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

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Abstract

This paper uses two natural experiments in Taiwan to estimate the liquidity effect and moral hazard effect of extended benefits. In Taiwan, since unemployed workers eligible for UI benefits receive 50% of their remaining entitlements if reemployed before benefit exhaustion, extending potential duration not only extends benefits but also extends reemployment bonuses. We show the effect of extended benefits on nonemployment duration can be decomposed into a liquidity effect and a moral hazard effect, which can be identified by the reemployment bonus effect. We identify the nonemployment effect of extended benefits by exploiting the fact that potential duration is a discontinuous function 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. On the other hand, to estimate the effect of reemployment bonuses, we exploit the kinks in potential reemployment bonuses as the bonuses, in effect, phased in. Preliminary estimates show the imposition of bonus

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program reduces insured duration and nonemployment duration by about 8% and 9%, respectively. Combined with theoretical results, our estimates imply liquidity effect accounts for about 57% of the increase in unemployment duration due to extended benefits.
1 Introduction

Optimal unemployment insurance (UI) benefits depends on the trade-off between a moral hazard effect and a liquidity effect. Moral hazard arises because more generous UI benefits decreases the opportunity cost of unemployment. In contrast, the liquidity effect is welfare enhancing because it increases workers’ ability to smooth consumption and allows more time to search for jobs. Empirically, however, only a few papers provide estimates for the liquidity effect of UI. Chetty (2008), using variation in severance pay and data from Survey of Income and Program Participation (SIPP), finds that the liquidity effect accounts for 60% of the increase in unemployment duration caused by raising the level of UI benefits. Landais (2015)’s estimates, using a kink in the UI benefits schedule and data from the Continuous Wage and Benefit History Project (CWBH), suggest the liquidity effect is about 47% of the disincentive effect of increasing UI benefits. In short, it is still unclear to what extent liquidity effect accounts for the disincentive effect of UI and how it varies in a different UI system and labor market.

This paper exploits Taiwan’s distinct unemployment insurance (UI) system and 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. As a result, the maximum duration of reemployment bonus qualification period is also extended as the potential UI benefits duration extends. Using a search model, we show that the effect of extended unemployment benefits on search intensity can be decomposed to liquidity and reemployment bonus effects. Since the extended benefit effect and reemployment bonus effect can be identified by two natural experiments, we can obtain the liquidity effect indirectly.

To estimate the effect of extended benefits on unemployment duration and reemployment wages, 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 reemployment bonus program was announced on May 31, 2002 and began on January 1, 2003. Workers who start receiving benefits after May 31, 2002 are eligible for bonuses and the maximum potential bonus is a linear and increasing function of the first date of receiving benefits. We use regression kink design to identify the effect of reemployment bonuses. Our preliminary estimates show reemployment bonus increases the monthly reemployment hazard by 12%.

The main contribution of this paper is to provide new evidence on liquidity of effect of UI. Combining the structural model with the reduced form estimates, our preliminary estimate for liquidity effect is 57% of the effect of extended benefits on unemployment duration. It suggests that the liquidity effect of UI is in the range of previous estimates from Chetty (2008), Card et al. (2007) and Landais (2015). This result, however, is inconsistent to what we expect because the saving rate in Taiwan (and other Asian countries) is relatively high, which should lead to smaller liquidity effect of UI. [Comparison]

This paper also links to the literature on the effect of unemployment benefits and reemployment 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). [Comparison]

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. Our results for the effect of reemployment bonuses on labor supply are also related to Woodbury and Spiegelman (1987). It is important to know that the reemployment bonus in Taiwan is variable because it depends on when UI recipients find jobs, while the reemployment bonus in the Illinois experiment was fixed. As
a result, although our estimates suggest the reemployment bonus reduces unemployment duration, the magnitude of the estimates is not directly comparable to those in Woodbury and Spiegelman (1987). [Comparison to NJ, WA and PA Experiments]

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 $b_t$. 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 is the probability of finding a job in period $t$. If an unemployed workers finds a job before benefits are exhausted, she will receive
a reemployment bonus, \( r_t \), equal to \( \theta \) percent of remaining benefits. Formally,

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

If a job is found at time \( t \), she receives wage rate, \( w_t \), bonus, \( r_t \), and pays a lump sum tax, \( T \). The flow utility when employed at time \( t \) equals

\[
u(c_t^e) = u(A_t - A_{t+1} + w_t + r_t - T),
\]

