The Impact of Means-Tested Unemployment Benefits on the Joint Employment Decisions of Couples

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ABSTRACT

This paper examines how means-tested unemployment benefits affect joint employment decisions of couples. Empirical evidence suggests that the net unemployment benefit replacement-rate gap is related to the employment-rate gap between women with employed and unemployed husbands. A joint search model is used to understand these patterns. I find that means-tested unemployment benefits can generate negative work incentives for those with unemployed spouses but positive work incentives for those with employed spouses. I then quantitatively examine how these incentives contribute to the changes in the proportions of workless and dual-earner couples, employment rates, and government spending on unemployment benefits.

KEY WORDS

Means-tested Unemployment Benefits, Unemployment Insurance, Joint Search Model

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1. Introduction

It has been well documented that wives with unemployed husbands tend to have a lower employment rate than those with employed husbands. This is especially true in the UK and Australia where the difference in the employment rates between these two groups of women exceeds 30 percentage points[1]. Various explanations have been proposed and examined. Some focus on common characteristics between husbands and wives such as skill levels, which may lead to a spurious state dependent relationship (e.g., Ultee et al. 1987, Davies et al. 1992, Henkens et al. 1993). Some focus on cultural or social codes that discourage wives from taking up a breadwinner role when their husbands are out of work (e.g., Sinfield 1981, Barrere-Maurisson et al. 1985, McKee and Bell 1985, Kelvin and Jarrett 1985, Harkonen 2007). Some focus on health or other sociological factors (e.g., Cooke 1987, Strom 2003). Some focus on the means-tested structure of unemployment benefits.[2]

Spurious state dependent relationships and sociological factors are certainly important in explaining a large employment-rate gap between wives with unemployed husbands and wives with employed husbands. However, as shown in Table 1, the employment-rate gap varies greatly across countries. Not every country, such as the US and Spain, reports a large employment-rate gap as found in the UK and Australia. In addition, there is also a very large cross-country variation in the differences in net unemployment benefit replacement rates between unemployed workers with dependent spouses and those with working spouses, as indicated in Table 2. For example, in the UK and Australia, unemployed workers with working spouses receive substantially less amount of unemployment benefits than their counterparts with dependent spouses, while in the US and Spain, spouses' employment statuses have little impact on the total amount of unemployment benefits received by unemployed workers. Furthermore, Figures 1 and 2 show there is a strong positive correlation between the employment-rate gap and the net unemployment benefit replacement-rate gap.

The micro labor literature has examined the impacts of means-tested unemployment benefits on the employment decisions of wives with unemployed husbands in both intensive (i.e., Garcia 1991, and Dex et al. 1995) and extensive margin (i.e., Kell and Wright 1990, and Bingley and Walker 2001). Most of them find the effects of means-tested unemployment benefits to be negative although disagreement remains over the magnitudes of the effects. The negative work incentives are generated by a reduction of unemployment benefits which are tied to total household income. Therefore, wives will face a much higher effective marginal tax rate if their unemployed husbands receive means-tested instead of non-means-tested unemployment benefits.

There are three main contributions in this paper. First, I show that means-tested unemployment benefits involve both negative and positive work incentives, the latter of which

[1] It is based on 1991 UK Census and 1994 Australian labor force survey data.

[2] For example, Dilnot and Kell (1987), Garcia (1989 and 1991), Kell and Wright (1990), Dex et al. (1995), Giannelli and Micklewright (1995), Doris (1997 and 1999), Bingley and Walker (2001), McGinnity (2002), Headey and Verick (2006), Evans and Harkness (2010).

has been largely ignored in the micro labor literature. Second, by examining the reservation-wage map of a couple, I provide a direct comparison between non-means-tested unemployment benefits and means-tested unemployment benefits, the latter of which has been largely ignored in the macro labor literature.[3] In comparison with non-means-tested unemployment benefits, the negative work incentives generated by means-tested unemployment benefits can produce a larger proportion of workless couples, while its positive work incentives can produce a larger proportion of dual-earner couples. Therefore, it is important to examine the impacts of both negative and positive work incentives on the aggregate employment rate and government spending on unemployment benefits. Third, I provide quantitative analysis on the impacts of means-tested unemployment benefits. In particular, I examine the interaction between means-tested unemployment benefits and working tax credit and show that the negative work incentives generated by means-tested unemployment benefits can be offset by the implementation of working tax credit.

Both means-tested and non-means-tested unemployment benefits can be found in many OECD countries. The former are commonly referred to as unemployment assistance or social assistance while the latter are often called unemployment insurance. Unemployed workers are initially given unemployment insurance if certain past employment conditions are satisfied. Those who do not meet the eligibility requirements or have been unemployed for more than a certain length of time will be given means-tested unemployment benefits instead. The impacts of means-tested unemployment benefits are much more complex than those of unemployment insurance. Under unemployment insurance, the total amount of unemployment benefits does not depend on spouses' earnings. Therefore, unemployment insurance alone cannot generate different employment rates between those with employed spouses and those with unemployed spouses. On the other hand, means-tested unemployment benefits are tied to spouses' earnings, so the amount of unemployment benefits received and the spouses' labor supply decisions will be jointly determined.

Using a discrete-time version of labor joint search model, I examine how means-tested unemployment benefits and unemployment insurance affect couples' reservation wages. When the maximum size of unemployment benefits is small relative to average wage offers, which is likely to be true in many OECD countries, I show that means-tested unemployment benefits will generate higher reservation wages for those with unemployed spouses and lower reservation wages for those with employed spouses than unemployment insurance. When the maximum size of unemployment benefits exceeds a certain threshold, there could exist an interesting breadwinner cycle under means-tested unemployment benefits.

[3] Most macro labor papers, which examine the impacts of unemployment benefits, focus exclusively on single-agent household models, which are not built to examine the impacts of means-tested benefits. In the recent literature, there are a number of macro papers that model within-household decisions, such as Garcia-Perez and Rendon (2006), Dey and Flinn (2008), and Guler et al. (2010), but none of them focuses on the issues of means-tested unemployment benefits.

The remaining sections are organized as follows. Section 2 provides empirical motivations of the paper. Section 3 examines how reservation wages of couples are affected by unemployment insurance and means-tested unemployment benefits. Sections 4 offers quantitative analysis. Section 5 gives some concluding remarks.

2. Empirical Motivations

2.1 Cross-country Comparison

I conduct a cross-country comparison by using the Census data from IPUMS-International and net unemployment benefit replacement rate data from Martin (1996)[4]. I focus on the OECD countries in their early 1990s because those data are more related to the sample period of Martin's data set (1996). The population is restricted to civilian married couples aged between 18 and 60[5].

Table 1 documents the employment rates of married women conditional on their husbands' employment statuses. Except for Switzerland, the employment rates of married women with unemployed husbands are substantially higher than those of married women with employed husbands, as shown in Table 1. In addition, the employment-rate gaps between these two groups of women vary greatly across countries. For example, the gaps are more than 30 percentage points in Australia and the UK, but less than 10 percentage points in Portugal, the US, and Spain.

The substantial differences in the conditional employment rates of married women could be attributable to a spurious state dependent relationship in which a couple face similar economic conditions or are both low skilled workers facing a similar degree of job instability. On the other hand, some social norms might have also discouraged wives from taking up a breadwinner role when their husbands are out of work. However, spurious relationships or sociological factors alone might not provide a complete explanation for such a large cross-country variation in the employment-rate gaps shown in Table 1. In this section, I focus on countries' different unemployment benefit systems as an alternative explanation

Table 2 documents net unemployment benefit replacement rates conditional on the unemployment durations and on spouses' employment statuses. The net replacement rate data are obtained from Martin (Table 2, 1996)[6]. Martin's data takes into account of housing benefits which are often part of the benefit packages received by unemployed workers. As indicated in Table 2, unemployed workers with dependent spouses generally face a higher net replacement rate than unemployed workers with working spouses. Moreover, a large cross-country variation can also be found in those net-replacement-rate gaps. For example, in the first year of

[4] The Australian employment data are computed from an Australian Bureau of statistics report (1994).

[5] In the 1990 U.S. and Switzerland Census data sets, cohabiting and married couples are grouped together and cannot be separately identified. Other countries except Portugal do not provide any data on cohabiting couples.

[6] There are additional countries in Martin's (1996) Table 2, but they are excluded here because IPUMS-International does not have the data for those countries.

unemployment, the net-replacement-rate gaps were more than 30 percentage points in Australia and the UK, but less than 10 percentage points in the U.S. and Spain. In addition, there is a general upward trend in the net-replacement-rate gaps as unemployment duration increases.

Figure 1 displays a strong positive relationship between the married women's employment-rate gap and the net-replacement-rate gap, with a correlation of around 0.95 (if excluding Switzerland)[7]. If the net replacement-rate gaps are computed based on the 2nd-3rd year and the 4th-5th year of unemployment, the correlation will be lowered to 0.84 and 0.67, respectively. Figure 2 plots the employment-rate gap against the net-replacement-rate gap for two different age groups: (1) 18-30 and (2) 31-60. The correlation remains strong in both age groups, as shown in Figure 2.

2.2 Case Study: UK

The UK is an interesting candidate for examining the effects of means-tested unemployment benefits. As shown in Tables 1 and 2, both employment-rate gap and net-replacement-rate gap exceed 30 percentage points in the UK. In this section, I use the UK quarterly labor force survey data, obtained from the UK Data Archive, to examine UK's employment patterns over time. The population is restricted to married or cohabitating couples aged between 18 and 60. The reason to include cohabitating couples here is because they are treated as married couples when applying for unemployment benefits in the UK.

2.2.1. Unemployment Benefit System

Both means-tested and non-means-tested unemployment benefits exist in the UK. Before October 1996, the non-means-tested benefit is called national insurance unemployment benefits (UB), and the means-tested benefit is known as supplementary benefit (1966-1988) or income support (IS, 1988-1996). Both UB and IS pay a flat rate. The duration of UB is one year. If UB expires or if unemployed workers (who do not have a sufficient contribution to national insurance in one of the two tax years on which the claim is based) are ineligible for UB, they may apply for IS.

UB and IS (for unemployed workers) have been replaced by contribution-based Jobseeker's Allowance (JSA) and income-based JSA respectively Since October 1996. For the income-based JSA, only £10 is disregarded for partners' earnings, and then there will be a £1-to-£1 reduction from the benefits. The duration of the contribution-based JSA was reduced from previously one year to six months. The duration of the income-based Jobseeker is unlimited as long as claimants satisfy JSA rules. In March 2001, JSA imposed a joint claim requirement on both partners in a couple if they do not have dependent children and one or both partners are 25 year-old or younger. Before the joint claim rule was introduced, only one partner was required to

[7] Switzerland has the lowest unemployment rate among the sample countries. Only 451 out of 57287 husbands are unemployed.

satisfy JSA rules in order to claim allowance for dependent adult. In October 2002, the age for the joint claim requirement was extended to 45.

2.2.2. Conditional Employment Rates

Figure 3 displays the employment rates of women conditional on their spouses' employment statuses. As shown in Figure 3, the employment-rate gap between women with employed spouses and women with unemployed spouses is large, but it has been falling over time. The main contributor to the decline of the employment-rate gap is the rising employment rate of women with unemployed spouses while the employment rate of women with employed spouses remains relatively stable. This could be partially explained by the following policy reforms marked in Figure 2: (1) the duration of non-means-tested benefits was reduced from one year to six months in October 1996; (2) the Working Families' Tax Credit (WFTC) reform that took place in October 1999 substantially increased in-work benefits and childcare support; (3) Jobseeker's Allowance imposed a joint claim requirement in March 2001; and (4) WFTC was replaced by Working Tax Credit in April 2003, which extends in-work support to families without children.[8] Spurious state dependent relationships or sociological factors might be able to explain the large employment-rate gap, but they alone do not seem to provide a complete explanation for the reduction in the employment-rate gap over time. As indicated in Figure 3, economic agents do seem to respond to the unemployment and in-work benefit reforms to some degree.

Figure 4 displays the employment rates of women conditional on their spouses' unemployment durations. I focus on two ranges of unemployment durations: (1) less than or equal to six months; and (2) more than one year. When workers have been unemployed for less than six months, some of them might be receiving non-means-tested benefits throughout the sample period. However, those who have been unemployed for more than a year would not be eligible for non-means-tested benefits. Interestingly, the employment rates of women with spouses who have been unemployed for more than a year are substantially lower than those with spouses who have been unemployed for less than six months, as seen in Figure 4.

In order to provide a more direct comparison, I restrict their spouses' unemployment duration to be six months or less. Figure 5 displays the employment rates of those women conditional on the types of benefits received by their unemployed spouses. As shown in Figure 5, the employment rates of women with unemployed spouses receiving means-tested benefits are substantially lower than those with unemployed spouses receiving non-means-tested benefits.

Next, I divide the sample population by educational attainment. The cutoff point is "GCE A-level or equivalent". [9] Those who have achieved at least "GCE A-level or equivalent" will be

[8] In-work benefits in the UK are similar to the earned income tax credit in the United States.
[9] GCE A-level is similar to the American Advanced Placements. Many countries consider it as the equivalent to the first year courses of the four-year university degrees.

put into the high-educated group, and those who have not will be put into the low-educated group. Therefore, there are four types of couples: (1) LL couple, low-educated women married to or cohabiting with low-educated men; (2) LH couple, low-educated women married to or cohabiting with high-educated men; (3) HL couple, high-educated women married to or cohabiting with low-educated men; and (4) HH couple, high-educated women married to or cohabiting with high-educated men.[10]

Figure 6 compares the employment-rate gaps across educational-attainment groups. The employment-rate gap is the largest among LL couples and the smallest among HH couples, as indicated in Figure 6. Regardless of any benefit structures, it is not surprising to observe the largest employment-rate gap among LL couples as they are most likely to face a higher job-separation rate and a lower job-finding rate than other types of couples, and vice versa for HH couples. However, the interaction with the means-tested benefit system can amplify the positive incentive for those with employed spouses as well as the negative incentive for those with unemployed spouses, and produce an unusually large difference in the employment-rate gaps between LL and HH couples. As a comparison, during 1992-2006, (1) the average employment-rate gap among HH couples was close to zero in the US, but exceeded 0.15 in the UK; (2) the average difference in the employment-rate gaps between LL and HH couples was only about 0.1 in the US, but stood at about 0.25 in the UK.[11] In addition, there are also declining trends in the employment-rate gaps for each education group as seen in Figure 6, which might be related to the policy reforms in unemployment and in-work benefits.

3. Reservation Wage Map

Most empirical studies related to means-tested unemployment benefits restrict sample populations to women with unemployed spouses. However, the labor supply decisions of a married couple are usually made jointly, which takes into account of both the couple's current employment statuses and the expected duration of their current employment statuses.[12] Moreover, the negative work incentive of means-tested unemployment benefits, which has been much emphasized in the literature, is not a complete story because it ignores a positive work incentive also generated for women with employed spouses. Thus, a joint search model is more appropriate for studying a married couple's labor supply decision.

In this section, I extend Guler et al.'s (2012) joint search model to examine how means-tested unemployment benefits and unemployment insurance affect married couples' reservation

[10] The cutoff point is relatively low, but it is not practical to define a higher cutoff point, such as bachelor's degrees, because the sample size will be too small to compute reliable employment-rate gap data for HH couples.

[11] I use the March CPS data to compute the employment-rate gap data for the US. The high-educated group is defined as follows: above high school education.

[12] The expected duration of a marital relationship could also affect the labor supply decision of a married couple. Marital instability is certainly an important issue, but it is ignored in this paper in order to reduce the complexity of the analysis. I expect that the impact of the means-tested unemployment benefits would be reduced among the couples facing high degree of marital instability because each of them would behave more like a single individual.

wages[13]. In order to facilitate the interpretation, I call one of the household members, agent 1, and the other one agent 2. Only two employment statuses are considered: unemployed and employed. Therefore, there are three types of couples in the economy: dual-earner couples, single-earner couples, and workless couples.

The time dimension of the model is discrete. The job arrival rate is exogenous and assumed to be α. The job separation risk is assumed to be zero, implying that economic agents face non-decreasing wage earning profile. Economic agents are assumed to be risk neutral, and perfect income pooling is assumed. This setup allows me to ignore the saving decision because economic agents will have no incentives to save even if the saving option is available.

Similar to McCall's (1970) job search model, I assume an exogenous wage offer distribution, $F(w)$, known to each economic agent. The wage offer distribution is assumed to be the same for both couples. At the beginning of each time period, the unemployed agent receives a wage offer, w, with a probability α.

3.1 Unemployment Insurance

Under unemployment insurance, I assume that each unemployed agent will be given a flat rate, b.[14] The duration of unemployment insurance is assumed to be unlimited.[15]

The value function of a dual-earner couple is denoted as follows:

$$T(w_1, w_2) = w_1 + w_2 + \beta T(w_1, w_2) \qquad [1]$$

where w_1 denotes the income earned by agent 1 and w_2 denotes the income earned by agent 2. When both agent 1 and agent 2 are employed, they will reach the absorbing state in the absence of job separation risk.

