is available through the matched UI records-wage records. I therefore now restrict interest to Washington. To compute the liquidity to moral hazard ratio, one needs to estimate at the same time the effect of benefit level and that of potential duration. I therefore focus on the longest period (July 1980 to July 1981) for which we have a stationary schedule in Washington for both benefit level and potential duration. In table 4, I give in column (1) and (2) RKD estimates of the elasticities for the period of interest in Washington.

Estimation of liquidity and moral hazard effects: The estimation of liquidity and moral hazard effects follows from the application of the result of proposition 1. The result of proposition 1 relies on the assumption that the liquidity constraint is not yet binding at the exhaustion point B. I provide in online appendix A.8 a simple test for this assumption. The intuition for the test is the following. If the liquidity constraint is binding, it means that the unemployed can no longer deplete their asset; they are hand-to-mouth, and therefore, benefits that they have received in the past do not have any effect on their future behavior. If to the contrary, exit rates after the exhaustion point are affected by benefits received before exhaustion, it means that agents can still transfer part of their consumption across time periods. Results, reported in the appendix, show that one additional dollar of UI before 39 weeks reduces the exit rate of unemployment after exhaustion, between 40 weeks and 60 weeks, by a statistically significant .2 percentage point. These estimates suggest that the Euler equation holds and that variations in benefits prior to exhaustion affect exit rate of unemployment after the exhaustion point.

In practice, to implement the result of the result of proposition 1, I estimate separately in the regression kink design the effect of an increase in benefit level ($\frac{\partial s_0}{\partial b}\Big|_B$) and of an increase in potential duration ($\frac{\partial s_0}{\partial B}$) on the hazard rate out of unemployment at the beginning of a spell[39]. Proposition 1 requires that we estimate the effect of benefit level and potential duration for the same individuals. To ensure that the characteristics of individuals at both kinks (in benefit level and potential duration) are the same, I use a re-weighting approach described in online appendix A.10. Column (3) of table 4 reports ($\frac{1}{B}\ \frac{\partial s_0}{\partial b}\Big|_B - \frac{1}{b}\frac{\partial s_0}{\partial B}$), the difference between the RKD estimate of the effect of benefit level (divided by the potential duration) and the RKD estimate of the effect of potential duration (divided by the benefit level) on s_0. Standard errors for all statistics in column (3) are bootstrapped with 50 replications[40]. By a simple application of proposition 1, this difference is then divided by $\Phi_1 = -\frac{\overline{S_1^B} - S_1(B)}{D_1^B}$ to compute the moral hazard effect Θ_1 of an increase in benefit level and the ratio of liquidity to moral hazard ρ_1 in the effect of an increase in benefit level. I use the observed average survival rates and durations for the full period July 1980 to July 1981 in Washington and for individuals at the kink of benefit level in order to compute Φ_1.

The estimate reported in column (3) suggests the existence of substantial liquidity effects, with a ratio of liquidity effect to moral hazard effect of 88%. This estimate is however smaller than the figures reported in Chetty [2008], who finds a ratio of roughly 1.5 using data on severance payments. The great advantage of the RKD strategy is to be able to estimate liquidity effects from administrative UI data directly, without the need for information on severance payments or for consumption data.

Calibrations I now use these estimates to calibrate the welfare effects of UI. The optimal UI formulas expressed in terms of ratio of liquidity to moral hazard are presented, derived and explained in online appendix C.4 and C.5. To calibrate the Insured Unemployment Rate $D_B/(T-D)$, I use the total number of paid unemployed divided by the total number of employees paying payroll taxes in the wage records in Washington for the period July 1980 to July 1981. This yields $D_B/(T-D) \approx 3.9\%$. Similarly, I calibrate $D/T - D \approx 8.5\%$ as the average unemployment rate in Washington during the period computed from CPS[41]. $\omega_1 = \frac{B}{D_B - s_0(B-1)} - 1 \approx 17$ is calibrated directly from the CWBH data

[39]To increase the precision of the estimates, I define s_0 as the probability of exiting unemployment in the first 4 weeks. Shorter definitions for period 0 yield similar results but the standard errors on the estimates of the effect of potential duration increase sharply.

[40]To be precise, I merge observations from both samples, the one at the benefit level kink and the one at the potential duration kink, and draw with replacement 50 different samples from that merged sample. I then replicate the full estimation procedure from these 50 samples to compute the standard errors on ($\frac{1}{B}\ \frac{\partial s_0}{\partial b}\Big|_B - \frac{1}{b}\frac{\partial s_0}{\partial B}$), Θ_1 and ρ_1.

[41]The way I calibrate the ratios $D_B/(T-D)$ and $D/T-D$ relies on the assumption, implicit in the model, that each state UI agency balances its own budget every period. This assumption is somewhat restrictive, since the federal government subsidizes state UI agencies in practice. In particular, half of

in Washington. Plugging the estimated elasticities of column (2) of table 4 into formula (31) of the appendix yields the right-hand side of the optimal formula $\omega_1 \frac{D_B}{T-D}(1+\varepsilon_{D_B}+\varepsilon_D \frac{D}{T-D}) \approx 1.14$. With a ratio of liquidity to moral hazard $\rho_1 \approx .88$, it means that the left-hand side of the formula $(1+\rho_1 \approx 1.88)$ is greater than the right-hand side. This indicates that increasing the benefit level from its current level would be welfare increasing[42]. Similarly, one can calibrate the formula for the welfare effects of the potential duration of UI, derived in online appendix C.5. Under the approximation that $\rho_2 \approx \rho_1$, and given that in the CWBH data, $\omega_2/B \approx 14.2$, the right-hand side of equation (33) is approximately equal to 1.29, which is again lower than the left-hand side of the formula. Once again, the result of this calibration suggest that a small increase in the potential duration of UI would be welfare increasing.

V. Conclusions

This paper has shown how, in the tradition of the dynamic labor supply literature, one can identify the moral hazard and liquidity effects of UI using variations along the time profile of UI benefits brought about by exogenous variations in the benefit level as well as in the benefit duration. My strategy only relies on exploiting individuals' first order conditions and variations in the time profile of benefits, which makes it easily generalizable and applicable to any other transfer program with time-dependent benefits.

I have implemented this strategy using variations in UI benefit level and UI benefit duration in the RK design. Overall, my results confirm the evidence in Chetty [2008] that liquidity effects are substantial, and that an increase in the replacement rate and duration of UI might be welfare increasing[43] The advantage of calibrating the welfare formula using the regression kink design as described in this paper, is that the formula can technically be tested in real time, so that any UI administration could easily estimate the welfare effects of the small adjustments that are usually done in UI legislation such as a change in the maximum benefit amount.

Yet, the calibrations presented here are obtained in a very stylized version of the labor market[44]. Models in the tradition of Baily [1978] and Chetty [2006] such as the one presented here take a pure partial equilibrium view of the labor

the cost of EB extensions is paid by the federal budget.

[42]Note that the Baily formula focuses on the optimal UI benefit level net of all taxes. The switch operated in the 1980s towards making UI benefit part of the income tax base may have reduced the net-of-tax benefit level even further from the optimal benefit level b obtained from my calibration.

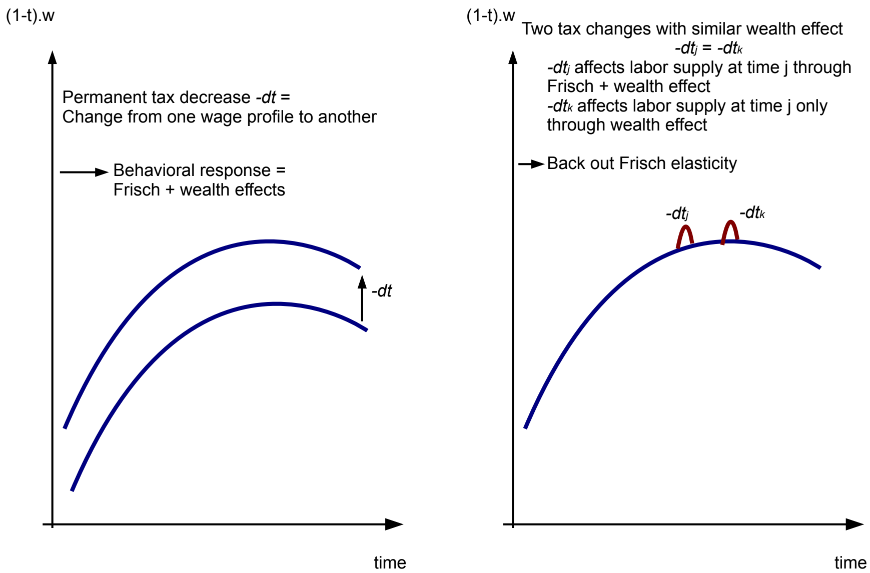
[43]It is important however to remember that these policy recommendations are only valid locally, at the value of the policy parameters at which the statistics entering the formula are estimated. Extrapolating the optimal level of benefit and duration of UI from these statistics would require the implausible assumption that all statistics would remain unchanged if we were to modify the policy parameters.

[44]Note for instance that calibrations have assumed perfect take-up of UI. As shown in Kroft [2008], in the presence of responses to UI at the extensive margin with endogenous take-up costs, social multiplier effects arise and the optimal replacement rates can be substantially higher than in traditional models with responses only along the intensive margin.

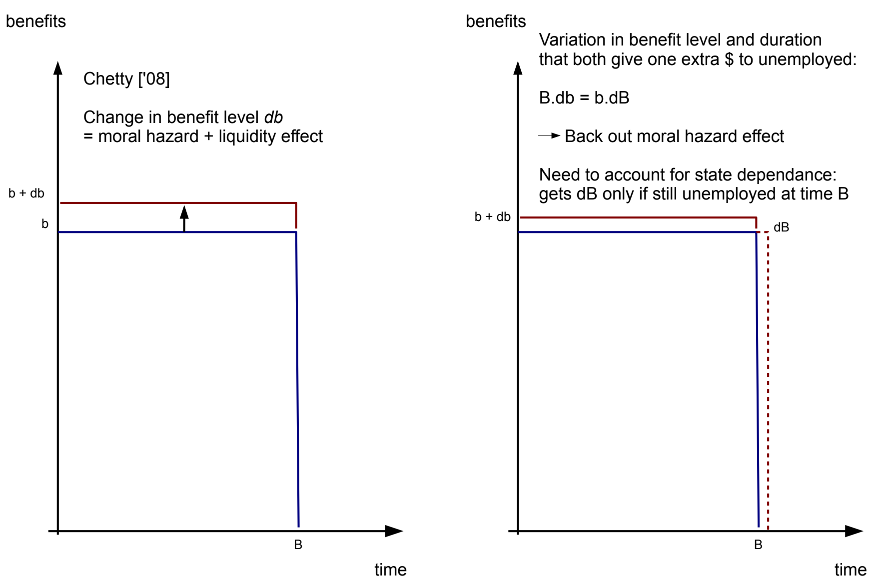
market, with an infinitely elastic labor demand. The unemployment problem is represented as a pure labor supply story, with no effect of UI on labor market equilibrium through labor demand effects. As shown in Landais, Michaillat and Saez [2010], in equilibrium search-and-matching models of the labor market, partial equilibrium labor supply responses to UI are no longer sufficient to compute the optimal trade-off between insurance and moral hazard, and one needs to estimate equilibrium employment responses as well.

Figure 1. Backing out moral hazard effects in dynamic labor supply models

A. Standard dynamic labor supply model

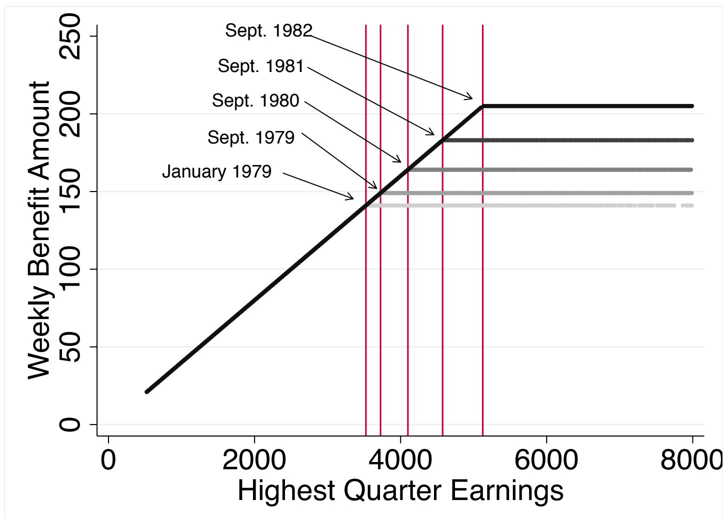


B. Dynamic UI model



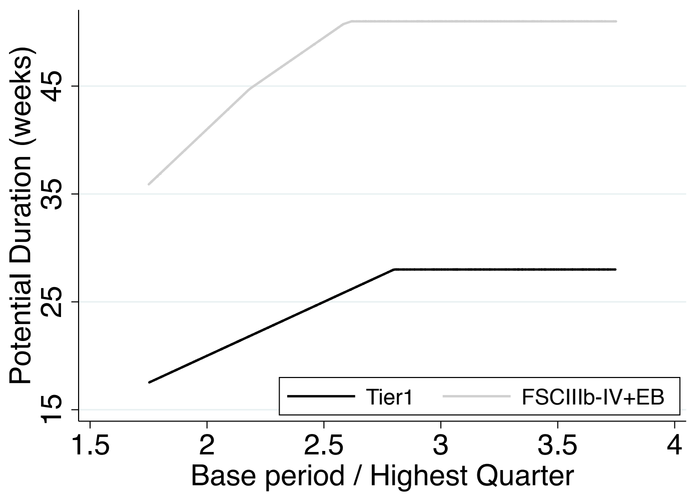
Notes: The figure explains the decomposition of tax / UI benefits changes into wealth effects and moral hazard (or Frisch) effects, and the relationship between the "Macurdy critique" (MaCurdy [1981]) and the liquidity vs moral hazard decomposition of Chetty [2008]. Panel A-left, shows the effect of a permanent tax change on the wage profile of an individual: the net return to work is affected every period, but so will the expected lifetime wealth of the individual. The behavioral response of labor supply to this tax change will be a mix of wealth and Frisch effects. In panel A-right, a marginal tax change at time j and a marginal tax change at time k will have a similar wealth effect on labor supply at time j, but the marginal tax change at time k will only affect labor supply at time j through the wealth effect. Comparing the effect of these two tax changes on labor supply at time j will therefore identify Frisch effects (MaCurdy [1981]). Panel B plots a change in the benefit level db received by the unemployed for the first B periods in a two-tier UI benefits system. This change in benefit is a full shift of the profile of the return to search effort, as in panel A-left, and its effects on search effort will be a mix of wealth effects and of distortionary "Frisch" effects (or moral hazard effects, Chetty [2008]). But the idea of exploiting variations in the net return to search effort at different points in time can also be implemented using variations in benefit level db and in the potential duration of benefits dB as shown in panel B-right. The only difference is the presence of state-dependence: search effort today affects in which state one will be tomorrow. When increasing potential duration dB, one only gets the higher benefits if still unemployed after B periods. Because of this, variations in future benefits do not only have an effect on current job search effort through the marginal utility of wealth, but also through the net return to search effort today. The difference in the effect of current and future benefits on search effort today only identifies the moral hazard effect up to a term that depends on the ex-ante survival function, as shown in proposition 1.

Figure 2. Louisiana: Schedule of UI Weekly Benefit Amount, jan1979-Dec1983



Source: Louisiana Revised Statutes RS 23:1592 and yearly *Significant Provisions of State Unemployment Insurance Laws* 1976 to 1984, Dpt of Labor, Employment & Training Administration.
Note: The graph shows the evolution of the schedule of the weekly benefit amount (WBA) in nominal terms as a deterministic and kinked function of the highest quarter of earnings in Louisiana. The schedule applies based on the date the UI claim was filed, so that a change in the maximum weekly benefit amount does not affect the weekly benefit amount of ongoing spells.

Figure 3. Louisiana: Schedule of UI Potential Duration, jan1979-Dec1983

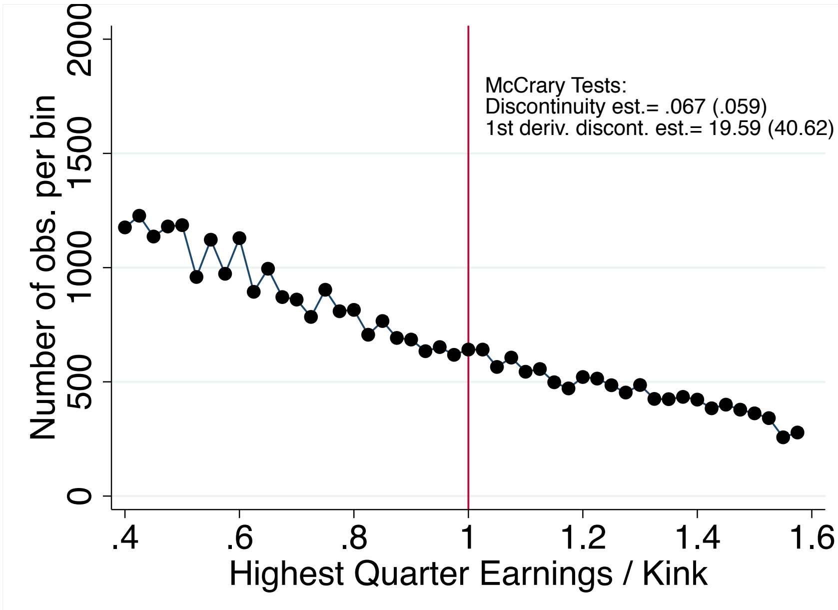


Source: Louisiana Revised Statutes RS 23:1592 and weekly state trigger notice reports

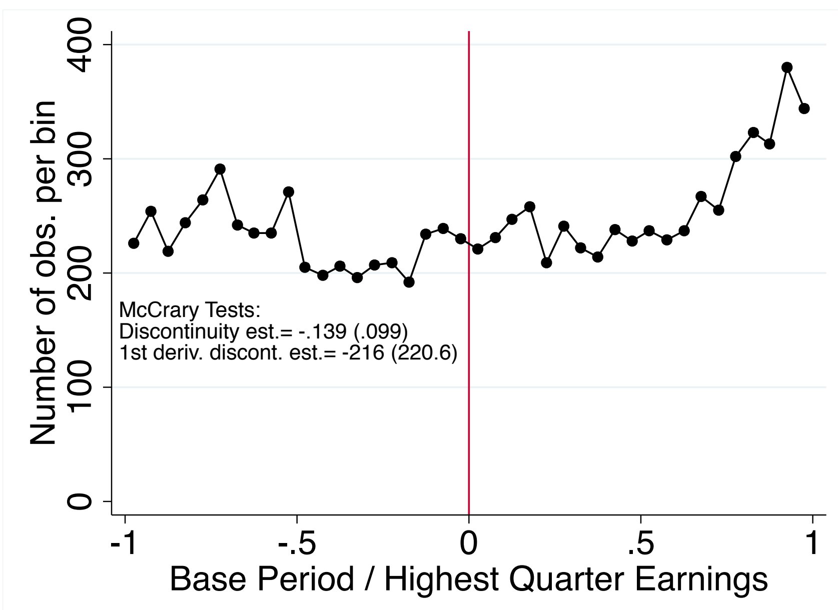
Note: The graph shows the evolution of the schedule of the potential duration of UI benefits as a deterministic and kinked function of the ratio of base period earnings to highest quarter of earnings in Louisiana. The schedule applies based on the date of the week of certified unemployment so that changes in the schedule do usually affect ongoing spells. In normal times, the potential duration is determined by the regular state UI program (Tier 1). During recessions, and conditional on states' labor market conditions, two additional UI programs (Extended Benefit program, and Federal extensions) may extend the potential duration over the maximum duration of Tier 1 which may affect the size and location of the kink. The graph shows for instance the schedule applying during most of 1983 when both the EB and Federal extensions (FSC-III and FSC-IV) were in place in Louisiana.

