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Evaluation of Optimal Unemployment Insurance with Reemployment Bonuses Using Regression Discontinuity (kink) Design

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Evaluation of Optimal Unemployment Insurance with Reemployment Bonuses Using Regression Discontinuity (Kink) Design

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Abstract

This paper estimates the liquidity effect and moral hazard effect of extended unemployment insurance (UI) benefits using two natural experiments. In Taiwan, since unemployed workers eligible for unemployment benefits receive 50% of their remaining entitlements if reemployed before they exhaust benefits, extending potential duration not only extends benefits but also extends reemployment bonuses. We show the effect of extended benefits on unemployment duration can be decomposed to the liquidity effect and moral hazard effect, which is proportionally reduced by the reemployment bonuses. To estimate the effect of reemployment bonuses, we exploit the kinks in potential reemployment bonuses as the bonuses phased in. Our estimates show the imposition of bonus program reduces insured duration and nonemployment duration by about 5% and 13%, respectively. On the other hand, to identify the effect of extended benefits, we exploit the fact that potential duration is a discontinuous function

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of exact age at job loss. The estimates using administrative data show the elasticity of insured duration to potential duration is about 0.7, and that of nonemployment duration is about 0.3. Combined with theoretical results, our estimates suggest liquidity effect explains 87% of the increase in unemployment duration due to extended benefits in Taiwan. Our calibration suggests it is optimal to increase potential duration and decrease the generosity of bonuses.

1 Introduction

Optimal unemployment insurance (UI) benefits depends on the trade-off between the consumption smoothing benefits and the disincentive effect of UI. The disincentive effect of UI, measured by the elasticity of unemployment duration to unemployment benefits, has been widely estimated across different contexts of UI. The consumption smoothing benefits, however, are relatively difficult to estimate due to the quality of data on consumption. The labor market approach proposed by Chetty (2008) shows labor supply response to increasing unemployment benefits is a composition of a liquidity effect and a moral hazard effect. An increase in unemployment benefits increases unemployment duration due to the two distinct effects. It decreases the opportunity cost of unemployment (moral hazard effect), while it also increases workers' ability to smooth consumption and allows more time to search for jobs (liquidity effect). It is important to distinguish these two effects because a moral hazard effect decreases welfare while a liquidity effect is welfare enhancing. Empirically, only a few papers (Chetty (2008), Card et al. (2007) and Landais (2015)) distinguish the liquidity effect from the moral hazard effect of UI because the variation in unemployment benefits confound these two sources of variation.

This paper proposes an alternative approach to disentangle these two effects through the reemployment bonus program in Taiwan's UI system. We exploit policy changes to potential benefits duration and reemployment bonus to identify the liquidity effect and the moral hazard effect of UI. In Taiwan, an unemployed worker eligible for UI benefits can receive half the amount of her remaining entitlement if she finds a job before exhausting benefits and hold the job for three months. As a result, the qualification period of reemployment bonus is also extended as the potential UI benefits duration extends. We decompose the effect of extended unemployment benefits on search intensity to a liquidity effect and a moral hazard effect. The moral hazard effect can be identified by the bonus effect because reemployment bonuses increase the opportunity cost of unemployment benefits and have nothing to do with the liquidity effect. Since the extended benefit effect and reemployment bonus effect can be identified by the two natural experiments exploited in this paper, we obtain the liquidity effect indirectly.

To estimate the effect of extended benefits on unemployment duration, we use the UI administrative data and exploit the extension of potential duration from 6 months to 9 months for job losers at least 45 years old. The regression discontinuity (RD) design comparing workers losing their jobs just after age 45 and those losing right before 45 has the potential to identify the causal effect of extended benefits on various outcomes, because the eligibility rule for extended benefits is a deterministic function of workers' ages when losing jobs and ideally does not relate to workers' characteristics except for age at job loss. Our estimates show a 10% increase in potential duration increases the insured duration of unemployment by 7% and the nonemployment duration by 3%. We do not find any discernible effect on the reemployment wage.

On the other hand, we use regression kink (RK) design to identify the effect of reemployment bonuses. The amount of reemployment bonuses is proportional to workers remaining benefits while reemployed, and importantly the bonus program also reached back to workers filing UI before the program officially began on Jan. 1, 2003. As a result, for workers started UI spells before 2003, the start of qualification period for bonuses is Jan. 1, 2003 rather than the date UI spell started, thereby reducing the length of qualification period. In other words, the maximum amount of reemployment bonuses is a piece-wise linear function of the date an UI spell started with two kink located at Jul.1, 2002 and Jan. 1, 2003. Our preliminary estimates using RK design show reemployment bonus reduces insured duration and nonemployment duration by 5% and 13%.

Combining the structural model with the reduced form estimates, our estimates suggest the liquidity effect accounts for 87% of the effect of extended benefits on unemployment duration. There are at least two reasons the ratio of liquidity effect to the overall effect in Taiwan might be different from that in the U.S. On one hand, the saving rate in Taiwan is relatively high at 20%. This might lead to a higher capability to smooth consumption and a smaller liquidity effect. However, the reemployment bonuses in Taiwan also reduce the moral hazard effect of UI and make liquidity effect relatively strong. Compared to previous estimates from Chetty (2008), Card et al. (2007) and Landais (2015), our estimate of 87% is larger than is relatively strong and suggests bonuses substantially reduce the moral hazard of extended benefits.

This paper is the first paper to evaluate optimal UI with reemployment bonus using sufficient statistic approach. We derive the formulas for optimal potential duration and optimal reemployment bonuses. Whether increasing potential duration is socially beneficial relies on the tradeoff between increased tax payment due to lengthened unemployment duration and the increased ability to smooth consumption. On the other hand, the optimal reemployment bonuses depends on whether the reduction of benefits payment is larger than the increased bonus payment and the increased utility of consumption when employed. Our calibration results suggest it is optimal to increase potential duration and decrease the generosity of bonuses.

Our results for the effect of reemployment bonuses on labor supply are related to the four field experiments conducted in New Jersey, Illinois, Washington and Pennsylvania. Most of the bonuses experiments are fixed amount of dollars or multiples of weekly benefits amount, while the experiment in New Jersey and one of the treatments in Pennsylvania decline over the qualification period (Corson and Spielgelman (2001) and Meyer (1995)). Overall, although the designs of bonuses differ from each other, these experiments suggest bonuses significantly reduce insured duration of unemployment by about one-half week (Decker et al. (2001)).[1] Among the design of the bonus experiments, New Jersey's design, which provides 50% of remaining entitlement, but the amount declines 10% per week, is the most similar one to Taiwan's design.[2]. On the surface, Taiwan's reemployment bonus program is more generous than New Jersey's, and it might explain why our estimated impact is larger in absolute value. However, in New Jersey the bonus offers were made after seven weeks of insured unemployment while the participants did not know the pending offers prior to the seventh week. Therefore, our estimates are not directly comparable to New Jersey's.

This paper also links to the literature on the effect of unemployment benefits and reem-

[1]The bonus program in the Illinois' experiment, which offer 500 dollars if workers finding jobs before the eleventh week of insured unemployment, is estimated to reduce insured duration by more than a week for workers eligible for Federal Supplemental Compensation, and about a half week for those not eligible(Decker et al. (2001) and Woodbury and Spiegelman (1987)).

[2]In New Jersey experiment, 60% of the bonus was paid after 4 weeks of employment and the remainder if they remained employed for 12 weeks

ployment bonuses on labor supply and match quality. The RD design exploiting the eligibility rule for extended benefits is similar to Schmieder et al. (2012), Card et al. (2007) and Nekoei and Weber (2015). Our identification strategy for the effect of reemployment bonuses is related to Card et al. (2015) and Landais (2015) exploiting the kink in benefits schedule to identify the effect of increasing benefits level or potential duration.

The rest of the paper is organized as follows. Section 2 theorizes about the effect of Taiwan's version of extended benefits on search effort using a search model, and derive the welfare effect of extended benefits. Section 3 introduces UI in Taiwan. In Section 4, we discuss our data and sample selection. In Section 5 and 6, we explain our empirical strategies and present the estimation results for the effects of extended benefits and reemployment bonuses. Section 7 calculates the liquidity effect of extended benefits based on our theoretical formula and reduced form estimates.

2 Theory

In this section, we show that we can back out the liquidity effect by comparing the effect of reemployment bonus and the effect of extended benefits on search intensity.

2.1 Model

Consider a discrete time search model based on Chetty (2008), Schmieder et al. (2012) and Landais (2015). An unemployed worker at time t holding assets A_t receives unemployment benefits b_t. If a worker's A_t hits A_t's lower bound, L, she is liquidity constrained and hand-to-mouth. No unemployment benefits will be received if they have been unemployed for P periods or longer, that is

$$b_t = \begin{cases} b, & \text{if } 0 \leq t \leq P-1 \\ 0, & \text{if } t \geq P \end{cases}$$

An unemployed worker exerts search intensity, s_t, which determines the probability of finding a job in period t. If an unemployed worker finds a job before benefits are exhausted, she will receive a reemployment bonus, r_t, equal to θ percent of remaining benefits. Formally,

$$r_t = \theta \sum_{k=t}^{P-1} b_k, 0 \leq \theta \leq 1$$

If a job is found at time t, she receives wage rate, w_t, bonus, r_t, and pays a tax, τ. The flow utility when employed at time t equals $u(c_t^e) = u(A_t - A_{t+1} + w_t + r_t - \tau)$, where c_t^e indicates the consumption when employed at time t. Assuming the interest rate and the time discount rate are zero, the value of being employed in period t is

$$V_t = \max_{A_{t+1}} u(A_t - A_{t+1} + w_t + r_t - \tau) + V_{t+1}(A_{t+1})$$

If an unemployed worker cannot find a job at time t, her flow utility is equal to $u(c_t^u) = u(A_t - A_{t+1} + b_t)$. The value of being unemployed in period t is

$$U_t = \max_{A_{t+1}} u(A_t - A_{t+1} + b_t) + J_{t+1}(A_{t+1}),$$

where $J_{t+1}(A_{t+1})$ is the value of entering period $t+1$ unemployed with asset A_{t+1}. Unemployed workers in the beginning of period t maximizes

$$J_t(A_t) = \max_{s_t} s_t V_t(A_t) + (1 - s_t) U_t(A_t) - g(s_t),$$

where $g(s_t)$ is strictly increasing and convex search cost. The first order condition for s_t equates the marginal cost of search and its marginal benefit at time t:

$$g'(s_t) = V_t(A_t) - U_t(A_t)$$

For $t \leq P$, the effect of extended benefits on the search intensity at time t is

$$\frac{\partial s_t}{\partial b_P} = \frac{u'(c_t^e) - u'(c_t^u)}{g''(s_t)} - (1-\theta)S_{t+1}(P)\frac{u'(c_t^e)}{g''(s_t)}; \forall t \leq P$$

$$\frac{\partial s_t}{\partial b_P} = \frac{\partial s_t}{\partial A_t} - (1-\theta)S_{t+1}(P)\frac{\partial s_t}{\partial w_t}; \forall t \leq P \tag{1}$$

where $S_{t+1}(P) = (1-s_{t+1})..(1-s_P)$ is the survival rate in period P conditional on being unemployed in period $t+1$. When there are no reemployment bonuses, that is $\theta = 0$, equation (1) is the same as that in Landais (2015). If there are reemployment bonuses, the moral hazard effect of extended benefits is reduced by $100\theta\%$. In other words, the effect of bonuses is $100\theta\%$ of the moral hazard effect in the absence of bonuses.

In the model, the change in wage rate, w_t, and bonuses, r_t, affects workers' behavior in the same way. Hence, we can rewrite equation (1) as

$$\frac{\partial s_t}{\partial b_P} = \frac{\partial s_t}{\partial A_t} - (1-\theta)S_{t+1}(P)\frac{\partial s_t}{\partial r_t}; \forall t \leq P$$

$$\frac{\partial s_t}{\partial b_P} = \frac{\partial s_t}{\partial A_t} - \frac{(1-\theta)S_{t+1}(P)}{\sum_{k=t}^{P-1} b_k - [s_{t+1}\sum_{k=t+1}^{P-1} b_k + .. + (1-s_{t+1})..s_{P-1}b_{P-1}]}\frac{\partial s_t}{\partial \theta}; \forall t \leq P \tag{2}$$

2.2 Welfare

2.2.1 Optimal Potential Duration

Consider the social planner chooses the optimal potential benefit duration to maximize the expected utility of unemployed worker subject to budget constraint. The welfare gain of increasing one unit of unemployment benefits at period P is

$$\frac{dW_0}{db_P} = S_0(P)[u'(c_p^u) - u'(c_P^e)] - \{(1-\theta)\frac{dB}{dP}|_2 + \frac{(1-\theta)B + \theta P}{T-D}\frac{dD}{dP}\}u'(c_P^e).$$

where P is potential duration, $B = \sum_{t=0}^{P-1} S(t)$, the average insured duration of unemployment, $D = \sum_{t=0}^{T-1} S(t)$, the average nonemployment duration and T is the total length of time. $S_0(P)$ is the survival rate at time P or the exhaustion rate of benefits. $\frac{dB}{dP}|_2 = \sum_{t=0}^{P-1} \frac{dS(t)}{dP}$. Rescale $\frac{dW_0}{db_P}$ by $u'(c_P^e)$, we get the following

$$\frac{dW_0}{db_P}/u'(c_P^e) = S_0(P)R_p - \{(1-\theta)\frac{dB}{dP}|_2 + \frac{(1-\theta)B + \theta P}{T-D}\frac{dD}{dP}\}$$

where $R_P = \frac{\partial s_P}{\partial A_P} / \frac{\partial s_P}{\partial w_P}$ is the ratio of liquidity effect to moral hazard effect of extended benefits at time P.

$$\frac{dW_0}{db_P}/u'(c_P^e) = S_0(k)R_k - \{(1-\theta)\frac{dB}{dP}|_2 + \frac{(1-\theta)B + \theta P}{T-D}\frac{dD}{dP}\} \qquad (3)$$

2.2.2 Optimal Reemployment Bonuses

The welfare gain of increasing the generosity of bonuses is

$$\frac{dW_0}{d\theta}/bu'(c_0^e) = (1-s_0)\Phi + s_0 P - \{\frac{(1-\theta)B + \theta P}{T-D}\frac{dD}{d\theta} + [(1-\theta)\frac{dB}{d\theta} + (P-B)]\} \qquad (4)$$

where $\Phi = [s_1(P-1) + (1-s_1)s_1(P-2) + .. + (1-s_1)..(1-s_{p-2})s_{p-1}]$.