The value function of a single-earner couple is denoted as follows:

$$\Omega(w_1) = w_1 + b + \beta \left\{ \begin{array}{l} \alpha \int \max\{T(w_1, w_2), \Omega(w_1), \Omega(w_2)\} \, dF(w_2)\} + \\ (1 + \alpha)\Omega(w_1) \end{array} \right\} \qquad [2]$$

[13] Guler et al. (2012) construct the continuous-time joint search model to examine the optimal search strategies of couples in comparison to those of singles. They show that the search strategies are the same when agents are risk neutral. When risk aversion or job location selection is introduced to the model, they show that the equivalency will no longer hold except in some special cases. In my paper, I use the discrete-time version because there is an interesting region in the reservation-wage map that won't be captured in the continuous-time version. To complement Guler et al.'s (2012) results, my paper show that the equivalency will be also broken when unemployment insurance is replaced by means-tested unemployment benefits even under the risk neutral preference.

[14] Unemployment benefits are usually related to past earnings, but in some countries such as the UK, New Zealand and Australia, unemployment benefits are flat-rate, unrelated to past earnings.

[15] In general, there is a time limit on the duration of unemployment insurance. Thus, assuming no time limit is certainly unrealistic. However, this unrealistic abstraction provides a direct comparison between means-tested unemployment benefits and unemployment insurance. In the calibration, this assumption is relaxed by introducing an additional state variable to keep track when unemployment insurance expires.

$\Omega(w_1)$ describes the situation when agent 1 is employed and agent 2 is unemployed, while $\Omega(w_2)$ describes the situation when agent 1 is unemployed and agent 2 is employed. $\Omega(w_2)$ is symmetric to $\Omega(w_1)$.

Assuming agent 1 is currently employed in a single-earner couple, there are two options for each agent: (1) agent 1 needs to decide whether to keep or quit the current job; (2) agent 2 needs to decide whether to reject or accept a job offer if received. Let $\widetilde{w}_{UI}(w_1)$ denote agent 2's reservation wage. If it is not optimal for agent 1 to quit, then agent 2's reservation wage is characterized as follows:

$$\Omega(\mathrm{w}_1) = T\big(w_1, \widetilde{w}_{UI}(w_1)\big) \quad [3]$$

$$T\big(w_1, \widetilde{w}_{UI}(w_1)\big) \geq \Omega\big(\widetilde{w}_{UI}(w_1)\big) \quad [4]$$

On the other hand, if it is optimal for agent 1 to quit, then agent 2's reservation wage is characterized as follows:

$$\widetilde{w}_{UI}(w_1) = w_1 \quad [5]$$

$$T\big(w_1, \widetilde{w}_{UI}(w_1)\big) < \Omega\big(\widetilde{w}_{UI}(w_1)\big) \quad [6]$$

Equation [5] follows naturally from the symmetric property of the Ω function: the minimum wage for them to switch their employment statuses is the current wage of agent 1.

The lower bound of w_1 from $\widetilde{w}_{UI}(w_1)$ depends on the value function of a workless couple, specified as follows:

$$U = 2b + \beta \left\{ \begin{array}{c} 2\alpha(1-\alpha) \displaystyle\int \max\{\Omega(w), U\}\, dF(w) + \\ \alpha^2 \displaystyle\iint \max\{T(w_1, w_2), \Omega(w_1), \Omega(w_2), U\}\, dF(w_1) dF(w_2) + \\ (1 - 2\alpha(1-\alpha) - \alpha^2) U \end{array} \right\} \quad [7]$$

There are four possible job-searching outcomes associated with a workless couple: (1) only agent 1 receives a job offer; (2) only agent 2 receives a job offer; (3) both of them receive a job offer; (4) neither of them receives a job offer. Conditional on the job-searching outcomes (1) and (2), the reservation wage for a workless couple to become a single-earner couple is characterized as follows:

$$\Omega(\widehat{w}_{UI}) = U \quad [8]$$

As shown in Appendix H, $\Omega(\widehat{w}_{UI})$ is strictly increasing in $\widehat{w}_{UI}$. Thus, $\widehat{w}_{UI}$ should be a singleton that equates the value of $\Omega(\widehat{w}_{UI})$ to some constant U. The relationship between $\widehat{w}_{UI}$ and $\widetilde{w}_{UI}(w_1)$ is described by the following proposition.

Proposition 1: Under unemployment insurance, (1) $\widetilde{w}_{UI}(w_1)$ is a constant, $\widetilde{w}_{UI}$, which does not depend on w_1; and (2) $\widetilde{w}_{UI} = \widehat{w}_{UI}$.

Proof. See Appendix B.

According to Appendix B, the following conditions will always hold under unemployment insurance:

$$T(w_1, w_2) \geq T(w_{UI}, w_2) = \Omega(w_2)$$
$$\text{Where } w_1, w_2 \geq w_{UI}, \widetilde{w}_{UI} = \widehat{w}_{UI} = w_{UI}$$

Therefore, it is never optimal for the currently employed agent to quit. In other words, unemployment insurance alone will not be able to generate a breadwinner cycle in which a couple climbs an earning ladder through alternating the roles between a worker and a job-seeker[16].

Figure 7 provides a graphical presentation of Proposition 1. The vertical axis denotes the wage offers for agent 1, and the horizontal axis denotes the wage offers for agent 2. Under unemployment insurance, each agent will accept the job offer as long as it is higher than w_{UI}, where $w_{UI} = \widetilde{w}_{UI} = \widehat{w}_{UI}$. Proposition 1 shows that there is no employment dependency on spouses' employment status. Therefore, the employment rate of those with unemployed spouses will be equal to that of those with employed spouses.

The conclusion from this section will remain the same if the model excludes the possibility for both unemployed agents to receive a job offer at the same time. In other words, the model can be equivalently formulated as a continuous-time model instead of a discrete-time model. However, whether or not to allow both unemployed agents to receive a job offer at the same time will become an important issue under means-tested unemployment benefits because some of the job offers will be rejected if not arriving at the same time, but could be accepted if they are bundled together and offered to a workless couple.

3.2 Means-Tested Unemployment Benefits

In order to conduct a direct comparison between means-tested unemployment benefits and unemployment insurance, I set the maximum means-tested benefit level to be $2b$. The final amount of means-tested unemployment benefits is determined by the following benefit rules:

$$\begin{cases} 2b & \text{if both unemployed} \\ \max\{2b - w_1, 0\} & \text{if agent 1 is employed} \\ \max\{2b - w_2, 0\} & \text{if agent 2 is employed} \end{cases} \qquad [9]$$

Due to the complete deduction of wage earnings in the benefit calculation, single-earner couples receive either no unemployment benefits or $2b$ as their total family income, depending on the size of b and wage draws. Therefore, I first examine two special cases: (1) no unemployment benefits for single-earner couples, and (2) the total family income of single-earner couples is always $2b$. Then, the reservation wage map under means-tested unemployment benefits can be characterized by the mixture of Cases (1) and (2). The smaller/bigger the

[16] In this paper, I only focus on risk-neutral preference. If we go beyond the risk-neutral preference, a breadwinner cycle can be generated from unemployment insurance, as shown in Guler et al. (2010). It is certainly an important future research direction to consider different classes of risk-averse preferences. However, even under risk-neutral preference, a breadwinner cycle can be generated if (1) unemployment insurance is replaced by means-tested unemployment benefits and (2) the maximum benefit level is larger than some threshold, as explained in Section 3.2.

maximum means-tested benefit level, the more closely the reservation wage map resembles Case (1)/Case (2).

3.2.1 Case (1): No Unemployment Benefits for Single-Earner Couples

The corresponding labor search model is presented as follows:

$$T(w_1, w_2) = \frac{w_1 + w_2}{1-\beta} \qquad [10]$$

$$\Omega(w_1) = \frac{w_1}{1-\beta} + \frac{\alpha\beta}{1-\beta}\left\{ \int \max\left\{ \begin{matrix} T(w_1, w_2) - \Omega(w_1), \\ \Omega(w_2) - \Omega(w_1), 0 \end{matrix} \right\} dF(w_2) \right\} \qquad [11]$$

$$U = \frac{2b}{1-\beta} + \frac{\beta}{1-\beta}\left\{ \begin{matrix} 2\alpha(1-\alpha)\int \max\{\Omega(w) - U, 0\}\, dF(w) + \\ \alpha^2 \iint \max\left\{ \begin{matrix} T(w_1, w_2) - U, \Omega(w_1) - U, \\ \Omega(w_2) - U, 0 \end{matrix} \right\} dF(w_1)dF(w_2) \end{matrix} \right\} \qquad [12]$$

Without loss of generality, the discussions below assume that agent 1 is employed and agent 2 is unemployed in a single-earner couple. The characterization of agent 2's reservation wages, $\widetilde{w}_{UA}(w_1)$, is based on the same conditions stated in [3]-[6]. Conditions [3] and [4] ensure that it is not optimal for agent 1 to quit the current job, while Conditions [5] and [6] deals with the breadwinner role alternating between agent 1 and agent 2.

If a workless couple receives only one job offer, the following condition characterizes the reservation wage, $\widehat{w}_{UA}$, for a workless couple to become a single-earner couple.

$$\Omega(\widehat{w}_{UA}) = U$$

As shown in Appendix H, $\Omega(w)$ is strictly increasing in w. Then, $\widehat{w}_{UA}$ is a singleton, similar to the case of unemployment insurance.

If a workless couple both receive a job offer at the same time, the following condition characterizes the reservation wages $(\breve{w}_1, \breve{w}_2)$ for the workless couple to become a dual-earner couple.

$$T(\breve{w}_1, \breve{w}_2) = U$$
$$T(\breve{w}_1, \breve{w}_2) \geq \max\{\Omega(\breve{w}_1), \Omega(\breve{w}_2)\}$$

Proposition 2: Under Case (1),

(i) $\widetilde{w}_{UA}(w_1)$ is a constant, $\widetilde{w}_{UA}$; $\widetilde{w}_{UA} < \widetilde{w}_{UI}$

(ii) $\widehat{w}_{UA} > \widetilde{w}_{UI}$

(iii) $\breve{w}_1 = -\breve{w}_2 + \widetilde{w}_{UA} + \widehat{w}_{UA}$, where $\widetilde{w}_{UA} \leq \breve{w}_2 \leq \widehat{w}_{UA}$

(iv) $U_{UI} > U_{UA}$, where $U_{UI} = T(\widetilde{w}_{UI}, \widetilde{w}_{UI})$ and $U_{UA} = T(\widehat{w}_{UA}, \widetilde{w}_{UA})$

Proof. See Appendix C.

The complete reduction of unemployment benefits creates negative work incentives for those with unemployed spouses, but it also creates positive work incentives for those with employed spouses. As shown in Propositions 2(i) and 2(ii), the reservation wage for a workless couple to become a single-earner couple is higher but the reservation wage for a single-earner couple to become a dual-earner couple is lower under the case-one-type means-tested unemployment benefits than under unemployment insurance. Proposition 2(iii) describes an interesting region in which wage offers will be accepted if bundled together but will be rejected if a workless couple do not receive them at the same time. Such an interesting region will not exist if under unemployment insurance. Moreover, Proposition 2 (i) – (iv) guarantee that the region of dual-earner couples will be larger under the case-one-type than under unemployment insurance.

Figure 8 provides a graphical presentation of Proposition 2. In order to provide a direct comparison, the two white-color lines denote the reservation wages under unemployment insurance. As shown in Figure 8, the region of dual-earner couples expands, but the region of single-earner couples shrinks under the case-one-type. The region of workless couples is likely to expand, but the exact change will depend on actual wage-off distributions and the size of unemployment benefits.

3.2.2 Case (2): Total Family Income of Single-Earner Couples is Always 2b

The corresponding labor search model is presented as follows:

$$T(w_1, w_2) = \frac{w_1 + w_2}{1-\beta} \quad [13]$$

$$\Omega(w_1) = \frac{2b}{1-\beta} + \frac{\alpha\beta}{1-\beta}\left\{ \int \max\left\{ \begin{matrix} T(w_1, w_2) - \Omega(w_1), \\ \Omega(w_2) - \Omega(w_1), 0 \end{matrix} \right\} dF(w_2)\} \right\} \quad [14]$$

$$U = \frac{2b}{1-\beta} + \frac{\beta}{1-\beta}\left\{ \begin{matrix} 2\alpha(1-\alpha)\int \max\{\Omega(w) - U, 0\}\, dF(w) + \\ \alpha^2 \iint \max\left\{ \begin{matrix} T(w_1, w_2) - U, \Omega(w_1) - U, \\ \Omega(w_2) - U, 0 \end{matrix} \right\} dF(w_1)dF(w_2) \end{matrix} \right\} \quad [15]$$

Case (2) is more complex than Case (1) because it contains two sub-cases, depending on parameter values. First, I identify a set of parameter values that define the border separating the two sub-cases. That is, there exists a triple-indifference point: indifferent of becoming a workless couple, a dual-earner couple, and a single-earner couple with either agent being employed.

Let $\widehat{w}_{UA}$ denote the reservation wage for a workless couple to become a single-earner couple as follows:

$$\Omega(\widehat{w}_{UA}) = U \quad [16]$$

In a single-earner couple, let $\overline{w}_{UA}$ denote a double-indifference point in which the employed agent is indifferent between keeping and quitting the current job and the unemployed spouse is indifferent between accepting and rejecting the job offer. In other words, $T(\overline{w}_{UA}, \overline{w}_{UA}) = \Omega(\overline{w}_{UA})$, which can be expanded as follows.

$$2\overline{w}_{UA} = 2b + \frac{\alpha\beta}{1-\beta}\left\{ \int_{\overline{w}_{UA}} w - \overline{w}_{UA} dF(w) \right\} \quad [17]$$

It is easy to show that $\overline{w}_{UA}$ always exists and is unique given [17]. However, $(\overline{w}_{UA}, \overline{w}_{UA})$ may not be feasible depending on whether it falls outside the region of workless couples.

Next, the existence of a triple-indifference point requires that the double-indifference point falls right on the border of the workless-couple region:

$$\overline{w}_{UA} = \widehat{w}_{UA} \qquad [18]$$

More specifically, the existence condition is defined as follows (see Appendix D):

$$0 = \left\{ \int_{\overline{w}_{UA}} \begin{pmatrix} w - \overline{w}_{UA} + (2 - 2\alpha(1 - F(\overline{w}_{UA})))(\widetilde{w}_{UA}(w) - \overline{w}_{UA}) \\ +2\alpha \int_{\widetilde{w}_{UA}(w)}^{\overline{w}_{UA}} w_2 - \widetilde{w}_{UA}(w) dF(w_2) \end{pmatrix} dF(w) \right\} \qquad [19]$$

Where $\overline{w}_{UA}$ and $\widetilde{w}_{UA}(w)$ are defined in [17] and [D.2] respectively. Figure 9(A) provides a graphical presentation of the existence condition. If the double-indifference point, $(\overline{w}_{UA}, \overline{w}_{UA})$, falls strictly outside the region of workless couple, the RHS of [19] will be negative, which implies that $\overline{w}_{UA} > \widehat{w}_{UA}$ (see Appendix D). If the double-indifference point falls strictly inside the region of workless couple, the RHS of [19] will be positive, which implies that $\widetilde{w}_{UA}(\widehat{w}_{UA}) < \widehat{w}_{UA}$ (see Appendix D).

Next, I characterize the reservation wages in each sub-case according to the value of the RHS of [19].

Proposition 3: Sub-case One (the RHS of [19] > 0)

(i) $\widetilde{w}_{UA}(\widehat{w}_{UA}) < \widehat{w}_{UA}$

(ii) $-1 < \frac{d\widetilde{w}_{UA}(w)}{dw} < 0$ when $w \geq \widehat{w}_{UA}$

(iii) $(\breve{w}_1, \breve{w}_2)$ is the set of reservation wages for a workless couple to become a dual-earner couple: $\breve{w}_1 = -\breve{w}_2 + \widetilde{w}_{UA}(\widehat{w}_{UA}) + \widehat{w}_{UA}$, where $\widetilde{w}_{UA}(\widehat{w}_{UA}) \leq \breve{w}_2 \leq \widehat{w}_{UA}$

(iv) $U_{UI} > U_{UA}$, where $U_{UI} = T(\widetilde{w}_{UI}, \widetilde{w}_{UI})$ and $U_{UA} = T(\widehat{w}_{UA}, \widetilde{w}_{UA}(\widehat{w}_{UA}))$

Proof. See Appendix E. The graphical presentation of Proposition 3 is provided in Figure 9(B). The two white-color lines denote the reservation wages under unemployment insurance. The reservation-wage map under sub-case one is similar to that under the case-one-type means-tested unemployment benefits (see Figure 8) except that the reservation wage of an unemployed agent is no longer constant but is decreasing in the spouse' current wages. It is because under sub-case one, the spouse's higher current wage leads to a higher expected contribution to the future family income when they switch from a single-earner couple to a double-earner couple. Moreover, Propositions 3(i)-(iv) guarantee a larger region of dual-earner couples and a smaller region of workless couples under sub-case one than under unemployment insurance.