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

\[
V_t = \max_{A_{t+1}} u(A_t - A_{t+1} + w_t + r_t - T) + V_{t+1}(A_{t+1}) \tag{1}
\]

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

\[
U_t = \max_{A_{t+1}} u(A_t - A_{t+1} + b_t) + J_{t+1}(A_{t+1}), \tag{2}
\]

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

\[
J_t(A_t) = \max_{s_t} s_t V_t(A_t) + (1 - s_t) U_t(A_t) - g(s_t), \tag{3}
\]

where \( g(s_t) \) is strictly increasing and convex search cost. The first order condition equates the marginal cost of search and its marginal benefit.

\[
g'(s_t) = V_t(A_t) - U_t(A_t) \tag{4}
\]

On the other hand, the Euler equations for intertemporal consumption are

\[
u'(c_t^e) = u'(c_{t+1}^e) \tag{5}
\]
\[ u'(c_t^u) = s_{t+1}u'(c_{t+1}^u) + (1 - s_{t+1})u'(c_{t+1}^u) \]  \tag{6}

Consider the effect of an increase in potential duration, \( P \), on search intensity. An increase in unemployment benefits in period \( P \) will not affect the search intensity at periods after \( P \), because \( V_t(A_t) \) and \( U_t(A_t) \) are not functions of \( b_P \) for all period \( t > P \).

\[ \frac{\partial s_t}{\partial b_P} = 0; \forall t > P \]  \tag{7}

For \( t \leq P \), the effect of extended benefits on the search intensity at time \( t \) will be affected.

\[
\frac{\partial s_t}{\partial b_P} = \frac{\theta u'(c_P^u) - [(1 - s_{t+1})..(1 - s_P)u'(c_P^u) + s_{t+1}\theta u'(c_{t+1}^u) + .. + (1 - s_{t+1})..s_P\theta u'(c_P^u)]]}{g''(s_t)} \tag{8}
\]

\[
= -S_{t+1}(P)u'(c_P^u) + \theta u'(c_t^u)[1 + s_{t+1} + .. + (1 - s_{t+1})..(1 - s_{P-1})s_P]
\]

\[
= F_{t+1}(P)u'(c_P^u) - u'(c_P^u) + \theta u'(c_t^u)[1 + 1 - S_{t+1}(P)]
\]

\[
= \frac{\partial s_t}{\partial A_P} - \frac{\partial s_t}{\partial w_t}[(1 + \theta)S_{t+1}(P) - 2\theta]; \forall t \leq P
\]

where \( S_{t+1}(P) = (1 - s_{t+1})..(1 - s_P) \) and \( F_{t+1}(P) = 1 - S_{t+1}(P) \). When there is no reemployment bonus, that is \( \theta = 0 \), extended benefits will discourage search activities. If there are reemployment bonuses, it is possible extending potential duration will increase search intensity if \( \theta \) is sufficiently large.

Since bonus effect, \( \frac{\partial s_t}{\partial r_t} \), has nothing to do with liquidity effect, \( \frac{\partial s_t}{\partial A_t} \), and it can be rescaled to the moral hazard effect, \( \frac{\partial s_t}{\partial w_t} \), we can write

\[
\frac{\partial s_t}{\partial b_P} = \frac{\partial s_t}{\partial A_P} - \frac{\partial s_t}{\partial w_t}[(1 + \theta)S_{t+1}(P) - 2\theta]
\]

\[
= \frac{\partial s_t}{\partial A_P} - \frac{\partial s_t}{\partial w_t} \left[ (1 + \theta)S_{t+1}(P) - 2\theta \right] \sum_{k=t}^{P-1} b_k - \left[ s_{t+1} \sum_{k=t+1}^{P-1} b_k + .. + (1 - s_{t+1})..s_{P-1}b_{P-1} \right]; \forall t \leq P
\]

Empirically, \( \frac{\partial s_t}{\partial b_P} \) and \( \frac{\partial s_t}{\partial \theta} \) are identified through two natural experiment.
2.2 Welfare

2.2.1 Optimal Potential Duration

This subsection derives the optimal UI formula in a UI system with reemployment bonus. 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

$$\frac{dW_0}{db_P} = \frac{dB}{dP} |_{1} [u'(c_p^p) - u'(c_e^p)] - \left\{ (1 - \theta) \frac{dB}{dP} |_{2} + \frac{(1 - \theta)B + \theta P D}{T - D} \frac{dD}{dP} \right\} u'(c_e^p).$$