3 Institutional Background

The current UI system in Taiwan is part of Employment Insurance. Job losers aged 15 to 65 with at least one year of work history in the three years prior to layoff are eligible for benefits. The regular potential benefit duration is 6 months, while it extends to 9 months if UI recipients lost their jobs when they were at least 45 years old or UI recipients are disability card holders. The monthly unemployment benefits replace 60% of recipients' average earnings during the 6 months prior to layoff for those who have no non-working dependents (subject to a maximum=$0.6 \cdot 43,900 = 26,340$ NTD). For UI recipients having non-working dependents, the replacement increases up to 80% depends on the number of dependents. Unemployed workers receiving UI benefits can also receive reemployment bonuses equal to 50% of remaining benefits, if they find jobs before benefit exhaustion and keep the job for at least three months. In addition, unemployed workers eligible for UI benefits are eligible for 6 months of vocational training and National Health Insurance subsidies.

UI in Taiwan has evolved to the current system through some major changes. Unemployment benefits in Taiwan were inaugurated in 1999, as part of the Labor Insurance Law. As shown in Figure 1, on January 1, 2003, reemployment bonus program began in order to encourage workers' early reemployment. Vocational training and National Health Insurance subsidies programs also started in 2003. Starting on May 1, 2009, UI recipients aged 45 or older when they lost their jobs have been eligible for 9 months of benefits instead of 6 months regular benefits.[3] It is important to note that although May 1, 2009 is the date that potential benefit duration begins to extend for the older workers, this policy change reaches back to any UI recipient who had not run out of benefits by May 1, 2009. As a result, UI recipients who started receiving benefits on November 1, 2008 were also eligible for extended benefits if they lost their jobs when they were at least 45.

4 Data and Sample

4.1 Data

We have obtained administrative Unemployment Benefits file from January 1999 to December 2013 and the corresponding UI recipients' employment history from Employment Insurance file. Each observation in Unemployment Benefit file represents one case of is-

[3]There are four other amendments. First, the age limit for the insured person was raised from 60 to 65. Second, the foreign spouse of an Taiwanese citizen was eligible for the employment insurance. Third, an extra up to 20% unemployment benefit was added when the insured person had non-working spouse, minor children or children with mental or physical impairment. Fifth, parental leave allowance was implemented as a new benefit item.

sue beneficiary, and each observation in Employment Insurance file represents a change in employment record, including new employment, job separation, wage changes and others. These two files together provide information on every UI recipient's id, date of birth, date of losing job, the first and the last date of receiving benefits, the amount of benefits and detailed employment history, including 4-digit occupation and insured earnings.

Among the information we have, the date of birth and date of losing job, and the date the first date of receiving benefits (the date UI spells started) are crucial for the quality of RD and RK designs. We use the date of job loss and date of birth to calculate the UI recipients' age at job loss, which is the running variable for RD design. On the other hand, with the date UI spell started, we can precisely construct the running variable for RK design, which is the number of days between the date an UI spell started and two calendar times.

4.2 Sample

The regression discontinuity design in this paper compares workers who lost their job just over 45 years old and those just below 45. To estimate the effects of extended benefits, we sample every UI recipient aged 43 to 46 at the time of job termination, and focus on those receiving a first month unemployment benefits between May 1, 2009 and Dec 31, 2012. This yields to 265,241 observations. As mentioned above, some UI recipients age at least 45 when lose their jobs and receive their first month benefits between November 1, 2008 and May 1, 2009 are also affected by extended benefits program. However, the effects of extending potential benefit duration on this group of workers are not directly comparable to those receiving first month of benefits after May 1, 2009. The potential benefits duration was actually also extended for older UI recipients in this period, but UI recipients might not be able to foresee this policy change and whether it will reach back to them. Therefore, UI recipients starting receiving benefits between November 1, 2008 and April 31, 2008 are not included in our estimation sample.

To estimate the effects of reemployment bonuses, we sample every UI recipient started an UI spell between June 1, 2001 and Dec. 31, 2003. As we will further explain in Section

6, the UI recipients started UI spells in June, 2002 are the first group of workers eligible for reemployment bonuses (a half month of benefits), while those who started UI spells before June 2002 are not eligible for bonuses. The potential bonuses increases as the date an UI spell started approaches Jan. 1, 2003, the date reemployment bonus program began. Any workers started UI spells after Jan, 2003 would be eligible for up to 3 months of benefits as bonuses. The sample consists of 165,685 UI spells started between one year before the first kink point, June 1, 2002, and one year after the second kink point, Dec. 31, 2003.

Our dependent variables include insured duration, nonemployment duration, reemployment hazard and reemployment wage. Benefit duration is defined as the total number of days workers receive unemployment benefits in an unemployment spell. The reemployment wage is the insured wage of the first registered employment after workers start receiving unemployment benefits.

We use two measures of nonemployment duration. The first measure, used by Card et al. (2007), calculates nonemployment duration as the total number of days from the end of previous job to the beginning of new job. The other measure, adopted by Schmieder et al. (2012), calculates it as the total number of days from the start of receiving unemployment benefits to the next registered employment spell. The first measure is necessarily at least as large as the latter because there is always a gap between the job separation date and the first date of receiving UI due to waiting period and other reasons. We use the second measure in our main analysis, and show the results using the first measure in the appendix. Since some UI recipients are not observed to be reemployed in our dataset, we cap nonemployment duration at 730 days. Their nonemployment duration is censored because they fail to find jobs, become self-employed, work for public sector or drop out of labor force. In our estimation sample, there are 15% of nonemployment duration censoring at 730 days.

Table 1 presents the summary statistics of various samples. Column 1 shows the means using all UI spells from May 1, 2009 to Dec 31, 2012, while Column 2 only includes job losers age 40-50 at layoff during the same sample period. On average, job losers age 40-50 are more likely to be male, have longer previous job tenure, have more dependents and higher previous insured wages. They also tend to receive more days of UI benefits, have longer nonemployment duration and higher reemployed wages. Column 3 shows the summary statistics of our estimation sample. Overall, they are similar to those using the sample from job losers age 40-50. [Column 4]

5 Results on Extended Benefits

5.1 Identification Strategy

Consider the following regression:

$$y_i = \alpha + \rho EB_i + u_i, \tag{5}$$

where y_i is an outcome variable, including insured duration, nonemployment duration and reemployment outcomes. EB_i is 1 if UI recipient i is eligible for extended benefits, and 0 otherwise. Based on the institutional background, EB_i is a deterministic and discontinuous function of age at layoff: workers lose their job at age below 45 are eligible for 6 months of benefits, while those lose their jobs at age over 45 can receive up to 9 months of benefits. That is

$$EB_i = \begin{array}{l} 1 \text{ if age at layoff } \geq 45 \\ 0 \text{ if age at layoff } < 45 \end{array}. \tag{6}$$

Estimating equation (6) using sample from all age groups is unlikely to generate causal effects of extended benefits because older workers are not otherwise similar to younger ones. In other words, EB_i may be correlated to the error term u_i. To address this, consider the following regression:

$$y_i = \alpha + \rho EB_i + f(a_i) + v_i, \tag{7}$$

where a_i is age when losing a job, which is the running variable. Note that EB_i depends solely on a_i. As long as $E(u_i|a_i)$ evolves smooth around the cutoff and is adequately controlled by $f(a_i)$, ρ will identify the effect of extended benefits. We consider equation (7) as a local linear regression and local quadratic regression in our baseline results.[4]

Our estimation sample is UI recipients ages 43 to 46 at layoff and started UI spells between May 1, 2009 and Dec 31, 2012. We use one year or two year bandwidth in our main results. This choice of bandwidth, however, seems arbitrary. In the appendix, we use the optimal bandwidths, and report the bias corrected estimates and the robust standard errors proposed by Calonico et al. (2014), which accounts for the induced variation due to bias correction. [discussion on nonparametric RD]

The RD design relies on the assumption that UI recipients age just above age 45 at layoff and those age just below age 45 at layoff are identical on average except eligibility for extended benefits. If the RD design is valid, we would expect no discontinuity in average outcomes at the 45 age cutoff before the reform. Hence, we plot the means of outcome variables over ages at layoff using the sample before the UI extension. As seen in Figure 6 and 7, the average insured duration and nonemployment duration evolve smoothly around the cutoff. Although the placebo test supports our RD design, it does not rule out the possibility that workers or firms might manipulate the age cutoff after the reform.

For Taiwan's UI, it is unlikely workers can manipulate the eligibility rule for extended benefits because the rule is based on the worker's age at the time of job loss rather than the age when claiming benefits. It seems possible, however, firms might be willing to wait for a certain period of time to lay off workers until they are eligible for extended benefits. We would expect an extra mass of workers just above 45 years old if firms do so. Furthermore, if these workers or employers can be categorized by certain types, then this sorting is non-random and needs to be addressed. We investigate this issue by examining the frequency of UI recipients over ages, and the means of observables around the cutoff.

Figure 2 shows the frequency of UI recipients ages 35 to 55 at layoff. Each bin represents the average number of UI recipients within a 145 day interval. There are roughly 500 more UI recipients age 45 than those age 44. In other words, about 250 workers move from the left to the right of the cutoff, which accounts for only .9 percent of our estimation sample.

[4] Gelman and Imbens (2014) argues global polynomial regression is not attractive since it tends to assign large weights on observations far away the cutoff.

To check whether this sorting behavior is non-random, we look for any discontinuities of the means of observables around the cutoff. Figure 3 demonstrates that five of the six observables, previous job tenure, whether workers are female, whether workers previously worked in the construction industry, the number of dependents, and whether workers are born in Taipei are smooth around age 45. The mean previous wages, however, jumps to the right after the cutoff.

The discontinuity of mean previous wages at 45 suggests high-wage employers might be more likely to delay the timing of layoff or high-wage workers have more bargaining power when negotiating with employers, but why this is so is beyond the scope of this paper. To make sure this small degree of selection does not invalidate our RD design. We estimate expected nonemployment duration conditional on available observables, excluding the treatment indicator as suggested by Card et al. (2007):

$$y_i = X_i\beta + u_i, \tag{8}$$

where y_i is insured duration of unemployment or other outcome variables. X_i includes the previous wage, tenure and industry, gender, number of dependents, place of birth and month/year of job loss. Figure 4 plots the average predicted insured duration of unemployment by age at layoff. The average predicted insured duration is smooth around the 45 years old cutoff. We do the same exercise for other outcome variables, and find no discontinuities at the threshold.

5.2 Results

We first plot our average outcomes by age at layoff in Figure 5. At ages over 45, the total number days of receiving unemployment benefits shifts up by about 50-60 days in Figure 5 (a), while nonemployment duration shifts up by roughly 30 days in Figure 5 (b). Figure 5 (c) plots the average reemployment hazard in the first six months of UI spells by age at layoff. There is discernible drop at the cutoff by about 3 percentage points. Overall, these

RD graphs imply extending potential benefits duration lowers search intensity even in an UI system with a variable reemployment bonus. On the other hand, the wage in the first month at the new job by age at layoff in Figure 5 (d) jumps at the cutoff. However, the reemployment wage does not permanently shift up above the cutoff, and the previous insured wage in Figure 3 also shares the similar feature. Hence, the jumps at the 45 age cutoff is likely due to sorting.

In Table 2, we estimate equation (7) for the effect of extended benefits on insured duration of unemployment, nonemployment duration and the reemployment hazard in the first month of the UI spell. Column 1 reports the estimates using a local linear estimator. A three-month increase in potential benefits duration is estimated to increase the insured duration of unemployment by 54 days, which translates into elasticity of insured duration of unemployment to potential benefits duration of 0.76. The estimated effect of extended benefits on nonemployment duration is slightly about 33 days, with an elasticity of 0.24. In general, the standard errors of the local linear estimators are smaller than local quadratic estimates. Adding controls, using local quadratic estimator or a smaller bandwidth changes the estimate little.[5] In our estimation sample, about 37% of UI recipients on the left of the cutoff exhaust their 6 months benefits. The finding that the marginal effect on nonemployment duration is smaller than that on insured duration is because the marginal effect on insured duration is partly mechanical. For exhaustees, the effect of extended benefits on insured duration is likely stronger than that on nonemployment duration.