Figure 4. RKD graphical evidence of the Effect of Unemployment Benefits: Duration of UI Claims

A. Assignment variable: RKD for benefit level

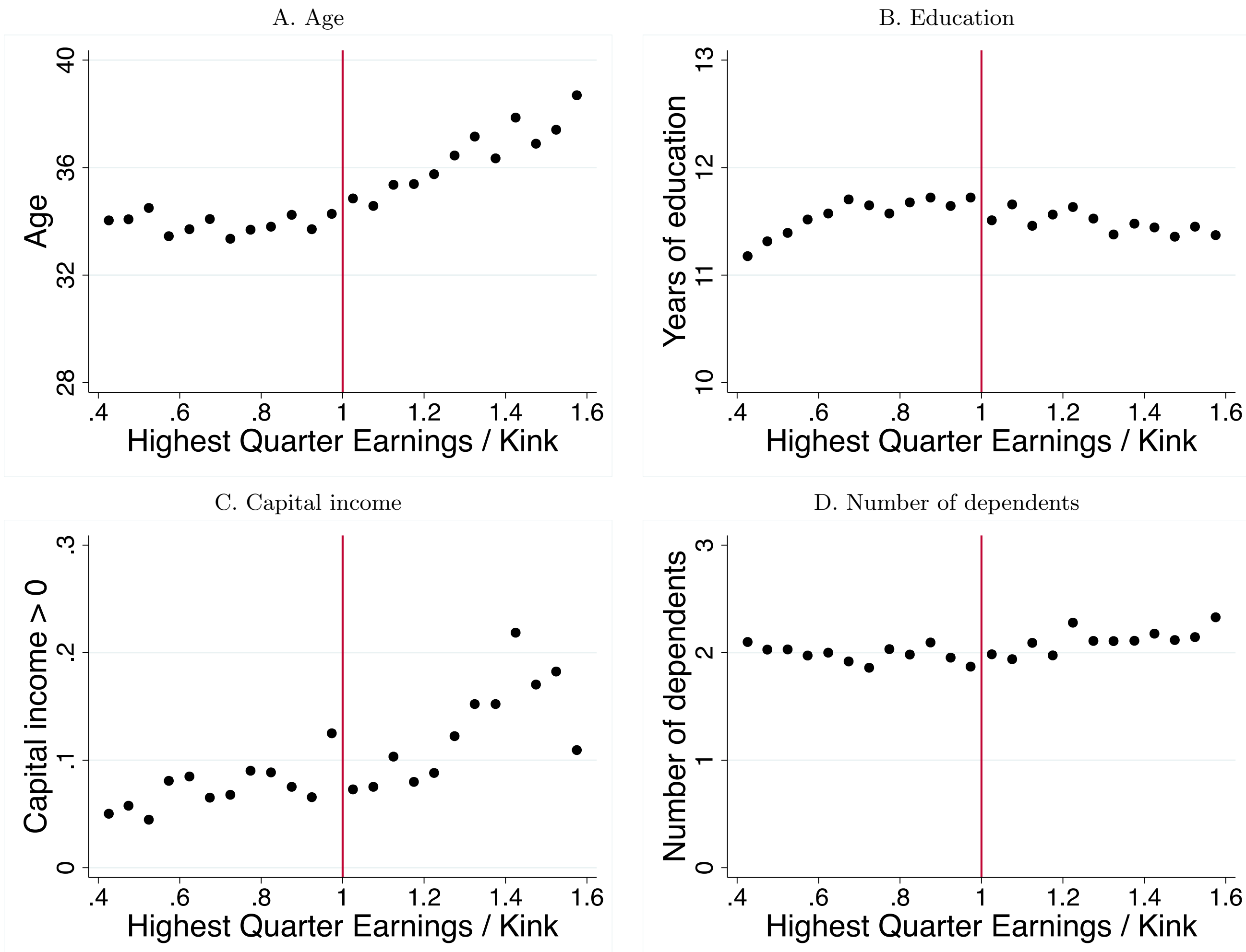


B. Assignment variable: RKD for potential duration



Notes: The graph assesses the validity of the assumptions of the RK design by testing graphically the smoothness of the distribution of the assignment variable at the kink point in the UI schedules. Panel A shows the probability density function of the assignment variable for the schedule of UI benefit level, normalized at the kink point. Panel B shows the probability density function of the assignment variable for the schedule of UI potential duration, centred at the kink point. I also display two tests of the identifying assumptions of the RKD. The first is a standard McCrary test of the discontinuity of the p.d.f of the assignment variable. I report here the log difference in height of the p.d.f at the kink. The second is a test for the continuity of the first derivative of the p.d.f. I report here the coefficient estimate of the change in slope of the p.d.f in a regression of the number of individuals in each bin on polynomials of the assignment variable interacted with a dummy for being above the kink. See text for details.

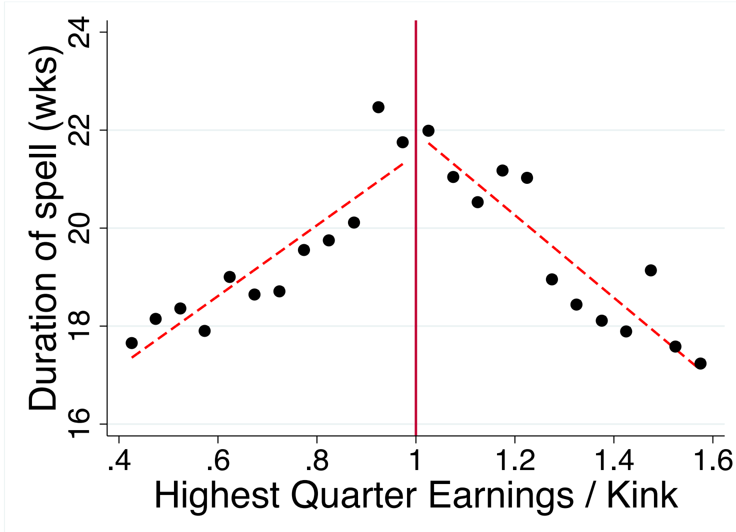
Figure 5. Distribution of Highest Quarter Earnings and Covariates, Louisiana



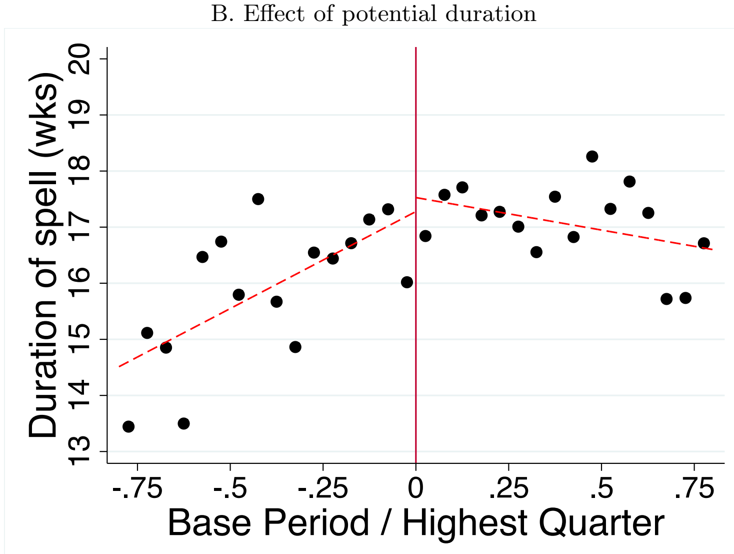
Notes: The graphs test the validity of the smoothness assumptions of the RK design (for the first sub-period of analysis in Louisiana). For all 4 panels, highest quarter of earnings, which is the assignment variable in the RK design for the estimation of the effect of benefit level, is normalized by the kink point. The binsize is .05 and passes the test of excess smoothing recommended in Lee and Lemieux [2010]. Each panel shows the mean values of a different covariate in each bin of the assignment variable. The graph shows evidence of smoothness in the evolution of covariates at the kink, in support of the RKD identification assumptions. Formal tests of smoothness are displayed in table 2.

Figure 6. RKD graphical evidence of the Effect of Unemployment Benefits: Duration of UI Claims, Louisiana 1979-1984

A. Effect of benefit level

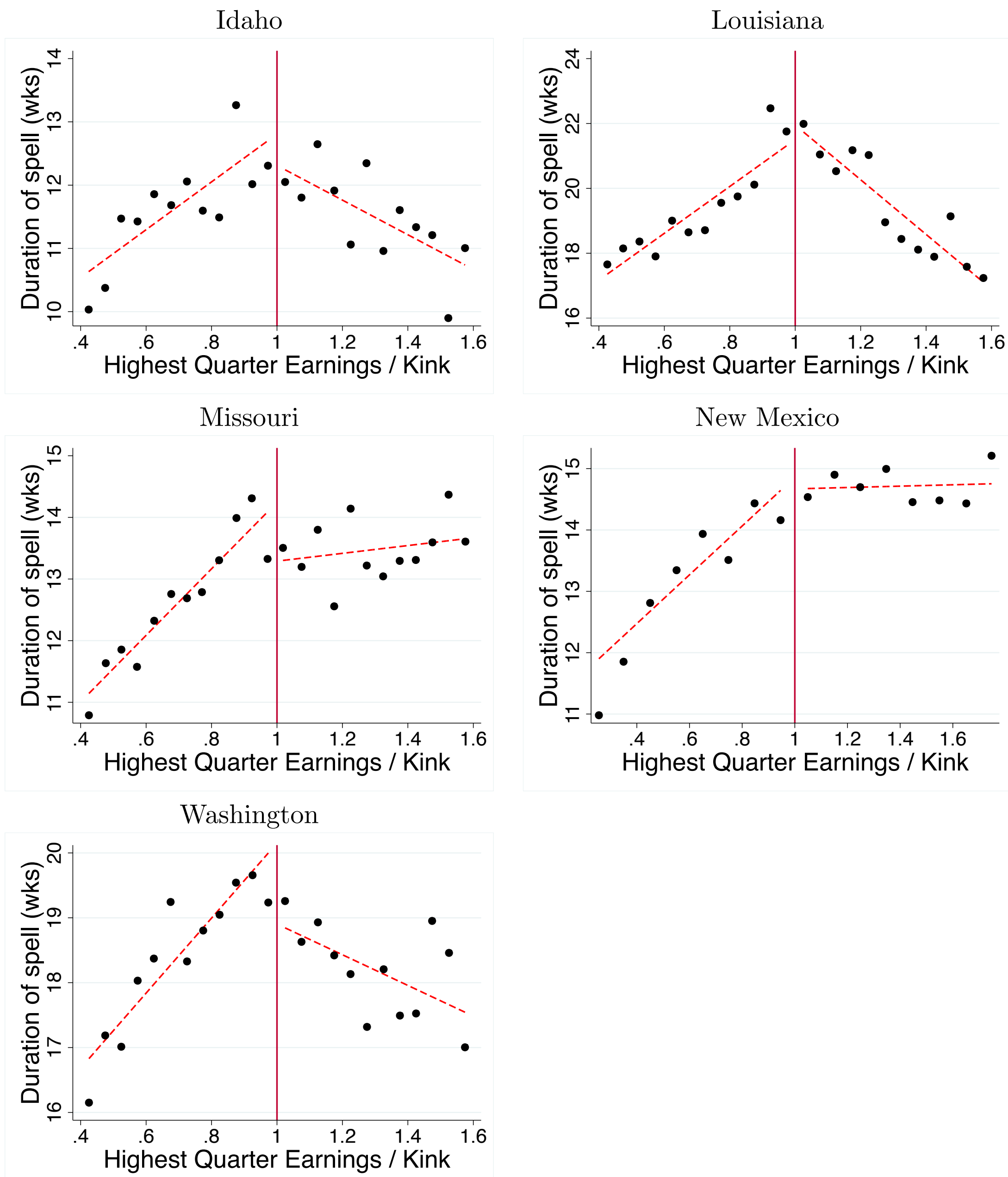


B. Effect of potential duration



Notes: Panel A shows for the first sub-period of analysis in each state the mean values of the duration of UI claims in each bin of highest quarter of earnings normalized at the kink point in the schedule of the weekly benefit amount. The graph shows evidence of a kink in the evolution of the outcome at the kink. Formal estimates of the kink using polynomial regressions of the form of equation 10 are displayed in table 2. The red lines display predicted values of the regressions in the linear case allowing for a discontinuous shift at the kink. Panel B shows the mean values of the duration of initial spell in each bin of the ratio of base period earnings (*bpw*) divided by highest quarter earnings (*hqw*), which is the assignment variable in the schedule of potential UI duration, and centered at the kink point in the schedule. The graph shows evidence of a kink in the evolution of the outcome at the kink. Formal estimates of the kink are displayed in table 3. The red lines display predicted values in the linear case allowing for a discontinuous shift at the kink.

Figure 7. RKD evidence of the Effect of Benefit Level: Duration of UI Claims vs Highest Quarter Earnings for All 5 States



Notes: The graph shows in each state the mean values of the duration of UI claims in each bin of highest quarter of earnings normalized by the kink point in the schedule of the UI benefit level. The graph shows evidence of a kink in the evolution of the outcome at the kink. Formal estimates of the kink using polynomial regressions of the form of equation 10 are displayed in table 2 and appendix tables B2 to B5. The red lines display predicted values of the regressions in the linear case allowing for a discontinuous shift at the kink.

Table 1—Descriptive Statistics for full CWBH sample

	Idaho			Louisiana		
	Mean	s.d.	N	Mean	s.d.	N
	Duration Outcomes (wks)					
Initial spell	13.8	12.3	33125	17.5	14.1	44702
wks UI paid	11.7	10.7	33125	17.3	13.8	44702
wks UI claim	15.8	12.2	33125	18.7	13.7	44702
	Earnings and Benefits ($2010)					
bpw	25163	22227	33125	26894	19029	44702
hqw	9835	16463	33125	9538	6228	44702
wba	261.8	86.3	33125	305.2	115.8	44702
pot. duration Tier I	20	5.5	33125	24.9	4.3	44702
kink / avg hqw	1.44	.9	33125	1.65	1.35	44702
% with max b	.37	.48	33125	.35	.48	44702
% with max D	.31	.46	33125	.64	.48	44702
Avg repl. rate	.44	.12	33125	.47	.09	44702
Exhaustion rate	.11	.29	33125	.13	.31	44702
	Covariates					
age	30.2	12.8	33121	34.6	12.6	44373
male	.67	.47	33121	.7	.46	44058
educ. (yrs)	12	2.2	17627	11.4	2.7	41308
dependents	2	1.6	18688	2.1	1.6	22525

	Missouri			New Mexico		
	Mean	s.d.	N	Mean	s.d.	N
	Duration Outcomes (wks)					
Initial spell	12.2	10.9	28599	14	12.6	27004
wks UI paid	12.5	11.4	28599	13.4	12.8	27004
wks UI claim	15.4	11.8	28599	15.8	12.6	27004
	Earnings and Benefits ($2010)					
bpw	23756	17346	28599	23334	17132	27004
hqw	8218	5835	28599	8252	5382	27004
wba	224.9	51.4	28599	230	69.5	27004
pot. duration Tier I	22.1	5.2	28599	25.7	1	27004
kink / avg hqw	.98	.74	28599	1.3	.8	27004
% with max b	.64	.48	28599	.43	.5	27004
% with max D	.52	.5	28599	.92	.27	27004
Avg repl. rate	.45	.16	28599	.43	.11	27004
Exhaustion rate	.18	.37	28599	.14	.32	27004
	Covariates					
age	34.8	12.7	28585	33.7	11.4	26924
male	.61	.49	28597	.65	.48	27002
educ. (yrs)	11.3	2.2	1852	11.7	2.5	26482
dependents	2	1.6	21701	2.2	1.7	25534

TABLE 1—(CONTINUED) DESCRIPTIVE STATISTICS FOR FULL CWBH SAMPLE

	Washington		
	Mean	s.d.	N
	Duration Outcomes (wks)		
Initial spell	17.6	15.4	41992
wks UI paid	16.2	14.8	41992
wks UI claim	18.9	15.4	41992
wks non-employed	27.9	16.3	38035
	Earnings and Benefits ($2010)		
bpw	31232	20380	41992
hqw	8982	5321	41992
wba	286.7	94.7	41992
pot. duration Tier I	27	4.2	41992
kink / avg hqw	1.49	1.2	41992
% with max b	.37	.48	41992
% with max D	.56	.5	41992
Avg repl. rate	.47	.21	41992
Exhaustion rate	.12	.31	41992
	Covariates		
age	34.2	11.9	41955
male	.627	.484	41972
educ. (yrs)	12.4	2.4	41702
dependents	1.7	1.5	28834

Notes: The initial spell, as defined in Spiegelman, O'Leary and Kline [1992], starts at the date the claim is filed and ends when there is a gap of at least two weeks in the receipt of UI benefits. The duration of paid UI corresponds to the number of weeks a claimant receives unemployment compensation. The duration of a UI claim is the number of weeks a claimant is observed in the administrative data for a given unemployment spell. bpw is the base period earnings, and hqw is the highest quarter of earnings. wba is the weekly benefit amount of UI. Potential duration Tier I is the potential duration of the regular state UI program.

Table 2—RKD Estimates of the effect of benefit level, Louisiana 1979-1983

	(1) Duration of Initial Spell	(2) Duration UI Claimed	(3) Duration UI Paid	(4) Age	(5) Male	(6) Years of Education	(7) Number of Dependents
				Jan-Sep 1979			
α	.006	.007	.006	-.121	0	.002	.004
	(.006)	(.006)	(.006)	(.069)	(.002)	(.014)	(.01)
ε_b	.183	.228	.186				
	(.183)	(.184)	(.165)				
p-value	.216	.274	.283	.116	.506	.056	.262
N	2129	2129	2129	2117	2106	1953	1479
				Sep 1979-Sep 1980			
α	.018	.019	.018	.052	-.001	.003	-.001
	(.005)	(.005)	(.005)	(.056)	(.002)	(.012)	(.001)
ε_b	.484	.518	.45				
	(.143)	(.142)	(.131)				
p-value	.589	.389	.499	.659	.041	.735	.742
N	3765	3765	3765	3752	3723	3483	2042
				Sep 1980-Sep 1981			
α	.018	.019	.018	.054	.002	-.025	-.026
	(.006)	(.006)	(.006)	(.069)	(0)	(.016)	(.01)
ε_b	.455	.467	.422				
	(.147)	(.148)	(.135)				
p-value	.007	.003	.006	.509	.064	.992	.908
N	3133	3133	3133	3116	3089	2932	1849
				Sep 1981-Sep 1982			
α	.042	.038	.04	.051	-.001	0	0
	(.009)	(.009)	(.009)	(.059)	(.002)	(.014)	(.014)
ε_b	.708	.665	.644				
	(.154)	(.154)	(.142)				
p-value	.091	.178	.108	.43	.595	.314	.28
N	3845	3845	3845	3823	3786	3553	1351
				Sep 1982-Dec 1983			
α	.047	.046	.042	-.013	-.001	.001	-.001
	(.006)	(.006)	(.006)	(.005)	(.001)	(.001)	(.001)
ε_b	.757	.763	.667				
	(.103)	(.105)	(.098)				
p-value	.199	.175	.084	.64	.508	.261	.843
N	6602	6602	6602	6558	6520	6078	3531

Notes: Duration outcomes are expressed in weeks. α is the RK estimate of the average treatment effect of benefit level on the outcome. Robust standard errors for the estimates of α are in parentheses. The elasticity of the three duration outcomes with respect to the UI benefit level $\varepsilon_b = \widehat{\alpha} \cdot \frac{b_{max}}{\overline{Y_1}}$, where $\overline{Y_1}$ is mean duration at the kink point, are also reported. P-values are from a test of joint significance of the coefficients of bin dummies in a model where bin dummies are added to the polynomial specification in equation 10. All estimates are for the linear case. Each period corresponds to a stable schedule for the benefit level (cf. figure 2).