Proposition 4: Sub-case Two (the RHS of [19] < 0)

(i) $\overline{w}_{UA} > \widehat{w}_{UA}$

(ii) $-1 < \frac{d\widetilde{w}_{UA}(w_1)}{dw_1} < 0$ when $w_1 \geq \overline{w}_{UA}$

(iii) $\widetilde{w}_{UA}(w) = w$ when $\widehat{w}_{UA} \leq w \leq \overline{w}_{UA}$

(iv) $\overline{w}_{UA} < \widetilde{w}_{UI}$

Proof. See Appendix F. Figure 9(C) provides a graphical presentation of Proposition 4. The reservation wages under unemployment insurance are indicated by the two white-color lines. Propositions 4(i) and 4(iv) ensure that $\widehat{w}_{UA} < \widetilde{w}_{UI}$, which is opposite to Proposition 2(ii). Furthermore, under sub-case two, there exists an interesting breadwinner cycle. Figure 9(C) outlines one of the possible paths as follows. At point A, agent 1 accepts a job offer that falls between $\widehat{w}_{UA}$ and $\overline{w}_{UA}$, and agent 2 rejects a job offer and continues searching for a better one. Then, agent 1 becomes a breadwinner of the family. However, when agent 2 receives a job offer higher than agent 1's current wage at point B, agent 2 will accept the job offer and agent 1 will quit the current job and look for a better one. Then, agent 2 takes over the role of the breadwinner. Further, when agent 1 receives a job offer at point C, both of them will be employed and become a dual-earner couple. Thus, they climb up a wage ladder through switching the role of breadwinners.

Given both sub cases, the following proposition explains that the reservation-wage map will be based on sub-case two when the government increases the maximum benefit level (b) beyond some threshold.

Proposition 5: There exists a threshold value of b above which the RHS of [19] is negative.

Proof. See Appendix G.

A negative value of the RHS of [19] indicates that the double-indifference point falls strictly outside the region of workless couples, which is sub-case two. In addition, by examining the sufficient condition that guarantees a negative value of the RHS of [19] in Appendix G, it is easy to show that a lower job finding rate or economic agents being less patient associates with a smaller threshold value of b for the existence of sub-case two.

Figures 9(A)-(C) consistently show that there is a smaller region of workless couples but a larger region of dual-earner couples under the case-two-type means-tested unemployment benefits than under unemployment insurance. Unlike the case-one-type means-tested unemployment benefits, the negative work incentive does not seem to operate under the case-two-type. One intuitive explanation comes from an interesting region in the case-one-type reservation-wage map in which both job offers will be accepted if bundled together but neither will be accepted if not arriving at the same time. The case-one-type requires that those job offers must be bundled in the same period, which reduces the reservation wage for workless couples to become dual-earner couples, but the case-two-type expands the time horizon by allowing job offers to arrive at different time because $2b$ is always guaranteed for single-earner couples, which also reduces the reservation wage for workless couples to become single-earner couples.

3.2.3 Original Benefit Function, $\max\{2b - w, 0\}$

The reservation-wage map based on the original benefit function, $\max\{2b - w, 0\}$, is closely related to Cases (1) and (2). Holding a wage-offer distribution fixed, when b is small, the probability to receive a job offer that pays lower than b will also be small. Then, the reservation-wage map will resemble Case (1). As b increases, the probability for single-earner couples to receive $2b$ as their total family income will also increase. Then, the left lower part of the reservation-wage map will resemble the left lower part of Case (2) but the upper left and bottom right parts of the reservation map will still resemble those of Case (1). As b continues to increase, the reservation-wage map will more and more resemble Case (2).

In this section, I provide a graphical presentation of reservation wage maps by changing the values of b while holding other parameter values constant. The comparison across b values is provided in Figure 10. Again, the two white-color lines from each graph denote the reservation wages, w_{UI}, under unemployment insurance. As expected, w_{UI} increases with the value of b. Therefore, under unemployment insurance, the region of dual-earner couples shrinks while the region of workless couples expands as b increases.

When $b = 0$, the reservation-wage map under unemployment insurance should be the same as the one under unemployment benefits. When $b > 0$, as shown in Figure 10, the region of dual-earner couples under means-tested unemployment benefits will be larger than that under unemployment insurance, which is consistent with Propositions 2-4. For a small value of b, the region of workless couples is likely to be larger under means-tested unemployment benefits than under unemployment insurance, depending on the wage-offer distribution. However, for a large value of b, the region of workless couples will be smaller under means-tested unemployment benefits. Moreover, there will exist a breadwinner cycle as b continues to increase under means-tested unemployment benefits.

Figure 10 shows that the negative work incentives generated by means-tested unemployment benefits exist only when b is relatively small. However, when b is larger than some threshold, the negative work incentives can be substantially reduced because workless couples will be willing to accept a job offer that pays below b and then climb a wage ladder through a breadwinner cycle under means-tested unemployment benefits. However, if under unemployment insurance, workless couples will never accept a job offer that pays below b. In other words, if b is large enough, the reservation wage for workless couples to become single-earner couples will be lower under means-tested unemployment benefits[17].

[17] In this model, I do not include disutility of work or leisure. If they are included, reservation wages will be certainly pushed upwards, but the qualitative comparison between means-tested unemployment benefits and unemployment insurance should remain the same.

4. Quantitative Analysis

4.1 Model

In this section, I first expand the model developed in Section 3 and then calibrate it to match some of the key features of the UK benefit system. There are three elements added to the model: (1) exogenous job separation rate, λ, (2) income tax rate, τ, (3) unemployment duration. Without job separation, it is impossible to match any sensible employment rates from the data. The income tax rate is endogenously determined so that government spending on unemployment benefits will be equal to tax revenues. Unemployment duration is served as a state variable to track when non-means-tested unemployment benefits expire. In order to simplify the notations, I call means-tested and non-means-tested unemployment benefits as UA and UI, respectively.[18]

The UK's benefit structure is much more complicated than the one examined in Section 3. First, an unemployment-benefit package can contain both UA and UI at the same time. For example, an unemployed worker who is receiving UI can still apply for a means-tested allowance for his or her dependent spouse. Second, the duration of UI is not unlimited. Before October 1996, the duration was one year, but after October 1996, it was reduced to six months. Third, means-tested housing benefits are available to low-income families as long as their income and capital are below certain levels. Housing benefits do not target unemployed workers alone, but their means-tested nature will function similarly as UA and they cannot be ignored because of the relatively large size of the benefits. Fourth, benefit levels differ between UA and UI.

By incorporating the UK's benefit structure, the value function of a workless couple that receives only UA is specified as follows:[19]

$$U_{AA} = b_A(1-\tau) + b_H + \beta \begin{Bmatrix} \alpha(1-\alpha)\int \max\{\Omega_{A_1}(w_1), U_{AA}\}\, dF(w_1) + \\ \alpha(1-\alpha)\int \max\{\Omega_{A_2}(w_2), U_{AA}\}\, dF(w_2) + \\ \alpha^2 \iint \max\begin{Bmatrix} T(w_1,w_2), \Omega_{A_1}(w_1), \\ \Omega_{A_2}(w_2), U_{AA} \end{Bmatrix} dF(w_1)dF(w_2) + \\ (1-2\alpha(1-\alpha)-\alpha^2)U_{AA} \end{Bmatrix} \qquad [20]$$

The subscript A indicates UA. The first subscript of U_{AA} refers to agent 1 while the second subscript refers to agent 2. b_A is the maximum benefit level for a couple under UA.[20] b_H

[18] The names of different types of unemployment benefits have been changed for several times in the UK (see Section 2.2.1).

[19] In principle, one might want to allow a wage offer distribution to vary with gender as well, in order to match gender-specific conditional employment rates.

[20] Unemployment benefits are considered as taxable income in the UK. The model adopts a single flat tax rate for all taxable income sources, but in reality the income tax rule is much more complicated, which involves personal allowance below which income tax is not levied and three different tax rates that increases with income. The total amount of unemployment benefits received by a workless is usually smaller than the income-tax personal allowance.

is the maximum level of housing benefits[21]. In the UK, if a workless couple is receiving UA, they will be qualified for a full amount of housing benefits.

The value function of a workless couple that receives only UI is specified as follows:

$$U_{II}(t_1,t_2)=\begin{Bmatrix}2b_I(1-\tau)\\ +b_H^{II}\end{Bmatrix}+\beta\left\{\begin{array}{c}\alpha(1-\alpha)\int \max\begin{Bmatrix}\Omega_{I_2}(w_2,t_1+1),\\ U_{II}(t_1+1,t_2+1)\end{Bmatrix}dF(w_2)+\\ \alpha(1-\alpha)\int \max\begin{Bmatrix}\Omega_{I_1}(w_1,t_2+1),\\ U_{II}(t_1+1,t_2+1)\end{Bmatrix}dF(w_1)+\\ \alpha^2\iint \max\begin{Bmatrix}T(w_1,w_2),\\ \Omega_{I_1}(w_1,t_2+1),\\ \Omega_{I_2}(w_2,t_1+1),\\ U_{II}(t_1+1,t_2+1)\end{Bmatrix}dF(w_1)dF(w_2)+\\ (1-2\alpha(1-\alpha)-\alpha^2)U_{II}(t_1+1,t_2+1)\end{array}\right\} \quad [21]$$

where $b_H^{II}=\max\{b_H-0.65\max\{2b_I(1-\tau)-\bar{b}_H,0\},0\}$

The subscript I indicates UI. The first subscript of U_{II} refers to agent 1 while the second subscript refers to agent 2. b_I is the benefit level under UI. t_1 and t_2 refers to the unemployment duration of agent 1 and agent 2, respectively. The calculation of housing benefits is slightly more complicated for couples who receive UI instead of UA. If $2b_I(1-\tau)$ is less than the applicable amount for a couple (dented as $\bar{b}_H$), a full amount of housing benefits will be payable. However, if $2b_I(1-\tau)>\bar{b}_H$, housing benefits will be reduced at a rate of 65% of any excess amount.

In [21], I assume that workless couples will not be penalized in the case of rejecting a job offer. To reject a job offer without a good cause, unemployed workers can be sanctioned by being denied unemployment benefits for up to twenty-six weeks in the UK, but in practice it is very difficult to monitor or implement this benefit rule especially in the 1990s, which is the time period targeted in this calibration exercise. If the unemployment duration reaches the time limit of UI, Equation [21] should be modified accordingly. For example, if both agents are still unemployed and agent 2 is no longer eligible for UI in the next period, $U_{II}(t_1,t_2)$ will be switched to $U_{IA}(t_1+1)$ instead of $U_{II}(t_1+1,t_2+1)$.[22] More specifically, $U_{IA}(t_1)$ is defined as follows:

If the tax on unemployment benefits is removed from the model, the model prediction results will stay roughly the same.

[21] In the UK, b_H varies across locations, time and the compositions of household members. It can be smaller than the actual rent paid by a household. Housing benefits are not taxable in the UK.

[22] In order to reduce the complexity of the model, I ignore the incomplete take-up issues of means-tested benefits. According to Department for Work and Pensions (1997), the take-up rate of housing benefits is between 89% to 94% by caseload, and the take-up rate of income support is between 76% and 82% by caseload in the financial year 1995/96.

$$U_{IA}(t_1) = \begin{Bmatrix} b_{IA}(1-\tau) \\ +b_H \end{Bmatrix} + \beta \begin{Bmatrix} \alpha(1-\alpha)\int \max\begin{Bmatrix} \Omega_{I_2}(w_2, t_1+1), \\ U_{IA}(t_1+1) \end{Bmatrix} dF(w_2) + \\ \alpha(1-\alpha)\int \max\begin{Bmatrix} \Omega_{A_1}(w_1), \\ U_{IA}(t_1+1) \end{Bmatrix} dF(w_1) + \\ \alpha^2 \iint \max\begin{Bmatrix} T(w_1, w_2), \\ \Omega_{I_2}(w_2, t_1+1), \\ \Omega_A(w_1), U_{IA}(t_1+1) \end{Bmatrix} dF(w_1)dF(w_2) + \\ (1-2\alpha(1-\alpha)-\alpha^2)U_{IA}(t_1+1) \end{Bmatrix} \quad [22]$$

b_{IA} is the benefit level received by a workless couple in which only agent 1 is eligible for UI. By the same token, $U_{AI}(t_2)$ denotes the case when only agent 2 is eligible for UI, and its structure is symmetric to that of $U_{IA}(t_1)$. Therefore, there are four groups of workless couples in the population: U_{AA}, $U_{II}(t_1, t_2)$, $U_{IA}(t_1)$ and $U_{AI}(t_2)$.

In the population, there are also four groups of single-earner couples, depending on the types of unemployment benefits received by unemployed spouses. For example, if agent 1 is the unemployed spouse and eligible for UI, their value function is specified as follows:

$$\Omega_{I_2}(w_2, t_1) = w_2(1-\tau) + \max\{\tilde{b}_A, \tilde{b}_I\} + \beta \begin{Bmatrix} (1-\lambda)\begin{Bmatrix} \alpha \int \max\begin{Bmatrix} T(w_1, w_2), \\ \Omega_{I_2}(w_2, t_1+1), \Omega_{A_1}(w_1) \end{Bmatrix} dF(w_1) \} + \\ (1-\alpha)\Omega_{I_2}(w_2, t_1+1) \end{Bmatrix} \\ + \lambda \left\{ \alpha \int \max\begin{Bmatrix} \Omega_{I_1}(w_1, 1), \\ U_{II}(t_1+1, 1) \end{Bmatrix} dF(w_1) + (1-\alpha)U_{II}(t_1+1, 1) \right\} \end{Bmatrix} \quad [23]$$

$$E = \max\{w_2(1-\tau) - D, 0\}$$
$$\tilde{b}_A = (1-\tau)\max\{b_A - E, 0\} + \max\{b_H - 0.65\max\{E - \bar{b}_H, 0\}, 0\}$$
$$\tilde{b}_I = (1-\tau)b_I + \max\{b_H - 0.65\max\{E + (1-\tau)b_I - \bar{b}_H, 0\}, 0\}$$

D indicates the amount of earnings disregarded in the calculation of housing and unemployment benefits. [23] indicates that the unemployed spouse who is eligible for UI can always apply for UA instead of UI, depending on whichever is higher. In addition, if the employed worker is laid off, he or she will be eligible for UI.[23] However, if the employed worker voluntarily quits his or her job, UA will be given instead.[24] Once the unemployment duration is beyond the time limit specified by UI, $U_{II}(t_1+1,1)$ and $\Omega_{I_2}(w_2, t_1+1)$ in [23] will be replaced

[23] The model description does not perfectly match the actual benefit rules in the UK because not every laid-off worker is able to receive UA, depending on how much National Insurance the workers have paid in the past two tax years.

[24] In the UK, to quit a job without a good cause, unemployment benefits can be delayed for up to 26 weeks. The penalty specified in the model is less severe, but the calibrated results show that the probability of quitting is zero among single-earner couples. Therefore, by further increasing the penalty of quitting, the calibration results will remain unchanged.

by $U_{AI}(1)$ and $\Omega_{A_2}(w_2)$ respectively. $\Omega_{A_2}(w_2)$ denotes the case when the unemployed spouse is not eligible for UI, specified as follows:

$$\Omega_{A_2}(w_2) = (1-\tau)w_2 + \tilde{b}_A + \beta\left\{ \begin{array}{l} (1-\lambda)\left\{ \begin{array}{l} \alpha \int \max\{T(w_1,w_2), \Omega_{A_1}(w_1), \Omega_{A_2}(w_2)\}\, dF(w_1) + \\ (1-\alpha)\Omega_{A_2}(w_2) \end{array} \right\} \\ + \lambda\left\{\alpha \int \max\{\Omega_{I_1}(w_1,1), U_{AI}(1)\}\, dF(w_1) + (1-\alpha)U_{AI}(1)\right\} \end{array} \right\} \quad [24]$$

If the unemployed spouse is agent 1 instead of agent 2, their value functions, $\Omega_{I_1}(w_1, t_2)$ and $\Omega_{A_1}(w_1)$, will be symmetric to [23] and [24], respectively.

In terms of dual-earner couples, their value function is specified as follows:

$$T(w_1,w_2) = (1-\tau)(w_1 + w_2) + \beta \left\{ \begin{array}{c} \lambda(1-\lambda)\max\{\Omega_{I_1}(w_1,1), U_{AI}(1)\} + \\ \lambda(1-\lambda)\max\{\Omega_{I_2}(w_2,1), U_{IA}(1)\} + \\ \lambda^2 U_{II}(1,1) + \\ (1-2\lambda(1-\lambda)-\lambda^2)T(w_1,w_2) \end{array} \right\} \quad [25]$$

In the RHS of [25], the first and second components in the bracket refer to the cases when agent 2 and agent 1 are laid off, respectively. A laid-off worker will be eligible for UI. The spouse, if not laid off, can choose to continue working or quit the current job. If the quit option is chosen, an additional means-tested allowance for the dependent spouse can be applied for by the laid-off worker, and the total amount of unemployment benefits will be equal to b_{IA}.