Our estimates for the marginal effect of extended benefits and the elasticity of nonemployment duration to potential benefits duration (0.24) are both larger than the estimates from Schmieder et al. (2012). Considering in Germany the potential benefits duration is longer and the percentage of exhaustees is smaller, it is not surprising to see this. The estimated elasticity in Taiwan is in the range of previous studies summarized in Krueger and Meyer (2002). [more discussion]

In Table 2, we also estimate the extended benefits effect on monthly reemployment hazard in the first month of the UI spell. Specifically, we estimate

[5]The insured duration elasticity equals percentage change of insured duration divided by percentage change of potential duration, which is $\frac{54/140}{(9-6)/6}$. Similarly, the nonemployment duration elasticity is $\frac{33/260}{(9-6)/6}$.

$$h_{im} = \alpha + \rho EB_i + \tau m + \theta EB_i m + f(a_i) + v_i \tag{9}$$

where h_{im} equals one if an UI recipient in the month m of her UI spell is employed in the $m + 1$. ρ captures the effect of extended benefits on the reemployment hazard at the beginning of the UI spell. These estimates indicate that a three-month increase in potential duration reduces the monthly reemployment rate by 1.7 percentage points at the beginning of the spell.

The estimates of extended benefits on three measures on job match quality, including log of reemployment wage, the probability of switching employers and the probability of switching industry are presented in Table 3. With or without controls, none of the estimates is significant at 5% significance level.

[Robustness] Barreca et al. (2016) Calonico et al. (2014)

6 Results on Reemployment Bonuses

6.1 Identification Strategy

Since the reemployment bonus program had been announced by the government on May 15, 2002, before it officially began on Jan. 1, 2003, the maximum amount of reemployment bonuses weakly increases as the program phased in. As shown in Figure 8, there are three segments distinguished by two kinks. The first kink is located at Jul. 1, 2002: any workers started to receive benefits before this date would not be eligible for bonus, while the bonus increased linearly as the date approaches Jan. 1, 2003, which is the second kink. Any workers started to receive benefits after Jan. 1, 2003 is potentially eligible for up to 3 months of benefits as bonuses. For example, an UI recipient lost his job on Aug. 1, 2002 was potentially eligible for up to a half month of benefits as a reemployment bonus, while an UI recipient who lost his job on Jan 1, 2003 was eligible for up to three months of benefits as a reemployment bonus.

We exploit the slope change at these two kinks to identify the effect of reemployment bonus on the hazard rate of reemployment and other outcomes. Following Card et al. (2015), the effect of reemployment bonus can be expressed as

$$\beta = \frac{\lim\limits_{t \to c^+} \frac{dE(Y|T=t)}{dt}|_{t=c} - \lim\limits_{t \to c^-} \frac{dE(Y|T=t)}{dt}|_{t=c}}{\lim\limits_{t \to c^+} \frac{dRB(t)}{dt}|_{t=c} - \lim\limits_{t \to c^-} \frac{dRB(t)}{dt}|_{t=c}}$$

where Y is nonemployment duration or the hazard rate of reemployment. T is the first date of receiving benefits and c is the kink. $RB(t)$ is the maximum amount of bonuses, which is a function of the first date of receiving benefits. The denominator is straightforward to calculate, since the slope change at these two kinks are deterministic. Specifically, the slope change is .5 for the first kink and -.5 for the second one. We estimate the numerator of equation (10) by estimate the following regression

$$y_i = \alpha + \gamma(t_i - c) + \beta_{RF}(t_i - c) \cdot D_c + u_i, \text{ where } |t_i - c| \leq 180 \tag{10}$$

β_{RF} divided by the first stage coefficient captures the effects of one day increase in bonus if there is no sorting around the kinks. To check the validity of RK, we examine the density of our running variable and the means of observables around the cutoffs.

If unemployed workers delay the timing to claim the first month benefits, we would expect there is an extra mass of claimants at the second kink, Jan. 1, 2003. Figure 9 presents the average number of UI spells started between June 1, 2001 and Dec. 31, 2003. Each bin represent the average within about 9 days interval. Since the bins pass through the kinks smoothly, Figure 9 does not support the existence of strategic behavior.

Figure 10 plots the means of six observables around the kinks. All of the means pass through the first kink smoothly. However, in Figure 10 (e), we find a jump in the average age at job loss at the second kink. In Figure 11, we do the same exercise as Figure 4. The bins evolve smoothly around the kinks, suggesting the selection of age at job loss around the kink has little impact on insured duration.

6.2 Results

Figure 12 presents the average outcomes over the number of days between UI spells started and Jan. 1, 2003. In Figure 12 (a), the mean insured duration shows a downward trend over time, partly due to the recession in early 2000s. At the first kink point, Jul. 1, 2002, the mean insured duration starts to decline with a steeper slope from about 150 days to below 140 days at the second kink point, Jan. 1, 2003. After Jan. 1, 2003, the rate of decline becomes smaller. The mean nonemployment duration in Figure 12 (b) shows more variability but a similar pattern to Figure 12 (a) with two discernible kinks. The mean nonemployment duration drop from about 370 days at the first kink point to 320 days at the second kink point. Figure 12 (c) plots the average monthly reemployment hazard over UI spells. As we should expect, the pattern is exactly opposite to that for insured duration and nonemployment duration.

Table 4 reports the estimates on the effect of reemployment bonuses on insured duration, nonemployment duration and the reemployment hazard in the first month of insured unemployment. The estimated effect of bonuses on insured duration and nonemployment duration vary with the kink choice, especially for the estimates on the effect of bonuses on nonempolyment duration. Why the results are not robust to kink choice and whether the differences are due to seasonal factor needs further investigation. At this stage, suppose we adopt the estimates using the first kink with covariates, potential three months benefits as a bonus is estimated to reduce insured duration and nonemployment duration about 8 days (5%) and 47 days(13%).[6] Contrary to the results from extended benefits, the estimated effect of bonuses on insured duration is significantly smaller than that on nonemployment duration. It is not surprising, however, considering a substantial amount of UI recipients exhaust their six months benefits. An UI recipient might reduce her nonemployment duration from 7 months to 5 months due to bonuses, whereas her insured duration decreases from 6 months to 5 months.

To estimate the effect on reemployment hazard at the beginning of the UI spell, we

[6]The percentage change of insured duration is $8/150 = .05$. Similarly, percentage change of the nonemployment duration is $47/360 = .13$.

estimate the following regression:

$$h_i = \alpha + \gamma(t_i - c) + \beta_{RF}(t_i - c) \cdot D_c + \theta \cdot m + \delta(t_i - c) \cdot m + \lambda(t_i - c) \cdot D_c \cdot m + u_i, \quad (11)$$

where h_i is equal to 1 if UI recipient i in month m finds a job in month $m+1$. β_{RF} divided by the first stage coefficient represents the effect of bonuses on the reemployment rate at the beginning of the spell. Columns (5) and (6) in Table 4 show the estimates of the effect on reemployment hazard at the beginning of the UI spell. The estimates using kink 1 or kink 2 are not significant different from each other. Bonuses are estimated to increase the reemployment rate at the beginning of the spell by roughly 2 percentage points.

In order to make the estimates more comparable to those on the effect of extended benefits, we run the same regression using sample from workers age 43-46 at layoff. Relative to the estimates using kink 2, the estimates using kink 1 are more precise. The estimates using kink 1 suggest bonuses increase the reemployment rate at the beginning of the spell by about 4 percentage points.

7 Calibration

7.1 Moral Hazard and Liquidity Effects

This section provides preliminary estimates for liquidity effect of extended benefits. According to equation (2) and policy background, we know that

$$b\frac{\partial s_0}{\partial b_P} = b\frac{\partial s_0}{\partial A_0} - \frac{\partial s_0}{\partial \theta}\frac{.5 \cdot S_1(P)}{6 - [5s_1 + .. + (1 - s_1)..s_{P-1}]}$$

According to Table 2, the estimate for the effect of three months increase in potential duration on monthly reemployment hazard at the beginning of the spell, $b\frac{\partial s_0}{\partial b_P}$, is .17. On the other hand, the effect of bonuses on monthly reemployment hazard $\frac{\partial s_0}{\partial \theta}$ is estimated to be .044/.5 = .088 based on Column (6) in Table 4. Plug in these estimates as well as our estimate for the survival rate, $S_1(P)$, we get

$$
\begin{aligned}
b\frac{\partial s_0}{\partial A_0} &= -.17/3 + .073 \cdot \frac{.5 \cdot S_1(P)}{6 - [5s_1 + .. + (1-s_1)..s_{P-1}]} \\
&= -.057 + .088 \cdot \frac{.5 \cdot .69}{4.29} \\
&= -.057 + .007 \\
&= -.050
\end{aligned}
$$

This result suggests the liquidity effect accounts for about 87% ($\frac{.050}{.057} \cdot 100\%$) of the disincentive effect of extending potential duration. Also, the ratio of the liquidity effect to moral hazard effect of extending potential duration is

$$
\begin{aligned}
R_0 &= \frac{\partial s_0}{\partial A_0} / \frac{\partial s_0}{\partial w_0} \\
&= .050 / \frac{.088}{4.29} \\
&= 2.43
\end{aligned}
$$

7.2 Welfare Implications

7.2.1 Potential Duration

We now calculate the welfare effect of extending potential duration using equation (3) by plugging in our reduced form estimates. First, $\frac{dB}{dP}|_1$, the exhaustion rate is .37 for UI recipients starting to receive benefits after May 2009 age 45 to 46 at job loss. $\frac{dB}{dP}|_2$, the increase in insured duration due to reduced search intensity before the exhaustion point equals $\frac{dB}{dP} - \frac{dB}{dP}|_1 = .57 - .37$. $\frac{B}{T-D}$, the insured unemployment rate is about .15 in our sample period, and $\frac{P}{B}$ is about 1.38.

$$\begin{aligned}\frac{dW_0}{db_P}/\frac{dW_0}{dw_P} &= (1-s_0)R_0 - \{(1-\theta)\frac{dB}{dP}|_2 + \frac{(1-\theta)B+\theta P}{T-D}\frac{dD}{dP}\} \\ &= .9 \cdot 2.43 - \{.5 \cdot .20 + (.5 \cdot .15 + 1.38 \cdot .5 \cdot .15) \cdot .33\} \\ &> 0\end{aligned}$$

The above result suggests that one NTD increase in benefits at period P will increase the utility for the UI recipients.

7.2.2 Reemployment Bonus

Based on equation (4),

$$\begin{aligned}\frac{dW_0}{d\theta}/bu'(c_0^e) &= (1-s_0)\Phi + s_0 P - \{\frac{(1-\theta)B+\theta P}{T-D}\frac{dD}{d\theta} + [(1-\theta)\frac{dB}{d\theta} + (P-B)]\} \\ &= .9 \cdot 4.29 + .1 \cdot 6 - .18 \cdot 47/30 + .5 \cdot 8/30 + 146/30 \\ &< 0\end{aligned}$$

The result implies the current reemployment bonus program is too generous.

8 Discussion

This section discusses four possible extension of this paper, including time-varying benefits profile, impatience, endogenous wage and externality.

The most natural extension to this paper is to estimate the liquidity effect and moral hazard effect of extended benefits over unemployment spells. Intuitively, if the ratio of a liquidity effect to a moral hazard effect is the sufficient statistic for the optimal UI, we should be able to infer the optimal profile of unemployment benefits over time. Specifically, the optimal benefits at time t, b_t should be an increasing function of R_t, which is the ratio of a liquidity effect to a moral hazard effect at time t:

$$b_t = \phi(R_t); R_t = \frac{\partial s_t}{\partial A_t} / \frac{\partial s_t}{\partial w_t}$$

By now, we have assumed in the model a fixed replacement rate of unemployment benefits within s fixed potential duration P. Theoretically, a flat benefits profile is not necessarily an optimal design (Hopenhayn and Nicolini (1997)). Our idea is related to Kolsrud et al. (2016). They consider a two part policy and derive the sufficient statistic for the optimal UI. Using data from Sweden, they found the current flat benefit profile in Sweden is too generous, while the empirical evidence does not support the introduction of a declining benefit profile. They use sample from both administrative and survey data on consumption to infer the consumption smoothing benefits over time. Our labor market approach can be a complement to their findings. A challenge of this line of research is issue on selection: workers at different time of the insured unemployment are not identical, which can bias our estimates of extended benefits and increasing bonuses on hazard rate.

The second extension is to consider impatience or overoptimism of job search (DellaVigna and Paserman (2005) and Spinnewijn (2015)). DellaVigna and Paserman (2005) shows impatience reduces search effort if the model with hyperbolic discounting. Although the sufficient statistic approach allows arbitrary discount rate (Landais (2015)), it is difficult to account for hyperbolic discounting into the search model and derive the sufficient statistic to calibrate. Nevertheless, it is valuable to consider hyperbolic discounting in Taiwan's UI due to its reemployment bonus program. It will be interesting to explore whether bonus program in Taiwan is a desired policy if workers' behavior are time inconsistent.