(10)

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. $\frac{dB}{dP} |_{1} = S(P)$, which 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 $\frac{dW_0}{dw_P}$, we get the following

$$\frac{dW_0}{db_P} / \frac{dW_0}{dw_P} = \frac{dW_0}{db_P} / u'(c_e^p) = \frac{dB}{dP} |_{1} R - \left\{ (1 - \theta) \frac{dB}{dP} |_{2} + \frac{(1 - \theta)B + \theta P D}{T - D} \frac{dD}{dP} \right\}$$

(11)

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

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.¹ 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 issue beneficiary, and each observation in Employment Insurance file represents a change in

¹There 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.
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 than the latter because there is always a gap between the job separation date and the first date of receiving UI. [Waiting period and other reasons] 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:

\[ y_i = \alpha + \rho EB_i + u_i, \]  

(12)

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 are eligible for 9 months. In other words,

\[ EB_i = \begin{cases} 
1 & \text{if age at layoff } \geq 45 \\
0 & \text{if age at layoff } < 45
\end{cases}. \]

Estimating equation (13) 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. For example, age is related to previous wage and job tenure, which are both determinants of \( y_i \). To address this, we restrict our sample to UI recipients from May 1, 2009 to Dec 31, 2012 ages 43 to 46 at layoff, then implement the regression discontinuity design by estimating the following:

\[ y_i = \alpha + \rho EB_i + f(a_i) + v_i, \]  

(13)

where \( a_i \) is age when losing a job, which is the running variable. In our main results, we specify \( f(a_i) \) as a linear function and allows different slopes on both sides of the cutoff. We leave the estimates using quadratic polynomial \( f(a_i) \) and smaller bandwidths in the
Appendix.

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 2 and 3, 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 this. 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 4 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 0.9 percent of our estimation sample.

To check whether this sorting behavior is non-random, we look for any discontinuities of the means of observables around the cutoff. Figure 5 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. If anything, selection on the previous wage might negatively bias our estimates for the extended benefits effect on duration of unemployment since the duration tends to be shorter for higher wage workers in our sample.
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):

\[ y_i = X_i \beta + u_i, \]  

(14)

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 6 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 7. At ages over 45, the total number days of receiving unemployment benefits shifts up by about 50-60 days in Figure 7 (a), while nonemployment duration shifts up by roughly 30 days in Figure 7 (b). Figure 7 (c) plots the average reemployment hazard in the first six months 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 7 (d) jumps at the cutoff. However, the reemployment wage does not permanently shift up at ages over 45, and the previous insured wage in Figure 5 also shares the similar feature. Hence, the jumps at the 45 age cutoff is more likely due to sorting.
In Table 2, we estimate equation (14) for the effect of extended benefits on insured duration of unemployment and nonemployment duration. Column 1 shows, without adding controls, 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. Adding controls changes the estimate very little. Column 3 and 4 report the estimates for the extended benefits effect on nonemployment duration. The estimated effect of extended benefits on nonemployment duration is slightly above 30 days, with an elasticity of 0.22.\footnote{The insured duration elasticity equals percentage change of insured duration divided by percentage change of potential duration, which is \( \frac{54}{140} = \frac{9}{20} \). Similarly, the nonemployment duration elasticity is \( \frac{30}{260} = \frac{9}{86} \).} 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. In our estimation sample, about 37% of UI recipients on the left of the cutoff exhaust their 6 months benefits. For exhaustees in the absence of extended benefits, 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 (0.22) are both larger than the estimates from Schmieder, von Wachter and Bender (2012). Considering in Germany the potential benefits duration is longer and the percentage of exhaustees is smaller, it is not surprising to see this. Compared to the previous studies summarized in Krueger and Meyer (2002), the estimated elasticity in Taiwan is in the range of previous studies.

In columns 5 and 6 of Table 2, we estimate the extended benefits effect on monthly reemployment hazard. Specifically, we estimate

\[
h_{im} = \alpha + \rho EB_i + \tau m + \theta EB_i m + f(a_i) + v_i
\]

where \( h_{im} \) equals one if an UI recipient in the month \( m \) of her UI spell is employed in the \( m+1 \). \( \rho \) 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.