4.2 Calibration

The data used in the calibration are from the UK five-quarter longitudinal labor force survey that covers the period between June 1995 and August 1996. Only married or cohabiting couples aged 25-60 are included in the sample population. To set 25 as the lower bound of the age range is to minimize the potential anticipation effects of the reform that took place in October 1996 because the reform reduced the amount of UI by more than 18% for those aged below 25. In addition, retirees are excluded from the sample population. Couples living with children and couples in which one or both members have major health or disability problems are also excluded, due to the following reasons: (1) time allocation problems associated with home-produced or market-purchased child care or nursing care services are much more complex than what the model is able to capture; (2) additional government benefits are available to both carers (Carer's Allowance) and people who are sick or disabled (Disability Living Allowance, Statutory Sick Pay or Employment and Support Allowance); and (3) unemployment benefit levels vary with the number of dependent children (aged below 19) and housing benefit levels vary with the number of family members.

Since the model considers only two employment statuses, I classify the sample population into two economic groups: the employed and the unemployed. Those who should be considered as the inactive will be put into the unemployed group. This classification is certainly not correct because the inactive group is distinctively different from the unemployed group. However, to model the behavior of the inactive is beyond the scope of this paper.[25] Moreover, this paper's sample selection criteria, which focus on non-retired couples aged between 25 and 60 without disability or dependent children, could effectively reduce the difference between the inactive and the unemployed.

The model period is one quarter. I set the discount factor β to 0.9902, corresponding to 4 percent of annual interest rate. The quarterly empirical transition rate from employment to unemployment is 0.013, which is used to set the value for λ. Similar to Ljungqvist and Sargent (2008), a wage-offer distribution is set to be a normal distribution with a mean of 0.7 and a variance of 0.02, truncated and normalized between 0 and 1.

During the sample period, the UA benefit was about £75 per week per couple while the UI benefit was about £47 per week per unemployed worker. The amount of earnings disregarded in computing unemployment and housing benefits was £10 per week per couple. The maximum housing benefit levels vary across locations and household compositions. In this calibration exercise, I use the median level of housing benefits received by couples without dependent children as the maximum housing benefit level, which was about £45 per week. The cut-off point beyond which the housing benefits would be reduced was £75 per week.

Given that the wage-offer distribution is bounded between 0 and 1 in the model, the actual benefit levels have to be scaled accordingly. I first compute the average net weekly pay (about £220) from the data. Then, I use the average net weekly pay (denoted as $\overline{W}$) computed from the model to calibrate the value of b_A as follows: $\overline{W}(75/220)$. Next, I set the values of b_H, b_I, D and $\bar{b}_H$ to be (45/75) b_A, (47/75) b_A, (10/75) b_A and (75/75) b_A, respectively. According to the actual benefit rules, the value of b_{IA} is equal to that of b_A. Last, the job arrival rate (α) is calibrated to match the average employment rate (0.9142) during the sample period. The calibrated values of α and b_A are 0.302 and 0.273 respectively.

4.3 Model Prediction

As shown in Table 3, the calibrated model predicts the proportions of workless couples and dual-earner couples to be 0.017 and 0.845 respectively. Those predictions match remarkably

[25] One possible way to distinguish the inactive from the unemployed is to add search cost into the model. Then, the decision to engage in the job searching process compares the expected net return of searching with the expected net return of remaining out of work. An increase in search cost will lead to a decline in the expected net return of searching, generating a larger inactive population.

well with the empirical observations mainly because the job separation rate and the job finding rate are calibrated to match related data moments. In addition, the model predicts the employment rates of those with unemployed spouses and those with employed spouses to be 0.803 and 0.925 respectively. As shown in Table 3, the model is able to explain 85% of the observed employment-rate gap.

In order to evaluate the relative importance of unemployment benefits and housing benefits in generating such a large employment-rate gap, three alternative benefit rules are examined: (1) no unemployment or housing benefits, (2) only housing benefits, and (3) only unemployment benefits. Under each alternative benefit rule, the model is re-calibrated and the corresponding model predications are provided in the last three columns of Table 3.

As shown in Column "Model B1" of Table 3, the re-calibrated model will not be able to explain any portion of the employment-rate gap if unemployment and housing benefits are completely ignored. The conditional employment rates, regardless of whether it is conditional on employed or unemployed spouses, will always be equal to the aggregate employment rate. By adding housing benefits to the model, the conditional employment rates will differ from the aggregate employment rate, and the re-calibrated model will be able to explain about 41% of the observed employment-rate gap (see Column "Model B2" of Table 3). However, it is still substantially smaller than the original model with both unemployment and housing benefits. On the other hand, if unemployment benefits instead of housing benefits are added to the model, only about 35% of the observed employment-rate gap will be explained by the re-calibrated model (see Column "Model B3" of Table 3). This simple re-calibration exercise shows that both unemployment and housing benefits are important components to explain the large employment-rate gap observed from the data. This is also why this paper uses Martin's net unemployment benefit replacement rate data, which takes into account of housing benefits, in Section 2.

4.4 Simulation Experiments

This paper conducts three simulation experiments. The first experiment is to examine two unemployment-benefit regimes: (1) unemployment insurance and (2) means-tested unemployment benefits. The second experiment is to examine how the duration of unemployment insurance affects couples' employment decisions. The third experiment is to examine the interaction between working tax credit and means-tested unemployment benefits.

4.4.1 Experiment I

In the first experiment, I modify the original benefit rules such that all unemployed workers receive either UI or UA. To restrict unemployment benefits to be UA only is equivalent to reducing the duration of UI to zero. As shown in Columns B and C of Table 4, the UA regime generates a larger proportion of both workless and dual-earner couples than the UI regime. Moreover, in comparison with the original model, the employment-rate gap increases by 5 percentage points under the UA regime but decreases by 6.2 percentage points under UI regime[26]. If policy makers are mainly concerned with employment situations of those with unemployed spouses, the UI regime might seem to be preferred because it does not generate any negative work incentives for them as the UA regime. However, the UA regime is also able to generate positive work incentives for those with employed spouses, so the aggregate employment rate is not necessarily smaller. As shown in Columns B and C of Table 4, the aggregate employment rate is actually 0.62 percentage points higher under the UA regime than under UI regime. In addition, the total government spending on both unemployment and housing benefits is 72% lower under the UA regime.

The comparisons between UA and UI from Columns B and C are based on the original benefit levels under which the maximum amounts of unemployment benefits payable to a couple are not the same under the two unemployment-benefit regimes ($b_A/2 \neq b_I$). As a robustness check, the first experiment is repeated by increasing the maximum unemployment benefit levels to the same level ($b_A/2 = b_I = 0.3$) in both regimes.[27] The experiment results provided in Columns D and E of Table 4 show that the qualitative conclusions remain unchanged.

4.4.2 Experiment II

As shown in Columns A-C of Table 4, the aggregate employment rate is higher under the original benefit regime (where the duration of UI is 4) than under the UA-only and UI-only regimes. This illustrates that the changes in the aggregate employment rate are not necessarily monotonic along the duration of UI. The second experiment is conducted to examine the impacts of the UI duration.

As shown in Panel A of Figure 11, the aggregate employment rate first rises and then declines as the duration of UI increases. However, the total government spending on unemployment and housing benefits has been strictly increasing in the duration of UI. In addition, Panel B of Figure 11 shows that the employment rates of those with employed spouses are strictly decreasing while the employment rates of those with unemployed spouses are strictly increasing in the duration of UI. This is because the positive work incentives generated for those with employed spouses and the negative work incentives generated for those with unemployed spouses by UA will be dampened as the duration of UI increases. Therefore, both proportions of dual-earner couples and workless couples decease as the duration of UI increases (see Panel C of Figure 11).

[26] Under the UI regime, the employment-rate gap is not completely reduced to zero because of the presence of housing benefits.
[27] Housing benefits have to be treated carefully in this counterfactual experiment because UI and UA have different impacts on the calculation of housing benefits under the original benefit rules. In order to avoid those impacts, I fix the housing benefits to their original levels.

4.4.3 Experiment III

The second experiment shows that the total government spending on housing and unemployment benefits can be lowered by reducing the UI duration. In October 1996, the UK government reduced the UI duration from 4 quarters to 2 quarters. As illustrated in Figure 11, this reform can increase the proportion of workless couples and lower the employment rate of those with unemployed spouses. This is one of the main arguments against UA in the policy debates. This paper has already shown that the negative work incentive is only a one-sided story because the positive work incentive can also be generated by UA. In addition, the amount of government spending saved by shortening the UI duration could be used for other purposes, such as implementing working tax credit to reduce the negative work incentive generated by UA. In the third experiment, I modify the original benefit rules by adding working tax credit into the model. The formula to calculate working tax credit is specified as below[28]:

$$\max\{b_w - r\max\{Y - D_w, 0\}, 0\} \qquad [26]$$

where b_w denotes the maximum level of tax credit, r denotes the withdraw rate, D_w denotes the withdraw threshold, and Y denotes the total family income[29].

The choice set faced by single-earner couples will expand by incorporating working tax credit into the model. For example, if a single-earner couple is not eligible for UI, they can choose either working tax credit or UA.[30] If a single-earner couple is eligible for UI, it is possible for the unemployed one to receive UI and the employed one to receive working tax credit at the same time. However, UI will be considered as additional family income in the calculation of working tax credit.

In the UK, the original purpose of working tax credit is to increase the work incentives of low-income families with dependent children. It was officially called Family Credit during the sample period. In 1999, Family Credit was replaced by Working Families' Tax Credit (WFTC) which had substantially increased the generosity of in-work benefits and childcare support. However, couples without dependent children were not eligible for WFTC. The coverage was finally extended to those couples in 2003 when WFTC was replaced by Working Tax Credit and

[28] Formula [26] captures the important features of working tax credit, but it is far from a perfect description of the actual rules implemented in the UK. First, it ignores the minimum weekly working-hour requirement. Second, it ignores the income disregard. Working tax credit is calculated based on claimants' previous year's income. The income disregard is the amount of the difference between workers' previous year's and current year's income, which will not reduce current year's working tax credit.

[29] In this experiment, I do not include housing benefits in the total family income when calculating working tax credit, but working tax credit will be included in the total family income in the calculation of housing benefits. The actual benefit rules in the UK will first use claimants' previous year's income (which includes previous year's housing benefits if applicable) to calculate working tax credit. Any amount of increase in the working tax credit will be taken into account in the calculation of current year's housing benefits. However, if current year's income is not greater than the sum of the previous year's income and the income disregard, the initial amount of working tax credit calculated will be the final amount given to claimants.

[30] In the UK, couples without dependent children are not allowed to choose both working tax credit and UA at the same time due to the minimum weekly working-hour requirement set by working tax credit and the maximum weekly working-hour requirement set by UA.

Child Tax Credit. In this experiment, I conduct three policy simulations by allowing couples without dependent children to be eligible for working tax credit.

The first policy simulation is related to the 1996 unemployment-benefit reform in the UK. Column A of Table 5 describes the employment situations prior to the reform. Column B of Table 5 describes the employment situations after the reform in which the duration of UI is reduced from 4 quarters to 2 quarters. As shown in Table 5, the government spending reduces from 0.0182 to 0.0143, but the employment rate of those with unemployed spouses has dropped by 2.2 percentage points. Alternatively, the government can maintain the same budget by implementing working tax credit[31]. The policy simulation results are provided in Column C of Table 5. In comparison to the original level (Column A of Table 5), the employment rate of those with unemployed spouses is increased by 3.7 percentage points and the proportion of workless couples is reduced by 20%. Even though the employment rate of those with employed spouses has dropped slightly, the aggregate employment rate has actually increased by a small amount.

The second policy simulation is related to the first policy simulation. Instead of targeting the government spending to be the same, we can hold the employment rate of those with unemployed spouses constant by implementing work tax credit. The policy simulation results are provided in Column C of Table 5. Similar to the first policy simulation, the proportion of workless couples is lower and the aggregate employment rate is higher than under the original benefit rule as shown in Table 5. However, unlike the first policy simulation, the proportion of dual-earner couples and the employment rate of those with employed spouses are higher than under the original benefit rule. More interestingly, the government spending still drops by 21%.

The third policy simulation is to conduct a robustness check on the outcome generated by the second policy simulation. As shown in Columns D and E of Table 5 (same as Column E and D of Table 4), when the UI-only regime ($b_I = 0.3$) is replaced by the UA-only regime ($b_A/2 = 0.3$), the government spending will be cut by more than half, but the employment rate of those with unemployed spouses will drop by 22 percentage points and the proportion of workless couples will double. Alternatively, the government can implement working tax credit to hold the employment rate of those with unemployed spouses constant. The policy simulation results are provided in Column F of Table 5. In comparison to the UI-only regime (Column D of Table 5), (1) the proportion of dual-earner couples increases by 1.2 percentage points; (2) the proportion of workless couples drops by 6%; (3) both the aggregate employment rate and the employment rate of those with employed spouses increase by 0.7 percentage points; and (4) the government spending still falls by 14 percent.

The last two policy simulations indicate that the negative work incentives generated by UA can be offset by implementing working tax credit. Working tax credit functions quite differently from UA because it is able to generate positive rather than negative work incentives

[31] During the sample period, the withdraw rate is 0.7 and the withdraw threshold is about £75 per week. That is what I use to set the values for r and D_w. b_w is the policy variable that I use to maintain the same government spending.

for those with unemployed spouses in the last two policy simulations. On the other hand, working tax credit can also create negative work incentives for those with employed spouses as shown in the first policy simulation (the employment rate of those with employed spouses has dropped slightly). By incorporating both working tax credit and UA in an appropriate way, the last two policy simulations show that it is possible to generate positive work incentives for those with employed spouses and those with unemployed spouses at the same time.

5. Conclusion

The literature may have overemphasized negative work incentives of means-tested unemployment benefits for those with unemployed spouses. This paper shows that means-tested unemployment benefits can also generate positive work incentives for those with employed spouses. By examining the reservation-wage maps under both unemployment insurance and means-tested unemployment benefits, this paper demonstrates that means-tested unemployment benefits are able to generate a larger proportion of dual-earner couples and a lower government spending on unemployment benefits. If the maximum benefit level is small relative to average wage offers, there will be a larger proportion of workless couples under means-tested unemployment benefits than under unemployment insurance. However, if the maximum benefit level is larger than some threshold, there will exist a breadwinner cycle that could reduce the negative work incentives for those with unemployed spouses, thus generating an even smaller proportion of workless couples under means-tested unemployment benefits.

By calibrating a joint search model to match some of the key features of the UK benefit system, I examine quantitatively how work incentives generated by unemployment insurance and means-tested unemployment benefits contribute to the changes in the proportions of workless and dual-earner couples, conditional employment rates, aggregate employment rates and government spending. Using simulation experiments, this paper shows that the employment rate of those with employed spouses, and the proportions of both workless and dual-earner couples all decrease with the unemployment insurance duration while the total government spending and the employment rate of those with unemployed spouses increase with the unemployment insurance duration. More interestingly, the relationship between the aggregate employment rate and the unemployment insurance duration is not monotonic, but an inverted U-shaped relationship.

This paper also examines the interaction between means-tested unemployment benefits and working tax credit. Working tax credit can generate positive work incentives for those with unemployed spouses but negative work incentives for those with employed spouses, which is opposite to the effects of means-tested unemployment benefits. By incorporating them together, it allows the positive work incentives generated from one side to offset or even overtake the negative work incentives generated from the other side. My last simulation experiment demonstrates a possibility for positive work incentives to operate in both channels by incorporating them in an appropriate way. This leads to an importation policy question of how to design an optimal unemployment benefit policy, which should take into account of the interaction between means-tested unemployment benefits and working tax credit to further improve our social welfare.

My quantitative analysis in this paper is limited since I exclude a number of important dimensions such as asset and human capital accumulation in an effort to reduce the complexity of this study. Means-tested unemployment benefits often impose a cap on savings. Unemployed workers with a large amount of savings are usually ineligible for means-tested benefits. Moreover, if human capital accumulation is allowed, the reservation wage function will depend on not only the spouse's current and expected employment outcome but also their skill levels. Workers with different skill levels may face different job separation risks or job acceptance rates, which will lead to different expected duration of employment and unemployment. Means-tested unemployment benefits could have a greater impact on couples when they face shorter expected duration of employment or longer expected duration of unemployment. Those interesting components will be left for future research.

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Table 1: Conditional Employment Rates of Married Women

	Unemployed Husband [1]	Employed Husband [2]	Gap [2] – [1]
Switzerland 1990	60.09	52.57	-7.52
Greece 1991	29.92	35.16	5.24
Spain 1991	23.18	28.94	5.76
U.S. 1990	59.84	68.10	8.26
Austria 1991	48.15	57.11	8.96
Portugal 1991	47.55	56.96	9.41
Ireland 1991	20.19	35.63	15.44
France 1990	43.17	61.42	18.25
U.K. 1991	35.25	68.69	33.44
Australia 1994	24.38	65.41	41.03

Notes:
1. Data sources: The census data are obtained from IPUMS-International. The 1994 Australia data are computed from Table 16 which is obtained from Australian Bureau of Statistics (1994).
2. The ages of the population from the census data are restricted to be 18-60. The age of the Australian population is 15 years or above.