Finally, externality is an important extension to consider (Davidson and Woodbury (1997), Landais et al. (2015a), Landais et al. (2015b) Marinescu (2015) and Lalive et al. (2015)). Note that our model assume a flat labor demand and every unemployed worker is eligible for unemployment benefits. However, in the standard search model, when the government increase the generosity of, workers will raise their reservation wage, so the firms might be less willing to open vacancies. On the other hand, since workers eligible for more generous benefits will decrease the search effort, those ineligible will have better chance to be employed and become more willing to exert search effort. Recent evidence suggest the latter dominates the former (Lalive et al. (2015)). This paper has a potential to estimate the externality of extended benefits as well. Since unemployment benefits are extended to older workers since May 2009, we can use calendar time as a running variable to estimate the effect of extended benefits for those age less than 45 at job loss. Our preliminary analysis shows little effect on those ineligible for extended benefits.

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9 Tables

Table 1: Descriptive Statistics

	05/2009-2012	05/2009-2012	05/2009-2012	06/2001-2003
	All	40-49	43-46	All
	(1)	(2)	(3)	(4)
age (years)	37.01	44.77	44.99	36.50
female	.52	.49	.49	.55
tenure	675.02	745.24	745.03	
number of dependants	.63	1.07	1.13	n/a
previous wage (NTD)	29,840	31,496	31,350	26,876
insured duration	139.29	168.27	170.1	146.69
nonemployment duration	236.18	275.65	274.75	339.35
right censored	.12	.15	.15	.10
reemployment wage	25,757	26,563	26,450	23,008
changed firm	.86	.87	.87	.89
changed industry	.76	.78	.78	.81
N	265,241	68,085	27,551	165,685

Note: This table shows the means of our main variables. The first three columns are related to the estimation of extended benefits effects, while the fourth column is the sample for estimating the effects of reemployment bonuses. The sample in Column (1) consists of all UI recipients starting UI spells between May, 1, 2009 and Dec. 31, 2012. Column (2) reports the results for UI recipients age 40 to 40 at job loss in the same sample period. Column (3) uses the UI recipients age 43 to 46 at job loss, which is our estimation sample. Column (4) uses the sample from every UI spell started between June 1, 2001 and Dec. 31, 2003.

Table 2: RD Estimates of the Effect of Extended Benefits on Unemployment Duration

	Insured duration		Nonemp. duration		Reemp. Hazard	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Age Sample 43-46 (Local Linear)						
	54.50	53.62	33.07	32.08	-.017	-.017
	(1.982)	(1.935)	(6.329)	(6.243)	(.003)	(.003)
Panel B: Age Sample 43-46 (Local Quadratic)						
	55.30	54.05	33.92	33.69	-.017	-.018
	(2.860)	(2.792)	(8.937)	(8.763)	(.004)	(.004)
Panel C: Age Sample 44-45 (Local Linear)						
	55.35	53.93	31.72	29.56	-.018	-.018
	(2.764)	(2.699)	(8.613)	(8.467)	(.005)	(.005)
Panel D: Age Sample 44-45 (Local Quadratic)						
	59.89	57.92	33.74	37.05	-.021	-.023
	(3.995)	(3.973)	(12.09)	(11.78)	(.006)	(.006)
Covariates		√		√		√

Note: This table shows the estimates of the effect of increasing potential duration from 6 months to 9 months on insured duration, nonemployment duration and reemployment hazard in the first month of the spell. Panel A and B use the sample from UI recipients age 43 to 46 at job loss, and start UI spell between May 1, 2009 and Dec. 31, 2012. The sample contains 27551 UI Spells and 182327 Spell-Months observations. Panel C and D use the sample from UI recipients age 44 to 45 at job loss, and start UI spell between May 1, 2009 and Dec. 31, 2012. The sample contains 13990 UI Spells and 93,421 Spell-Months observations. Controls include UI recipients' average previous wage, previous industry, gender, place of birth, number of dependents and the year and month of job loss as covariates. Standard errors in parentheses are clustered at age(days) level for results on insured duration and nonemployment duration, and clustered by UI spell for the results on reemployment hazard. We use a triangular kernel in each specification.

Table 3: RD Estimates of the Effect of Extended Benefits on Match Quality

	Change in Log Wage		Changed Firm		Changed Industry	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Age Sample 43-46 (Local Linear)						
	-.007	.002	-.011	-.015	-.004	-.009
	(.010)	(.009)	(.007)	(.007)	(.010)	(.009)
Panel B: Age Sample 43-46 (Local Quadratic)						
	-.017	-.001	-.012	-.020	-.006	-.014
	(.014)	(.013)	(.011)	(.011)	(.013)	(.013)
Panel C: Age Sample 44-45 (Local Linear)						
	-.020	-.005	-.011	-.019	-.006	-.015
	(.014)	(.013)	(.010)	(.010)	(.013)	(.012)
Panel D: Age Sample 44-45 (Local Quadratic)						
	-.037	-.014	-.025	-.036	-.015	-.025
	(.021)	(.020)	(.015)	(.015)	(.018)	(.017)
Covariates		√		√		√

Note: This table shows the estimates of the effect of increasing potential duration from 6 months to 9 months on wage growth, the probability of changing firm and changing industry. Panel A and B use the sample from UI recipients age 43 to 46 at job loss, and start UI spell between May 1, 2009 and Dec. 31, 2012. The sample contains 27551 UI Spells. Panel C and D use the sample from UI recipients age 44 to 45 at job loss, and start UI spell between May 1, 2009 and Dec. 31, 2012. The sample contains 13990 UI Spells. Covariates include UI recipients' average previous wage, previous industry, gender, place of birth, number of dependents and the year and month of job loss as controls. Standard errors in parentheses are clustered at age(days) level. We use a triangular kernel in each specification.

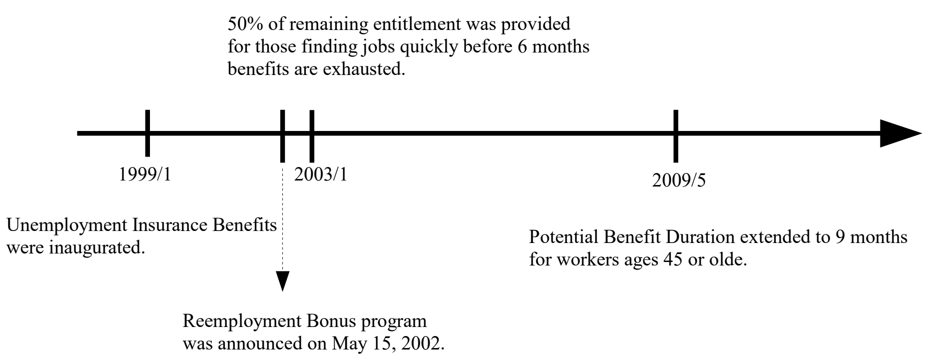
Table 4: RK Estimates of the Effect of Reemployment Bonuses on Unemployment Duration

	Insured duration		Nonemp. duration		Reemp. Hazard	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Full Sample (kink 1)						
$180 * \beta_{RF}$	-10.42	-8.32	-64.64	-47.04	.025	.019
	(2.11)	(1.64)	(11.83)	(8.93)	(.005)	(.005)
Panel B: Full Sample (kink 2)						
$180 * \beta_{RF}$	-17.78	-14.37	-36.52	-24.55	.023	.018
	(2.80)	(2.50)	(12.25)	(10.81)	(.007)	(.007)
Panel C: Age 43-46 (kink 1)						
$180 * \beta_{RF}$	-12.95	-13.97	-56.84	-70.62	.044	.044
	(3.40)	(3.56)	(24.92)	(25.21)	(.014)	(.014)
Panel D: Age 43-46 (kink 2)						
$180 * \beta_{RF}$	-17.58	-17.17	-35.70	-32.32	.020	.023
	(5.37)	(5.45)	(30.39)	(31.39)	(.020)	(.020)
Covariates		$\surd$		$\surd$		$\surd$

Note: This table reports the estimates of the effect of reemployment bonus (three months benefits) on insured duration, nonemployment duration and reemployment hazard in the beginning of the spell. We estimate equation (10) in Columns (1) to (4) and equation(11) in Columns (5) and (6), and multiply the estimated effect by 183. For the first kink, the sample consists of 69,275 UI spells (344,988 spell-month observations) starting between Jan. 1, 2002 and Dec. 31 2002. For the second kink, the sample is 55,462 spells (279,909 spell-month observations) starting between June 1, 2002 and June 1, 2003. Columns (2), (4) and (6) include indicators for whether an observation is on the right of the kinks, recipients' average previous wage, previous industry, age at job loss, gender and place of birth as covariates. Standard errors in parentheses are clustered at day level for results on insured duration and nonemployment duration, and clustered by UI spell for the results on reemployment hazard. We use a triangular kernel in each specification.

10 Figures

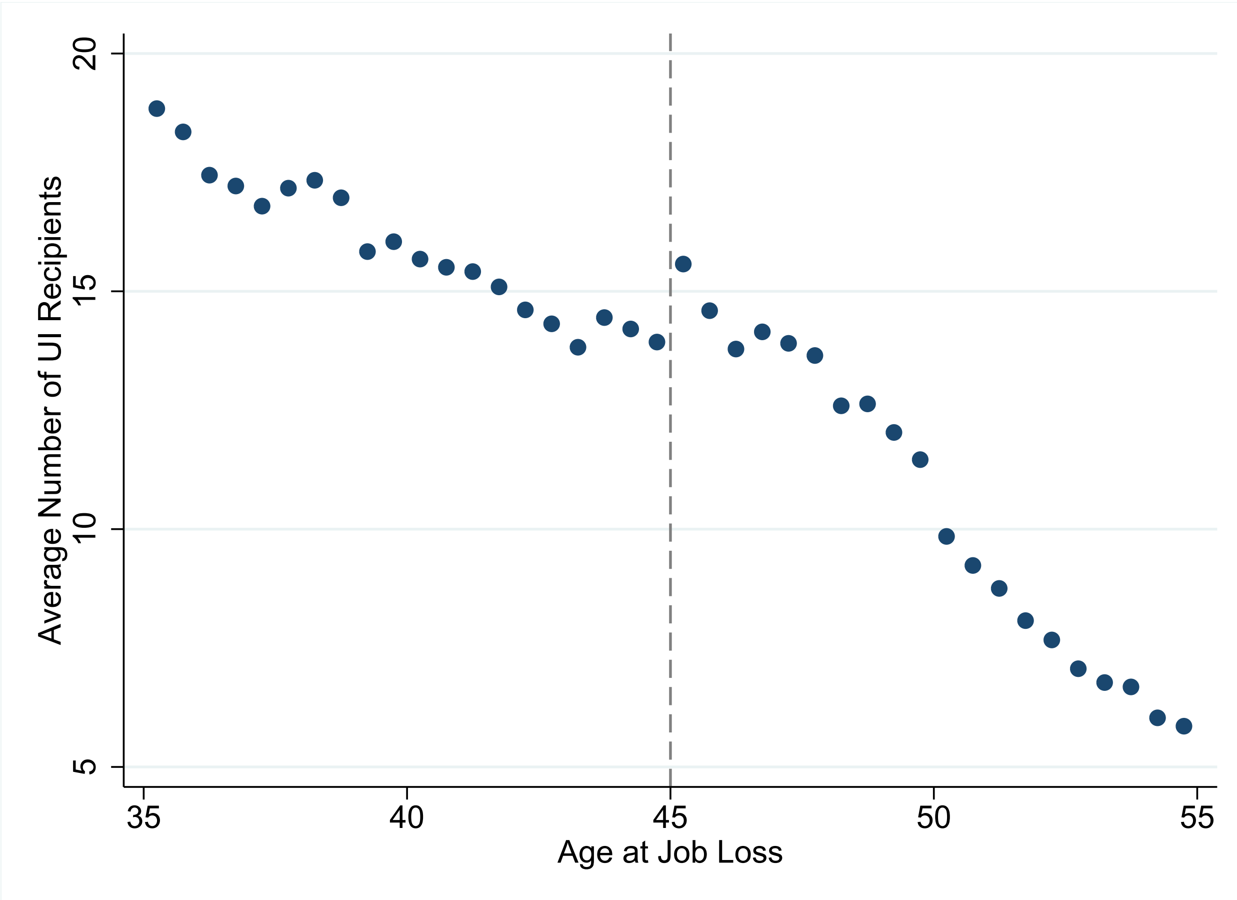
Figure 1: UI Timeline



Notes: This figure summarizes the evolution of Taiwan's UI. UI in Taiwan was inaugurated in Jan 1999. On May 15, 2002, the reemployment bonus program was announced. On Jan. 1, 2003, a bonus, equal to 50% of remaining benefits, began to offer for UI recipients who find jobs before exhausting benefits. The potential duration for the worker age 45 or older has been extended from 6 months to 9 months since May 1, 2009.