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 potential reemployment bonus 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 May 31, 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 July 1, 2002 was potentially eligible for up to one 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

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

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 potential bonus, 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 (.5 for the first kink and -.5 for the second). We estimate the numerator of equation (16) by estimate the following regression

\[
y_i = \alpha + \gamma(t_i - c) + \beta_{RF}(t_i - c) \cdot D_c + u_i, \text{ where } |t_i - c| \leq 183
\]

\( \beta_{RF} \) 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 6. 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. [unemployment rate in Taiwan] At the first kink point, June 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 a similar pattern 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. The mean reemployment hazard at the beginning of the spell is shown in Figure 12 (c). We do not observe any kinks in the graph but rather a clear jump on Jan. 1, 2003. The reemployment hazard at the beginning of the UI spell for any UI recipients who started spells before Oct. 31, 2002 should not be affected by reemployment bonus program because they would not be able to receive bonuses if they find jobs in the second month of the spells. We would expect the reemployment bonuses increase the reemployment hazard at the beginning of the spell for any UI recipients starting UI spells after Nov. 1, 2002. It is somewhat puzzling that the mean reemployment hazard jumps at Jan. 1, 2003 instead of Nov. 1, 2002. One possible explanation is that unemployed workers who are less likely to exhaust benefits intentionally claim their first month benefits later after the program officially started on Jan. 1, 2003. This would lower (raise) the reemployment rate on the left (right) of the cutoff.

Columns (1) to (4) in Table 4 report the estimates on the effect of reemployment bonuses on insured duration and nonemployment duration. The estimates from the second kink are robust to adding controls. Potential three months benefits as a bonus is estimated to reduce insured duration and nonemployment duration up to 12 days (8%) and 33 (9%) days.\(^3\)

To estimate the effect on reemployment hazard at the beginning of the UI spell, we estimate the following RD style regression using sample from UI recipients starting UI spells between June 1, 2002 and June 1, 2003, excluding those starting spells between Nov. 1, 2002 and Feb. 1, 2003.

\[
h_i = \alpha + \rho d_i + f(d_i) + v_i,
\]

where \(h_i\) is equal to 1 if UI recipient \(i\) at the beginning of the spell finds a job in the second month. \(d_i\) is indicates whether an UI spell starts after Jan. 1, 2003. We specify \(f(d_i)\) as a piece-wise linear function around the cutoff. Columns (5) and (6) presents the estimates of the effect on reemployment hazard at the beginning of the UI spell. The imposition of bonus program is estimated to increase the reemployment hazard at the beginning of the spell.

\(^3\)The percentage change of insured duration is 12/150 = .08. Similarly, percentage change of the nonemployment duration is 33/360 = .09.
spell by .37 with controls.

[Results on Match Quality]

7 Calibration

7.1 Moral Hazard and Liquidity Effects

This section provides preliminary estimates for liquidity effect of extended benefits. According to equation (10) and policy background, we know that

\[ b \frac{\partial s_0}{\partial b} = \frac{b \frac{\partial s_0}{\partial A}}{\partial A} - \frac{\partial s_0}{\partial \theta} \frac{1.6 S_1(P) - 1.2}{6 - [5 s_1 + .. + (1 - s_1) .. s_{P-1}]}. \]  

(19)

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, \( b \frac{\partial s_0}{\partial b} \), is .17. On the other hand, the effect of bonuses on monthly reemployment hazard \( \frac{\partial s_0}{\partial \theta} \) is estimated to be .037/6 = .06 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

\[ b \frac{\partial s_0}{\partial A} = -\frac{.17}{3} + \frac{.06}{6 - [5 s_1 + .. + (1 - s_1) .. s_{P-1}]} \frac{1.6 S_1(P) - 1.2}{6 - [5 s_1 + .. + (1 - s_1) .. s_{P-1}]} \]  

(20)

\[ = -0.057 + 0.06 \cdot 0.04 \]  

(21)

\[ = -0.033 \]  

(22)

This result suggests that the ratio of liquidity effect to extended benefits effect \( \frac{\partial s_0}{\partial A} / \frac{\partial s_0}{\partial b} \) is .033/.057 = .57
7.2 Welfare Implications

We now calculate the welfare effect of extending potential duration using equation (12) 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.