Table 2: Net Unemployment Benefit Replacement Rates by Unemployment Duration

Unemployment Duration	First Year			Second and Third Year	Fourth and Fifth Year
Countries	With Dependent Spouse [1]	With Working Spouse [2]	Gap [2] – [1]	Gap	Gap
Spain	70	70	0	7	39
U.S.	38	32	6	14	14
Switzerland	86	77	9	59	80
France	80	60	20	36	60
Ireland	58	36	22	53	58
U.K.	75	44	31	74	74
Australia	57	0	57	57	57

Notes:
1. Data sources: Martin (Table 2, 1996).
2. Net unemployment benefit replacement rate = (net unemployment benefits + housing benefits)/(net earnings + housing benefits).

Table 3: Prediction of the Calibrated Model

	Data (%)	Original Model (%)	Model B1 (%)	Model B2 (%)	Model B3 (%)
Proportion of workless couples	1.66	1.69	0.74	1.20	1.13
Proportion of dual-earner couples	84.75	84.53	83.58	84.04	83.97
Employment rate: unemployed spouses	78.35	80.28	91.42	86.03	86.84
Employment rate: employed spouses	92.61	92.46	91.42	91.93	91.85
Aggregate employment rate (targeted)	**91.42**	**91.42**	**91.42**	**91.42**	**91.42**

Notes:
1. Data source: the five-quarter longitudinal data from the UK labor force survey (June 1995 – August 1996).
2. Original Model: include both unemployment and housing benefits; Model B1: no unemployment or housing benefits; Model B2: only housing benefits; Model B3: only unemployment benefits.
3. Under each benefit rule, the model is re-calibrated so the aggregate employment rate is matched perfectly with the empirical data in each model.

Table 4: Comparison between Means-Tested Unemployment Benefits and Unemployment Insurance

	A) Original Model	B) UA only Original b_A	C) UI only Original b_I	D) UA only $b_A/2 = 0.3$	E) UI only $b_I = 0.3$
Proportion of workless couples (%)	1.69	2.13	1.38	3.98	1.88
Proportion of dual-earner couples (%)	84.53	84.66	82.66	83.90	80.37
Employment rate: unemployed spouses (%)	80.28	75.60	85.26	60.35	82.51
Employment rate: employed spouses (%)	92.46	92.76	91.20	93.26	90.06
Aggregate employment rate (%)	91.42	91.26	90.64	89.96	89.25
Government spending	0.0182	0.0093	0.0330	0.0299	0.0641

Notes:
(1) UA only: unemployed workers receive only UA.
(2) UI only: unemployed workers receive only UI
(3) b_I refers to unemployment benefits received by an unemployed worker, while b_A refers to unemployment benefits received by a couple.
(4) In Column D, the housing benefits are fixed to the original levels as in Column B. In Column E, the housing benefits are fixed to the original levels as in Column C.

Table 5: Interactions between Means-Tested Unemployment Benefits and Working Tax Credit

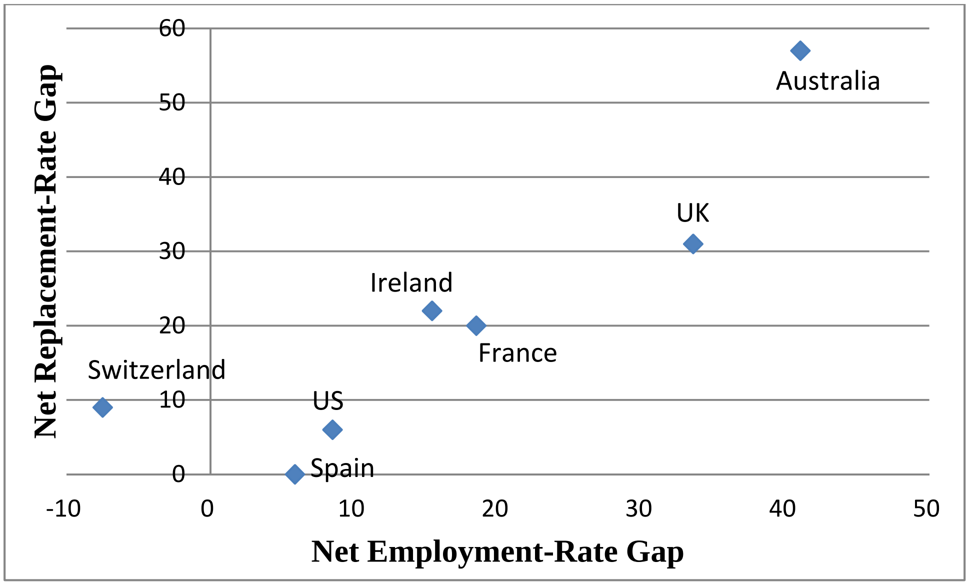
	Original Model				UI only $b_I = 0.3$	UA only $b_A/2 = 0.3$	UA only $b_A/2 = 0.3$
UI Durations	4 Quarters	2 Quarters			∞	0	0
	A) UI + UA	B) UI + UA	C) UI + UA + WT		D) UI only	E) UA only	F) UA + WT
Proportion of workless couples (%)	1.69	1.89	1.36	1.67	1.88	3.98	1.76
Proportion of dual-earner couples (%)	84.53	84.67	84.35	84.71	80.37	83.90	81.59
Employment rate: unemployed spouses (%)	**80.28**	78.08	84.01	**80.28**	**82.51**	60.35	**82.51**
Employment rate: employed spouses (%)	92.46	92.64	92.19	92.56	90.06	93.26	90.74
Aggregate employment rate (%)	91.42	91.39	91.49	91.52	89.25	89.96	89.91
Government spending	**0.0182**	0.0143	**0.0182**	0.0144	0.0641	0.0299	0.0548

Notes:

(1) Column A: original model; Column B: same as the original model, but the UI duration is reduced from 4 quarters to 2 quarters; Column C: add working tax credit to the original model. Policy simulation from Column C: (1) reduce the UI duration from 4 quarters to 2 quarters and hold government spending constant; (2) reduce the UI duration from 4 quarters to 2 quarters and hold the employment rate of those with unemployed spouses constant.

(2) Column D: a model with only UI (same as Column E from Table 4); Column E: a model with only UA (same as Column D from Table 4); Column F: add working tax credit to the model with only UA. Policy simulation from Column F: switch from the UI regime to the UA regime and hold the employment rate of those with unemployed spouses constant.

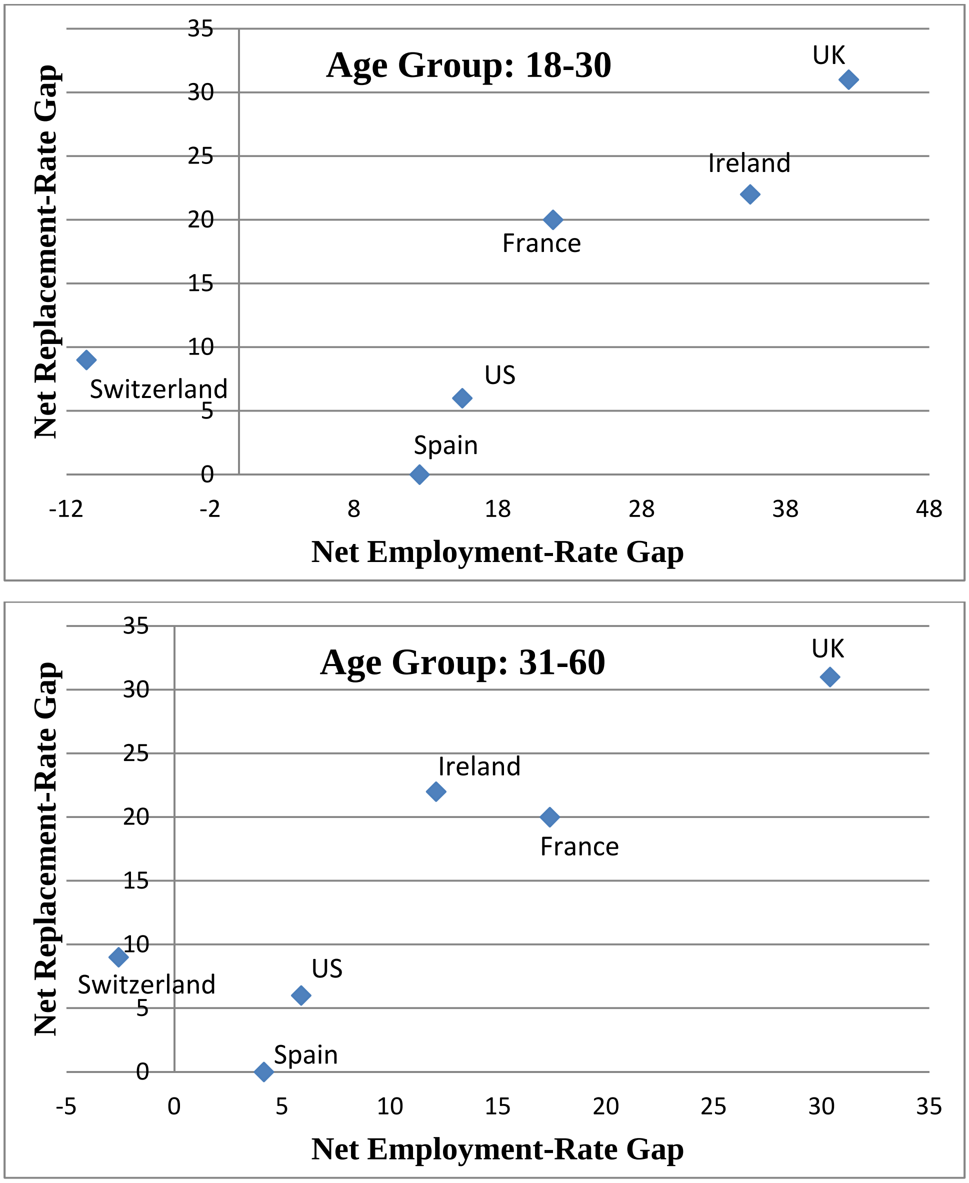
Figure 1: Married Women's Employment-Rate Gap versus Net-Replacement-Rate Gap



Notes:

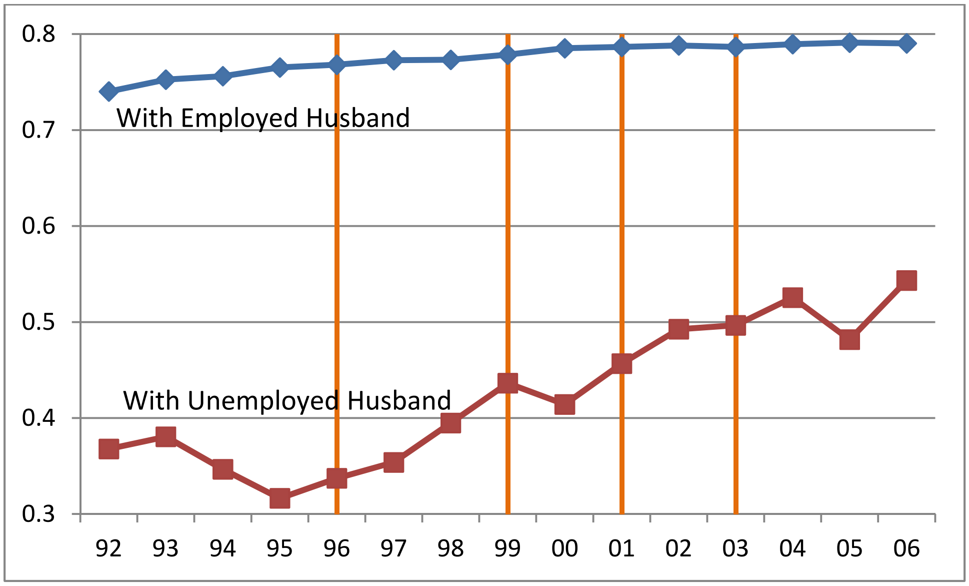
1. Data sources: The census data are obtained from IPUMS-International, and the 1994 Australia data are computed from Table 16 in Australian Bureau of Statistics (1994) by the author.
2. The net unemployment benefit replacement rate data are based on the first year of unemployment duration, obtained from Table 2 in Martin (1996). Those replace rate data refer to the period between 1994 and 1995.
3. Married Women's Employment-Rate Gap = married women's employment rate with employed husbands – married women's employment rate with unemployed husbands.
4. Net-Replacement-Rate Gap = unemployment benefits with dependent spouses – unemployment benefits with working spouses.

Figure 2: Married Women's Employment-Rate Gap versus Net-Replacement-Rate Gap by Age Group



Notes:
1. Data sources: The census data are obtained from IPUMS-International.
2. The net unemployment benefit replacement rate data are based on the first year of unemployment duration, obtained from Table 2 in Martin (1996). Those replace rate data refer to the period between 1994 and 1995.
3. Married Women's Employment-Rate Gap = married women's employment rate with employed husbands – married women's employment rate with unemployed husbands.
4. Net-Replacement-Rate Gap = unemployment benefits with dependent spouses – unemployment benefits with working spouses.

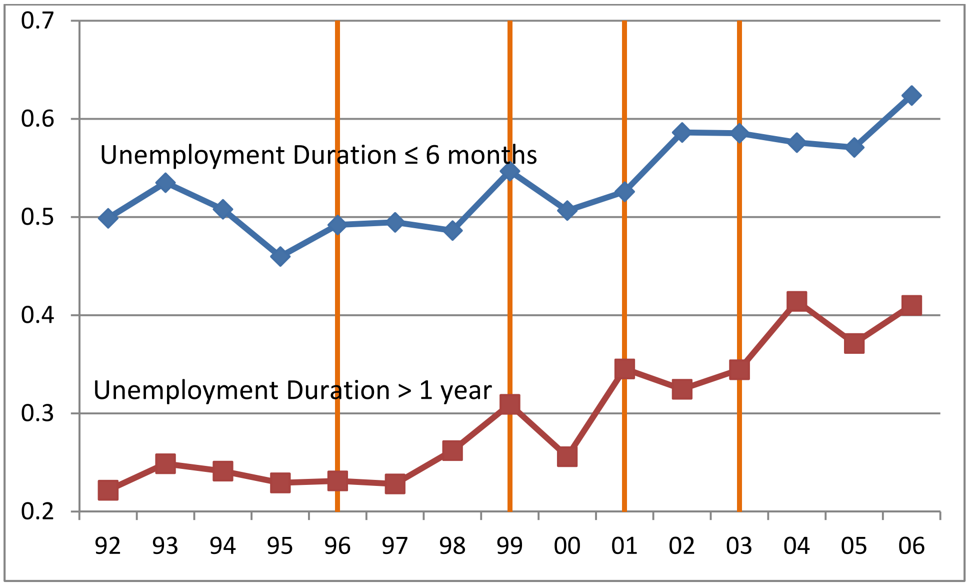
Figure 3: Women's Employment Rates in the UK, Conditional on Spouses' Employment Statuses



Notes:

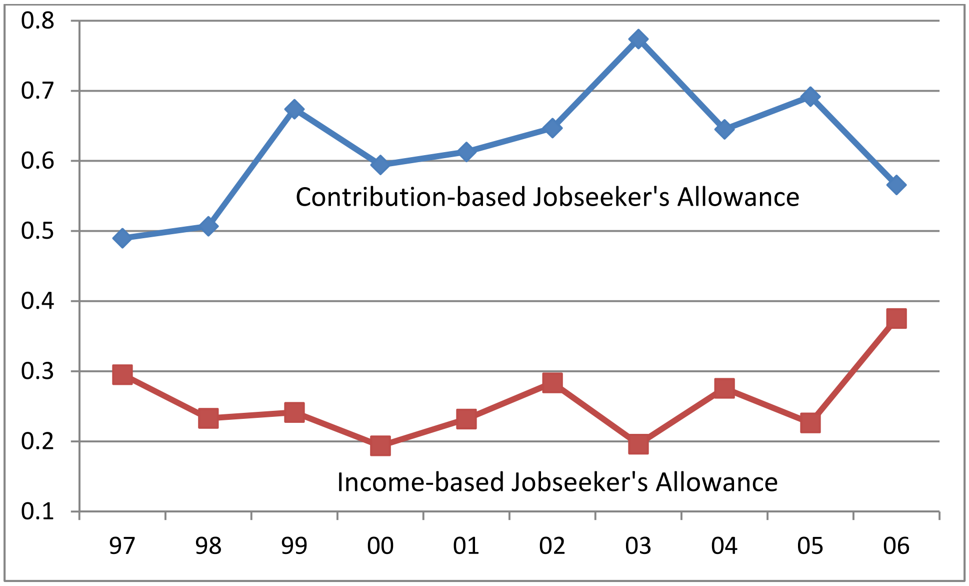
1. Source: The UK April-June quarterly labor force survey, obtained from the UK Data Archive.
2. Policy breaks: (1) In October 1996, the duration of contribution-based Jobseeker's Allowance was reduced from previously one year to be six months; (2) In October 1999, Family Credit was replaced with the Working Families' Tax Credit (WFTC), which had substantially increased the generosity of in-work benefits and childcare support; (3) In March 2001, Jobseeker's Allowance imposed a joint claim requirement; and (4) In April 2003, WFTC was replaced by Working Tax Credit, which extends in-work support to families without children.