10.1 RD

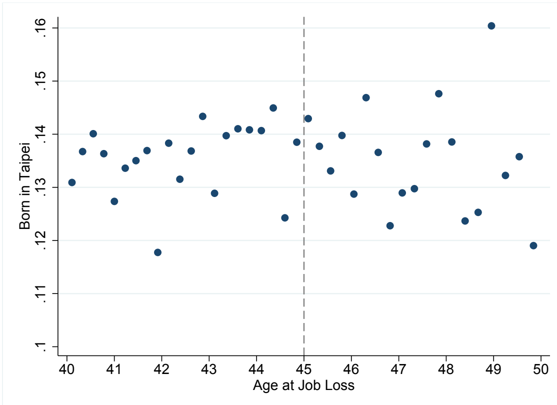
Figure 2: RD–Density Test



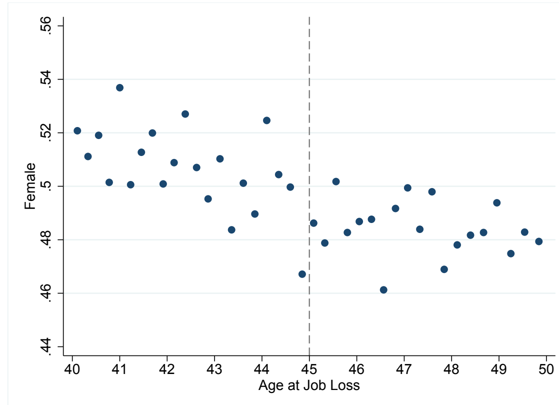
Notes: This figure plots the average number of UI recipients starting receiving benefits between May 1, 2009 and Dec. 31, 2012 over ages at job loss. Each bin represents the average within 145 days interval.

Figure 3: RD–Selection on Observables I

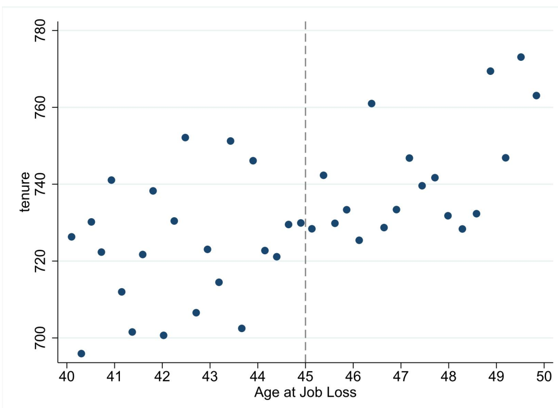
(a) Born in Taipei



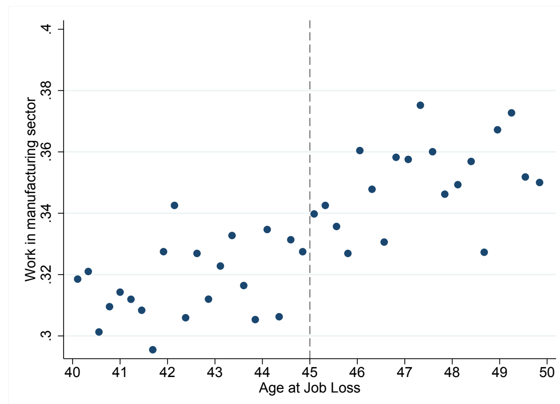
(b) Female



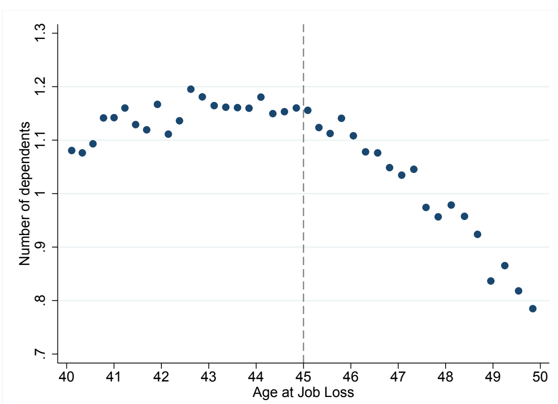
(c) Tenure



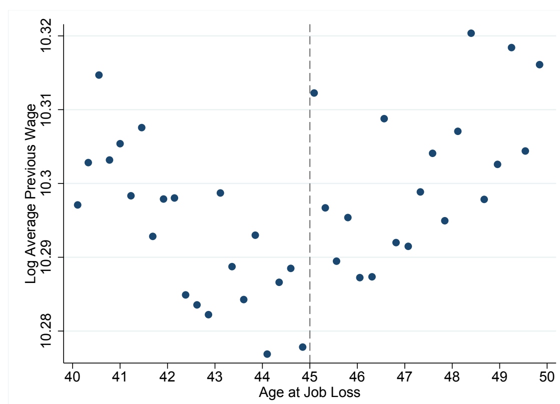
(d) Worked in Manufacturing Sector (Last Job)



(e) Number of Dependents

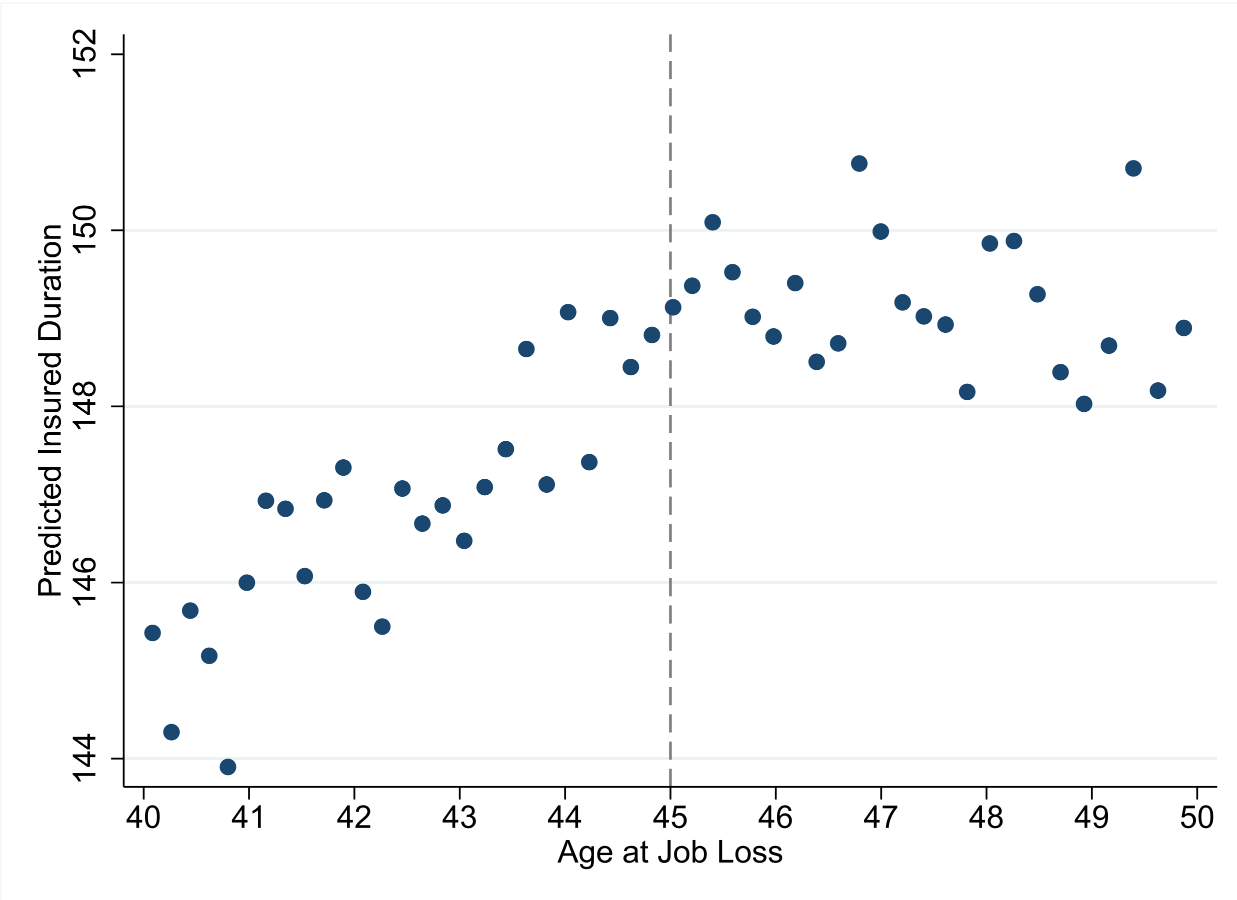


(f) Log Average Monthly Wage Prior to Layoff



Notes: This figure plots the means of six observables for UI recipients start receiving benefits between May 1, 2009 and Dec. 31, 2012 over ages at job loss. Each bin represents the mean within 90 day interval.

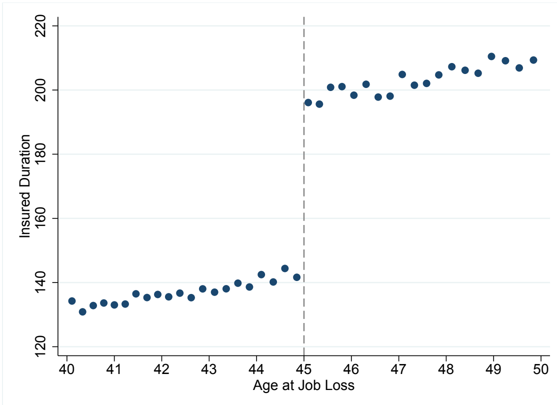
Figure 4: RD–Selection on Observables II



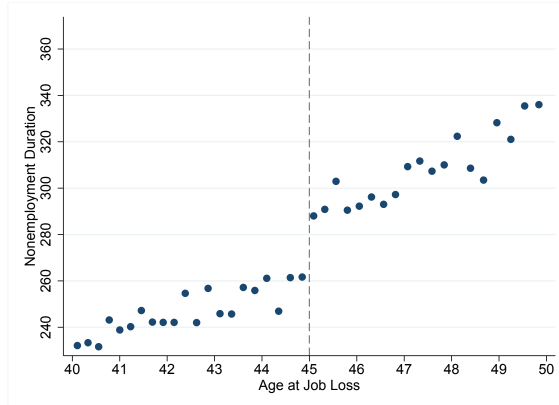
Notes: This figure plots the means of predicted insured duration for UI recipients start receiving benefits between May 1, 2009 and Dec. 31, 2012 over ages at job loss. The predictors are previous wage, previous job tenure, previous industry, gender, place of birth and year and month when workers start receiving benefits. Each bin represents the average predicted insured duration within 90 day interval.

Figure 5: RD–Outcomes

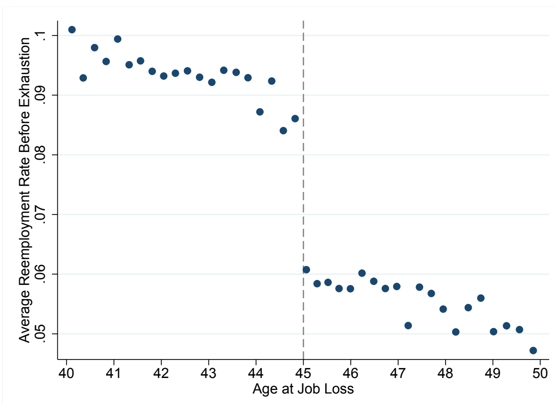
(a) Insured Duration



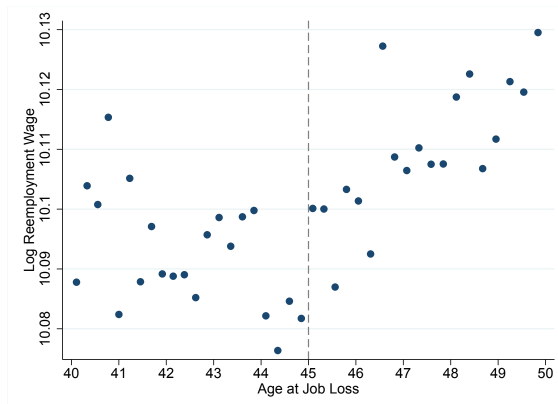
(b) Nonemployment Duration



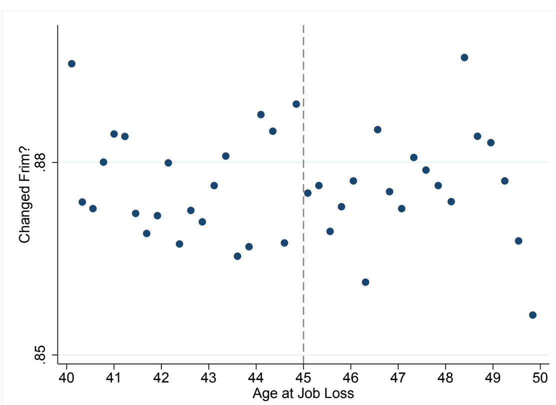
(c) Average Monthly Reemployment Hazard Prior to Exhaustion



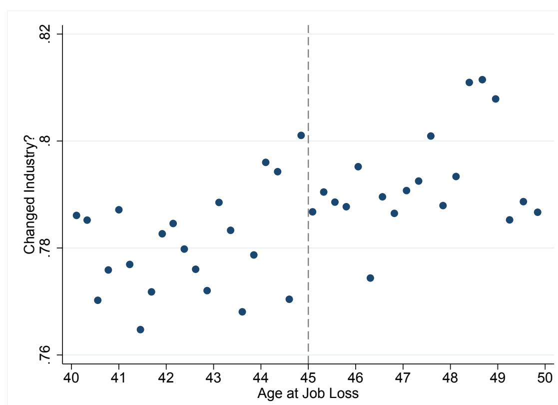
(d) Log Reemployment Wage



(e) Changed Firm?