$$\frac{dW_0}{dbP} / \frac{dW_0}{dW_P} = \frac{dB}{dP}|_1 R - \{(1-\theta)\frac{dB}{dP}|_2 + (1-\theta)B + \theta P \frac{dD}{dP}\}$$

$$= .37 \cdot .57 - \{.04 \cdot .20 + \frac{4B + .6P}{T - D} \cdot .33\}$$

$$= .37 \cdot .57 - \{.04 \cdot .20 + (.4 \cdot .15 + 1.38 \cdot .6 \cdot .15) \cdot .33\}$$

$$= .22$$

The above result suggests that one NTD increase in benefits at period $P$ (the tenth month of UI spell) will increase the utility for the UI recipients age 45 to 46 at job loss by the equivalent of .22 NTD increase in monthly wage.


References


Table 1: Descriptive Statistics

<table>
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<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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<tbody>
<tr>
<td>age (years)</td>
<td>37.01</td>
<td>44.77</td>
<td>44.99</td>
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<td>female</td>
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<td>.49</td>
<td>.49</td>
<td>.55</td>
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<td>tenure</td>
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<td>745.24</td>
<td>745.03</td>
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<td>31,496.07</td>
<td>31,350.56</td>
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<td>insured duration</td>
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<td>274.75</td>
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<td>nonemployment duration (excluding censored)</td>
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<td>193.45</td>
<td>193.35</td>
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<td>right censored</td>
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<td>.15</td>
<td>.15</td>
<td>.10</td>
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<td>.89</td>
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<td>changed industry</td>
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<td>.78</td>
<td>.78</td>
<td>.81</td>
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<td>265,241</td>
<td>68,085</td>
<td>27,524</td>
<td>165,685</td>
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</table>

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>
<thead>
<tr>
<th>Extended Benefit</th>
<th>Insured duration</th>
<th>Nonemployment duration</th>
<th>Reemployment Hazard</th>
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<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>54.37</td>
<td>53.96</td>
<td>30.49</td>
<td>30.49</td>
</tr>
<tr>
<td>(1.834)</td>
<td>(1.806)</td>
<td>(5.785)</td>
<td>(5.785)</td>
</tr>
<tr>
<td>With controls</td>
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<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>sample size</td>
<td>27524</td>
<td>27524</td>
<td>27524</td>
</tr>
</tbody>
</table>

Note: Columns (1)-(6) estimate the effect of increasing potential duration from 6 months to 9 months on insured duration, nonemployment duration and monthly reemployment hazard prior to benefits exhaustion in a local linear regression allowing different slopes on either side of age 45 cutoff. The sample consists of UI recipients age from 43 to 46 at job loss, and start UI spell between May 1, 2009 and Dec. 31, 2012. Columns (2), (4) and (6) include UI recipients’ average previous wage, previous industry, last job tenure, gender, place of birth and number of dependents as controls. Standard errors in parentheses are clustered at day level.
Table 3: Estimates of Extended Benefits on Match Quality

<table>
<thead>
<tr>
<th></th>
<th>Log Reemployment Wage</th>
<th>Changed Firm</th>
<th>Changed Industry</th>
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<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>Extended Benefit</td>
<td>.008</td>
<td>.000</td>
<td>-.010</td>
</tr>
<tr>
<td></td>
<td>(.010)</td>
<td>(.009)</td>
<td>(.007)</td>
</tr>
<tr>
<td>With controls</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>sample size</td>
<td>23195</td>
<td>23195</td>
<td>27524</td>
</tr>
</tbody>
</table>

Note: Columns (1)-(6) estimate the effect of increasing potential duration from 6 months to 9 months on log of reemployment wage, the probability of switching firm and switching industry in a local linear regression allowing different slopes on either side of age 45 cutoff. The sample consists of UI recipients age from 43 to 46 at job loss, and start UI spell between May 1, 2009 and Dec. 31, 2012. Columns (1) and (2) exclude UI recipients whose nonemployment spells are censored at Dec. 31, 2013. Columns (2), (4) and (6) include UI recipients’ average previous wage, previous industry, last job tenure, gender, place of birth and number of dependents as controls. Standard errors in parentheses are clustered at day level.
Table 4: Estimates of Reemployment Bonuses on Unemployment Duration