Figure 4: Women's Employment Rates in the UK, Conditional on Spouses' Unemployment Durations



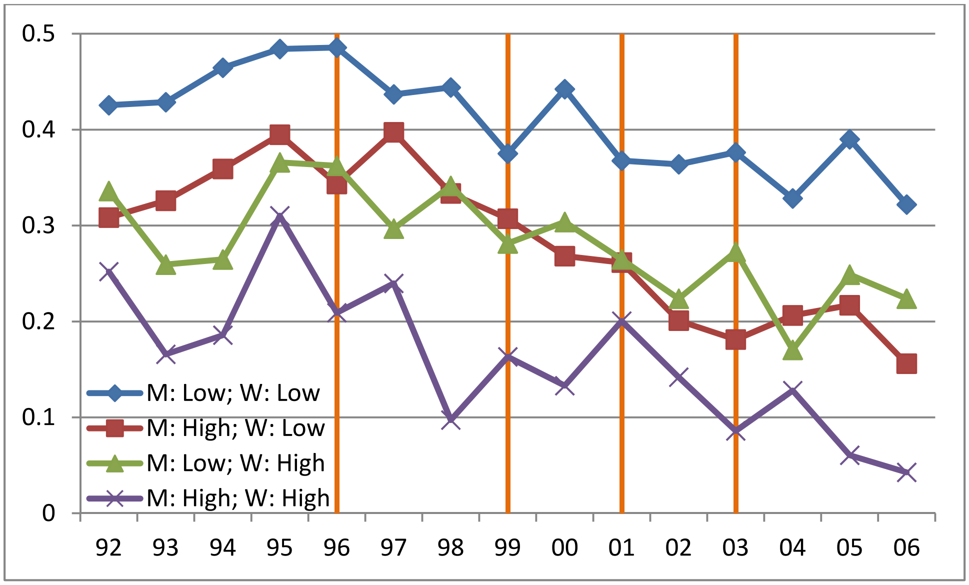
Notes:
1. Source: The UK April-June quarterly labor force survey, obtained from the UK Data Archive.
2. Policy breaks: (1) In October 1996, the duration of contribution-based Jobseeker's Allowance was reduced from previously one year to six months; (2) In October 1999, Family Credit was replaced with the Working Families' Tax Credit (WFTC), which had substantially increased the generosity of in-work benefits and childcare support; (3) In March 2001, Jobseeker's Allowance imposed a joint claim requirement; and (4) In April 2003, WFTC was replaced by Working Tax Credit, which extends in-work support to families without children.

Figure 5: Women's Employment Rates in the UK, Conditional on the Types of Government Benefits Received by Their Unemployed Spouses



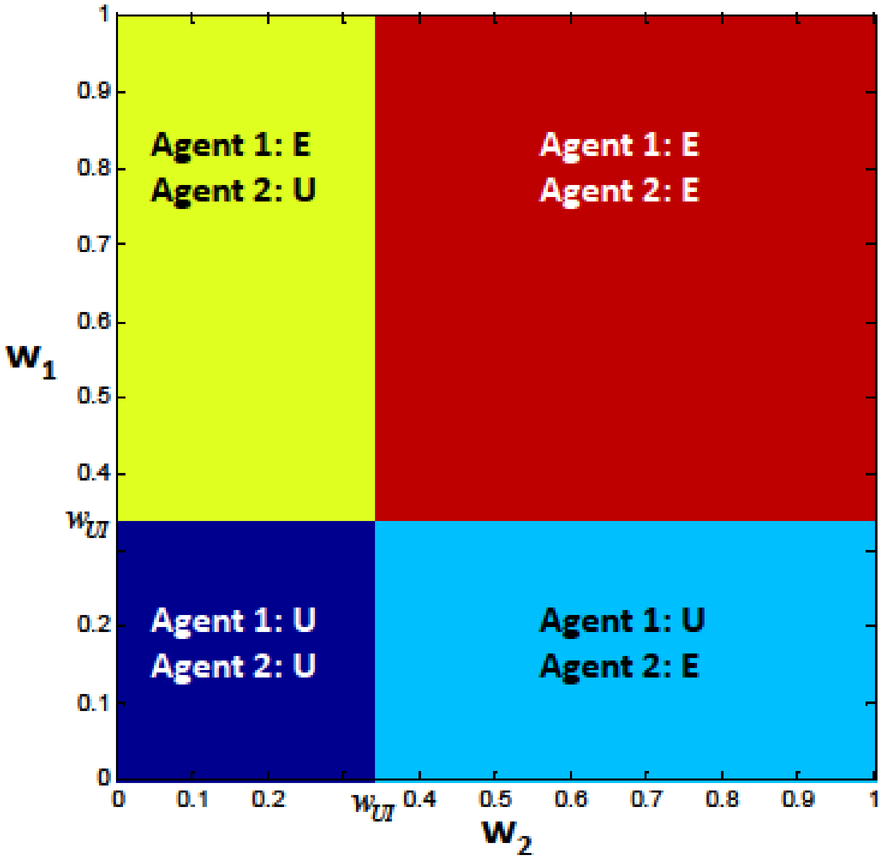
Notes:
1. Source: The UK April-June quarterly labor force survey, obtained from the UK Data Archive.
2. Spouses' unemployment durations: $\leq$ 6 months
3. Non-means-tested benefits: contribution-based jobseeker's allowance. Means-tested benefits: income-based jobseeker's allowance, income support, housing benefit, council tax benefit, and rent rebate.

Figure 6: Employment-Rate Gaps across Educational Attainment Groups



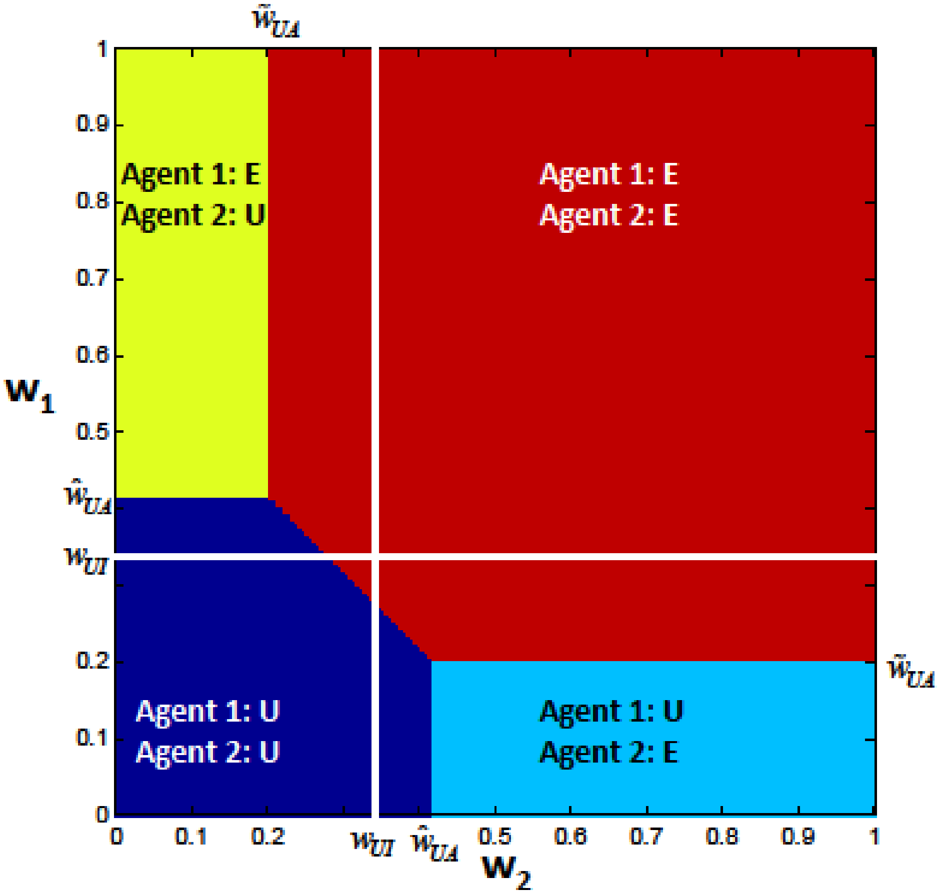
Notes:
1. Source: The UK April-June quarterly labor force survey, obtained from the UK Data Archive.
2. Policy breaks: (1) In October 1996, the duration of contribution-based Jobseeker's Allowance was reduced from previously one year to six months; (2) In October 1999, Family Credit was replaced with the Working Families' Tax Credit (WFTC), which had substantially increased the generosity of in-work benefits and childcare support; (3) In March 2001, Jobseeker's Allowance imposed a joint claim requirement; and (4) In April 2003, WFTC was replaced by Working Tax Credit, which extends in-work support to families without children.
3. Low: low educational attainments, below "GCE, A-level or equivalent"
4. High: high educational attainments, "GCE, A-level or equivalent" or above
5. "M: Low; W: Low": low-educated men married or cohabiting with low-educated women; "M: Low; W: High": low-educated men married or cohabiting with High-educated women; "M: High; W: Low": high-educated men married or cohabiting with low-educated women; "M: High; W: High": high-educated men married or cohabiting with high-educated women.

Figure 7: Reservation Wage Map under Unemployment Insurance



Notes:
1. The vertical axis denotes the wage offers for agent 1, and the horizontal axis denotes the wage offers for agent 2.
2. E denotes Employed, and U denotes Unemployed.

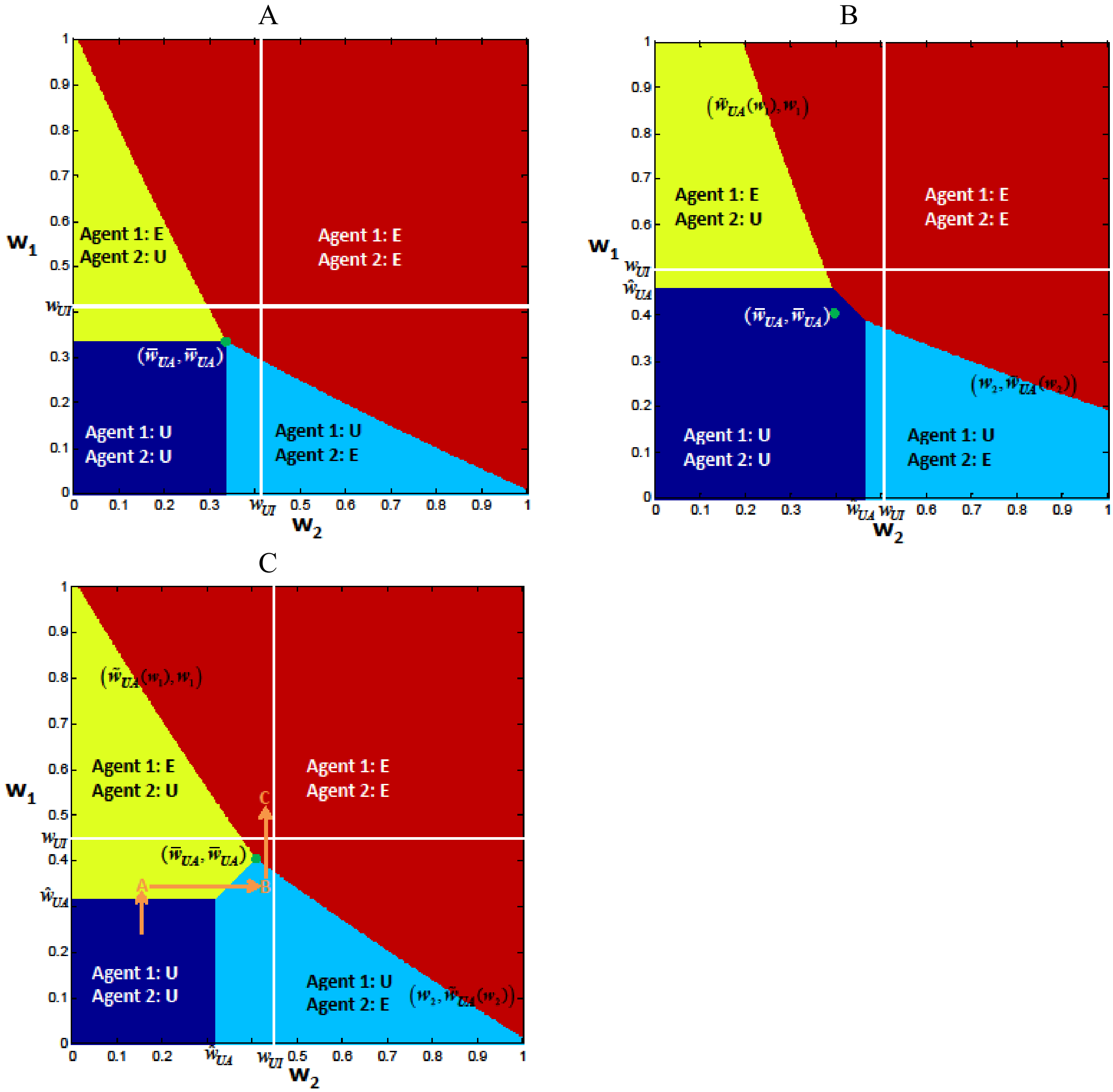
Figure 8: Reservation Wage Map under the Case-One-Type Means-Tested Unemployment Benefits



Notes:

1. The vertical axis denotes the wage offers for agent 1, and the horizontal axis denotes the wage offers for agent 2.
2. E denotes Employed, and U denotes Unemployed.
3. The two white-color lines denote the reservation wages under unemployment insurance.

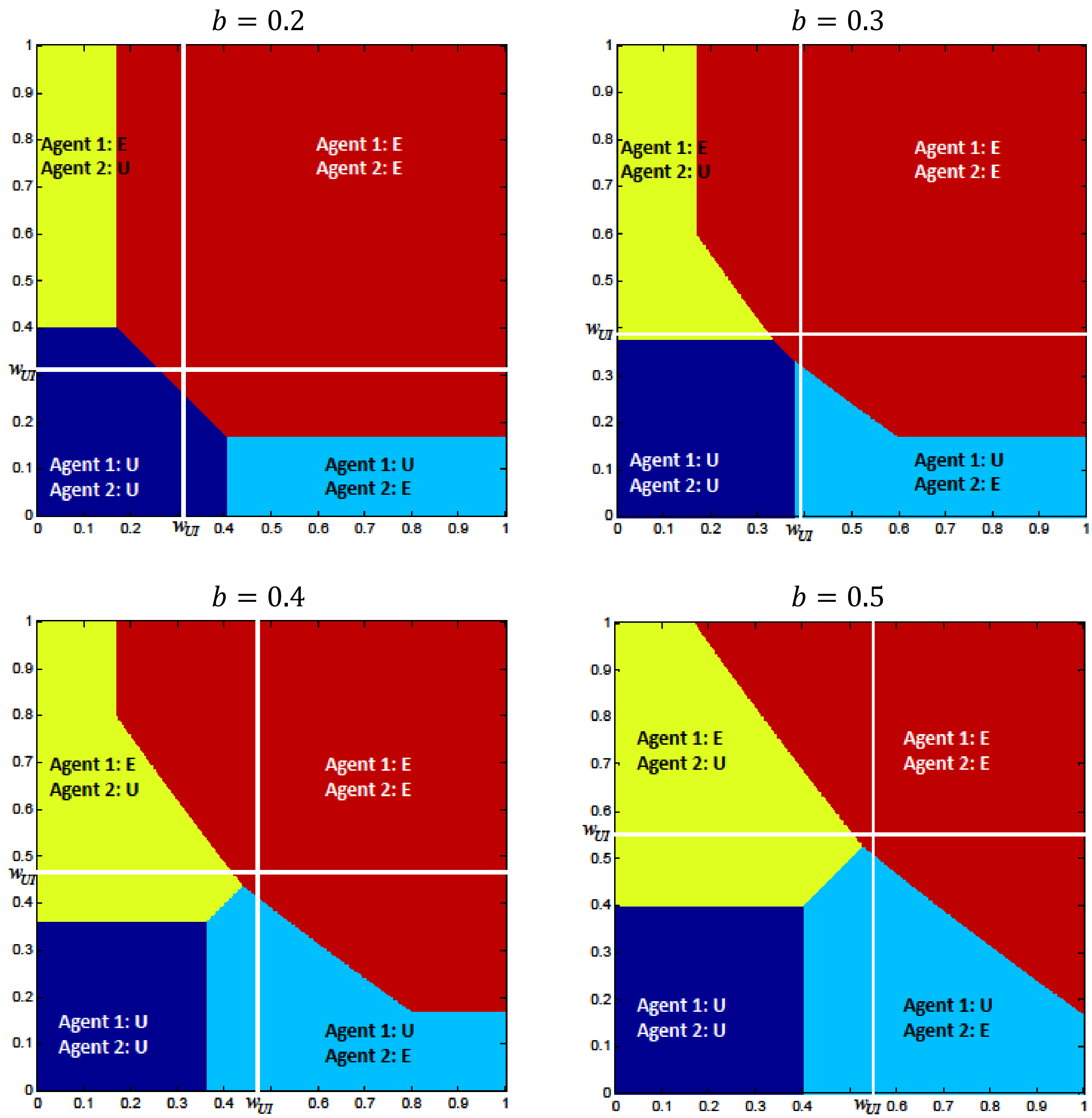
Figure 9: Reservation Wage Map under the Case-Two-Type Means-Tested Unemployment Benefits



Notes:

1. The vertical axis denotes the wage offers for agent 1, and the horizontal axis denotes the wage offers for agent 2.
2. E denotes Employed, and U denotes Unemployed.
3. The two white-color lines denote the reservation wages under unemployment insurance.
4. Panel A: Existence of a triple-indifference point (two (the RHS of [19] = 0)); Panel B: sub-case one (the RHS of [19] > 0); Panel C: sub-case two (the RHS of [19] < 0).
5. Green dot: a double-indifference point.
6. The comparison between unemployment insurance and means-tested unemployment is valid only within each graph because the parameter values are not held constant across graphs (in order to generate different values of the RHS of [19]).