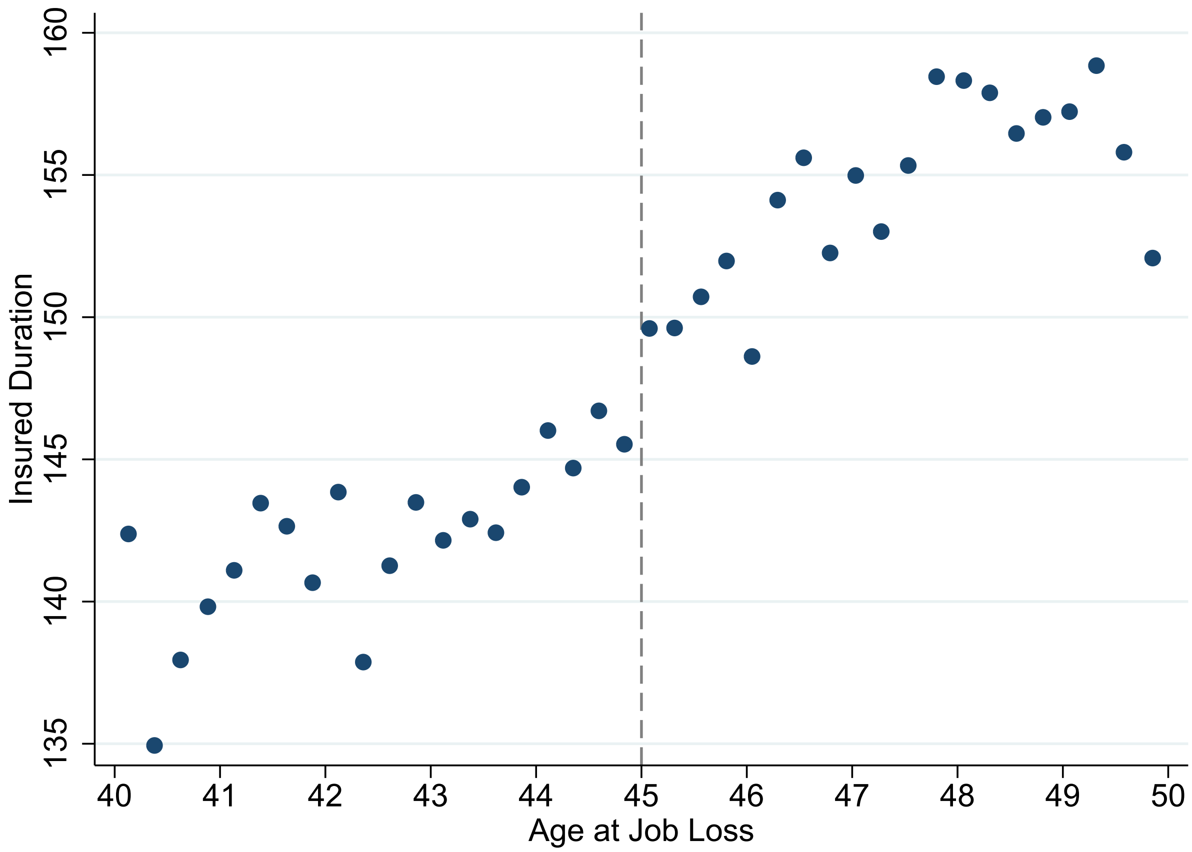


(f) Changed Industry?



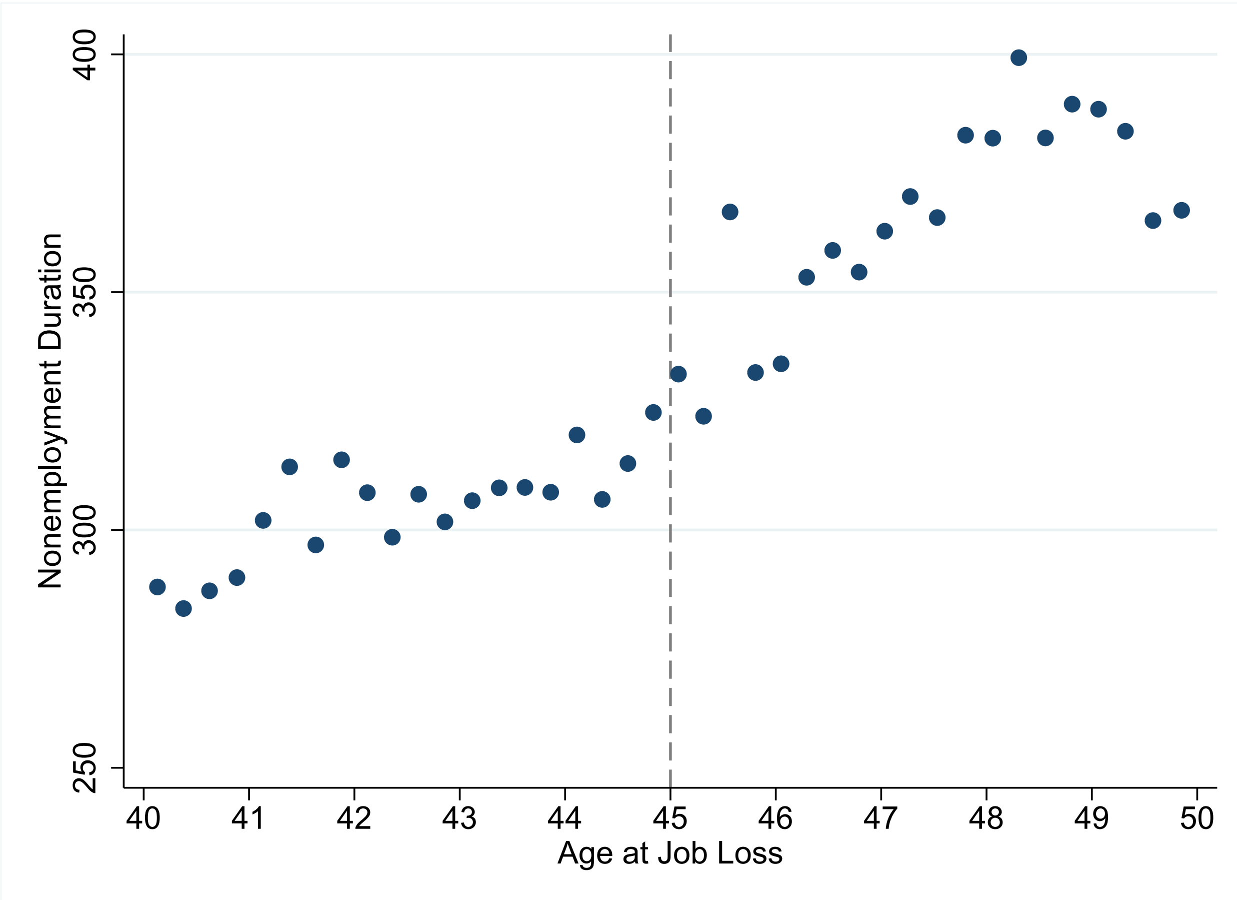
Notes: This figure plots the means of six outcomes for UI recipients start receiving benefits between May 1, 2009 and Dec. 31, 2012 over ages at job loss. Each bin represents the mean within 90 day interval.

Figure 6: Placebo Test: Insured Duration Prior to UI Extension



Notes: This Figure plots the average insured duration for UI recipients age 40 to 50 at job loss and start receiving benefits before Nov. 1, 2008. Each bin represents the average insured duration within 72 day interval.

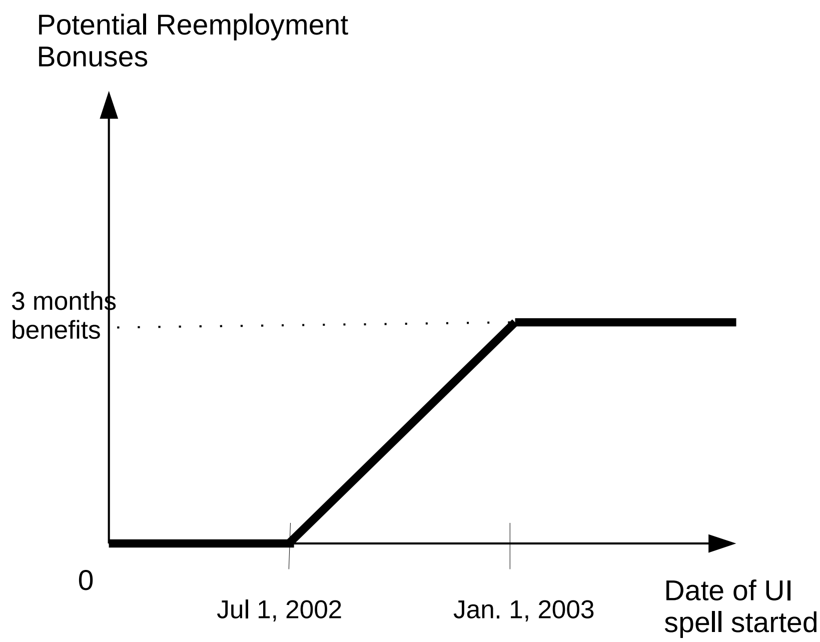
Figure 7: Placebo Test: Nonemployment Duration Prior to UI Extension



Notes: This Figure plots the average nonemployment duration for UI recipients age 40 to 50 at job loss and start receiving benefits before Nov. 1, 2008. Each bin represents the average nonemployment duration within 72 day interval.

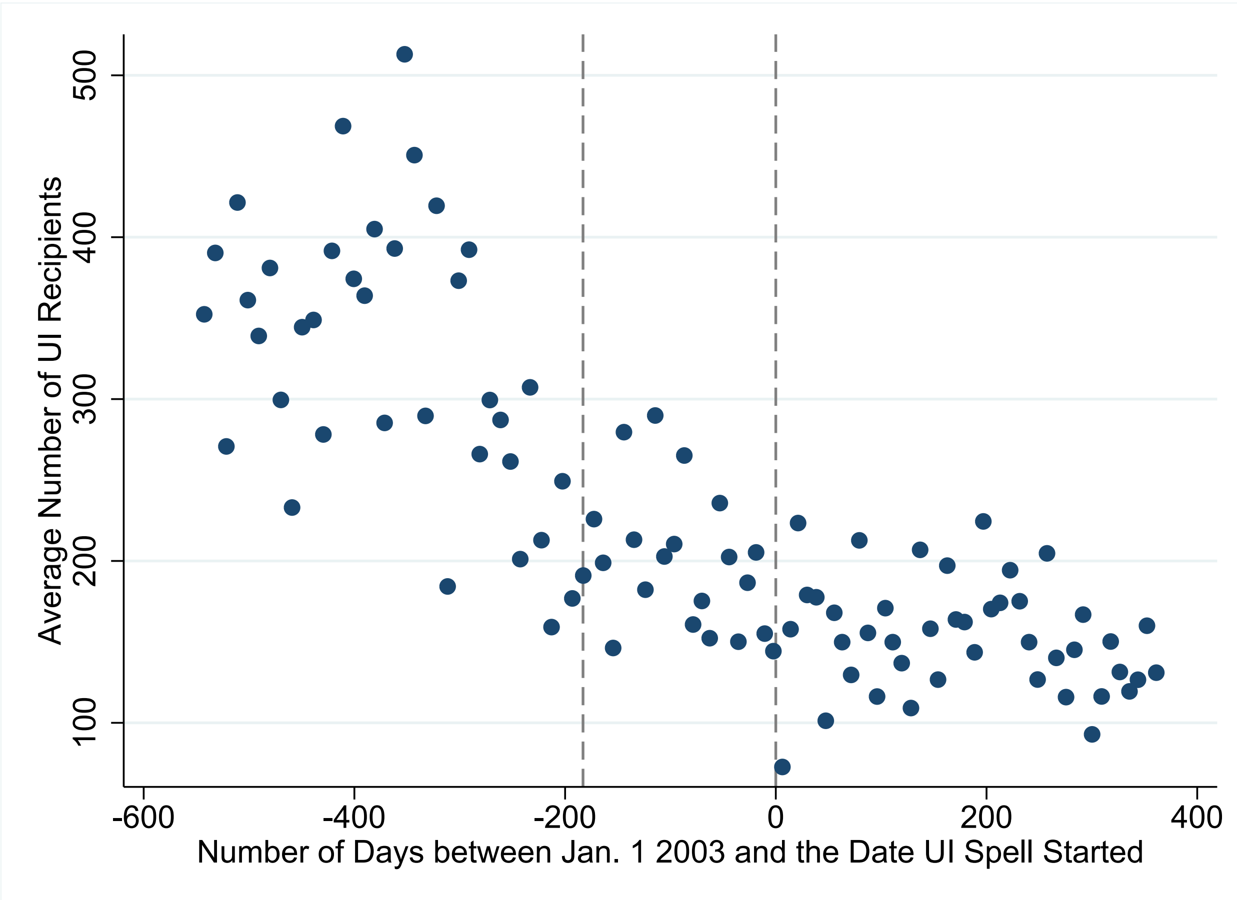
10.2 RK

Figure 8: RKD's First Stage



Notes: This figure demonstrates the relationship between the potential reemployment bonus and the date when UI recipients started to receive benefits. UI recipients start receiving benefits before May 31, 2002 are not eligible for any reemployment bonus. As the program phased in, UI recipients are eligible for more bonuses, while the potential reemployment bonus is constant for UI recipients start receiving benefits after Jan. 1, 2003.