<table>
<thead>
<tr>
<th></th>
<th>Insured duration</th>
<th>Nonemployment duration</th>
<th>Reemployment Hazard</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>Bonuses (kink 1)</td>
<td>-12.08</td>
<td>-4.58</td>
<td>-63.69</td>
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<tr>
<td>(Sample size=70497)</td>
<td>(1.65)</td>
<td>(2.20)</td>
<td>(9.33)</td>
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<tr>
<td>Bonuses (kink 2)</td>
<td>-12.99</td>
<td>-11.53</td>
<td>-26.54</td>
</tr>
<tr>
<td>(Sample size=55462)</td>
<td>(2.01)</td>
<td>(3.11)</td>
<td>(9.33)</td>
</tr>
<tr>
<td>With controls</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

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. Columns (1) to (4) estimate equation (17) and multiply $\beta_{RF}$ by 183. Columns (5) and (6) estimate equation (18) specifying $f(d)$ as a piece-wise linear function. For the first kink, the sample consists of UI recipients started UI spell between Jan. 1, 2002 and Dec. 31 2002. For the second kink, the sample is those started UI spell between June 1, 2002 and June 1, 2003. Columns (2), (4) and (6) include UI recipients’ average previous wage, previous industry, last job tenure, age at job loss, gender, place of birth and number of dependents as controls. Standard errors in parentheses are clustered at day level.
9 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.
Figure 2: 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 3: 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.
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 5: 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) 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 6: 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 7: RD–Outcomes

(a) Insured Duration

(b) Nonemployment Duration

(c) Average Monthly Reemployment Hazard Prior to Exhaustion

(d) Reemployment Wage

(e) Changed Firm?

(f) Changed Industry?

Notes: This figure plots the means of six outcomes for UI recipients starting 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 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 includes every UI spell started between June 1, 2001 and Dec. 31, 2003. Each bin represents the average number of UI recipients within a 9-day 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 the bonus program began.
Figure 10: RK–Selection on Observables

(a) Born in Taipei

(b) Female

(c) Tenure

(d) Worked in Manufacturing Sector (Last Job)

(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.
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) Reemployment Hazard in the First Month of UI Spell

(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.
10 Appendix

10.1 Welfare Effects of Extending Potential Duration

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

(27)

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

(28)

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

(29)

\[ \frac{\partial U_0}{\partial b_P} = S_1(P) u'(c_P^u) + s_1 \theta u'(c_P^e) + \ldots + (1 - s_1) \ldots (1 - s_{P-1}) s_P \theta u'(c_P^e) \]  

(30)

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

(31)

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

(32)

\[ \frac{\partial V_0}{\partial w} = T u'(c_0^e) \]  

(33)

\[ \frac{d\tau}{db_P} = \frac{d\tau}{dP \ b} \]  

(34)

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

(35)
\[
\frac{dW_0}{db_P} = (1 - s_0) \frac{\partial U_0}{\partial b_P} - (1 - s_0) \frac{\partial U_0}{\partial w} - s_0 \frac{\partial V_0}{\partial w} \frac{d\tau}{db_P} 
= (1 - s_0) \frac{\partial U_0}{\partial b_P} - E_{0,T-1} u'(c^e_P) [(1 - \theta) \frac{dB}{dP} + \theta + \frac{(1 - \theta)B + \theta P dD}{T - D} ] 
= S_1(P) u'(c^u_P) + s_1 \theta u'(c^e_1) + \ldots + (1 - s_1) \ldots (1 - s_{P-1}) s_P \theta u'(c^e_P) 
- E_{0,T-1} u'(c^e_P) [(1 - \theta) \frac{dB}{dP} + \theta + \frac{(1 - \theta)B + \theta P dD}{T - D} ] 
\]

\[
\frac{dB}{dP} = S_0(P) + \sum_{t=0}^{P-1} \frac{dS_0(P)}{dP} 
= \frac{dB}{dP}|_1 + \frac{dB}{dP}|_2 
\]

\[
\frac{dW_0}{db_P} = \frac{dB}{dP}|_1 [u'(c^u_P) - u'(c^e_P)] - [(1 - \theta) \frac{dB}{dP}|_2 + \frac{(1 - \theta)B + \theta P dD}{T - D} ] u'(c^e_P) 
\]

\[
\frac{dW_0}{db_P} / \frac{dW_0}{dw_P} = \frac{dW_0}{db_P} / u'(c^e_P) = \frac{dB}{dP}|_1 R - [(1 - \theta) \frac{dB}{dP}|_2 + \frac{(1 - \theta)B + \theta P dD}{T - D} ] 
\]

39