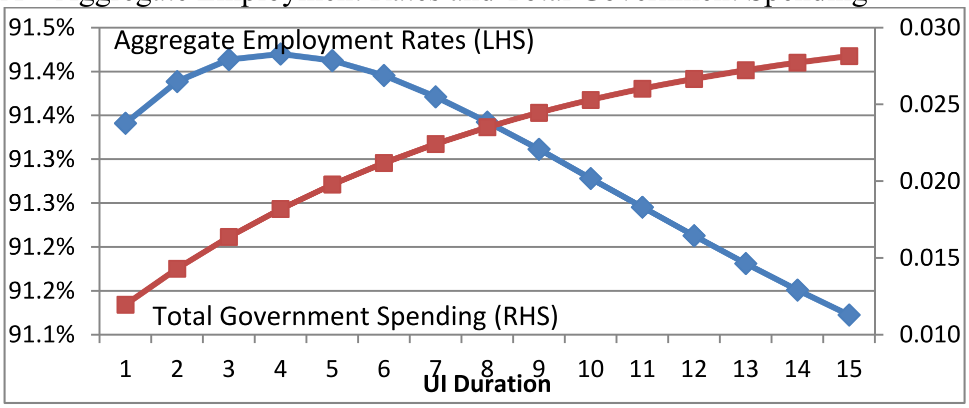
Figure 10: Reservation Wage Map under Means-Tested Unemployment Benefits



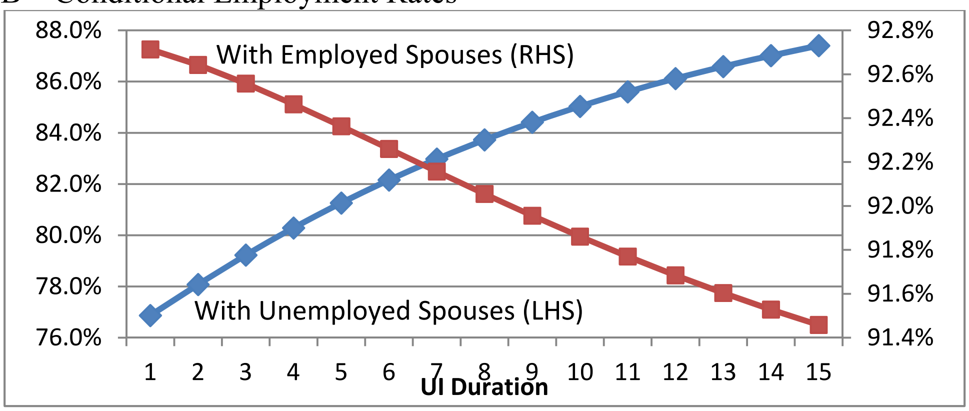
Notes:
1. The vertical axis denotes the wage offers for agent 1, and the horizontal axis denotes the wage offers for agent 2.
2. E denotes Employed, and U denotes Unemployed.
3. The two white-color lines denote the reservation wages under unemployment insurance.

Figure 11: Impacts of Unemployment Insurance Duration

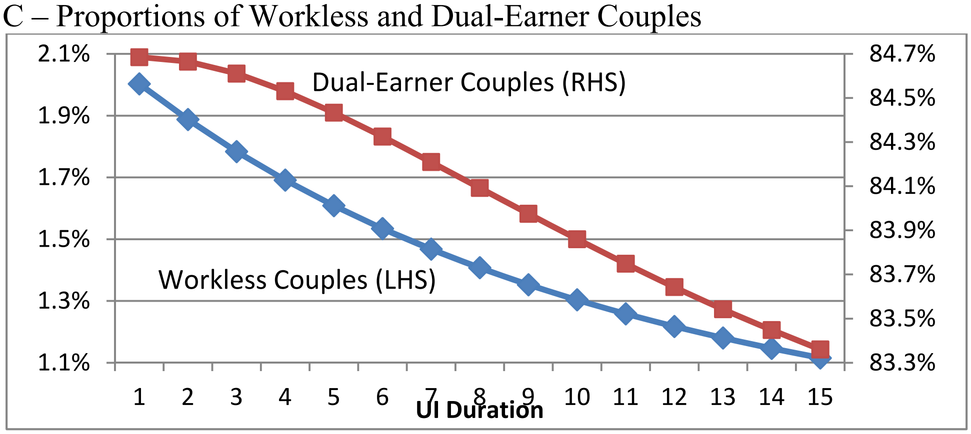
A – Aggregate Employment Rates and Total Government Spending



B – Conditional Employment Rates



C – Proportions of Workless and Dual-Earner Couples



Appendix A: Proof of the Equivalence between the Simplified Model and the Original Model

Proof. The simplified model is described by Equations [1], [2], and [B.5], and the original model is described by Equations [1], [2], and [7].

Equation [7] is denoted as follows:

$$U = \frac{2b}{1-\beta} + \frac{\beta}{1-\beta}\left\{ \begin{matrix} 2\alpha(1-\alpha)\int \max\{\Omega(w) - U, 0\}\, dF(w) + \\ \alpha^2 \iint \max\{T(w_1, w_2) - U, \Omega(w_1) - U, \Omega(w_2) - U, 0\}\, dF(w_1) dF(w_2) \end{matrix} \right\}$$

Equation [B.5] is denoted as follows:

$$U = \frac{2b}{1-\beta} + \frac{2\alpha\beta}{1-\beta}\{\int \max\{\Omega(w) - U, 0\}\, dF(w)\}$$

The contraction mapping theorem holds for both models. If the solutions to the simplified model are also the solutions to the original model, then the two models should be equivalent.

Since both models share the same Equations [1] and [2], the proof is reduced to show that the following component, the difference between Equation [B.5] and [7], is equal to zero, given the solutions from the simplified model.

$$G = \alpha^2 \left(\begin{matrix} \iint \max\{T(w_1, w_2) - U, \Omega(w_1) - U, \Omega(w_2) - U, 0\}\, dF(w_1) dF(w_2) + \\ -2\int \max\{\Omega(w) - U, 0\}\, dF(w) \end{matrix} \right) \quad [A.1]$$

Let's expand the first component of [A.1] as follows ($\underline{w}$ and $\overline{w}$ are the lower and upper supports of $F(w)$, respectively):

$$\iint \max\{T(w_1, w_2) - U, \Omega(w_1) - U, \Omega(w_2) - U, 0\}\, dF(w_1) dF(w_2) \quad [A.2]$$

$$= \int_{\underline{w}}^{w_{UI}} \int_{w_{UI}}^{\overline{w}} \Omega(w_1) - U dF(w_1) dF(w_2) + \int_{w_{UI}}^{\overline{w}} \int_{\underline{w}}^{w_{UI}} \Omega(w_2) - U dF(w_1) dF(w_2) + \int_{w_{UI}}^{\overline{w}} \int_{w_{UI}}^{\overline{w}} T(w_1, w_2) - U dF(w_1) dF(w_2)$$

$$= 2\int_{w_{UI}}^{\overline{w}} (\Omega(w) - U) F(w_{UI}) dF(w) + \int_{w_{UI}}^{\overline{w}} \int_{w_{UI}}^{\overline{w}} T(w_1, w_2) - U dF(w_1) dF(w_2)$$

By substituting [A.2] into [A.1], it yields:

$$G = \alpha^2 \left(\begin{matrix} 2\int_{w_{UI}}^{\overline{w}} (\Omega(w) - U) F(w_{UI}) dF(w) + \int_{w_{UI}}^{\overline{w}} \int_{w_{UI}}^{\overline{w}} T(w_1, w_2) - U dF(w_1) dF(w_2) \\ -2\int_{w_{UI}}^{\overline{w}} (\Omega(w) - U) dF(w) \end{matrix} \right)$$

$$= \alpha^2 \left(\begin{matrix} \int_{w_{UI}}^{\overline{w}} \int_{w_{UI}}^{\overline{w}} T(w_1, w_2) - U dF(w_1) dF(w_2) \\ -2(1 - F(w_{UI})) \int_{w_{UI}}^{\overline{w}} (\Omega(w) - U) dF(w) \end{matrix} \right)$$

$$= \alpha^2 \left(\begin{matrix} \int_{w_{UI}}^{\overline{w}} \int_{w_{UI}}^{\overline{w}} T(w_1, w_2) - U dF(w_1) dF(w_2) \\ -2\int_{w_{UI}}^{\overline{w}} \int_{w_{UI}}^{\overline{w}} \Omega(w_1) - U dF(w_1) dF(w_2) \end{matrix} \right)$$

$$= \alpha^2 \left(\int_{w_{UI}}^{\overline{w}} \int_{w_{UI}}^{\overline{w}} T(w_1, w_2) - U - 2(\Omega(w_1) - U) dF(w_1) dF(w_2) \right) \quad [A.3]$$

$$= \alpha^2 \left(\int_{w_{UI}}^{\overline{w}} \int_{w_{UI}}^{\overline{w}} T(w_1, w_2) - 2\Omega(w_1) + U dF(w_1) dF(w_2) \right)$$
$$= \alpha^2 \left(\int_{w_{UI}}^{\overline{w}} \int_{w_{UI}}^{\overline{w}} T(w_1, w_2) - \Omega(w_1) - \Omega(w_2) + U dF(w_1) dF(w_2) \right)$$
$$= \alpha^2 \left(\int_{w_{UI}}^{\overline{w}} \int_{w_{UI}}^{\overline{w}} \begin{pmatrix} T(w_1, w_2) - T(w_1, w_{UI}) - \\ T(w_{UI}, w_2) + T(w_{UI}, w_{UI}) \end{pmatrix} dF(w_1) dF(w_2) \right)$$
$$= \alpha^2 \left(\int_{w_{UI}}^{\overline{w}} \int_{w_{UI}}^{\overline{w}} \frac{w_1 + w_2}{1-\beta} - \frac{w_1 + w_{UI}}{1-\beta} - \frac{w_{UI} + w_2}{1-\beta} + \frac{w_{UI} + w_{UI}}{1-\beta} dF(w_1) dF(w_2) \right)$$
$$= 0$$

Q.E.D.

Appendix B: Proof of Proposition 1

Proposition 1: Under unemployment insurance, (1) $\widetilde{w}_{UI}(w_1)$ is a constant, $\widetilde{w}_{UI}$, which does not depend on w_1; and (2) $\widetilde{w}_{UI} = \widehat{w}_{UI}$

Proof. The original model has a simple recursive structure. The value function U is determined by the value functions $\Omega(w_1)$ and $T(w_1, w_2)$. The value function $\Omega(w_1)$ is determined by $T(w_1, w_2)$. The value function of $T(w_1, w_2)$ is determined by Equation [1] as follows:

$$T(w_1, w_2) = \frac{w_1 + w_2}{1 - \beta} \qquad [B.1]$$

Equation [2] can be rearranged as follows:

$$\Omega(w_1) = \frac{w_1 + b}{1 - \beta} + \frac{\alpha\beta}{1 - \beta} \left\{ \int \max \begin{Bmatrix} T(w_1, w_2) - \Omega(w_1), \\ \Omega(w_2) - \Omega(w_1), 0 \end{Bmatrix} dF(w_2) \right\} \qquad [B.2]$$

I conjecture that it is never optimal for the currently employed spouse to quit, and I will verify my conjecture at the end. Under such conjecture, Equation [B.2] can be simplified as follows:

$$\Omega(w_1) = \frac{w_1 + b}{1 - \beta} + \frac{\alpha\beta}{1 - \beta} \left\{ \int_{\widetilde{w}_{UI}(w_1)} T(w_1, w_2) - \Omega(w_1) dF(w_2) \right\} \qquad [B.3]$$

By substituting Equation [3] into [B.3] and using [B.1], the reservation wage, $\widetilde{w}_{UI}(w_1)$, can be derived in the following steps:

$$T(w_1, \widetilde{w}_{UI}(w_1)) = \frac{w_1 + b}{1 - \beta} + \frac{\alpha\beta}{1 - \beta} \left\{ \int_{\widetilde{w}_{UI}(w_1)} T(w_1, w_2) - T(w_1, \widetilde{w}_{UI}(w_1)) dF(w_2) \right\}$$
$$\widetilde{w}_{UI}(w_1) = b + \frac{\alpha\beta}{1 - \beta} \left\{ \int_{\widetilde{w}_{UI}(w_1)} w_2 - \widetilde{w}_{UI}(w_1) dF(w_2) \right\} \qquad [B.4]$$

Equation [B.4] provides an implicit function for $\widetilde{w}_{UI}(w_1)$. Given that the LHS of [B.4] is strictly increasing in $\widetilde{w}_{UI}(w_1)$ passing through the origin and the RHS of [B.4] is strictly decreasing in $\widetilde{w}_{UI}(w_1)$, $\widetilde{w}_{UI}(w_1)$ should be a unique constant that does not depend on w_1. Denote $\widetilde{w}_{UI}(w_1)$ as $\widetilde{w}_{UI}$.

The next step is to compare $\widehat{w}_{UI}$ with $\widetilde{w}_{UI}$. In order to simplify the comparison, I reformate the value function, U as in [B.5].

$$U = \frac{2b}{1-\beta} + \frac{2\alpha\beta}{1-\beta}\left\{\int \max\{\Omega(w) - U, 0\}\, dF(w)\right\} \quad \text{[B.5]}$$

By substituting Equation [8] into [B.5], it yields

$$\Omega(\widehat{w}_{UI}) = \frac{2b}{1-\beta} + \frac{2\alpha\beta}{1-\beta}\left\{\int_{\widehat{w}_{UI}} \Omega(w) - \Omega(\widehat{w}_{UI}) dF(w)\right\} \quad \text{[B.6]}$$

By replacing w_1 with $\widetilde{w}_{UI}$ in Equation [B.3], I obtain the following equation:

$$\Omega(\widetilde{w}_{UI}) = \frac{\widetilde{w}_{UI} + b}{1-\beta} + \frac{\alpha\beta}{1-\beta}\left\{\int_{\widetilde{w}_{UI}} T(\widetilde{w}_{UI}, w_2) - \Omega(\widetilde{w}_{UI}) dF(w_2)\right\} \quad \text{[B.7]}$$

By symmetry, the following two equations hold:

$$\Omega(\widetilde{w}_{UI}) = T(\widetilde{w}_{UI}, \widetilde{w}_{UI}) = \frac{2\widetilde{w}_{UI}}{1-\beta} \quad \text{[B.8]}$$

$$T(\widetilde{w}_{UI}, w_2) = \Omega(w_2) \quad \text{[B.9]}$$

By substituting Equations [B.8] and [B.9] into [B.7] and then multiplying it by 2, it yields:

$$\begin{aligned}\Omega(\widetilde{w}_{UI}) &= -\Omega(\widetilde{w}_{UI}) + 2\frac{\widetilde{w}_{UI} + b}{1-\beta} + \frac{2\alpha\beta}{1-\beta}\left\{\int_{\widetilde{w}_{UI}} \Omega(w_2) - \Omega(\widetilde{w}_{UI}) dF(w_2)\right\} \\ &= \frac{2b}{1-\beta} + \frac{2\alpha\beta}{1-\beta}\left\{\int_{\widetilde{w}_{UI}} \Omega(w) - \Omega(\widetilde{w}_{UI}) dF(w)\right\} \quad \text{[B.10]}\end{aligned}$$

By subtracting Equation [B.10] from [B.6], it yields

$$\Omega(\widehat{w}_{UI}) - \Omega(\widetilde{w}_{UI}) = \quad \text{[B.11]}$$
$$\tfrac{2\alpha\beta}{1-\beta}\{\int_{\widehat{w}_{UI}} \Omega(w) - \Omega(\widehat{w}_{UI}) dF(w) - \int_{\widetilde{w}_{UI}} \Omega(w) - \Omega(\widetilde{w}_{UI}) dF(w)\}$$

As shown in Appendix H, $\Omega(w)$ is strictly increasing in w. If $\widehat{w}_{UI} > \widetilde{w}_{UI}$, the LHS of Equation [B.11] is positive, while the RHS of Equation [B.11] is negative. If $\widehat{w}_{UI} < \widetilde{w}_{UI}$, the LHS of Equation [B.11] is negative, while the RHS of Equation [B.11] is positive. Therefore, $\widehat{w}_{UI}$ must be equal to $\widetilde{w}_{UI}$. Let $w_{UI} = \widetilde{w}_{UI} = \widehat{w}_{UI}$

Given $U = \Omega(w_{UI})$, it sets the lower bound of w from $\Omega(w)$ to be w_{UI}. Then, the following condition must satisfy:

$$T(w_1, w_2) \geq T(w_{UI}, w_2) = \Omega(w_2) \quad \text{[B.12]}$$

Where $w_1, w_2 \geq w_{UI}$

The condition [B.12] shows that the quit option from a single-earner couple is at most the second best option, so the employed agent from a single-earner couple will never have an incentive to quit, which confirms my initial conjecture. *Proposition 1* holds for the model described by Equations [1]. [2] and [B.5].