Table 3—Baseline RKD Estimates of the effect of potential duration, Louisiana

	(1) Duration of Initial Spell	(2) Duration UI Claimed	(3) Duration UI Paid	(4) Age	(5) Years of Education	(6) Male	(7) Dependents
	Period 1: Jan 1979 - Jan 1980						
β	.21	.184	.211	-.277	.013	.006	-.027
	(.113)	(.114)	(.111)	(1.609)	(.03)	(.006)	(.024)
ε_B	.413	.363	.38				
	(.223)	(.225)	(.2)				
Opt. Poly	1	1	1	3	1	1	1
p-value	.557	.484	.471	.338	.087	.511	.022
N	3497	3497	3497	3476	3216	3465	2208
	Period 2: Sep 1981 - Apr 1982						
β	.349	.352	.335	-.251	.005	.002	-.023
	(.141)	(.138)	(.136)	(.135)	(.029)	(.005)	(.03)
ε_B	.793	.804	.71				
	(.32)	(.315)	(.289)				
Opt. Poly	1	1	1	1	1	1	1
p-value	.133	.149	.107	.486	.493	.842	.388
N	2165	2165	2165	2148	1959	2138	888
	Period 3: Jun 1983 - Dec 1983						
β	.387	.363	.334	-.061	-.014	.006	-.125
	(.088)	(.086)	(.085)	(.079)	(.019)	(.003)	(.061)
ε_B	.854	.851	.708				
	(.194)	(.201)	(.181)				
Opt. Poly	1	1	1	1	1	1	2
p-value	.675	.751	.742	.624	.898	.493	.754
N	2936	2936	2936	2917	2720	2904	1601

Notes: Duration outcomes are expressed in weeks. β is the RK estimate of the average treatment effect of potential duration on the outcome. Standard errors for the estimates of β are in parentheses. P-values are from a test of joint significance of the coefficients of bin dummies in a model where bin dummies are added to the polynomial specification in equation 10. The optimal polynomial order is chosen based on the minimization of the Aikake Information Criterion.

Table 4—RKD estimates of behavioral responses to UI and liquidity and moral hazard effect estimates, Washington, Jul 1980 - Jul 1981

	(1)	(2)	(3)
	Effect of benefit level	**Effect of potential duration**	**Liquidity and moral hazard estimates**
ε_{D_B}	.730	1.348	
	(.110)	(.685)	
	[.814]	[.388]	
ε_D	.291	.330	
	(.071)	(.425)	
	[.392]	[.474]	
$(\frac{1}{B}\frac{\partial s_0}{\partial b}\Big\|_B - \frac{1}{b}\frac{\partial s_0}{\partial B}) \times 10^3$			-.042
			(.01)
Moral Hazard:			.0014
Θ_1			(.0001)
Liquidity to Moral Hazard:			.876
ρ_1			(.022)
N	6061	2049	9471

Notes: For all columns, standard errors for the estimates are in parentheses. P-values are reported between brackets and are from a test of joint significance of the coefficients of bin dummies in a model where bin dummies are added to the polynomial specification in equation 10. Results are obtained from a linear specification. The bandwidth for the RK estimate of benefit level is 2500 (assignment variable: highest quarter of earnings) and .75 for the RK estimate of the potential duration (assignment variable: ratio of base period to highest quarter of earnings). This table shows how to use the RKD to estimate all the statistics needed to calibrate the welfare effects of UI. Column (1) reports the RKD estimate of the elasticity of UI duration (ε_{D_B}) and of the elasticity of non-employment duration (ε_D) with respect to benefit level. Column (2) reports the RKD estimate of the same elasticities with respect to potential duration. Column (3) reports the liquidity and moral hazard effect estimates following the strategy detailed in proposition 1. $(\frac{1}{B}\frac{\partial s_0}{\partial b}\Big|_B - \frac{1}{b}\frac{\partial s_0}{\partial B})$ is the difference between the RKD estimate of the effect of benefit level (divided by the potential duration) and the RKD estimate of the effect of potential duration (divided by the benefit level) on s_0 defined as the exit rate out of unemployment in the first 4 weeks of unemployment. To ensure that the characteristics of individuals at both kinks (in benefit level and potential duration) are the same, I use a reweighing approach described in appendix B. Following proposition 1, this difference is then used to compute the moral hazard effect Θ_1 of an increase in benefit level and the ratio of liquidity to moral hazard ρ_1 in the effect of an increase in benefit level. For the three statistics of column (3), bootstrapped s.e. with 50 replications are in parentheses. See text for additional details.

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ONLINE APPENDIX
Not for publication

A. Additional Results, Figures and Tables on the Robustness of the RK Design

1. *Sensitivity of RKD estimates to bandwidth and polynomial order.*

In table A1 panel A, I begin by analyzing the sensitivity of the results to the choice of the polynomial order. I group unemployment spells over all five periods periods, which has the advantage of providing with a larger number of observations at the kink for statistical power. I display the results of the estimation of equation 10 for a linear, a quadratic, and a cubic specification. For all three specifications, the bandwidth is set at 2500. I also report the Aikake Information Criterion (AIC) for all specifications. The estimates for α are of similar magnitude across the different specifications. Standard errors of the estimates nevertheless increase quite substantially with higher order for the polynomial. The AIC suggest that the quadratic specification is always dominated but the linear and the cubic specification are almost equivalent, and none of them is too restrictive based on the p-values of the Goodness-of-Fit test. Table A1 panel B explores the sensitivity of the results to the choice of the bandwidth level. Results are consistent across bandwidth sizes, but the larger the bandwidth size, the less likely is the linear specification to dominate higher order polynomials. Overall though, it should be noted that the RKD does pretty poorly with small samples, and therefore is quite demanding in terms of bandwidth size compared to a regression discontinuity design. In practice, I found that the precision and consistency of the estimates would fall quite substantially when reducing bandwidth sizes below 1500.

Table A1—Sensitivity analysis of the RKD Estimates, Effect of Benefit Level, Louisiana Sept 81- Dec 83

	(1)	(2)	(3)		(4)	(5)	(6)
	A. Sensitivity to Poly Order				**B. Sensitivity to Bandwidth**		
	Duration of Initial Spell	Duration UI Paid	Duration UI Claimed		Duration of Initial Spell	Duration UI Paid	Duration UI Claimed
	Poly Order=1				**Bandwidth=1500**		
α	.030	.029	.028	α	.040	.038	.037
	(.003)	(.003)	(.003)		(.006)	(.006)	(.006)
AIC	159415	159042	158408	AIC	93187	92986	92579
				Opt. poly	1	1	1
	Poly Order=2				**Bandwidth=2500**		
α	.056	.054	.055	α	.040	.043	041
	(.012)	(.012)	(.012)		(.032)	(.031)	(.031)
AIC	159414	159042	158407	AIC	159412	159041	158405
				Opt. poly	3	3	3
	Poly Order=3				**Bandwidth=4500**		
α	.040	.043	.041	α	.047	.043	.046
	(.032)	(.031)	(.031)		(.015)	(.015)	(.015)
AIC	159412	159041	158405	AIC	209792.15	209296	208492
				Opt. poly	3	3	3

Notes: The table explores the sensitivity of the results to the choice of the polynomial order (panel A) and of the bandwidth (panel B) for the regression specification in equation 10. In panel A, the bandwidth level is equal to 2500 for all specifications. α is the RK estimate of the average treatment effect of benefit level on the outcome. Standard errors for the estimates of α are in parentheses. AIC is the Aikake Information Criterion.

2. RKD for effect of UI benefits on the hazard rate at different points of the hazard support.

The advantage of the RKD setting is that it can easily be extended to the estimation of the effect of unemployment benefits on the hazard rate at different points of the hazard support.

Let $s_t = Pr[Y = t|Y \geq t, W = w]$ define the hazard rate at time t conditional on the assignment variable, I am interested in the average effect on the hazard rate of a continuous regressor b [45]:

$$\alpha_t = \frac{\partial s_t(Y|W = w)}{\partial b}$$

Under the assumption that $\frac{\partial s_t(Y|W=w)}{\partial w}|_{b=b(w)}$ is smooth, the logic of the RK design can be extended to identification of α_t and we have:

$$\alpha_t = \frac{\lim_{w\to k_1^+} \frac{\partial s_t(Y|W=w)}{\partial w} - \lim_{w\to k_1^-} \frac{\partial s_t(Y|W=w)}{\partial w}}{\lim_{w\to k_1^+} \frac{\partial b(w)}{\partial w} - \lim_{w\to k_1^-} \frac{\partial b(w)}{\partial w}}$$

Estimation of α_t is done by estimating the numerator of the estimand, with a linear probability model of the following form:

(11)

$$Pr[Y = t|Y \geq t, W = w] = \mu_{t,0} + [\sum_{p=1}^{\bar{p}} \gamma_{t,p}(w-k)^p + \nu_{t,p}(w-k)^p \cdot D] \quad \text{where } |w - k| \leq h$$

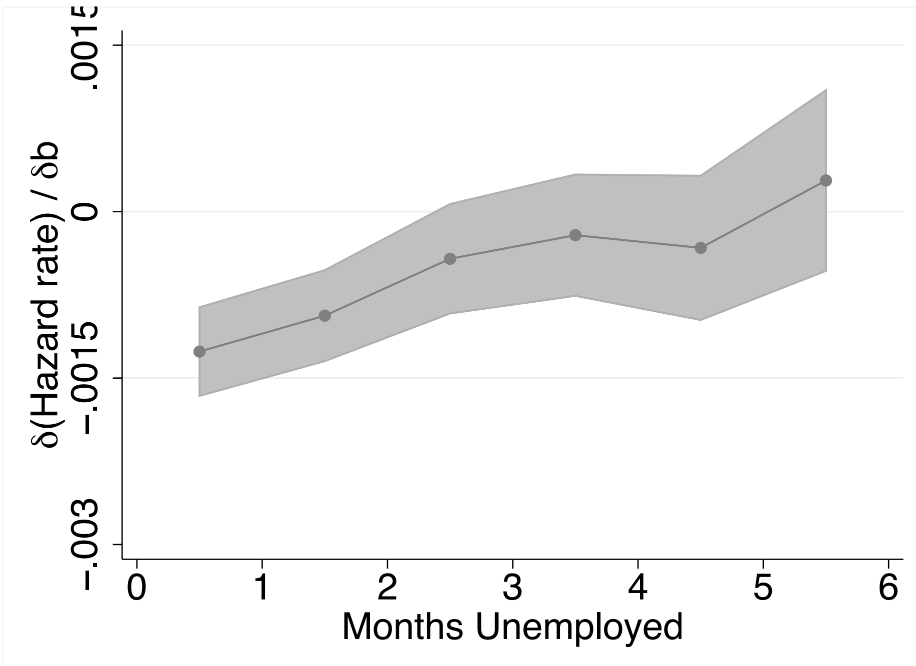
where $\nu_{t,1}$ gives once again the numerator of the RK estimand for the effect of benefit level on the hazard rate at week t.

Figure A1 displays the RKD estimates of α_t in Louisiana where I define hazard rates as the probability of exiting unemployment each month. The graph shows that having higher benefits has a negative impact on the probability of exiting unemployment, and that this effect is particularly strong at the beginning of a spell.

Note that the assumption that $\frac{\partial s_t(Y|W=w)}{\partial w}|_{b=b(w)}$ evolves smoothly at the kink is actually relatively strong regarding the selection process (into remaining unemployed) when unobserved heterogeneity θ also determines the exit rate out of unemployment $s_t(\{b_t\}_{t=0}^B, \theta)$. In fact, it implies that the heterogeneity effect is additively separable, in which case $\forall t$, $\frac{\partial^2 s_t}{\partial b_t \partial \theta} = 0$, meaning that the unobserved heterogeneity only acts as a shifter, independently of UI benefits. Once again, even though this smoothness assumption is fundamentally untestable, it is nevertheless always possible to check empirically for clear violations by looking for all t at the smoothness of the p.d.f of the assignment variable (conditional on still being unemployed after t weeks) around the kink, as well as at the smoothness of the relationship between some covariates and the assignment variable (conditional on still being unemployed after t weeks) around the kink.

[45] The same logic applies to effect of potential duration D.

FIGURE A1. RKD ESTIMATES OF THE EFFECT OF BENEFIT LEVEL ON THE HAZARD RATE, LOUISIANA, 1979-1983



Notes: The graph shows RKD estimates of $\alpha_t = \frac{\partial s_t(Y|W=w)}{\partial b}$, the effect of benefit level on the hazard rate at time t. Time periods for the definition of the hazard rate are in months. The grey shaded area represents the 95% confidence interval for the estimates. The graph shows that having higher benefits has a negative impact on the probability of exiting unemployment, and that this effect is particularly strong at the beginning of a spell.

3. RKD in Double-Difference

One main issue with the identifying assumptions of the RK design concerns the functional dependence between the forcing variable and the outcome of interest. It could be that the relationship between the forcing variable and the outcome is either kinked or quadratic. Then estimates are likely to be picking up this functional dependence between y and w_1.

A simple way to understand the issue is to remember the basic intuition behind the RK design. The model that I am interested in is $y = f(b, w_1, \varepsilon)$, where I want to get an estimate of f_1'. In this model, we have: $\frac{dy}{dw_1} = f_1' \frac{\partial b}{\partial w_1} + f_2' + f_3' \frac{\partial \varepsilon}{\partial w_1}$. The RKD assumes that f_2' and f_3' are the same on both sides of the kink (smoothness assumptions). Then, it follows that

$$\frac{\underset{k^+,k^-}{\Delta} \frac{dy}{dw_1}}{\underset{k^+,k^-}{\Delta} \frac{\partial b}{\partial w_1}}$$

identifies f_1', because $\underset{k^+,k^-}{\Delta} f_2' = 0$ and $\underset{k^+,k^-}{\Delta} f_3' = 0$.
If the assumption of smoothness in the functional dependence between the forcing variable and the outcome is violated, meaning that $\underset{k^+,k^-}{\Delta} f_2' \neq 0$ then, identification is not possible in the standard RKD. But if we have two sets of observations A and B for which we are willing to assume that $\underset{k^+,k^-}{\Delta} f_2'$ is the same, and for these two groups

$$\underset{k^+,k^-}{\Delta} \frac{\partial b}{\partial w_1}$$

is different, then f_1' is identified by α_{DD}, where:

$$\alpha_{DD} = \frac{\underset{A,B}{\Delta} \underset{k^+,k^-}{\Delta} \frac{dy}{dw_1}}{\underset{A,B}{\Delta} \underset{k^+,k^-}{\Delta} \frac{\partial b}{\partial w_1}} \tag{12}$$

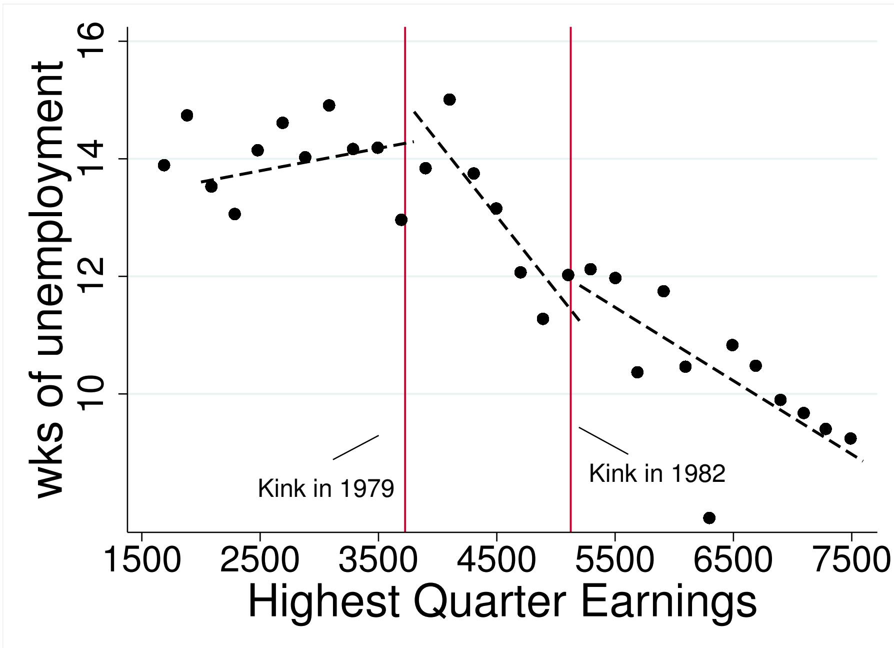
Such an identification strategy is reminiscent of double-difference strategies. In practice it consists in comparing the change in slope at point k in the relationship between the outcome and the forcing variable for two identical groups of observations, but one of the two groups is subject to a kink in the schedule of b at k, and the other group is not.

To implement this strategy, the idea is to use the presence of variations in the maximum benefit amount over time, that shift the position of the kink across the distribution of the forcing variable (as shown in figure 2). The problem though is that, taken separately, each variation in max_b is too small to give enough statistical power to detect changes in slopes because the bandwidths are too small, and as previously pointed out, the drawback of the RKD is to be quite demanding in terms of bandwidth size. The idea therefore is to compare periods that are further away in time. The obvious drawback of this option is that the identifying assumption is less likely to hold as one compares periods that are further away in time. In particular, one may worry about the high inflation rates during this period. It is important to note here that the maximum benefit amount increased in Louisiana a lot faster than inflation (40% between September 1979 and Sept 1982 and total inflation was less than 20% during that period), so that there is a clear and important change in the schedule in *real* terms [46]. Figure A2 shows the relationship between the duration of paid unemployment and the forcing variable in 1979 and 1982. Interestingly, there is a kink in this relationship in 1979 at the level of the 1979-kink in the schedule, and this kink disappears in 1982, when a new kink appears right at the level of the 1982-kink. Furthermore, in the interval between the 1979 and 1982 kinks, there is a change in slope in the relationship between the duration of unemployment and the forcing variable. This evidence is strongly supportive of the validity of the RK design.