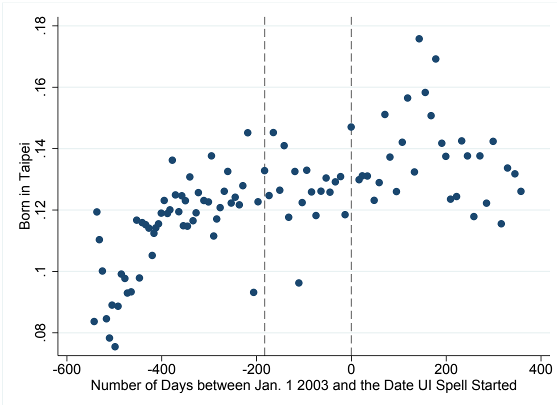
Figure 9: RK–Density Test



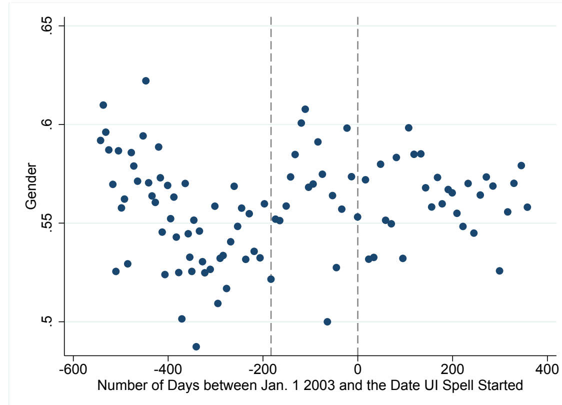
Notes: This graph plots the average number of UI recipients over the number of days between Jan. 1, 2003 and the date UI spells started. The sample include every UI spell started between July 1, 2001 and Dec. 31, 2003. Each bin represents the average number of UI recipients within 9 days interval. The first dash line indicates June 1, 2002, 6 months before the bonus program began. The second line indicates Jan. 1, 2003, the date bonus program began.

Figure 10: RK–Selection on Observables

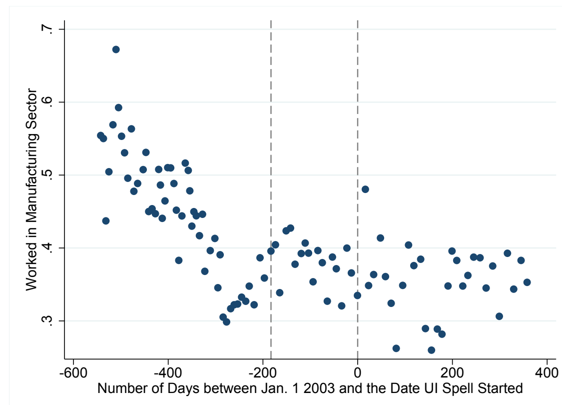
(a) Born in Taipei



(b) Female

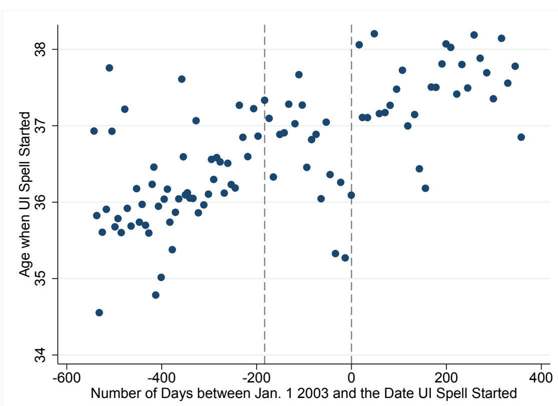


(d) Worked in Manufacturing Sector (Last Job)

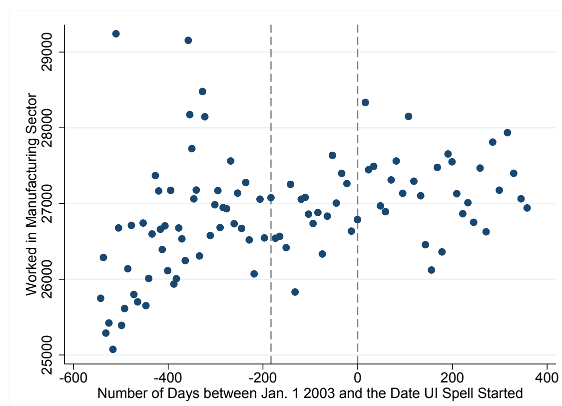


(c) Tenure

(e) Age at Job Loss

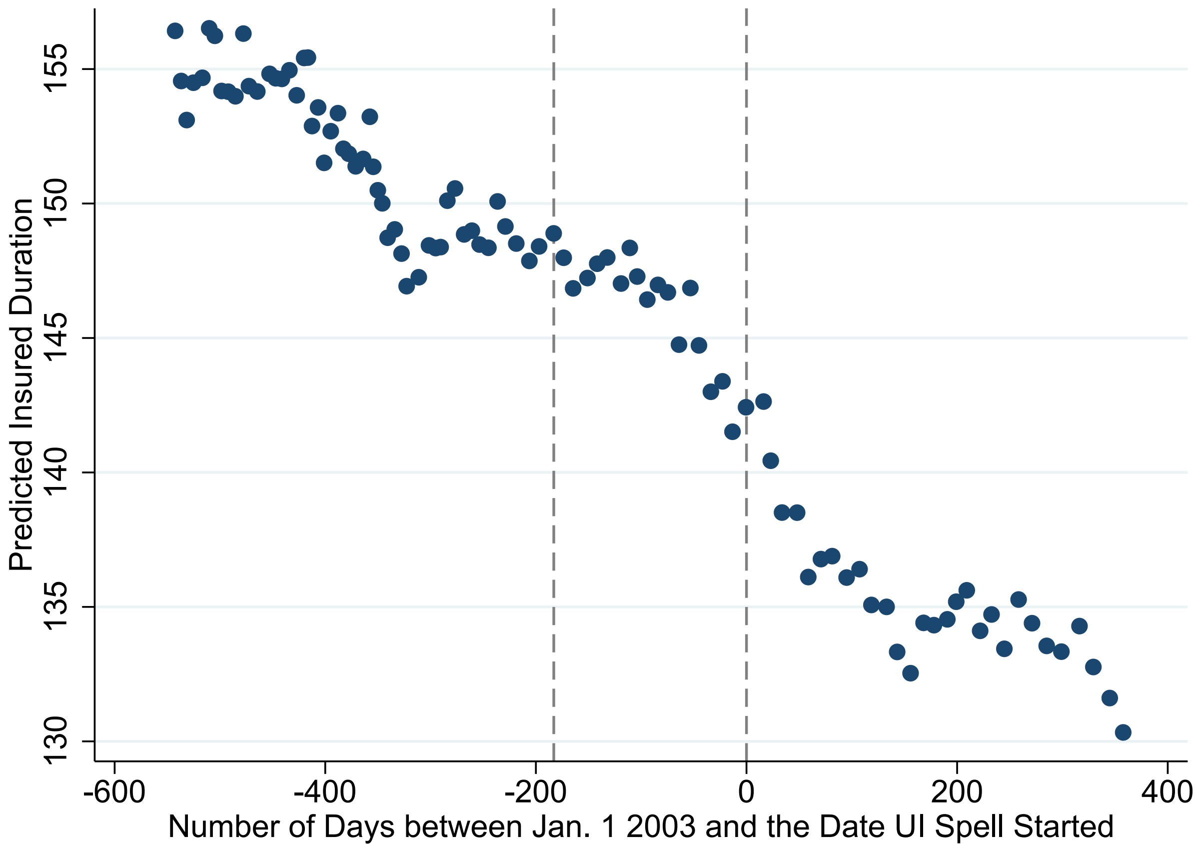


(f) Average Monthly Wage Prior to Layoff



Notes: This graph plots the means of observables over the number of days between Jan. 1, 2003 and the date UI spells started. The sample include every UI spell started between June 1, 2001 and Dec. 31, 2003. Each bin represents the means of observables within 9 days interval. The first dash line indicates June 1, 2002, 6 months before the bonus program began. The second line indicates Jan. 1, 2003, the date bonus program began.

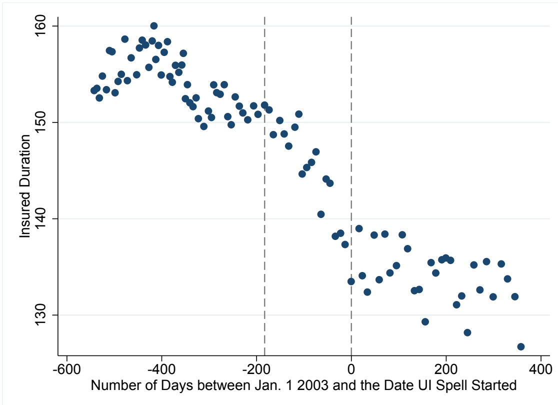
Figure 11: RK–Selection on Observables II



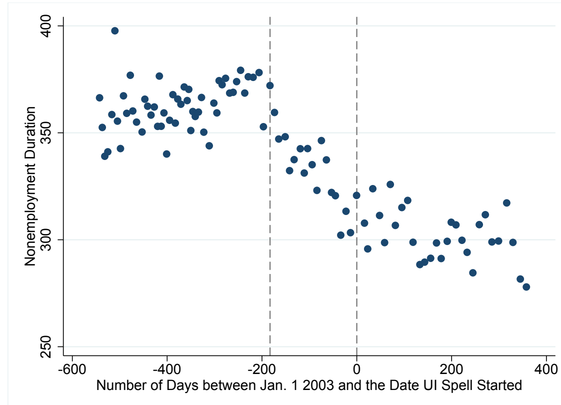
Notes: This figure plots the means of predicted insured duration for UI recipients start receiving benefits between June 1, 2001 and Dec. 31, 2003 over ages at job loss. The predictors are previous wage, previous job tenure, previous industry, gender, place of birth and year and month when workers start receiving benefits. Each bin represents the average predicted nonemployment duration within 9 day interval.

Figure 12: RK–Outcomes

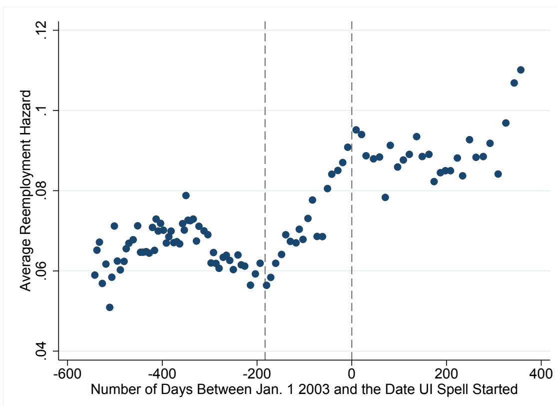
(a) Insured Duration



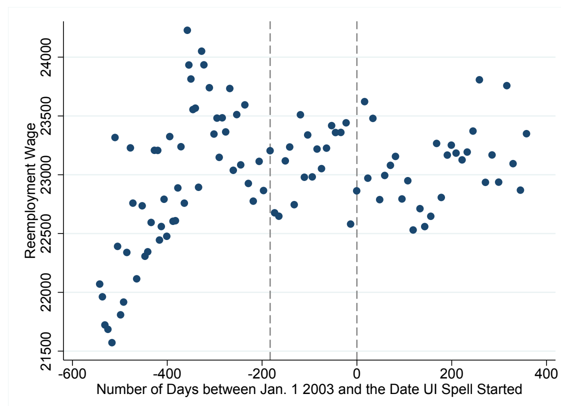
(b) Nonemployment Duration



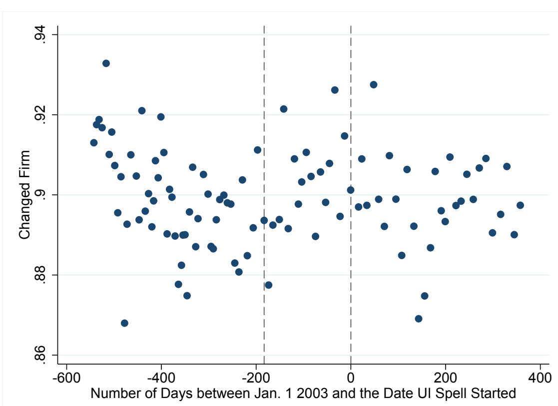
(c) Average Monthly Reemployment Hazard



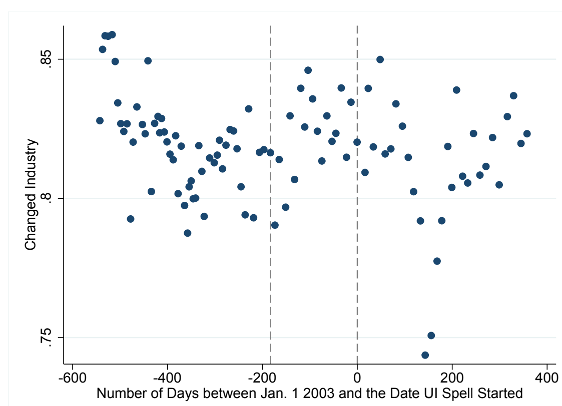
(d) Reemployment Wage



(e) Changed Firm?