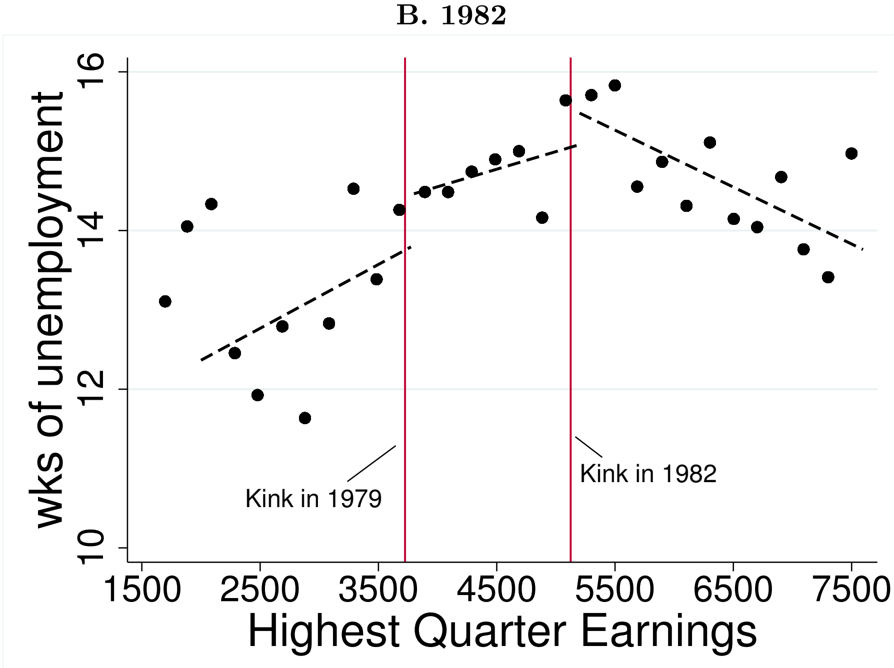
[46]To further alleviate this concern, I also control for quadratic in *real* highest quarter of earnings in the DD-RKD specifications and find similar results.

Figure A2. RKD in Double-Difference using variations in the maximum benefit level, Louisiana, 1979 vs 1982

A. 1979



B. 1982



Notes: The graph shows the average value of the duration of paid unemployment in each bin of the forcing variable in 1979 (panel A) and 1982 (panel B). The maximum benefit amount has been increased by more than 40% during the period, shifting the position of the kink in the schedule across the distribution of the forcing variable, as shown by the two red bars indicating the position of the kink for the two periods. The change in slope between the two periods in the interval between the two kinks is indicative of an effect of b on y, and can be used to identify the average treatment effect of b in a double-difference RKD. See text for details.

Table A2—Double-difference RKD estimates of the Effect of Benefit Level using variations in the maximum benefit level, Louisiana, 1979 vs 1982

	(1)	(2)	(3)	(4)	(5)	(6)
	Duration of Initial Spell	Duration UI Claimed	Duration UI Paid	Duration of Initial Spell	Duration UI Claimed	Duration UI Paid
	A. 1979 Kink			**B. 1982 Kink**		
α_{DD}	.064	.088	.051	.065	.069	.05
	(.035)	(.035)	(.035)	(.034)	(.034)	(.034)
h_-	2500	2500	2500	1400	1400	1400
h_+	1400	1400	1400	2500	2500	2500
Opt. Poly	1	1	1	1	1	1
N	6495	6495	6495	4744	4744	4744

Notes: The table reports the results of the implementation of a Double-Difference RKD using variations in the maximum benefit amount over time, as described in the previous subsection. α_{DD} is the Double-Difference RKD estimate of the average treatment effect of benefit level as described in equation (12). It consists in comparing the change in slope at point k in the relationship between the outcome and the forcing variable for two identical groups of observations, but one of the two groups is subject to a kink in the schedule of b at k, and the other group is not. Standard errors for the estimates of α_{DD} are in parentheses. There are two sets of DD-RKD estimates, one for each kink. For the 1979-kink, I compare the change in slope in the duration of unemployment spells at the level of the 1979-kink in the forcing variable for the unemployed in 1979 (who had a schedule of benefit kinked at that point) against the unemployed in 1982 (who had a continuous schedule of benefits at that point). For the 1982-kink, I compare the change in slope in the duration of unemployment spells at the level of the 1982-kink in the forcing variable for the unemployed in 1982 (who had a schedule of benefit kinked at that point) against the unemployed in 1979 (who had a continuous schedule of benefits at that point). h_- and h_+ are the sizes of the lower and upper bandwidth. The optimal polynomial order is chosen based on the minimization of the AIC.

4. Placebo forcing variable

Another way to test for the existence of a kinked or quadratic functional dependence between earnings and unemployment duration is to use a placebo forcing variable. The placebo needs to be a good proxy for lifetime earnings, but must not be too correlated with the highest quarter of earnings that determines the benefit level. Table A3 explores the robustness of the RKD results by using the post unemployment wage as a placebo forcing variable instead of the pre-unemployment highest quarter of earnings. The post unemployment wage used is the wage for the first quarter of full employment after an unemployment spell. Post unemployment wages are available only for spells starting after September 1979 in Louisiana. Post unemployment wages are correlated with lifetime earnings but are not too much correlated with the highest quarter of earnings that determines the benefit level. Therefore, this table explores to what extent the baseline results are driven by some functional dependence between earnings and unemployment duration and shows that we cannot detect any effect in these placebo specifications using post unemployment wages as a forcing variable.

Table A3—Robustness: RKD Estimates of the effect of benefit level using post unemployment wage as the forcing variable, Louisiana

	(1) Duration of Initial Spell	(2) Duration UI Claimed	(3) Duration UI Paid
	Sep 79-Sep 80		
α	-.024	-.022	-.02
	(.046)	(.045)	(.045)
Opt. Poly	1	1	1
	Sep 80-Sep 81		
α	-.025	-.019	-.019
	(.026)	(.026)	(.026)
Opt. Poly	1	1	1
	Sep 81-Sep 82		
α	.026	.031	.019
	(.034)	(.033)	(.033)
Opt. Poly	1	1	1
	Sep 82-Dec 83		
α	.01	.009	.005
	(.024)	(.024)	(.023)
Opt. Poly	1	1	1

Notes: The table explores the robustness of the RKD results by using the post unemployment wage as a placebo forcing variable instead of the pre-unemployment highest quarter of earnings. The post unemployment wage used is the wage for the first quarter of full employment after an unemployment spell. Post unemployment wages are available only for spells starting after September 1979 in Louisiana. Post unemployment wages are correlated with lifetime earnings but are not too much correlated with the highest quarter of earnings that determines the benefit level. Therefore, this table explores to what extent the baseline results are driven by some functional dependence between earnings and unemployment duration and shows that we cannot detect any effect in these placebo specifications using post unemployment wages as a forcing variable. α is the RK estimate of the average treatment effect of benefit level on the outcome. Standard errors for the estimates of α are in parentheses. The displayed estimates are for the optimal polynomial order chosen to minimize the Aikake Information Criterion.

5. Non-parametric tests for the the existence and location of a kink

An important concern in the RKD is that the estimates are picking up some spurious breakpoints in the relationship between the forcing variable and the outcome of interest. Despite their usually bad small sample properties, I recommend that non-parametric or semi-parametric tests for the detection and location of structural breakpoints are always performed when running RKD estimation, following the tests existing in the time series analysis literature, like for instance Bai and Perron [2003]. The number of tests that one can implement is large, but will usually fall within one of two categories. Tests for the existence of one or several breakpoints. And tests trying to detect the location of these breakpoints. By essence, testing for the statistical significance of the RKD estimates can be seen as falling into the first category. One could nevertheless envisage testing for the existence of more than one breakpoint, in order to make sure that the RKD estimates are not driven by the existence of multiple kinks in the relationship between the outcome and the forcing variable. An example of such tests can be found in Bai and Perron [1998].

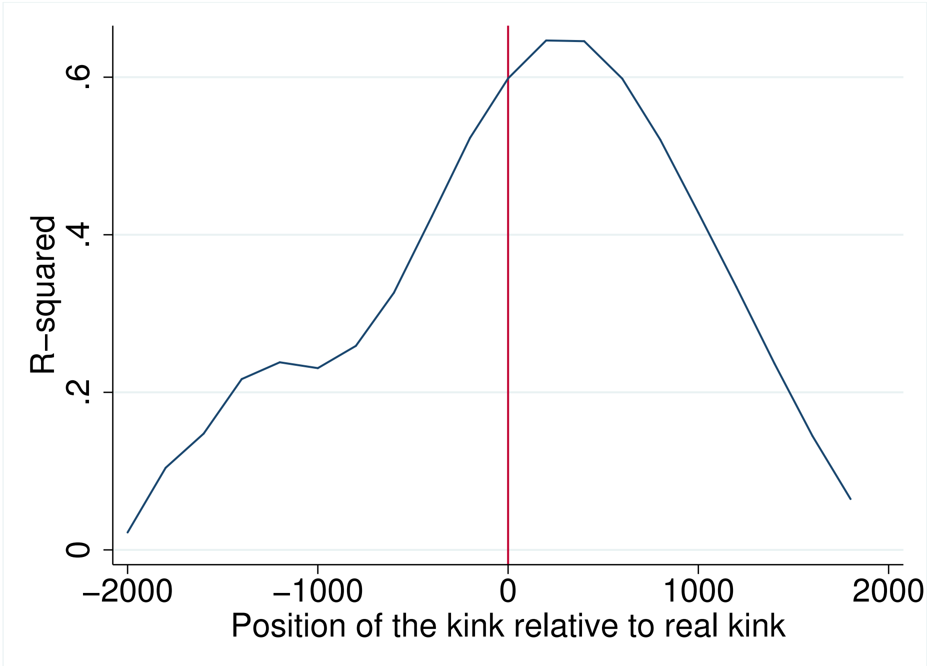
Here, I carry out a straightforward test that falls in the second category. I intend to make sure that the real location of the kink in the schedule is the location that would be detected if one were to look for the location of the kink in the data without knowing where the kink actually stands. The test simply consists in running the RKD specification[47] of equation (10) for a large number of virtual kink points k, and then in looking at the kink point that minimizes the residual sum of squares or equivalently that maximizes the R-squared[48]. For efficiency, I again group all unemployment spells for all periods together, and center the assignment variable at the kink point applicable given the schedule in place at each particular time. Because of the large variance of unemployment durations across individuals, I collapse the observations in bins of $50 of the assignment variable in order to reduce the residuals sum of squares to begin with[49]. I report in figure A3 the evolution of the R-squared as I change the location of the kink point in specification (10). The evolution of the R-squared as one varies the location of the kink points provides evidence in support of the validity of the RKD design. The R-squared increases sharply as one moves closer to the actual kink point and then decreases sharply, supportive of the existence of a kink around 0. The kink point that maximizes the R-squared is situated $200 to the right of the real kink point, but one cannot reject the hypothesis that the kink point is actually at 0. I interpret these results as strong evidence in support of the validity of the RK design.

[47] I again group all unemployment spells for all periods together, and center the assignment variable at the kink point applicable given the schedule in place at each particular time.

[48] I conduct here a simple grid search but these tests can become computationally burdensome when looking for several breakpoints or for more complicated models, in which case the use of more efficient algorithms is recommended, as in Bai and Perron [2003]

[49] This procedure increases the power of the test considerably.

Figure A3. R-squared as a function of the location of the kink point in RKD specification (10), Louisiana



Notes: The graph shows the value of the R-squared as a function of the location of the kink point in RKD specification (10). The assignment variable is centered at the actual kink point in the benefit schedule so that virtual kink points are expressed relative to the real kink point in the schedule. Inspired by non-parametric tests for the detection of structural breakpoints in time series analysis, I conduct a grid search to look for the kink point that maximizes the R-squared. See text for details.

6. *Proportional hazard models*

To get a sense of the validity of the RK design, it is useful to compare the RKD estimates to the estimates of more standard empirical strategies widely used in the existing literature. Most empirical studies on US data use proportional hazard models. In table A4, I report the estimates of Cox proportional hazard models on the CWBH data which enables me to compare my results to the widely cited benchmark of Meyer [1990], who used a smaller sample of the same CWBH records.

This table estimates the effect of UI weekly benefits levels b on the hazard rate of leaving UI using the CWBH complete data for the 5 US states . I fit standard Cox proportional hazard models. All specifications include controls for gender, ethnicity, marital status, year of schooling, a 6-pieces exhaustion spline and state fixed effects. u denotes the state unemployment rate. log(b) denotes the log-weekly UI benefit amount. p25 and p75 denote the 25th and 75th percentile of unemployment rates (among all state×quarter in our data).

Coefficient estimates for log(b) in the proportional hazard models can be interpreted as the elasticity of the hazard rate s with respect to the weekly benefit level. Under the assumption that the hazard rate is somewhat constant, these elasticities can be easily compared to the RKD elasticities of unemployment duration, since $D \approx 1/s$ so that $\varepsilon_D \approx -\varepsilon_s$.

Column (1) replicates the specification of Meyer [1990], Table VI, column (7). Note that Meyer [1990] was using a much smaller sample of the same CWBH records. The estimates show that the result of Meyer [1990], who found an elasticity of .56, can be fully replicated using his specification. The drawback of these estimates is that they do not fully address the endogeneity issue due to the joint determination of UI benefits and previous earnings. Meyer [1990] only controls for previous wages using the log of the base period earnings. Column (2) further adds non-parametric controls for previous earnings and experience. Column (3) further adds year×state fixed effects. Interestingly, if one adds this richer set of non parametric controls for previous earnings to mitigate the concern of endogeneity, and fully controls for variations across labor markets by adding time fixed effects interacted with state fixed effects, the results converge to the RKD estimates and the elasticity goes down to around .3. The reason is that, as one controls more efficiently for the functional dependence between unemployment duration and previous earnings, the only identifying variation in benefit level that is left comes from the kink in the benefit schedule, and the model naturally converges to the identification strategy of the RKD. Overall, I find this evidence to be supportive of the validity of the RK design.

Columns (4) to (6) investigate the cyclicality of the partial equilibrium labor supply elasticities in the standard proportional hazard model to analyze the robustness of the results of table A5. Columns (4) and (5) add the interaction of log(UI) and high unemployment dummies (unemployment rate above the median across all US states in the same quarter in column (4) and unemployment rate above 8% in column (5)). Column (6) adds the interaction of log(b) with quartiles for the level of unemployment (quartiles defined across all state×quarter cells in our sample).

Table A4—Semi-Parametric Estimates of Hazard Rates

	(1) Meyer [1990]	(2)	(3)	(4)	(5)	(6)
log(b)	-0.587***	-0.274***	-0.320***	-0.341***	-0.323***	
	(0.0394)	(0.0365)	(0.0368)	(0.0374)	(0.0370)	
State unemployment rate	-0.0550***	-0.0552***	-0.0207	-0.0226	-0.0251	-0.105***
	(0.00518)	(0.00519)	(0.0142)	(0.0143)	(0.0153)	(0.0209)
log(b)× (u>median)				0.0248**		
				(0.00812)		
log(b)×(u> .08)					0.00527	
					(0.00685)	
log(b)×(u<p25)						-0.363***
						(0.0376)
log(b)×(p25<u<median)						-0.353***
						(0.0371)
log(b)×(median<u<p75)						-0.292***
						(0.0371)
log(b)×(u>p75)						-0.274***
						(0.0378)
Non-param controls for previous wage & experience	NO	YES	YES	YES	YES	YES
Year×state F-E	NO	NO	YES	YES	YES	YES
# Spells	39852	39852	39852	39852	39852	39852
Log-likelihood	-136305.0	-136364.8	-135976.0	-135971.4	-135975.7	-135946.2

This table estimates the effect of UI weekly benefits levels b on the hazard rate of leaving UI using the CWBH complete data for 5 US states from the late 1970s to early 1980s. I fit Cox proportional hazard models. All specifications include controls for gender, ethnicity, marital status, year of schooling, a 6-pieces exhaustion spline and state fixed effects. u denotes the state unemployment rate. log(b) denotes the log-weekly UI benefit amount. p25 and p75 denote the 25th and 75th percentile of unemployment rates (among all state×quarter in our data). Column (1) replicates the specification of Meyer [1990], Table VI, column (7) (Meyer [1990] was using a much smaller dataset). Column (2) further adds non-parametric controls for previous earnings. Column (3) further adds year×state fixed effects. Columns (4) and (5) add the interaction of log(b) and high unemployment dummies (unemployment rate above the median across all US states in the same quarter in column (4) and unemployment rate above 8% in column (5)). Column (6) adds the interaction of log(b) with quartiles for the level of unemployment (quartiles defined across all state×quarter cells in our sample).

7. *Cyclical behavior:*

Following the Great Recession, a recent literature has been interested in estimating how labor supply responses to UI vary over the business cycle in order to assess the optimality of UI rules that are contingent on the state of the labor market (Schmieder, von Wachter and Bender [2012], Kroft and Notowidigdo [2011]). I take advantage of the large variations in labor market conditions across states and over time in the CWBH data to investigate how the RKD estimates vary with indicators of (state) labor market conditions. I correlate the RKD estimates with the average monthly unemployment rate from the Current Population Survey prevailing in the state for each period[50]. Results are displayed in table A5. In all specifications, I weight the observations[51] by the inverse of the standard error (of the elasticity)[52]

Column (1) to (3) correlates the estimated elasticity with the unemployment rate for all three duration outcomes. In all three columns, the coefficient on the state unemployment rate is very small (around -.02 and not significantly different from zero), which means that a 1 percentage point increase in the unemployment rate is associated with a .02 percentage point decrease in the estimated elasticity. This result implies that elasticity varies between .38 (.09) when the state unemployment rate is at 4.5% (minimum in the CWBH data) and .25 (.10) when the unemployment rate is at 11.8% (the max in the CWBH data). This evidence is in line with the evidence of Kroft and Notowidigdo [2011] for the US, though the cyclicality of the estimates is somewhat larger in their analysis. One needs to acknowledge though that the standard errors on the estimated coefficient is rather large and the result of this type of exercise should always be interpreted with caution.

The estimates are not affected by the inclusion of state fixed effects as shown in column (4). In column (5), I add more observations by estimating the RKD model for subsets of the labor force in each state and sub-period. Here, I estimate the RKD elasticity for young (below 40) and old (above 40 years old) workers separately, but one can think of other partitions of the labor market, as long as: 1) unemployment rates can be computed for these sub-labor markets, 2) variation in unemployment rate across these sub-labor markets is large enough, and 3) each sub-labor market is large enough in order to estimate RKD elasticities with enough precision. Adding several estimates within state and sub-periods has two advantages. First, it increases the statistical power of the analysis, and more importantly, it enables me to control for the level of the policy parameters at which the elasticity is estimated. Each RKD elasticity is of course by nature endogenous to the level of the maximum benefit amount and the potential duration at which it is estimated, and these parameters vary for each state and sub-period. Results in column (5) show that partitioning the data into a larger number of sub-labor markets does not affect the result. The coefficient of the correlation between the

[50]To know to what extent variations in labor market conditions across states are a good proxy for business cycle fluctuations is another question. I tend to prefer in table A5 specifications with state fixed effects so that all variation in labor market conditions is variation over time, which mimics more clearly the concept of business cycles.

[51]Each observation is a RKD elasticity estimate of unemployment duration with respect to the UI benefit level for a state and sub period.

[52]Weighting reduces substantially the standard errors on the estimates of the correlation of the elasticity with labor market conditions, without affecting the point estimates.

unemployment rate in the sub-labor market and the RKD elasticity is still negative, and somewhat smaller in absolute value, though the amount of variation over time in each sub-labor market when controlling for sub-labor market fixed effects (here for age group fixed effects) is rather limited.

In table A4, columns (4) to (6) , I also investigate how the effect of the log benefit correlates with state unemployment conditions in the standard Cox proportional hazard model, and find similar results, with the estimated elasticity decreasing slightly as the state unemployment rate increases.

Table A5—Cyclical Behavior of the RKD Estimates of the effect of benefit level

	(1)	(2)	(3)	(4)	(5)
	Average Treatment Effects				
	ε_b	ε_b	ε_b	ε_b	ε_b
	Initial Spell	UI Paid	UI Claimed	Initial Spell	
U	-0.0195	-0.0293	-0.0259	-0.0289	-0.00576
	(0.0262)	(0.0263)	(0.0239)	(0.0303)	(0.0445)
Kink (K\$2010)					-0.111
					(0.170)
Potential Duration					-0.00950
					(0.0177)
State F-E				×	×
Age Group F-E					×
Inverse s-e weights	×	×	×	×	×
N	26	26	26	26	52

Notes: Standard errors in parentheses, * p<0.10, ** p<0.05, *** p<0.01.
Each observation is a RKD estimate of the elasticity of unemployment duration with respect to the UI benefit level for a state and sub period. Initial spell refers to the elasticity of the duration of the initial unemployment spell as defined above. UI paid refers to the elasticity of the duration that UI is paid, and UI claimed refers to the elasticity of the duration of the UI claim. U is the average monthly state unemployment rate from CPS and in column (5) U is the average monthly state unemployment rate from CPS for each age group (the young, below 40, and the older workers, above 40 years old). Unemployment rates are expressed in percentage points, so that the results in column (1) for instance should be interpreted as follows: a 1 percentage point increase in the unemployment rate is associated with a .019 percentage point decrease in the estimated elasticity.

8. *Test for the slackness of the liquidity constraint*

The result of proposition 1 relies on the assumption that the liquidity constraint is not yet binding at the exhaustion point B. I begin by providing a simple test for this assumption. The intuition for the test is simple. If the liquidity constraint is binding, it means that the unemployed can no longer deplete their asset; they are hand-to-mouth, and therefore, benefits that they have received in the past do not have any effect on their future behavior. If to the contrary, exit rates after the exhaustion point are affected by benefits received before exhaustion, it means that agents can still transfer part of their consumption across time periods.

Formally, if the Euler equation is satisfied, one can express the effect of benefit in period 0 on effort in period 1 using (4):

$$\frac{\partial s_1}{\partial b_0} = \frac{u''(c_0^u)}{\beta(u'(c_1^e) - u'(c_1^u))} \leq 0$$

$\frac{\partial s_1}{\partial b_0}$ is inversely proportional to the liquidity effect. In other words, when the Euler equation holds and agents can transfer money freely across periods, an increase in benefits earlier during the spell reduces the probability of exiting unemployment because it increases asset level. But when the agents can no longer smooth consumption perfectly or have little asset to transfer across periods, the denominator (which is directly proportional to the consumption smoothing benefits of UI) increases and $\frac{\partial s_1}{\partial b_0}$ tends to be small in absolute value. When agents hit the borrowing constraint, they become hand-to-mouth and set consumption equal to income every period, in which case the Euler equation does not hold any more and $\frac{\partial s_1}{\partial b_0} = 0$.

The implementation of the test relies on estimation of $\frac{\partial s_{B+1}}{\partial b_B}$, the effect of receiving extra benefits at time B on exit rates after benefit exhaustion at time $B+1$. To identify $\frac{\partial s_{B+1}}{\partial b_B}$, the idea is to compare the exit rates conditional on still being unemployed after the maximum exhaustion point of two individuals, one having been given exogenously one more week of covered UI than the other. Once again, the RK design can be used to implement the test[53], taking advantage of the kink in the schedule of the potential duration of benefits, which creates variations in the number of weeks that individuals can collect UI before time B, or equivalently in the total amount of benefits that individuals can collect before time B. I run regressions of the form of equation (10) where the outcome is the probability of exiting unemployment between 40 and 60 weeks[54], conditional on still being unemployed after 39 weeks (the maximum duration of benefits in Washington between July 1980 and July 1981). The assignment variable is the ratio of base period earnings to highest quarter of earnings, that determines the potential duration of UI. The RKD identifies[55] $\partial s_{B+1}/\partial B$ that I then divide by the benefit amount b to get $\frac{\partial s_{B+1}}{\partial b_B}$[56].

Results are reported in column (1) of table A5. Having received one extra dollar of benefits before 39 weeks reduces the exit rate out of unemployment after exhaustion by a statistically significant .19 percentage point. This means that benefits received before the exhaustion point still have a negative effect on exit

[53]The advantage of the RKD setting is that it can easily be extended to the estimation of the effect of unemployment benefits on the hazard rate at different points of the hazard support as explained in appendix A.2.

[54]Because of the small number of observations, I am forced to choose a rather large interval to increase the precision of the estimates.

[55]As explained in appendix A.2, when dealing with hazard rates, identification requires some assumptions regarding the selection process in case some unobserved heterogeneity θ also determines the exit rate out of unemployment $s_t(\{b_t\}_{t=0}^B, \theta)$. Under the assumption that the heterogeneity effect is additively separable, in which case $\frac{\partial^2 s_B}{\partial b_B \partial \theta} = 0$, then $\frac{u''(c_B^u)}{u'(c_{B+1}^u) - v'(c_{B+1}^e)}$ is point identified. I ran tests of smoothness of the relationship between observable covariates at the kink and the assignment variable conditional on still being unemployed after 39 weeks, and could not detect significant changes in slope, indicative of the validity of the identifying assumption.

[56]I assume here that a marginal change in the potential duration of benefits B normalized by the benefit amount b is the same as a marginal change in b_B. This would be the case if B could be increased by a fraction of period. This simplification does not affect the validity of the test but only the interpretation of the coefficient in column (1) of table A5.

rates after the exhaustion point, or in other words, that the liquidity constraint is not yet binding at the exhaustion point. Note that *per se*, this statistics is interesting in the sense that it is inversely related to the consumption smoothing benefits of UI at the exhaustion point. The lower this statistics, the larger the liquidity effect of UI benefits at exhaustion. It would therefore be interesting to be able to replicate this type of test to look at the evolution of this statistics over the business cycle. I also provide some quantile regression analysis in appendix A.9 showing that this test does not seem to be contaminated by heterogeneity.

Table A5—RKD estimates of behavioral responses to UI, tests for the slackness of the liquidity constraint, and liquidity effect estimates, Washington, Jul 1980 - Jul 1981

	(1)	(2)	(3)	(4)
	Test for slackness of the liquidity constraint	**Effect of benefit level**	**Effect of potential duration**	**Liquidity and moral hazard estimates**
$\frac{\partial s_{B+1}}{\partial b_B}$	-.0019			
	(.00082)			
	[.337]			
ε_{D_B}		.730	1.348	
		(.110)	(.685)	
		[.814]	[.388]	
ε_D		.291	.330	
		(.071)	(.425)	
		[.392]	[.474]	
$(\frac{1}{B}\ \frac{\partial s_0}{\partial b}\Big\vert_B - \frac{1}{b}\frac{\partial s_0}{\partial B}) \times 10^3$				-.042
				(.01)
Moral Hazard:				.0014
Θ_1				(.0001)
Liquidity to Moral Hazard:				.876
ρ_1				(.022)
N	529	6061	2049	9471

Notes: For all columns, standard errors for the estimates are in parentheses. P-values are reported between brackets and are from a test of joint significance of the coefficients of bin dummies in a model where bin dummies are added to the polynomial specification in equation 10. Results are obtained from a linear specification. The bandwidth for the RK estimate of benefit level is 2500 (assignment variable: highest quarter of earnings) and .75 for the RK estimate of the potential duration (assignment variable: ratio of base period to highest quarter of earnings). This table shows how to use the RKD to estimate all the statistics needed to calibrate the welfare effects of UI. Column (1) begins by testing for the slackness of the liquidity constraint. It reports the RK estimate of $b \cdot \frac{\partial s}{\partial b_B}$, the effect of one additional dollar of UI before 39 weeks on the exit rate of unemployment after exhaustion, between 40 weeks and 60 weeks. The estimates suggest that the Euler equation holds and that variations in benefits prior to exhaustion affect exit rate of unemployment after the exhaustion point. Column (2) reports the RKD estimate of the elasticity of UI duration (ε_{D_B}) and of the elasticity of non-employment duration (ε_D) with respect to benefit level. Column (3) reports the RKD estimate of the same elasticities with respect to potential duration. Column (4) reports the liquidity and moral hazard effect estimates following the strategy detailed in proposition 1. $(\frac{1}{B}\ \frac{\partial s_0}{\partial b}\Big\vert_B - \frac{1}{b}\frac{\partial s_0}{\partial B})$ is the difference between the RKD estimate of the effect of benefit level (divided by the potential duration) and the RKD estimate of the effect of potential duration (divided by the benefit level) on s_0 defined as the exit rate out of unemployment in the first 4 weeks of unemployment. To ensure that the characteristics of individuals at both kinks (in benefit level and potential duration) are the same, I use a reweighing approach described in appendix B. Following proposition 1, this difference is then used to compute the moral hazard effect Θ_1 of an increase in benefit level and the ratio of liquidity to moral hazard ρ_1 in the effect of an increase in benefit level. For the three statistics of column (4), bootstrapped s.e. with 50 replications are in parentheses. See text for additional details.

9. *Heterogeneity in the test for slackness of the credit constraint at benefit exhaustion*

One potential concern with the test for the slackness of the liquidity constraint presented in section 4 of the paper is that the average effect, which shows that on average the liquidity constraint is not yet binding at benefit exhaustion, is contaminated by heterogeneity. In particular, it may be that some individuals hit the credit constraint, and for them, $\frac{\partial s_{B+1}}{\partial b_B} = 0$. To investigate the extent of heterogeneity in the estimate, I estimate quantile treatment effects of the effect of past benefits on D_{B+1}, the duration of non-employment after 39 weeks (conditional on being unemployed after 39 weeks). In case of a large degree of heterogeneity, (some people being extremely credit constrained, and some other being less credit constrained), we would expect these quantile treatment effects to be very different: because the amount of your credit constraint is directly correlated with your exit rate after exhaustion (the less asset you have, the harder your search effort), the lower quantile of the distribution of D_{B+1} should react much less (or even not at all) to a change in prior benefits. Results, reported in table A6 show that even though lower quantile of the distribution do react a little less to a change in benefits before 39 weeks, differences across quantiles are small and not statistically significant. This evidence is supportive of the fact that the credit constrained is not firmly binding at benefit exhaustion. Almost everybody maintains some ability to transfer money across periods at time benefits are exhausted (albeit certainly at different costs).

Table A6—Heterogeneous effects in the test for slackness of the credit constraint at exhaustion

	(1)	(2)	(3)	(4)	(5)
	Quantile Treatment Effects				
	q=.1	q=.25	q=.5	q=.75	q=.9
$\frac{\partial D_{B+1}}{\partial b_B}$	.109	.194	.545	.220	.256
	(.068)	(.091)	(.200)	(.170)	(.172)
p-value	.231	.475	.365	.521	.198
Optimal poly.	1	1	1	1	1
N	529	529	529	529	529

Notes: Bootstrapped standard errors in parentheses.

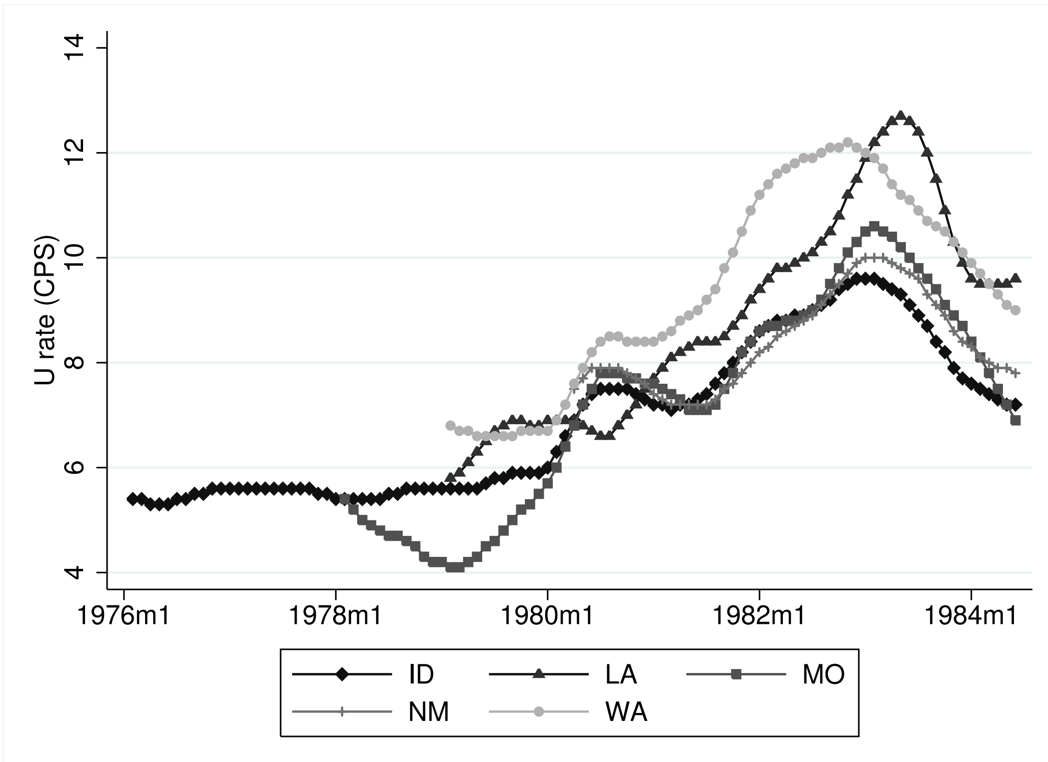
10. *Construction of weights for the reweighted approach estimation in liquidity effects and moral hazard estimates*

To make sure that our comparison of the effect of benefit level and potential duration using the two deterministic and kinked benefit schedules is not mixing heterogenous individuals, we re-weight the observations in the sample for the RKD estimates of $\frac{\partial s_0}{db}\Big|_B$ (sample 1) to match the distribution of observable characteristics of observations in the sample for the RKD estimates of $\frac{\partial s_0}{dB}$ (sample 2).

To generate these weights, for each period, I merge observations from both samples. I then estimate a probit model of the probability that a given observation in this merged sample belongs to sample 1. The predictors in this regression are gender, age, age squared, education in years, and dummies for 5 main industries. Using predicted propensity score p, I then weight each observation in the RKD regressions with the weight $\omega = p/(1-p)$

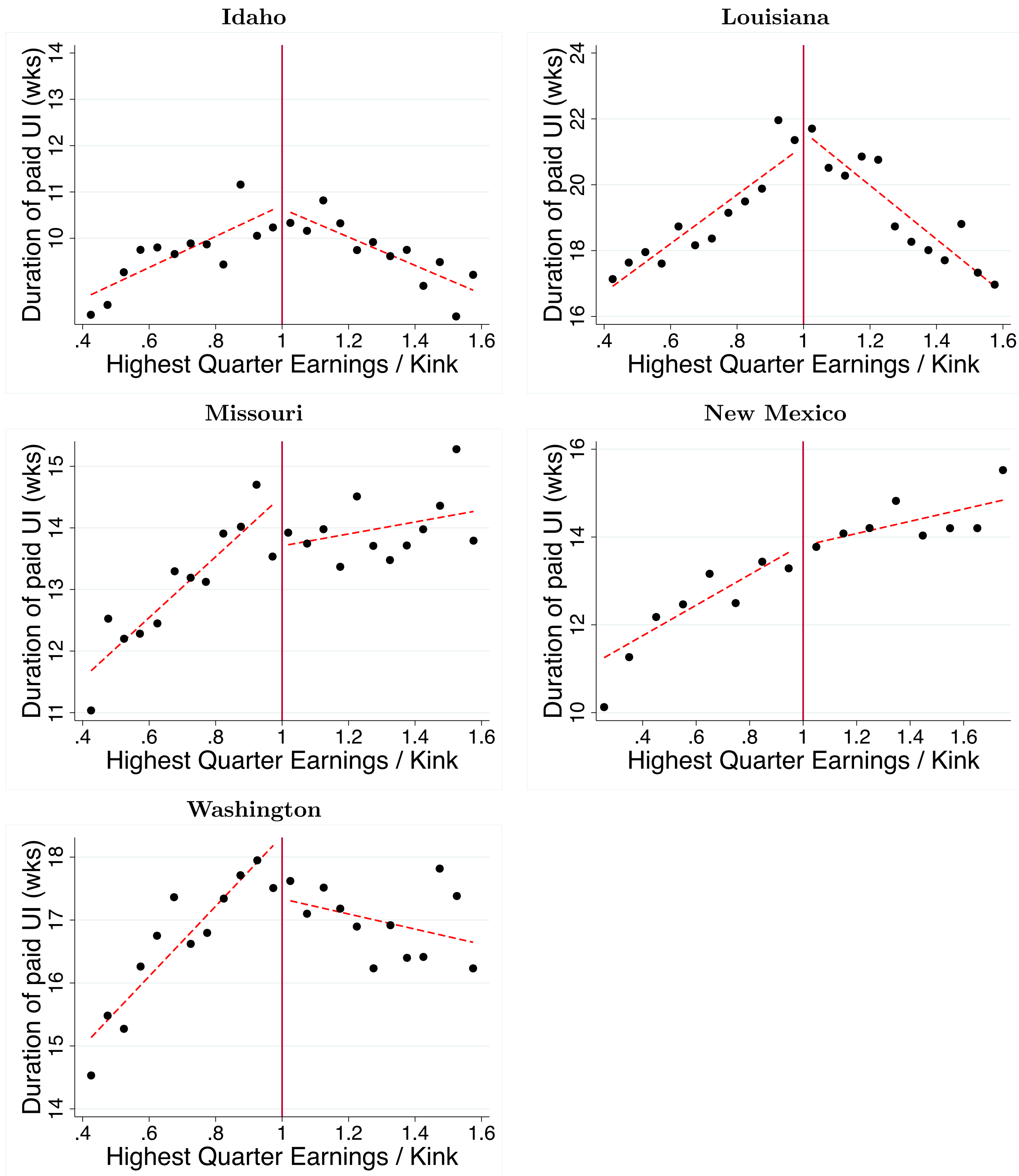
B. RKD Figures & Results for all 5 states

Figure B1. Unemployment Rates in CWBH states 1976-1984



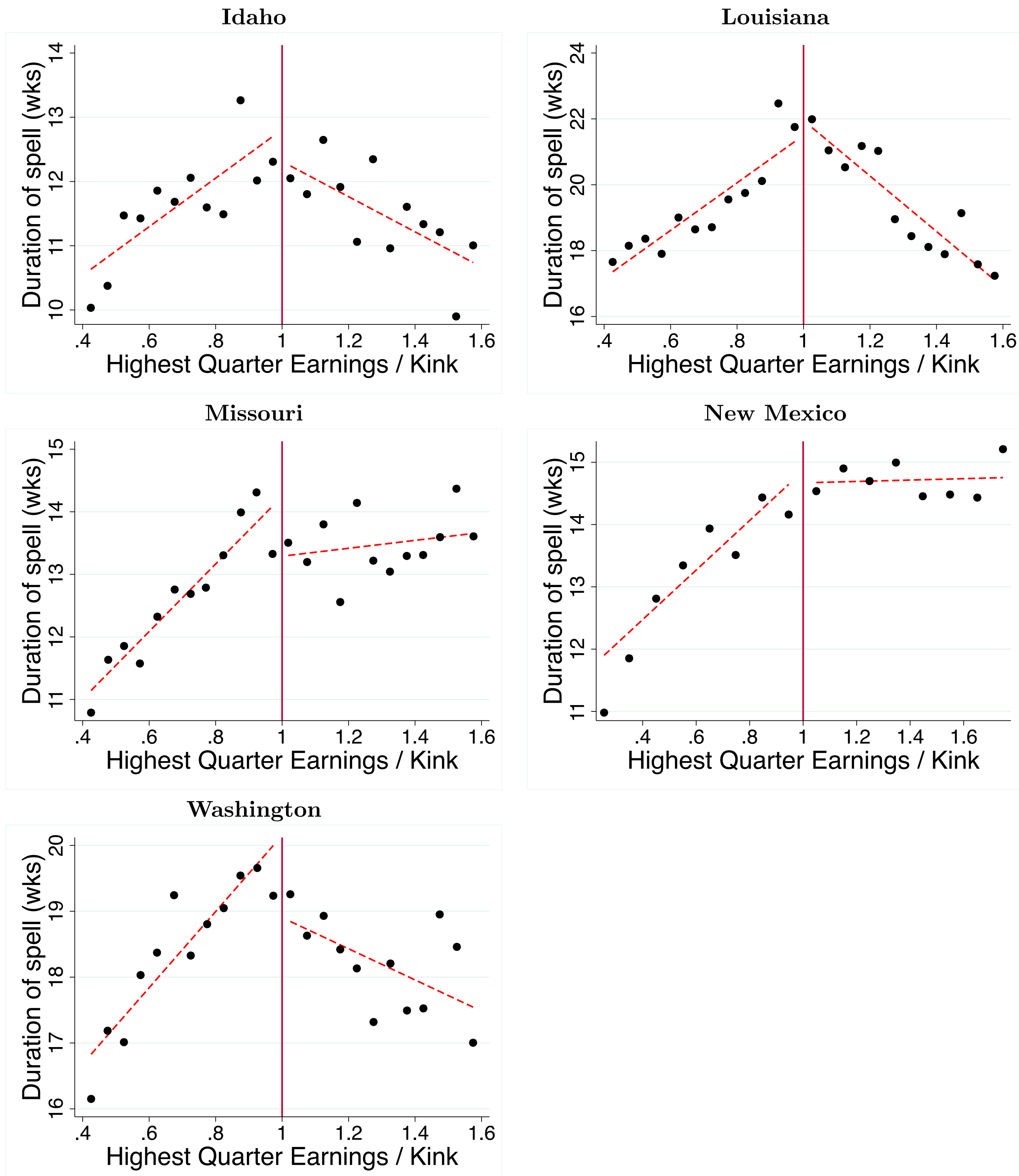
Sources: Current Population Survey
Notes: The graph shows the evolution of the monthly unemployment rate in the 5 states with the universe of unemployment spells available from the CWBH data. The CWBH data for the 5 states covers period of low unemployment as well as the two recessions of 1980 and 1981-82 with two-digit national unemployment rates, which gives the opportunity to examine the evolution of behavioral responses to UI over the business cycle.