(f) Changed Industry?



Notes: This graph plots the means of outcomes over the number of days between Jan. 1, 2003 and the date UI spells started. The sample include every UI spell started between June 1, 2001 and Dec. 31, 2003. Each bin represents the means of outcomes within 9 days interval. The first dash line indicates June 1, 2002, 6 months before the bonus program began. The second line indicates Jan. 1, 2003, the date bonus program began.

11 Appendix

11.1 Decomposition of the Effect of Extended Benefits

The effect of one NTD increase in unemployment benefits in period P on search intensity in period t is dependent on the effect on the value of employment in period t and the value of unemployment in period t, respectively. One NTD increase in b_P raises r_t by θ NTD, and increases the value of employment in period t by $\theta u'(c_t^e)$.

$$\frac{\partial V_t(A_t)}{\partial b_P} = \theta u'(c_t^e)$$

One NTD increase in b_P increases the value of unemployment in period t through two channels. On one hand, it increases the value of unemployment in period t because it increases the utility of being unemployed in period P. On the other hand, it also increases the utility of finding a job in any period before exhaustion point.

$$\begin{aligned}
\frac{\partial U_t(A_t)}{\partial b_P} &= (1-s_{t+1})..(1-s_P)u'(c_P^u) + s_{t+1}\theta u'(c_{t+1}^e) + .. + (1-s_{t+1})..s_P\theta u'(c_P^e) \\
&= S_{t+1}(P)u'(c_P^u) + \theta u'(c_t^e)[1 - S_{t+1}(P)]
\end{aligned}$$

Hence, we can write

$$\begin{aligned}
\frac{\partial s_t}{\partial b_P} &= \frac{\theta u'(c_t^e) - \{S_{t+1}(P)u'(c_P^u) + \theta u'(c_t^e)[1 - S_{t+1}(P)]\}}{g''(s_t)} \\
&= \frac{-S_{t+1}(P)u'(c_P^u) - \theta u'(c_t^e)S_{t+1}(P)}{g''(s_t)}
\end{aligned}$$

The Euler equations for intertemporal consumption are

$$u'(c_t^e) = \begin{array}{c} u'(c_{t+1}^e);\ \text{if } A_t > L \\ u'(w-\tau);\ \text{if } A_t = L \end{array}$$

$$u'(c_t^u) = \begin{array}{c} s_{t+1}u'(c_{t+1}^e) + (1-s_{t+1})u'(c_{t+1}^u);\ \text{if } A_t > L \\ u'(b_t);\ \text{if } A_t = L \end{array}$$

If liquidity constraint is not binding, then

$$u'(c_t^e) = u'(c_P^e);$$

$$u'(c_t^u) = [1 - S_{t+1}(P)]u'(c_P^e) + S_{t+1}(P)u'(c_P^u)$$

Note that

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

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

Hence,

$$\begin{aligned} \frac{\partial s_t}{\partial b_P} &= \frac{[1 - S_{t+1}(P)]u'(c_t^e) - u'(c_t^u) + \theta S_{t+1}(P)u'(c_t^e)}{g''(s_t)} \\ &= \frac{u'(c_t^e) - u'(c_t^u) - (1-\theta)S_{t+1}(P)u'(c_t^e)}{g''(s_t)} \\ &= \frac{\partial s_t}{\partial A_t} - (1-\theta)S_{t+1}(P)\frac{\partial s_t}{\partial w_t}; \forall t \leq P \end{aligned}$$

Finally,

$$\frac{\partial s_t}{\partial \theta} = \{\sum_{k=t}^{P-1} b_k - [s_{t+1}\sum_{k=t+1}^{P-1} b_k + .. + (1-s_{t+1})..s_{P-1}b_{P-1}]\}\frac{\partial s_t}{\partial w_t}.$$

Therefore, we get

$$\frac{\partial s_t}{\partial b_P} = \frac{\partial s_t}{\partial A_t} - \frac{\partial s_t}{\partial \theta}\frac{(1-\theta)S_{t+1}(P)}{\sum_{k=t}^{P-1} b_k - [s_{t+1}\sum_{k=t+1}^{P-1} b_k + .. + (1-s_{t+1})..s_{P-1}b_{P-1}]}; \forall t \leq P$$

11.2 Welfare Effects of Extending Potential Duration

$$W_0 = \max_{s_0} s_0 V(A_0) + (1-s_0)U(A_0) - g(s_0)$$

$$s.t. Bb + (P-B)\theta b = (T-D)\tau;$$

$$\frac{dW_0}{db_P} = (1-s_0)[\frac{\partial U_0}{\partial b_P} - \frac{\partial U_0}{\partial w}\frac{d\tau}{db_P}] + s_0[\frac{\partial V_0}{\partial b_P} - \frac{\partial V_0}{\partial w}\frac{d\tau}{db_P}]$$

$$\begin{aligned}
\frac{\partial U_0}{\partial b_P} &= S_1(P)u'(c_p^u) + s_1\theta u'(c_1^e) + .. + (1-s_1)..(1-s_{P-1})s_P\theta u'(c_P^e) \\
&= S_1(P)u'(c_p^u) + [1-S_1(P)]\theta u'(c_P^e)
\end{aligned}$$

$$\frac{\partial V_0}{\partial b_P} = \theta u'(c_0^e)$$

$$\frac{\partial U_0}{\partial w} = \sum_{t=1}^{T-1}[\prod_{i=1}^{t-1}(1-s_i)]s_t(T-t)u'(c_t^e)$$

$$\frac{\partial V_0}{\partial w} = Tu'(c_0^e)$$

$$E_{0,T-1}u'(c_t^e) = \frac{1}{T-D}[(1-s_0)\frac{\partial U_0}{\partial w} - s_0\frac{\partial V_0}{\partial w}]$$

$$\begin{aligned}
\frac{dW_0}{db_P} &= (1-s_0)\frac{\partial U_0}{\partial b_P} + s_0\frac{\partial V_0}{\partial b_P} - [(1-s_0)\frac{\partial U_0}{\partial w} - s_0\frac{\partial V_0}{\partial w}]\frac{d\tau}{db_P} \\
&= S_0(P)u'(c_p^u) + (1-s_0)[1-S_1(P)]\theta u'(c_P^e) + s_0\theta u'(c_0^e) - E_{0,T-1}u'(c_t^e)\frac{d\tau}{db_P} \\
&= S_0(P)u'(c_p^u) + (1-s_0)[1-S_1(P)]\theta u'(c_p^e) + s_0\theta u'(c_p^e) - u'(c_p^e)\frac{d\tau}{db_P} \\
&= S_0(P)u'(c_p^u) + [1-S_0(P)]\theta u'(c_p^e) - u'(c_p^e)\frac{d\tau}{db_P}
\end{aligned}$$

$$\begin{aligned}\frac{dB}{dP} &= S_0(P) + \sum_{t=0}^{P-1} \frac{dS_0(P)}{dP} \\ &= S_0(P) + \frac{dB}{dP}|_2\end{aligned}$$

$$\begin{aligned}\frac{d\tau}{db_P} &= \frac{d\tau}{dP}\frac{1}{b} \\ &= \frac{1}{T-D}[(1-\theta)\frac{dB}{dP} + \theta + \frac{(1-\theta)B + \theta P}{T-D}\frac{dD}{dP}]\end{aligned}$$

$$\begin{aligned}\frac{dW_0}{db_P} &= S_0(P)u'(c_p^u) + [1-S_0(P)]\theta u'(c_p^e) - u'(c_p^e)[(1-\theta)\frac{dB}{dP} + \theta + \frac{(1-\theta)B + \theta P}{T-D}\frac{dD}{dP}] \\ &= S_0(P)[u'(c_p^u) - u'(c_P^e)] - u'(c_P^e)\{(1-\theta)\frac{dB}{dP}|_2 + \frac{(1-\theta)B + \theta P}{T-D}\frac{dD}{dP}\}\end{aligned}$$

$$\begin{aligned}\frac{dW_0}{db_P}/u'(c_P^e) &= S_0(P)R_p - \{(1-\theta)\frac{dB}{dP}|_2 + \frac{(1-\theta)B + \theta P}{T-D}\frac{dD}{dP}\} \\ &= S_0(k)R_k - \{(1-\theta)\frac{dB}{dP}|_2 + \frac{(1-\theta)B + \theta P}{T-D}\frac{dD}{dP}\}\end{aligned}$$

11.3 Welfare Effects of Increasing Bonuses

$$\frac{dW_0}{d\theta} = (1-s_0)\frac{\partial U_0}{\partial \theta} + s_0\frac{\partial V_0}{\partial \theta} - [(1-s_0)\frac{\partial U_0}{\partial w} - s_0\frac{\partial V_0}{\partial w}]\frac{d\tau}{d\theta}$$

$$\begin{aligned}\frac{\partial U_0}{\partial \theta} &= b[s_1(P-1) + (1-s_1)s_1(P-2) + .. + (1-s_1)..(1-s_{p-2})s_{p-1}] \cdot u'(c_0^e) \\ &= b \cdot \Phi \cdot u'(c_0^e)\end{aligned}$$

$$\frac{\partial V_0}{\partial \theta} = bPu'(c_0^e)$$

$$\frac{d\tau}{d\theta} = \frac{1}{T-D}\{\tau\frac{dD}{d\theta} + b[(1-b)\frac{dB}{d\theta} + (P-B)]\}$$

$$\frac{dW_0}{d\theta}/u'(c_0^e) = (1-s_0)\Phi b + s_0 Pb - \{\frac{Bb + (P-B)\theta b}{T-D}\frac{dD}{d\theta} + b[(1-b)\frac{dB}{d\theta} + (P-B)]\}$$

11.4 Robustness on the RD Design

Table 5: Estimates of the Effect of Extended Benefits on Unemployment Duration–Excluding Observations Within k Months of the Cutoff

	Insured duration		Nonemp. duration		Reemp. Hazard	
	(1)	(2)	(3)	(4)	(5)	(6)
$k = 1$	53.39	52.86	25.16	24.04	-.014	-.013
	(2.00)	(1.97)	(6.48)	(6.42)	(.003)	(.003)
Observations	26,301	26,301	26,301	26,301	174,108	174,108
$k = 2$	52.98	52.63	29.80	28.50	-.015	-.014
	(2.17)	(2.14)	(7.08)	(7.00)	(.003)	(.003)
Observations	25,189	25,189	25,189	25,189	166,552	166,552
$k = 3$	52.42	52.10	31.77	29.89	-.016	-.015
	(2.47)	(2.43)	(7.73)	(7.63)	(.003)	(.003)
Observations	23,998	23,998	23,998	23,998	158,660	158,660
Controls		√		√		√

Note: This table shows the estimates of the effect of increasing potential duration from 6 months to 9 months on insured duration, nonemployment duration and reemployment hazard in the first month of the spell. We estimate local linear regressions on each side of the cutoff. The sample are UI recipients who start UI spell between May 1, 2009 and Dec. 31, 2012, and age 43 to 46 at job loss excluding those age within k months of the cutoff. Controls include UI recipients' average previous wage, previous industry, gender, place of birth, number of dependents and the year and month of job loss as controls. Standard errors in parentheses are clustered at age(days) level for results on insured duration and nonemployment duration, and clustered by UI spell for the results on reemployment hazard.

Table 6: Bias-Corrected Estimates of the Effect of Extended Benefits on Unemployment Duration Using Optimal Bandwidth

	Insured duration		Nonemp. duration		Reemp. Hazard	
	(1)	(2)	(3)	(4)	(5)	(6)
Conventional	54.63	56.12	33.55	33.44	-.017	-.018
	(2.36)	(3.15)	(7.75)	(9.98)	(.002)	(.004)
Bias-Corrected	55.05	56.69	34.78	32.11	-.016	-.019
	(2.81)	(3.56)	(9.27)	(11.36)	(.003)	(.005)
Main Bandwidth	1.46	1.73	1.45	1.88	2.11	1.60
Pilot Bandwidth	2.24	2.36	2.22	2.52	3.22	2.18
Observations	20,260	23,890	20,086	25,940	192,278	147,244
pth order local polynomial	1	2	1	2	1	2

Note: The table shows the bias corrected estimates and the robust standard errors proposed by Calonico et al. (2014). The optimal main bandwidth for the conventional estimates and pilot bandwidth for the estimates on bias-corrected term are calculated by Calonico et al. (2014)'s algorithm. We use pth order local polynomial regression for conventional estimates and $p+1$th order local polynomial regression for the estimates on the bias corrected term. To save computation time, we restrict our sample to UI recipients age 40 to 50 at job loss and started UI spells between May 1, 2009 and Jan 1, 2013.