Figure B2. RKD evidence of the Effect of Benefit Level: Duration UI Paid vs Highest Quarter Earnings for All 5 States



Notes: The graph shows for the first sub-period of analysis in each state the mean values of the duration of paid UI in each bin of $250 of highest quarter of earnings, which is the assignment variable in the RK design for the estimation of the effect of benefit level. The assignment variable is centered at the kink. The graph shows evidence of a kink in the evolution of the outcome at the kink. Formal estimates of the kink using polynomial regressions of the form of equation 10 are displayed in table 2. The red lines display predicted values of the regressions in the linear case allowing for a discontinuous shift at the kink.

FIGURE B3. RKD EVIDENCE OF THE EFFECT OF BENEFIT LEVEL: DURATION OF INITIAL UNEMPLOYMENT SPELL VS HIGHEST QUARTER EARNINGS FOR ALL 5 STATES

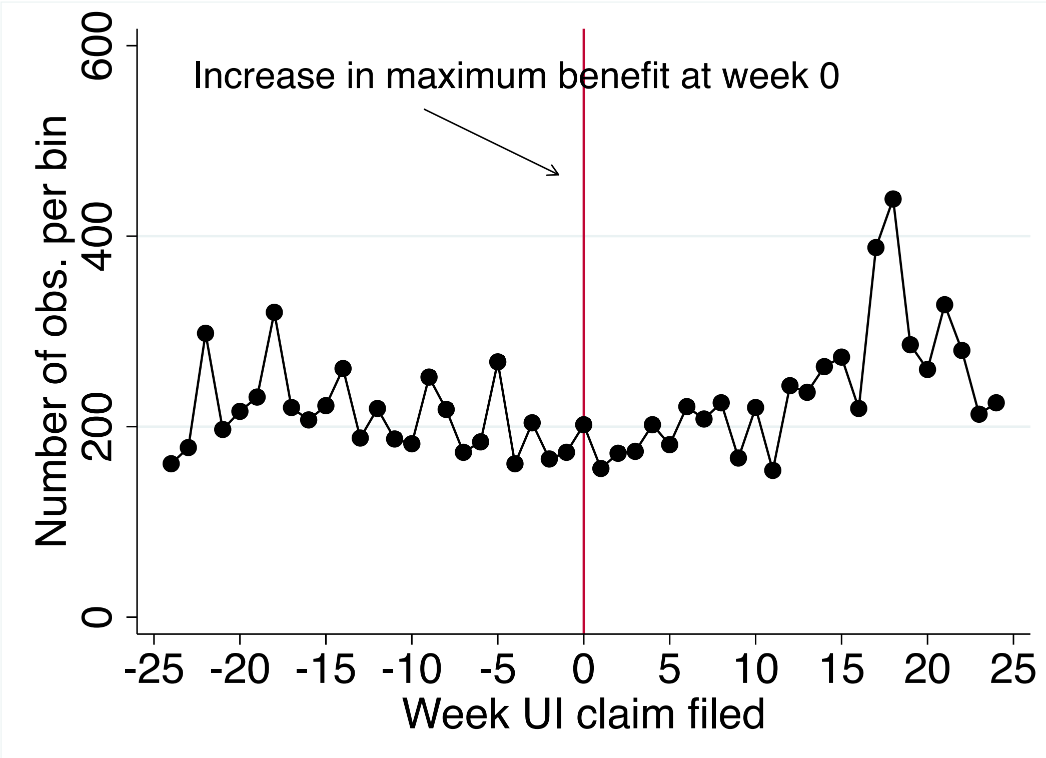


Notes: The graph shows for the first sub-period of analysis in each state the mean values of the duration of initial spell in each bin of $250 of highest quarter of earnings, which is the assignment variable in the RK design for the estimation of the effect of benefit level. The assignment variable is centered at the kink. The graph shows evidence of a kink in the evolution of the outcome at the kink. Formal estimates of the kink using polynomial regressions of the form of equation 10 are displayed in table 2. The red lines display predicted values of the regressions in the linear case allowing for a discontinuous shift at the kink.

Strategic timing of UI claims

If individuals can perfectly anticipate when the maximum benefit amount is increased, this may lead to strategic behaviors in terms of the timing of UI claims. To investigate the extent of strategic manipulation of the timing of claims, I look at the distribution of claims by dates (in weeks) centered at the time when the maximum benefit is increased (week 0). I pool all maximum benefit increases together to maximize power. The sample is restricted to individuals who have highest quarter earnings above the kink of the initial schedule (prior to the benefit increase) so that all individuals in the sample would benefit from the increase in the maximum benefit if they claimed after week 0. In the presence of strategic manipulation, we would expect the presence of bunching just after week 0, and a hole in the distribution just before week 0. In practice, no evidence of manipulation can be detected in the distribution of claiming dates, as can be seen from Figure B4 which shows the distribution of claiming dates centered at the time the maximum benefit amount is increased for Louisiana. This evidence greatly alleviates the concern that strategic timing of claims may affect our empirical setting.

Figure B4. Distribution of claiming dates, centered at the time the maximum benefit amount is increased, Louisiana



Notes: The figure investigates the extent of strategic manipulation of the timing of claims that may arise if individuals can perfectly anticipate when the maximum benefit amount is increased. The figure displays the distribution of claims by dates (in weeks) centered at the time when the maximum benefit is increased (week 0). I pool all maximum benefit increases together to maximize power. The sample is restricted to individuals who have highest quarter earnings above the kink of the initial schedule (prior to the benefit increase) so that all individuals in the sample would benefit from the increase in the maximum benefit if they claimed after week 0. In the presence of strategic manipulation, we would expect the presence of bunching just after week 0, and a hole in the distribution just before week 0. In practice, no evidence of manipulation can be detected in the distribution of claiming dates. This evidence greatly alleviates the concern that strategic timing of claims may affect our empirical setting.

Table B2— RKD Estimates, effect of benefit level, Idaho, 1976 - 1983

	(1) Duration of Initial Spell	(2) Duration UI Claimed	(3) Duration UI Paid
		Period 1: jan1976 to jul1978	
α	.037	.037	.043
	(.009)	(.008)	(.009)
ε_b	.337	.386	.334
	(.086)	(.086)	(.072)
p-value	.022	.007	.003
N	7487	7487	7487
		Period 2: jul1978 to jul1980	
α	.087	.079	.09
	(.009)	(.008)	(.009)
ε_b	.756	.815	.698
	(.079)	(.084)	(.07)
p-value	.035	.02	.099
N	8143	8143	8143
		Period 3: jul1980 to jul1981	
α	.065	.038	.057
	(.016)	(.014)	(.016)
ε_b	.58	.392	.445
	(.144)	(.141)	(.125)
p-value	.602	.277	.38
N	3596	3596	3596
		Period 4: jul1981 to jun1982	
α	.006	.005	-.002
	(.02)	(.016)	(.018)
ε_b	.053	.048	-.015
	(.143)	(.144)	(.122)
p-value	.443	.57	.273
N	3968	3968	3968
		Period 5: jun1982 to dec1983	
α	.047	.048	.045
	(.022)	(.02)	(.022)
ε_b	.381	.466	.319
	(.182)	(.195)	(.16)
p-value	.121	.275	.062
N	2245	2245	2245

Notes: Duration outcomes are expressed in weeks. α is the RK estimate of the average treatment effect of benefit level on the outcome. Standard errors for the estimates of α are in parentheses. P-values are from a test of joint significance of the coefficients of bin dummies in a model where bin dummies are added to the polynomial specification in equation 10. The optimal polynomial order is chosen based on the minimization of the Aikake Information Criterion. Periods correspond to stable UI benefit schedules.

Table B3— RKD Estimates, effect of benefit level, Missouri Jan 1978 - Dec 1983

	(1) Duration of Initial Spell	(2) Duration UI Claimed	(3) Duration UI Paid
	Period 1: jan1978 to dec1979		
α	.02	.02	.031
	(.009)	(.01)	(.01)
ε_b	.164	.165	.196
	(.075)	(.08)	(.064)
p-value	.131	.479	.259
N	6071	6071	6071
	Period 2: dec1979 to dec1980		
α	.031	.026	.044
	(.012)	(.013)	(.013)
ε_b	.226	.179	.24
	(.089)	(.087)	(.073)
p-value	.49	.346	.077
N	5500	5500	5500
	Period 3: jan1981 to jan1982		
α	.01	.005	.02
	(.012)	(.012)	(.013)
ε_b	.084	.043	.13
	(.102)	(.102)	(.084)
p-value	.877	.843	.942
N	3625	3625	3625
	Period 4: jan1982 to aug1982		
α	.033	.034	.049
	(.016)	(.017)	(.018)
ε_b	.232	.239	.277
	(.117)	(.119)	(.102)
p-value	.174	.091	.006
N	2550	2550	2550
	Period 5: aug1982 to dec1983		
α	.052	.043	.061
	(.011)	(.012)	(.012)
ε_b	.376	.317	.364
	(.082)	(.085)	(.07)
p-value	.489	.529	.597
N	5036	5036	5036

Notes: Duration outcomes are expressed in weeks. α is the RK estimate of the average treatment effect of benefit level on the outcome. Standard errors for the estimates of α are in parentheses. P-values are from a test of joint significance of the coefficients of bin dummies in a model where bin dummies are added to the polynomial specification in equation 10. The optimal polynomial order is chosen based on the minimization of the Aikake Information Criterion. Periods correspond to stable UI benefit schedules.

Table B4— RKD Estimates, effect of benefit level, New Mexico 1980 - 1983

	(1) Duration of Initial Spell	(2) Duration UI Claimed	(3) Duration UI Paid
		Period 1: apr1980 to jan1981	
α	.051	.046	.055
	(.019)	(.019)	(.018)
ε_b	.353	.332	.34
	(.129)	(.135)	(.114)
p-value	.20	.24	.18
	2851	2851	2851
		Period 2: jan1981 to jan1982	
α	.033	.026	.031
	(.012)	(.013)	(.012)
ε_b	.316	.272	.262
	(.118)	(.129)	(.105)
p-value	.3	.29	.37
	4906	4906	4906
		Period 3: jan1982 to jan1983	
α	.041	.023	.037
	(.016)	(.017)	(.016)
ε_b	.342	.202	.273
	(.137)	(.147)	(.122)
p-value	.9	.783	.647
	3905	3905	3905
		Period 4: jan1983 to dec1983	
α	.04	.03	.04
	(.015)	(.015)	(.015)
ε_b	.382	.297	.335
	(.14)	(.149)	(.123)
p-value	.391	.389	.375
	4209	4209	4209

Notes: Duration outcomes are expressed in weeks. α is the RK estimate of the average treatment effect of benefit level on the outcome. Standard errors for the estimates of α are in parentheses. P-values are from a test of joint significance of the coefficients of bin dummies in a model where bin dummies are added to the polynomial specification in equation 10. The optimal polynomial order is chosen based on the minimization of the Aikake Information Criterion. Periods correspond to stable UI benefit schedules.

Table B5—Baseline RKD Estimates, effect of benefit level on Unemployment and Non-Employment Duration, Washington 1979 - 1983

	Duration Initial Spell	Duration UI Claimed	Duration UI Paid	Non-Employment Duration
	Period 1: July 1979- July 1980			
α	.085	.078	.087	.088
	(.018)	(.017)	(.018)	(.022)
ε_b	.68	.69	.657	.419
	(.147)	(.152)	(.136)	(.104)
Opt. Poly	1	1	1	1
p-value	.162	.197	.198	.327
N	3485	3485	3485	3485
	Period 2: July 1980- July 1982			
α	.07	.059	.077	.056
	(.017)	(.016)	(.017)	(.02)
ε_b	.583	.546	.591	.278
	(.138)	(.146)	(.128)	(.097)
Opt. Poly	1	1	1	1
p-value	.987	.991	.985	.968
N	3601	3601	3601	3601
	Period 3: July 1982- Dec 1983			
α	.054	.035	.055	.059
	(.021)	(.02)	(.021)	(.022)
ε_b	.37	.263	.351	.281
	(.146)	(.153)	(.137)	(.105)
Opt. Poly	1	1	1	1
p-value	.022	.036	.009	.183
N	4275	4275	4275	4275

Notes: Duration outcomes are expressed in weeks. Washington is the only state for which we observe reemployment dates from wage records in the CWBH data. I therefore constructed a variable for the total duration of non-employment in Washington, and display in column (4) the estimates of the effect of benefit level on this duration outcome as well. α is the RK estimate of the average treatment effect of the UI benefit level on the outcome. Standard errors for the estimates of α are in parentheses. P-values are from a test of joint significance of the coefficients of bin dummies in a model where bin dummies are added to the polynomial specification in equation 10. The optimal polynomial order is chosen based on the minimization of the Aikake Information Criterion. Periods correspond to stable UI benefit schedules.

C. Proofs and Results

1. *Understanding the comparison with a simple dynamic labor supply model with no state dependence:*

Here, I briefly present a very simple two-period model with no state dependence, to understand how one can relate a dynamic search model to this general class of models. I also show how the Frisch elasticity literature uses variations along the wage profile over time to identify distortionary effects and liquidity effects separately, and how this relates to the technique employed in this paper to identify moral hazard effects and liquidity effects. Imagine a simple two-period model where utility in each period is given by $U_t = u(c_t) - \psi(s_t)$ where s_t is some effort level that brings a monetary reward (wage) r_t. $\psi(.)$ is increasing and convex. Agents start with some asset level A_0. The individual's program is therefore: $\max_{c_0,c_1,s_0,s_1} \; U_0 + U_1 \;$ s.t. $r_0 s_0 + r_1 s_1 + A_0 \geq c_0 + c_1$ The first order conditions give us:

$$\begin{cases} \psi'(s_0) = \lambda r_0 \\ \psi'(s_1) = \lambda r_1 \\ u'(c_0) = \lambda \\ u'(c_1) = \lambda \end{cases}$$

where λ is the Lagrange multiplier, or in other words, the marginal utility of wealth. Combining these first order conditions we get the Euler equation giving the optimal inter temporal allocation:

$$\frac{u'(c_0)}{u'(c_1)} = 1$$

And the static intratemporal optimal allocation rule:

$$\psi'(s_0) = r_0 u'(c_0)$$

From this, we immediately see that the response to a change in the return to effort at time 0 is the sum of a liquidity effect and of a distortionary effect:

$$\frac{\partial s_0}{\partial r_0} = \frac{-\lambda - r_0 \frac{\partial \lambda}{\partial r_0}}{\psi''(s_0)} = \frac{-u'(c_0)}{\psi''(s_0)} - \frac{r_0 u''(c_0)}{\psi''(s_0)}$$

This decomposition is exactly the same as the one in Chetty [2008], and is at the centre of the dynamic labor supply literature: The first-term is the Frisch effect, keeping marginal utility of consumption constant. The second one is a liquidity effect because we alter the marginal utility of consumption: $-\frac{r_0 u''(c_0)}{\psi''(s_0)} = \frac{\partial s_0}{\partial A_0}$. Here of course, the return to effort is continuous (r), but it is easy to see from a simple Taylor expansion that it is equivalent to the liquidity effect ($-\frac{u'(c_e)-u'(c_u)}{\psi''(s_0)} = \frac{\partial s_0}{\partial A_0}$) that we have in Chetty [2008] in the case of the return to job search effort.

The important insight from extending this simple example to a multi period case is that, in the absence of state-dependence as is the case here, effort at time t is always a function of wage at time t and all other wages affect current effort only through λ, because of the optimal inter temporal allocation rule. So that we have $s_t = s_t(r_t, \lambda_t)$ where $\lambda_t = \lambda_t(r_0, ..., r_N, A_0)$.

From this, there are two possible routes to identify the Frisch effect of a change in the wage rate. The first route, as in MaCurdy [1981] is to impose some structure on the problem by specifying the utility function so as to obtain a nice log-linear form for the Frisch effort function of individual i : $ln(s_t^i) = \beta ln r_t^i + \alpha ln \lambda_t^i$ and under some assumptions, the marginal utility of consumption can be written as an individual fixed effect and a time effect $ln\lambda_t^i = \gamma_i + e_t$. Then, the model can be identified in first-difference using panel data and variations along the wage profile: $\Delta ln(s_t^i) = \beta \Delta ln r_t^i + \Delta e_t$. The difficulty is to find credibly exogenous variations in the wage profile.

The second route is to use more credibly exogenous variations, and use reduced form estimates of the effect of a change in the wage at different point in times. This is the route chosen in this paper. The idea is that we have:

$$\begin{cases} \frac{\partial s_0}{\partial r_0} = \frac{-\lambda - r_0 \frac{\partial \lambda}{\partial r_0}}{\psi''(s_0)} \\ \frac{\partial s_0}{\partial r_1} = \frac{-r_0 \frac{\partial \lambda}{\partial r_1}}{\psi''(s_0)} \end{cases}$$

And we also know that $\frac{\partial \lambda}{\partial r_1} = \frac{\partial \lambda}{\partial r_0}$. The difference in the reduced form estimates of the effect of a change in wages at time 0 and 1 can identify the Frisch effect $\frac{-\lambda}{\psi''(s_0)}$ keeping marginal utility of wealth constant. This technique has the advantage that the identifying variations are more transparent, but relies on the exact same idea of using variations along the wage profile over time. In this paper, the only complication comes from the presence of state dependence, as explained in section 1.

2. *Multi-period model:*

Here, I present the multi-period model extension of the simple model presented in section 1 of the paper and derive the main results. The model describes the behavior of a worker living T discrete periods (e.g., weeks) who is laid-off and therefore becomes unemployed in period zero. When unemployed, the worker exerts search effort in each period s_t that translates into a probability to find a job[57]. This probability is normalized to s_t to simplify presentation. Search effort is not observable (hence the presence of moral hazard) and has a utility cost $\psi(s_t)$ increasing and convex. Wages w_t are exogenous[58], and when an unemployed finds a job, it lasts forever. When unemployed, an agent starts her unemployment spell with asset level A_0 and receives unemployment insurance benefits b_t each period. As a baseline, I consider that the initial asset level A_0 is exogenous and do not allow for heterogeneity. Both assumptions can be relaxed, as I show in extensions of the model below. To finance the unemployment benefits, the government levies a lump sum tax τ on each employed worker.

[57]This captures the presence of search frictions in the labor market.

[58]Empirical evidence seems to support this assumption that wages in fact do not respond much to UI. There is a vast empirical micro literature in labor trying to estimate how re-employment wages are affected by the generosity of UI benefits. The striking finding is that it has proven impossible to find such an effect. Card, Chetty and Weber [2007] use full population administrative payroll data from Austria in a compelling regression discontinuity design and find no effects (very precisely estimated) on subsequent re-employment wages. Wages of workers who are already on the job are even less likely to respond to a change in benefits than wages of workers who are coming from unemployment and negotiating with employers. So wages of existing workers are likely to respond less than wages of new hires to UI generosity.

The planner sets taxes τ and benefits b to maximize welfare W_0 (defined as the expected life-time utility of an unemployed worker), under a balanced-budget constraint: $D_B \cdot b = (T - D)\tau$ where D_B is the duration of paid unemployment and D is the total duration of unemployment. I restrict attention here to the class of typical UI systems where benefits are defined by a constant level b for a fixed period B[59]. Therefore choosing the optimal benefit schedule amounts to choosing potential duration B and benefit level b.

Timing of the model: Individuals enter unemployment at period $t = 0$. At the beginning of every period, if the individual is still unemployed, she chooses search effort. Once search effort is realized, she chooses consumption. The value function of finding a job at time t is:

$$V(A_t) = \max_{A_{t+1} \geq L} \; u(A_t - A_{t+1} + w_t - \tau) + \beta V(A_{t+1})$$

The value function of being unemployed at time t is:

$$U(A_t) = \max_{A_{t+1} \geq L} \; u(A_t - A_{t+1} + b_t) + \beta J(A_{t+1})$$

$$J(A_t) = \max_{s_t} \; s_t \cdot V(A_t) + (1 - s_t) \cdot U(A_t) - \psi(s_t)$$

s.t.

$$u(c_t^u) \geq 0$$
$$u(c_t^e) \geq 0$$

We assume that $\psi(.)$ is increasing and convex.

For simplicity, and following Chetty [2008] who shows that in simulations U is always concave, we assume U is always concave.

Definition and notations: We define the effect on any variable Z of a change in the constant benefit level b for a finite period of potential duration of UI benefits B as:

$$\left.\frac{\partial Z}{\partial b}\right|_B = \sum_{i=0}^{B-1} \frac{\partial Z}{\partial b_i}$$

We also define a series of search and duration measures in the following way:

- $f_k(t) = \prod_{i=k}^{t-1}(1 - s_i)s_t$ is the probability that the unemployment spell lasts exactly t periods conditional on being still unemployed at the beginning of period k.

- $S_k(t) = \prod_{i=k}^{t}(1 - s_i)$ is the survival rate at time t conditional on being still unemployed at period k.

- $F_k(t) = \sum_{s=k}^{t} f(s) = 1 - S_k(t)$ is the probability that the length of a spell is inferior or equal to t conditional on being still unemployed at period k.

- $D_k^T = \sum_{i=0}^{T} S_k(i)$ is the average duration of a spell truncated at T periods conditional on being still unemployed after k periods.

[59]A large theoretical literature has derived the full optimal time-path of UI benefits. See for instance Hopenhayn and Nicolini [1997], or **?**.

Optimal search effort at time t is given by the following first-order condition:

$$\psi'(s_t) = V(A_t) - U(A_t) \tag{13}$$

Euler equations:

$$\forall t \quad u'(c_t^e) = \begin{cases} \beta u'(c_{t+1}^e) \\ u'(w-\tau) \ \text{ if } A_t = L \end{cases}$$

$$\forall t \quad u'(c_t^u) = \begin{cases} \beta[s_{t+1}u'(c_{t+1}^e) + (1-s_{t+1})u'(c_{t+1}^u)] \\ u'(b_t) \ \text{ if } A_t = L \end{cases}$$

Therefore, if the credit constraint is not binding at time t we have that:

$$\forall t \ \ u'(c_0^e) = \beta^t u'(c_t^e) \tag{14}$$

$$\begin{aligned} \forall t \ \ u'(c_0^u) &= \sum_{j=1}^{t}\left(\prod_{i=1}^{j-1}(1-s_i)s_j\right)\beta^j u'(c_j^e) + \beta^t \prod_{i=1}^{t}(1-s_i)u'(c_t^u) \\ &= F_1(t)u'(c_0^e) + \beta^t S_1(t)u'(c_t^u) \end{aligned} \tag{15}$$

Moral hazard and liquidity effects:

Using the first order condition for search effort given in equation 13 we get the effect of benefit level at time t on optimal search:

$$\frac{\partial s_t}{\partial b_t} = -\frac{u'(c_t^u)}{\psi''(s_t)}$$

and more generally the effect of benefit level at time $t+j$ on optimal search at time t:

$$\frac{\partial s_t}{\partial b_{t+j}} = -\frac{\beta^j \prod_{i=1}^{j}(1-s_{t+i})u'(c_{t+j}^u)}{\psi''(s_t)} = -\frac{S_{t+1}(t+j)\beta^j u'(c_{t+j}^u)}{\psi''(s_t)} \tag{16}$$

From 13, we also have that:

$$\frac{\partial s_t}{\partial A_t} = \frac{u'(c_t^e) - u'(c_t^u)}{\psi''(s_t)}$$

$$\frac{\partial s_t}{\partial w_t} = \frac{u'(c_t^e)}{\psi''(s_t)}$$

so that:

$$\frac{\partial s_t}{\partial b_t} = \overbrace{\frac{\partial s_t}{\partial A_t}}^{\text{liquidity effect}} - \underbrace{\frac{\partial s_t}{\partial w_t}}_{\text{moral hazard effect}} \tag{17}$$

which is the Chetty (2007) decomposition of the effect of benefits between the liquidity and moral hazard effect.
The first term is a liquidity effect that is proportional to the difference in marginal utility of consumption while employed and unemployed. The second term is the standard moral hazard effect that arises because b_t works as an unemployment subsidy, and distorts the relative price of employment. Since

Similarly, the effect on search effort at time 0 of a change in the constant benefit level b for a finite period of potential duration of UI benefits B can also be written as the sum of two components, a moral hazard and a liquidity effect:

$$\left.\frac{\partial s_0}{\partial b}\right|_B = \overbrace{\left.\frac{\partial s_0}{\partial A}\right|_B}^{\text{liquidity effect}} - \underbrace{\left.\frac{\partial s_0}{\partial w}\right|_B}_{\text{moral hazard effect}} \tag{18}$$

where $\left.\frac{\partial s_0}{\partial A}\right|_B = \sum_{i=0}^{B-1} \frac{\partial s_0}{\partial A_i}$ is the effect of a change in the level of an annuity that pays \$$a$ every period and $\left.\frac{\partial s_0}{\partial w}\right|_B = \sum_{i=0}^{B-1} \frac{\partial s_0}{\partial w_i}$

3. *Proof of proposition 1:*

I now show how $\left.\frac{\partial s_0}{\partial w}\right|_B$, the moral hazard effect on search effort at time 0 of a change in the constant benefit level b for a finite period of potential duration of UI benefits B can be identified using variations in search effort at time 0 in response to a change in benefit level $\left.\frac{\partial s_0}{\partial b}\right|_B$ and variations in search effort at time 0 in response to a change in benefit duration $\frac{\partial s_0}{\partial B}$.

This proof is a simple generalization in a multi-period model of the proof given in the two-period model in the main text of this paper.

Using the first order condition for search effort given in equation 13 we get the effect of a change in wage at time t on optimal search at time 0:

$$\frac{\partial s_0}{\partial w_t} = \frac{\frac{\partial V(A_0)}{\partial w_t} - \frac{\partial U(A_0)}{\partial w_t}}{\psi''(s_0)}$$

After some algebra, we have that:

$$\frac{\partial V(A_0)}{\partial w_t} = \beta^t u'(c_t^e)$$

$$\frac{\partial U(A_0)}{\partial w_t} = F_1(t)\beta^t u'(c_t^e)$$

so that, using the Euler equations, we have that:

$$\frac{\partial s_0}{\partial w_t} = \frac{(1-F_1(t))\beta^t u'(c_t^e)}{\psi''(s_0)} = \frac{S_1(t)u'(c_0^e)}{\psi''(s_0)} = S_1(t)\frac{\partial s_0}{\partial w_0} \tag{19}$$

Equation 19 generalizes equation 5 from the two period model, and gives the relationship between the effect on effort at time 0 of a change in wage at time t and the effect on effort at time 0 of a change in wage at time 0. This relationship stems from the presence of state dependence. In the absence of state dependence, as is usually the case in the standard dynamic labor supply literature, $S_1(t) = 0$ and therefore there is no moral hazard effect of changing benefits in time t on current effort at time 0: all the effect of changing the wage rate at time t on effort at time 0 happens through the liquidity effect (the change in the marginal utility of wealth). The intuition is that $S_1(t) = 0$ means that no matter what my effort at time 0 is, I will be employed at time t with certainty, therefore changing the wage rate at time t has no forward-looking effect on my effort at time 0. The higher the probability that I remain unemployed at time t, the larger the forward looking effect of changing the wage rate at time t on my effort at time 0.

Using equation 19, we can now rewrite the moral hazard effect of an increase in benefit level b for B periods that we call Θ_1:

$$\Theta_1 = \left.\frac{\partial s_0}{\partial w}\right|_B = \sum_{t=0}^{B-1} \frac{\partial s_0}{\partial w_t} = \frac{\partial s_0}{\partial w_0} \cdot \sum_{t=0}^{B-1} S_1(t) \tag{20}$$

Using equation 16 and the Euler equations, the effect of an increase in benefit level at time t on exit rate at time 0 can be written:

$$\begin{aligned}
\frac{\partial s_0}{\partial b_t} &= -\frac{S_1(t)\beta^t u'(c_t^u)}{\psi''(s_0)} \\
&= \frac{F_1(t)u'(c_0^e) - u'(c_0^u)}{\psi''(s_0)} \\
&= \frac{(1 - S_1(t))u'(c_0^e) - u'(c_0^u)}{\psi''(s_0)} \\
&= \frac{\partial s_0}{\partial A_0} - S_1(t)\frac{\partial s_0}{\partial w_0} \qquad (21)
\end{aligned}$$

Equation 21 generalizes equation 6 from the two period model. Equation 21 stems from the presence of state dependence and has the same intuition as equation 19 above. In the absence of state dependence, as is usually the case in the standard dynamic labor supply literature, $S_1(t) = 0$ all the effect of changing the wage rate at time t on effort at time 0 happens through the liquidity effect (the change in the marginal utility of wealth). But with state dependence, changing benefits at time t has a negative forward-looking moral hazard effect on effort at time 0 on top of the mere liquidity effect. The higher the probability $S_1(t)$ that I remain unemployed at time t, the larger the forward looking effect of of increasing benefits at time t on my effort at time 0.

Using equation 21, we can write the effect of an increase of benefit level b for B periods as:

$$\left.\frac{\partial s_0}{\partial b}\right|_B = \sum_{t=0}^{B-1} \frac{\partial s_0}{\partial b_t}$$

$$= B \cdot \frac{\partial s_0}{\partial A_0} - \frac{\partial s_0}{\partial w_0} \cdot \sum_{t=0}^{B-1} S_1(t) \tag{22}$$

Using equation 21, we can also write the effect of an increase in benefit duration B periods keeping constant benefit level b:

$$\frac{\partial s_0}{\partial B} \approx b \cdot \frac{\partial s_0}{\partial b_B}$$

$$= b \cdot \left\{ \frac{\partial s_0}{\partial A_0} - \frac{\partial s_0}{\partial w_0} \cdot S_1(B) \right\} \tag{23}$$

From 22 and 23, it follows that:

$$\frac{1}{B} \left.\frac{\partial s_0}{\partial b}\right|_B - \frac{1}{b} \frac{\partial s_0}{\partial B} = -\Big(\sum_{t=0}^{B-1} \frac{S_1(t)}{B} - S_1(B) \Big) \frac{\partial s_0}{\partial w_0}$$

$$= -\Big(\overline{S_1^B} - S_1(B) \Big) \frac{\partial s_0}{\partial w_0} \tag{24}$$

where $\overline{S_1^B}$ is the average survival rate between time 1 and time $B-1$ conditional on being unemployed at time 1. Proposition 1 follows from using 20 and 24:

$$\frac{1}{B} \left.\frac{\partial s_0}{\partial b}\right|_B - \frac{1}{b} \frac{\partial s_0}{\partial B} = -\frac{\overline{S_1^B} - S_1(B)}{D_1^B} \cdot \Theta_1 \tag{25}$$

4. Optimal benefit level b:

Planner's problem: the government cannot observe effort and cannot contract directly on s_t, any increase in b_t leads to a decline in search effort. The planner sets taxes τ and benefits b_t to maximize welfare W_0 (defined as the expected life-time utility of an unemployed worker), under a balanced-budget constraint: $D_B \cdot b = (T-D)\tau$ where D_B is the duration of paid unemployment and D is the total duration of unemployment. I restrict attention here to the class of typical UI systems where benefits are defined by a constant level b for a fixed period B[60]. Therefore choosing the optimal benefit schedule amounts to choosing potential duration B and benefit level b.

The social planner chooses the UI benefit level to maximize expected utility subject to a balanced-budget constraint and given a potential duration of benefits B:

[60]A large theoretical literature has derived the full optimal time-path of UI benefits. See for instance Hopenhayn and Nicolini [1997], or **?**.

$$\max_{b,\tau} W_0 = (1-s_0)U(A_0) + s_0 V(A_0) - \psi(s_0)$$
$$\text{subject to} \quad D_B \cdot b = (T-D)\tau$$

The first order condition is given by:

$$\frac{dW_0}{db} = (1-s_0)\Big[\left.\frac{\partial U_0}{\partial b}\right|_B - \left.\frac{\partial U_0}{\partial w}\right|_B \frac{d\tau}{db}\Big] + s_0 \Big[\underbrace{\left.\frac{\partial V_0}{\partial b}\right|_B}_{=0} - \left.\frac{\partial V_0}{\partial w}\right|_B \frac{d\tau}{db}\Big] = 0$$

From 13, we have that:

$$\forall y, \left.\frac{\partial s_0}{\partial y}\right|_B = \frac{1}{\psi''(s_0)}\Big[\left.\frac{\partial V_0}{\partial y}\right|_B - \left.\frac{\partial U_0}{\partial y}\right|_B\Big]$$

So that:

$$\frac{dW_0}{db} = -(1-s_0)\psi''(s_0)\left.\frac{\partial s_0}{\partial b}\right|_B - \frac{d\tau}{db}\Big((1-s_0)\left.\frac{\partial U_0}{\partial w}\right|_B + s_0 \left.\frac{\partial V_0}{\partial w}\right|_B\Big) \tag{26}$$

We also know that: $\forall t, \quad \frac{\partial V_0}{\partial w_t} = \beta^t u'(c_t^e)$ so that :

$$\begin{aligned}
\left.\frac{\partial V_0}{\partial w}\right|_B &= \sum_{t=0}^{B-1} \beta^t u'(c_t^e) \\
&= Bu'(c_0^e) \quad \text{if the credit constraint does not bind at time } B \qquad (27)
\end{aligned}$$

And, similarly: $\forall t, \quad \frac{\partial U_0}{\partial w_t} = \sum_{j=1}^{t} f_1(j)\beta^t u'(c_t^e)$ so that :

$$\begin{aligned}
\left.\frac{\partial U_0}{\partial w}\right|_B &= \sum_{t=1}^{B-1} F_1(t)\beta^t u'(c_t^e) \\
&= \sum_{t=1}^{B-1} F_1(t) u'(c_0^e) \quad \text{if the credit constraint does not bind at time } B \qquad (28)
\end{aligned}$$

And therefore, if the credit constraint does not bind at time B

$$\begin{aligned}
(1-s_0)\left.\frac{\partial U_0}{\partial w}\right|_B &= \sum_{t=1}^{B-1}(1-s_0)F_1(t)u'(c_0^e) \\
&= \sum_{t=1}^{B-1} F_0(t)u'(c_0^e) \\
&= (B - D_B - s_0)u'(c_0^e) \qquad (29)
\end{aligned}$$

where we use the fact that $\sum_{t=0}^{B-1} S(t) = D_B$, the average duration of unemployment truncated at B.

Note that the moral hazard effect of an increase in b can also be expressed as a simple function of $u'(c_0^e)$ if the credit constraint is not binding at time B:

$$\left.\frac{\partial s_0}{\partial w}\right|_B = \frac{1}{\psi''(s_0)}\left[\left.\frac{\partial V_0}{\partial w}\right|_B - \left.\frac{\partial U_0}{\partial w}\right|_B\right] = \frac{(D_B - s_0(B-1))u'(c_0^e)}{(1-s_0)\cdot\psi''(s_0)} \tag{30}$$

Using (18), (27), (29) and (30), we can rewrite (26) such that:

$$\frac{dW_0}{db} = -(1-s_0)\psi''(s_0)\Big[\Big(\left.\frac{\partial s_0}{\partial a}\right|_B - \left.\frac{\partial s_0}{\partial w}\right|_B\Big) + \frac{d\tau}{db}\Big(\left.\frac{\partial s_0}{\partial w}\right|_B \cdot (B/(D_B - s_0(B-1)) - 1)\Big)\Big]$$

We get from the government budget constraint that:

$$\frac{d\tau}{db} = \frac{D_B}{T-D}(1 + \varepsilon_{D_B} + \varepsilon_D\frac{D}{T-D})$$

where $\varepsilon_{D_B} = \frac{b}{D_B}\frac{dD_B}{db}$ is the elasticity of the duration of paid unemployment with respect to the benefit level and $\varepsilon_D = \frac{b}{D}\frac{dD}{db}$ is the elasticity of the duration of total unemployment with respect to the benefit level.

Therefore, if the credit constraint is not yet binding at time B, the first-order condition $\frac{dW_0}{db} = 0$ takes a simple form:

$$1 + \rho_1 = (\frac{B}{D_B - s_0(B-1)} - 1)\frac{D_B}{T-D}(1 + \varepsilon_{D_B} + \varepsilon_D\frac{D}{T-D}) \tag{31}$$

where $\rho_1 = -\frac{\left.\frac{\partial s_0}{\partial a}\right|_B}{\left.\frac{\partial s_0}{\partial w}\right|_B}$ is the liquidity to moral hazard ratio in the effect of an increase of benefit level. When the lefthand side of 31 is superior to the righthand side, it is socially desirable to increase the benefit level b, at the given level of potential duration B.

5. *Optimal potential duration B:*

To analyze marginal changes in B, I assume that a marginal change in the potential duration of benefits B normalized by the benefit amount b is therefore the same as a marginal change in b_B [61]. In this context, following the same logic as previously, we have that :

$$\frac{dW_0}{dB} = b.\frac{dW_0}{db_B} = b.\Big(-(1-s_0)\psi''(s_0)\Big[\big(\frac{\partial s_0}{\partial a_B} - \frac{\partial s_0}{\partial w_B}\big) + \frac{d\tau}{db}\big(\frac{\partial s_0}{\partial w_B}\cdot(1/(S(B)-s_0)-1)\big)\Big]\Big)$$

[61] This is the case if B can potentially be increased by a fraction of period (a week in our case) and that if the potential duration B is not an integer number of periods, then, we can change b_t within a period such that the benefits in a given period is the fraction of the period that is covered time the benefit amount b.

Differentiating the budget constraint of the government, we get that:

$$\frac{d\tau}{db_B} = \frac{1}{b} \cdot \frac{d\tau}{dB} = \frac{D_B}{B \cdot (T-D)}(\varepsilon_{D_B,B} + \varepsilon_{D,B}\frac{D}{T-D}) \tag{32}$$

where $\varepsilon_{D_B,B} = \frac{B}{D_B}\frac{dD_B}{dB}$ is the elasticity of the duration of paid unemployment with respect to the potential duration of UI benefits and $\varepsilon_{D,B} = \frac{B}{D}\frac{dD}{dB}$ is the elasticity of the duration of total unemployment with respect to the potential duration of UI benefits. Note of course that because $D_B = \sum_{t=0}^{B-1} S(t)$, we have that $\frac{\partial D_B}{\partial B} = \sum_{t=0}^{B-1} \frac{\partial S(t)}{\partial B} + S(B)$, which means that the effect of a change in potential duration on the actual average duration of UI benefits is the sum of the mechanical effect of truncating the distribution of spells at a later point in time $S(B)$ and a behavioral response. This point is central to the argument in Schmieder, von Wachter and Bender [2012].

Using (32) and

$$1 + \rho_2 = (\frac{1}{S(B) - s_0} - 1)\frac{D_B}{B \cdot (T-D)}(\varepsilon_{D_B,B} + \varepsilon_{D,B}\frac{D}{T-D}) \tag{33}$$

where $\rho_2 = -\frac{\frac{\partial s_0}{\partial a_B}}{\frac{\partial s_0}{\partial w_B}}$ is the liquidity to moral hazard ratio in the effect of an increase of potential duration. When the lefthand side of 33 is superior to the righthand side, it is socially desirable to increase the potential duration of benefits, at the given level of benefit level b.

6. *Stochastic wage offers:*

The result of proposition 1 can be extended to the presence of stochastic wage offers, whereby an agent's hazard rate out of unemployment would depend both on her search effort and her reservation wage. Suppose that in period t with probability s_t (controlled by search intensity) the agent is offered a wage $w \sim \hat{w} + F(w)$ and assume i.i.d. wage draws across periods. In such a framework, the agent follows a reservation-wage policy: in each period, there is a cutoff R_t such that the agent accepts a job only if the wage $w > R_t$ (McCall [1970]). I show here that the result of proposition 1 remains unchanged in this context. The intuition for the result is that the agent is setting her reservation wage profile optimally, so that the envelope theorem applies and there is no first-order effect of a change in reservation-wage policy on the agent's expected utility.

For simplicity we focus on the two-period case. Expected utility at the start of period 0 is then:

$$
\begin{aligned}
\mathcal{U} = {} & s_0 P[w \geq R_0] u(c_0^e) + (1 - s_0 P[w \geq R_0]) u(c_0^u) - \psi(s_0) + \\
& \beta \Big(s_0 P[w \geq R_0] u(c_1^e) + (1 - s_0 P[w \geq R_0]) \Big(s_1 P[w \geq R_1] u(c_1^e) + (1 - s_1 P[w \geq R_1]) u(c_1^u) - \psi(s_1) \Big) \Big)
\end{aligned} \tag{34}
$$

where $P[w \geq R_t]$ is the probability that the wage offered in period t is larger than the reservation wage in period t.

First-order conditions of the agent's problem with respect to s_0

$$
\begin{aligned}
\psi'(s_0) = {} & P[w \geq R_0] u(c_0^e) + \beta P[w \geq R_0] u(c_1^e) - P[w \geq R_0] u(c_0^u) \\
& - P[w \geq R_0] \Big(s_1 P[w \geq R_1] u(c_1^e) + (1 - s_1 P[w \geq R_1]) u(c_1^u) - \psi(s_1) \Big)
\end{aligned} \tag{35}
$$

First-order conditions of the agent's problem with respect to R_0

$$
\begin{aligned}
0 = {} & \frac{\partial P[w \geq R_0]}{\partial R_0} u(c_0^e) + \beta \frac{\partial P[w \geq R_0]}{\partial R_0} u(c_1^e) - \frac{\partial P[w \geq R_0]}{\partial R_0} u(c_0^u) \\
& - \frac{\partial P[w \geq R_0]}{\partial R_0} \Big(s_1 P[w \geq R_1] u(c_1^e) + (1 - s_1 P[w \geq R_1]) u(c_1^u) - \psi(s_1) \Big)
\end{aligned} \tag{36}
$$

First-order conditions of the agent's problem with respect to R_1

$$
s_1 \frac{\partial P[w \geq R_1]}{\partial R_1} u(c_1^e) - s_1 \frac{\partial P[w \geq R_1]}{\partial R_1} u(c_1^u) = \psi'(s_1) \tag{37}
$$

Euler equations:

$$
u'(c_0^e) = \beta u'(c_1^e)
$$
$$
u'(c_0^u) = \beta (s_1 P[w \geq R_1] u'(c_1^e) + (1 - s_1 P[w \geq R_1]) u'(c_1^u))
$$

Using the envelope theorem:

$$
\frac{\partial s_0}{\partial b_0} = - \frac{P[w \geq R_0] u'(c_0^u)}{\psi''(s_0)}
$$

And using the Euler equations and the envelope theorem:

$$
\frac{\partial s_0}{\partial b_1} = \frac{\partial s_0}{\partial b_0} - \frac{s_1 P[w \geq R_1] P[w \geq R_0] u'(c_0^e)}{\psi''(s_0)}
$$

Because $\frac{\partial s_0}{\partial w_0} = - \frac{P[w \geq R_0] u'(c_0^e)}{\psi''(s_0)}$ we have that

$$
\frac{\partial s_0}{\partial b_0} - \frac{\partial s_0}{\partial b_1} = - h_1 \frac{\partial s_0}{\partial w_0}
$$

where $h_1 = s_1 P[w \geq R_1]$ is the hazard rate out of unemployment in period 1, and $P[w \geq R_1]$ is the probability that the wage offered in period 1 is larger than the reservation wage in period 1 R_1.

The only difficulty lies in defining the empirical counterparts for the implementation of the formula, as changes in empirically observed job finding hazards cannot be directly used to infer the relevant changes in search intensity because part of the change in job finding hazards comes from changes in the reservation wage. There are two options for empirical implementation. The first one relies on the estimation of reservation wage variations to changes in UI benefits and therefore requires credible data on reservation wages. The idea is that the job finding hazard h_t can be decomposed into its search effort component s_t and its reservation-wage policy component $P[w \geq R_t] = 1 - F(R_t)$ where F is the c.d.f. of the job offer distribution. We have for instance in the two-period case:

$$\frac{d \log s_0}{db_0} - \frac{d \log s_0}{db_1} = [\frac{d \log h_0}{db_0} - \frac{d \log h_0}{db_1}] - \frac{f(R_0)}{1 - F(R_0)} \cdot [\frac{\partial R_0}{\partial b_0} - \frac{\partial R_0}{\partial b_1}]$$

To back out the difference in the effect of benefits at time 0 and at time 1 on search effort, one needs to estimate the difference in the effect of benefits at time 0 and at time 1 on the hazard rate ($\frac{d \log h_0}{db_0} - \frac{d \log h_0}{db_1}$) as well as the difference in the effect of benefits at time 0 and at time 1 on the reservation wage ($\frac{\partial R_0}{\partial b_0} - \frac{\partial R_0}{\partial b_1}$). There is unfortunately little empirical evidence on the behaviour of reservation wages. The best empirical evidence comes from Krueger and Mueller [2014], who, using high frequency survey data on reservation wage matched with administrative UI data in New Jersey, show that reservation wage profiles do not respond to UI benefits ($\frac{\partial R_0}{\partial b} \approx 0$). The second option consists as in Chetty [2008] in using variations in mean accepted wages upon reemployment in response to variations in UI benefits. Again, recent evidence indicates that UI benefit levels have little effect on wages and other measures of the accepted job's quality (Ours and Vodopivec [2006]). In light of the empirical evidence, the empirical implementation of formula 1 using changes in hazard rates h_0 to directly infer changes in search effort s_0 seems to remain a valid approximation in the presence of stochastic wage offers.

D. State UI Information

Information on state UI laws come from the *Significant Provisions of State Unemployment Insurance Laws*, published bi-annually by the US Dept of Labor, Employment and Training Administration. I consulted state laws and state employment agencies for more detailed information on benefit schedule variations[62].

1. Idaho

In Idaho, the fraction of highest quarter of earnings to compute the weekly benefit amount is 1/26 for the whole period 1976 to 1984.

Maximum benefit amount
The maximum benefit amount in Idaho in January 1976 is $b_{max} = \$90$.
It was then increased seven times until December 1983:
$99 for claims filed after 04jul1976
$110 for claims filed after 01jul1977
$116 for claims filed after 01jul1978
$121 for claims filed after 01jul1979
$132 for claims filed after 01jul1980
$145 for claims filed after 01jul1981
$159 for claims filed after 20jun1982.

Minimum benefit amount
The minimum benefit amount in Idaho in January 1976 is $b_{min} = \$17$.
It was then increased twice until December 1983:
$36 for claims filed after 01jul1980
$45 for claims filed after 01jan1984.

Duration of Benefits
Idaho has a special determination rule for potential duration described in table B5.

[62]CWBH has exhaustive information in Georgia on unemployment spells and wage records. But because of the parameters of the UI system in Georgia, the RK design was inoperable. $\tau_1 = 1/25$, $D_{max} = 26$, $\tau_2 = 1/4$ so that $D_{max} \cdot \frac{\tau_1}{\tau_1} > 4$ always larger than $\frac{bpw}{hqw}$ for all individuals on the left side of the benefit level kink. I don't have any observation with only kink in benefit level at the kink.

Table B5—Determination of Potential Duration 1st tier UI Idaho: 1976-1984

Ratio of bqw/hpw		UI Duration	
At Least...	Less Than...	before Jul 1st 1983	after Jul 1st 1983
1.25	1.50	10	
1.50	1.750	12	10
1.750	2.00	14	12
2.00	2.250	16	14
2.250	2.500	18	16
2.500	2.750	20	18
2.750	3.000	22	20
3.000	3.250	24	22
3.250	3.500	26	24
3.500	–	26	26

2. *Louisiana*

In Louisiana, the fraction of highest quarter of earnings to compute the weekly benefit amount is 1/25 for the whole period 1979 to 1984.

Maximum benefit amount
The maximum benefit amount in Louisiana in January 1979 is $b_{max} = \$141$.
It was then increased four times until December 1983:
$149 for claims filed after 02sep1979
$164 for claims filed after 07sep1980
$183 for claims filed after 06sep1981
$205 for claims filed after 05sep1982

Minimum benefit amount
The minimum benefit amount in Louisiana from January 1979 until December 1983 is always $10.

Duration of Benefits
The fraction of base period earnings to determine the total amount of benefits payable for a given benefit year is 2/5. The maximum duration of benefits was set at 28 weeks. It was reduced to 26 weeks for claims filed after 03apr1983.

3. *Missouri*

In Missouri, the fraction of highest quarter of earnings to compute the weekly benefit amount is 1/20 from the beginning of the period covered by the CWBh data (January 1978) until December 2nd, 1979 when it becomes .045.

Maximum benefit amount
The maximum benefit amount in Missouri in January 1978 is $b_{max} = \$85$.
It was then increased only once until December 1983:

$105 for claims filed after02dec1979.

Minimum benefit amount

The minimum benefit amount in Missouri from January 1979 until December 1983 is always $15.

Duration of Benefits

The fraction of base period earnings to determine the total amount of benefits payable for a given benefit year is 1/3. The maximum duration of benefits is 26 weeks for the whole period covered by the CWBH data.

4. New Mexico

In New Mexico, the fraction of highest quarter of earnings to compute the weekly benefit amount is 1/26 for the whole period covered by the CWBh data (January 1980 to December 1983).

Maximum benefit amount

The maximum benefit amount in New Mexico in January 1980 is $b_{max} = \$106$.
It was then increased three times until December 1983:
$105 for claims filed after02dec1979.
$117 for claims filed after 01jan1981
$130 for claims filed after 01jan1982
$142 for claims filed after 01jan1983

Minimum benefit amount

The minimum benefit amount in New Mexico in January 1980 is $22.
It was then increased to: $24 for claims filed after 01jan1981
$26 for claims filed after 01jan1982
$29 for claims filed after 01jan1983

Duration of Benefits

The fraction of base period earnings to determine the total amount of benefits payable for a given benefit year is 3/5. The maximum duration of benefits is 26 weeks for the whole period covered by the CWBH data.

5. Washington

In Washington, the weekly benefit amount is computed as a fraction of the average of the two highest quarters of earnings. The fraction to compute the weekly benefit amount is 1/25 for the whole period covered by the CWBh data (June 1979 to December 1983).

Maximum benefit amount

The maximum benefit amount in Washington in June 1st, 1979 is $b_{max} = \$128$.
It was then increased to:
$137 for claims filed after 25jun1979
$150 for claims filed after 06jul1980

$163 for claims filed after 01jul1981
$178 for claims filed after 01jul1982
$185 for claims filed after 01jul1983

Minimum benefit amount

The minimum benefit amount in in Washington in June 1979 is always $17.
It was then increased to: $41 for claims filed after 06jul1980
$45 for claims filed after 01jul1981
$49 for claims filed after 01jul1982
$51 for claims filed after 01jul1983

Duration of Benefits

The fraction of base period earnings to determine the total amount of benefits payable for a given benefit year is 1/3. The maximum duration of benefits is 30 weeks for the whole period covered by the CWBH data.
Note that until February 26, 1983, the state of Washington provides for 13 weeks of State-funded additional benefits for individuals who have exhausted their regular and Federal-State Extended Benefits[63]. However, no additional benefit period was paid while a Federal program was in effect.

[63]The additional benefits correspond to an *ad hoc* program which is triggered on only if the Governor determines it necessary.

6. EB trigger dates

Information on national and state triggers and trigger dates comes from the weekly trigger notice reports of the Bureau of Labor Statistics. Note that in the weekly trigger notice reports, there are sometimes some slight adjustments ex-post because of lags in the computation of the IUR triggers. I therefore rely on ex post trigger notices where the starting and ending dates of each episodes of EB are indicated.

National Trigger Dates
Until the Omnibus Budget Reconciliation Act of 1981, (effective July 1st 1981), the EB system had two triggers. A national trigger and state specific triggers. During the period 1976 to 1981, the national trigger was on three times, from 2/23/1975 to 7/2/1977, from 8/28/1977 to 01/28/1978, and from 7/20/1980 to 1/24/1981, automatically triggering periods of EB in all US states.

Idaho Trigger Dates
During the period 1976 to 1984, and on top of national EB periods, the EB trigger for Idaho was on four times: from 4/30/1978 to 7/29/1978, from 2/25/79 to 6/6/1979, from 2/17/80 to 7/18/81, and finally from 10/18/81 to the end of the period covered by the CWBH data.

Louisiana Trigger Dates
During the period 1979 to 1984, and on top of national EB periods, the EB trigger for Louisiana was on three times: from 7/20/1980 to 1/24/1981, from 9/12/1981 to 10/23/1982, and finally from 1/23/83 to the end of the period covered by the CWBH data.

Missouri Trigger Dates
During the period 1978 to 1984, and on top of national EB periods, the EB trigger for Missouri was on twice: from 6/1/80 to 7/25/1981, and from 3/26/1982 to 6/19/82.

New Mexico Trigger Dates
During the period 1980 to 1984, and on top of national EB periods, the EB trigger for New Mexico was on only once from 8/29/82 to 11/27/82

Washington Trigger Dates
During the period 1979 to 1984, and on top of national EB periods, the EB trigger for Washington was on without interruption from 7/6/1980 to 7/2/83.

7. Graphical illustration of the kinks in the schedule of UI benefit level and of UI potential duration

The schedule of UI benefits exhibits kinks for both potential duration and benefit level. But in some cases these two schedules are related, and therefore the location of the kinks may also overlap as one can see from the formula for the schedule of potential duration

$$D = \begin{cases} D_{max} & \\ \tau_2 \cdot \frac{bpw}{min(\tau_1.hqw, b_{max})} & \text{if} \quad \tau_2 \cdot \frac{bpw}{min(\tau_1 \cdot hqw, b_{max})} \leq D_{max} \end{cases}$$

To analyze independently the effects of duration and of the benefit amount in the regression kink design, it is therefore useful to break down the sample in different subgroups. Figure D1 summarizes the kinked schedules of the weekly amount and potential duration of UI benefits for Louisiana for all the different subgroups. First, for claimants who hit the maximum weekly benefit amount, $b = b_{max}$, there is a kink in the relationship between potential duration and base period earnings bpw at $bpw = D_{max} \cdot \frac{b_{max}}{\tau_2}$.

$$D = \begin{cases} D_{max} & \\ \frac{\tau_2}{b_{max}} \cdot bpw & \text{if} \quad bpw \leq D_{max} \cdot \frac{b_{max}}{\tau_2} \end{cases}$$

The schedules of b and D for this subgroup is displayed on the left of panel B in figure D1.

For claimants who are below the maximum weekly benefit amount, $b < b_{max}$, there is a kink in the relationship between potential duration and the ratio of base period earnings to the highest-earning quarter at $\frac{bpw}{hqw} = D_{max} \cdot \frac{\tau_1}{\tau_2}$.

$$D = \begin{cases} D_{max} & \\ \frac{\tau_2}{\tau_1} \cdot \frac{bpw}{hqw} & \text{if } \frac{bpw}{hqw} \leq D_{max} \cdot \frac{\tau_1}{\tau_2} \end{cases}$$

These claimants are displayed on the right of panel B in figure D1.

Finally, if $\frac{bpw}{min(hqw, \frac{b_{max}}{\tau_1})} \leq D_{max} \cdot \frac{\tau_1}{\tau_2}$,

$$D = \tau_2 \cdot \frac{bpw}{min(\tau_1.hqw, b_{max})}$$

, potential duration is always inferior to the maximum duration D_{max} but the relationship between duration and highest quarter earnings hqw exhibits an upward kink at $hqw = \frac{b_{max}}{\tau_1}$, which is also the point where the relationship between the weekly benefit amount b and hqw is kinked. The schedule for these claimants is displayed on the left of panel A in figure D1 When estimating the independent effect of b on unemployment duration in the regression kink design, I drop these observations and focus only on individuals with maximum potential duration ($D = D_{max}$) to avoid having two endogenous regressors kinked at the same point.

Figure D1. UI Benefit Schedule: Weekly Benefit Amount (GREY) & Potential Duration(Black), Louisiana

Notes: The graph shows the weekly benefit amount (wba: grey dots) and potential duration (potduration: black dots) of Tier I observed in the CWBH data for Louisiana for 1979 to 1983. Each dot is the average value in the corresponding bin of the assignment variable. Panel A shows that the weekly benefit amount is a kinked function of the highest quarter of earnings. Panel B shows that potential duration is a kinked function of the base period earnings for individuals with $b = b_{max}$ (left) and of the ratio of base period to highest