Appendix A shows that the model described by Equations [1], [2], and [B.5] is equivalent to the original model described by Equations [1], [2], and [7].

Q.E.D.

Appendix C: Proof of Proposition 2

***Proposition* 2**: Under Case (1):

(i) $\widetilde{w}_{UA}(w_1)$ is a constant, $\widetilde{w}_{UA}$; $\widetilde{w}_{UA} < \widetilde{w}_{UI}$

(ii) $\widehat{w}_{UA} > \widetilde{w}_{UI}$
(iii) $\breve{w}_1 = -\breve{w}_2 + \widetilde{w}_{UA} + \widehat{w}_{UA}$, where $\widetilde{w}_{UA} \le \breve{w}_2 \le \widehat{w}_{UA}$
(iv) $U_{UI} > U_{UA}$, where $U_{UI} = T(\widetilde{w}_{UI}, \widetilde{w}_{UI})$ and $U_{UA} = T(\widehat{w}_{UA}, \widetilde{w}_{UA})$

Proof. If a job seeker from a single-earner couple receives a job offer, I conjecture that it will never be optimal for the currently employed spouse to quit, and I will verify the conjecture at the end of the proof. Under such conjecture, the following reservation wage conditions must be satisfied:

$$\Omega(w_1) = T\big(w_1, \widetilde{w}_{UA}(w_1)\big) = \frac{w_1 + \widetilde{w}_{UA}(w_1)}{1-\beta} \qquad [C.1]$$

$$\Omega(\widehat{w}_{UA}) = T\big(\widehat{w}_{UA}, \widetilde{w}_{UA}(\widehat{w}_{UA})\big) \ge \Omega\big(\widetilde{w}_{UA}(\widehat{w}_{UA})\big) \qquad [C.2]$$

By the symmetry of Ω, Condition [C.2] implies that $\widehat{w}_{UA} \ge \widetilde{w}_{UA}(\widehat{w}_{UA})$.

Next, Equation [11] can be simplified as follows:

$$\Omega(w_1) = \frac{w_1}{1-\beta} + \frac{\alpha\beta}{1-\beta}\left\{\int_{\widetilde{w}_{UA}(w_1)} T(w_1, w_2) - \Omega(w_1)F(w_2)\right\} \qquad [C.3]$$

By substituting [C.1] into [C.3], it yields:

$$\frac{w_1 + \widetilde{w}_{UA}(w_1)}{1-\beta} = \frac{w_1}{1-\beta} + \frac{\alpha\beta}{1-\beta}\left\{\int_{\widetilde{w}_{UA}(w_1)} \frac{w_1 + w_2}{1-\beta} - \frac{w_1 + \widetilde{w}_{UA}(w_1)}{1-\beta}F(w_2)\right\}$$

$$\widetilde{w}_{UA}(w_1) = \frac{\alpha\beta}{1-\beta}\left\{\int_{\widetilde{w}_{UA}(w_1)} w_2 - \widetilde{w}_{UA}(w_1)F(w_2)\right\} \qquad [C.4]$$

Equation [C.4] shows that $\widetilde{w}_{UA}(w_1)$ should be a unique constant, $\widetilde{w}_{UA}$, which does not depend on w_1. Then, $\widehat{w}_{UA} \ge \widetilde{w}_{UA}(\widehat{w}_{UA})$ implies that $\widehat{w}_{UA} \ge \widetilde{w}_{UA}$.

By subtracting Equation [B.4] from Equation [C.4], it yields:

$$\widetilde{w}_{UA} - \widetilde{w}_{UI} = -b + \frac{\alpha\beta}{1-\beta}\left\{\int_{\widetilde{w}_{UA}} w_2 - \widetilde{w}_{UA}F(w_2) - \int_{\widetilde{w}_{UI}} w_2 - \widetilde{w}_{UI}dF(w_2)\right\} \qquad [C.5]$$

The second part of Proposition 2(i) can be proved by contradiction. Assume $\widetilde{w}_{UA} \ge \widetilde{w}_{UI}$. When $\widetilde{w}_{UA} = \widetilde{w}_{UI}$, the LHS of [C.5] is zero while the RHS of [C.5] is negative for any positive b, which leads to a contradiction. When $\widetilde{w}_{UA} > \widetilde{w}_{UI}$, the LHS of [C.5] is positive while the RHS of [C.5] is negative, which again leads to a contradiction. Therefore, $\widetilde{w}_{UA} < \widetilde{w}_{UI}$. If one of the couple is currently employed, there will be a greater probability for the other one to accept a job offer under the case-one-type of means-tested unemployment benefits than under unemployment insurance.

In order to prove (ii), let's reformulate Equation [12] as follows:

$$U = \frac{2b}{1-\beta} + \frac{\beta}{1-\beta}\left\{2\alpha \int \max\{\Omega(w) - U, 0\}\, dF(w)\right\} + G \qquad [C.5]$$

$$\text{where } G = \frac{\beta\alpha^2}{1-\beta}\left\{\begin{matrix}\iint \max\left\{\begin{matrix}T(w_1, w_2) - U,\\ \Omega(w_1) - U,\\ \Omega(w_2) - U, 0\end{matrix}\right\} dF(w_1)dF(w_2)\\ -2\int \max\{\Omega(w) - U, 0\}\, dF(w)\end{matrix}\right\}$$

The next step is to show $G \ge 0$. Given that $\widehat{w}_{UA} \ge \widetilde{w}_{UA}$ and $\Omega(w)$ is strictly increasing in w (see Appendix H), the following relationship must hold:

$$\iint \max\{T(w_1, w_2) - U, \Omega(w_1) - U, \Omega(w_2) - U, 0\}\, dF(w_1)dF(w_2) \qquad [C.6]$$

$$= \int_{\underline{w}}^{\widehat{w}_{UA}} \int_{\widehat{w}_{UA}}^{\overline{w}} \max\{T(w_1, w_2) - U, \Omega(w_1) - U, \Omega(w_2) - U, 0\}\, dF(w_1)dF(w_2) +$$
$$\int_{\widehat{w}_{UA}}^{\overline{w}} \int_{\widehat{w}_{UA}}^{\overline{w}} \max\{T(w_1, w_2) - U, \Omega(w_1) - U, \Omega(w_2) - U, 0\}\, dF(w_1)dF(w_2) +$$
$$\int_{\underline{w}}^{\widehat{w}_{UA}} \int_{\underline{w}}^{\widehat{w}_{UA}} \max\{T(w_1, w_2) - U, \Omega(w_1) - U, \Omega(w_2) - U, 0\}\, dF(w_1)dF(w_2) +$$
$$\int_{\widehat{w}_{UA}}^{\overline{w}} \int_{\underline{w}}^{\widehat{w}_{UA}} \max\{T(w_1, w_2) - U, \Omega(w_1) - U, \Omega(w_2) - U, 0\}\, dF(w_1)dF(w_2)$$
$$\geq \int_{\underline{w}}^{\widehat{w}_{UA}} \int_{\widehat{w}_{UA}}^{\overline{w}} \max\{\Omega(w_1) - U, \Omega(w_2) - U, 0\}\, dF(w_1)dF(w_2) +$$
$$\int_{\widehat{w}_{UA}}^{\overline{w}} \int_{\widehat{w}_{UA}}^{\overline{w}} \max\{T(w_1, w_2) - U, 0\}\, dF(w_1)dF(w_2) +$$
$$\int_{\widehat{w}_{UA}}^{\overline{w}} \int_{\underline{w}}^{\widehat{w}_{UA}} \max\{\Omega(w_1) - U, \Omega(w_2) - U, 0\}\, dF(w_1)dF(w_2)$$
$$= 2F(\widehat{w}_{UA}) \int_{\widehat{w}_{UA}}^{\overline{w}} \Omega(w) - UdF(w) + \int_{\widehat{w}_{UA}}^{\overline{w}} \int_{\widehat{w}_{UA}}^{\overline{w}} T(w_1, w_2) - UdF(w_1)dF(w_2)$$

Given [C.6], it yields:

$$G \geq \frac{\beta\alpha^2}{1-\beta} \begin{Bmatrix} \int_{\widehat{w}_{UA}}^{\overline{w}} \int_{\widehat{w}_{UA}}^{\overline{w}} T(w_1, w_2) - UdF(w_1)dF(w_2) \\ -2\left(1 - F(\widehat{w}_{UA})\right) \int_{\widehat{w}_{UA}}^{\overline{w}} \Omega(w) - UdF(w) \end{Bmatrix} \quad \text{[C.7]}$$
$$= \frac{\beta\alpha^2}{1-\beta} \int_{\widehat{w}_{UA}}^{\overline{w}} \int_{\widehat{w}_{UA}}^{\overline{w}} T(w_1, w_2) - \Omega(w_1) - \Omega(w_2) + UdF(w_1)dF(w_2)$$
$$= \frac{\beta\alpha^2}{1-\beta} \int_{\widehat{w}_{UA}}^{\overline{w}} \int_{\widehat{w}_{UA}}^{\overline{w}} \frac{w_1 + w_2}{1-\beta} - \frac{w_1 + \widetilde{w}_{UA}}{1-\beta} - \frac{w_2 + \widetilde{w}_{UA}}{1-\beta} + \frac{\widehat{w}_{UA} + \widetilde{w}_{UA}}{1-\beta} dF(w_1)dF(w_2)$$
$$= \frac{\beta\alpha^2}{1-\beta} \int_{\widehat{w}_{UA}}^{\overline{w}} \int_{\widehat{w}_{UA}}^{\overline{w}} \frac{\widehat{w}_{UA} - \widetilde{w}_{UA}}{1-\beta} dF(w_1)dF(w_2) \geq 0$$

Given that $U = \Omega(\widehat{w}_{UA})$, Equation [C.5] can be modified as follows:

$$\Omega(\widehat{w}_{UA}) = \frac{2b}{1-\beta} + \frac{2\alpha\beta}{1-\beta}\left\{\int_{\widehat{w}_{UA}} \Omega(w) - \Omega(\widehat{w}_{UA})dF(w)\right\} + G \quad \text{[C.8]}$$

Using Equation [C.1], Equation [C.8] can be further simplified as follows:

$$\frac{\widehat{w}_{UA} + \widetilde{w}_{UA}}{1-\beta} = \frac{2b}{1-\beta} + \frac{2\alpha\beta}{1-\beta}\left\{\int_{\widehat{w}_{UA}} \frac{w + \widetilde{w}_{UA}}{1-\beta} - \frac{\widehat{w}_{UA} + \widetilde{w}_{UA}}{1-\beta} dF(w)\right\} + G$$

$$\widehat{w}_{UA} = 2b + \frac{2\alpha\beta}{1-\beta}\left\{\int_{\widehat{w}_{UA}} w - \widehat{w}_{UA}dF(w)\right\} - \widetilde{w}_{UA} + G(1-\beta) \quad \text{[C.9]}$$

Let's multiply Equation [B.4] by 2 and subtract it from Equation [C.9]. It yields:

$$\widehat{w}_{UA} - 2\widetilde{w}_{UI} = \frac{2\alpha\beta}{1-\beta}\begin{Bmatrix} \int_{\widehat{w}_{UA}} w - \widehat{w}_{UA}dF(w) - \\ \int_{\widetilde{w}_{UI}} w - \widetilde{w}_{UI}dF(w) \end{Bmatrix} - \widetilde{w}_{UA} + G(1-\beta) \quad \text{[C.10]}$$

Proposition 2(ii) can be proved by contradiction. Assume $\widehat{w}_{UA} \leq \widetilde{w}_{UI}$. When $\widehat{w}_{UA} = \widetilde{w}_{UI}$, Equation [C.10] can be reduced to $\widetilde{w}_{UA} = \widetilde{w}_{UI} + G(1-\beta) > \widetilde{w}_{UI}$, which contradicts Proposition 2(i). When $\widehat{w}_{UA} < \widetilde{w}_{UI}$, Equation [C.10] can be modified as follows:

$$\widehat{w}_{UA} - 2\widetilde{w}_{UI} > -\widetilde{w}_{UA} + G(1-\beta)$$
$$\widehat{w}_{UA} - \widetilde{w}_{UI} > \widetilde{w}_{UI} - \widetilde{w}_{UA} + G(1-\beta) \quad \text{[C.11]}$$

The LHS of Equation [C.11] is less than zero, but the RHS of Equation [C.11] is greater than zero, which again leads to a contradiction. Therefore, $\widehat{w}_{UA} > \widetilde{w}_{UI}$.

Both (i) and (ii) imply that $\widehat{w}_{UA} > \widetilde{w}_{UA}$. Without loss of generality, in a single-earner couple, I assume that agent 1 is employed and agent 2 is unemployed. Given that $U = \Omega(\widehat{w}_{UA})$, the wage of agent 1 from a single-earner couple should not be lower than $\widehat{w}_{UA}$. Then, the following relationship must hold:

$$T(w_1, w_2) \geq T(\widehat{w}_{UA}, w_2) > T(\widetilde{w}_{UA}, w_2) = \Omega(w_2) \qquad [C.12]$$

Inequality [C.12] implies that it will never be optimal for the employed agent 1 to quit regardless of the unemployed agent 2's employment decisions, which confirms my initial conjecture.

Under the case-one-type of means-tested unemployment benefits, Proposition 2(ii) shows that the reservation wage for a workless couple to become a single-earner couple is higher than that under unemployment insurance. However, as soon as one of the couple is employed, the reservation wage of the other one will be the same as that under unemployment insurance when $b = 0$ due to the complete reduction in the unemployment benefits.

Given that $T(\breve{w}_1, \breve{w}_2) = U$, it yields:

$$\frac{\breve{w}_1 + \breve{w}_2}{1-\beta} = U = \Omega(\widehat{w}_{UA}) = \frac{\widehat{w}_{UA} + \widetilde{w}_{UA}}{1-\beta} \qquad [C.13]$$

$$\breve{w}_1 = -\breve{w}_2 + \widehat{w}_{UA} + \widetilde{w}_{UA}$$

Given that $T(\breve{w}_1, \widehat{w}_{UA}) \geq \Omega(\widehat{w}_{UA})$, it yields:

$$\frac{\breve{w}_1 + \widehat{w}_{UA}}{1-\beta} \geq \Omega(\widehat{w}_{UA}) = \frac{\widehat{w}_{UA} + \widetilde{w}_{UA}}{1-\beta} \qquad [C.14]$$

Given that $T(\widehat{w}_{UA}, \breve{w}_2) \geq \Omega(\widehat{w}_{UA})$, it yields:

$$\frac{\widehat{w}_{UA} + \breve{w}_2}{1-\beta} \geq \Omega(\widehat{w}_{UA}) = \frac{\widehat{w}_{UA} + \widetilde{w}_{UA}}{1-\beta} \qquad [C.15]$$

[C.14] and [C.15] can be simplified as follows: $\widetilde{w}_{UA} \leq \breve{w}_2 \leq \widehat{w}_{UA}$

Under unemployment insurance, the value functions of workless couples can be defined as follows:

$$U_{UI} = \frac{2b}{1-\beta} + \frac{\beta}{1-\beta}\left\{2\alpha \int \max\{\Omega_{UI}(w) - U_{UI}, 0\}\, dF(w)\right\} \qquad [C.16]$$

$$U_{UI}^0 = \frac{\beta}{1-\beta}\left\{2\alpha \int \max\{\Omega_{UI}^0(w) - U_{UI}^0, 0\}\, dF(w)\right\} \qquad [C.17]$$

Equation [C.16] corresponds to a positive benefit level (b), and Equation [C.17] corresponds to a zero benefit level. According to [B.4], the reservation wage is increasing in the benefit level under unemployment insurance. Then, given [3], it is clear that $\Omega_{UI}(w) > \Omega_{UI}^0(w)$.

Next, let's expand Equation [C.16] as follows:

$$U_{UI} = \frac{2b}{1-\beta} + \frac{\beta}{1-\beta}\left\{2\alpha(1-\alpha) \int \max\{\Omega_{UI}(w) - U_{UI}, 0\}\, dF(w)\right\} + \tilde{G} \qquad [C.18]$$

where $\tilde{G} = \frac{\beta\alpha^2}{1-\beta}\left\{\iint \max\begin{Bmatrix} T(w_1, w_2) - U_{UI}, \\ \Omega_{UI}(w_1) - U_{UI}, \\ \Omega_{UI}(w_2) - U_{UI}, 0 \end{Bmatrix} dF(w_1)dF(w_2)\right\}$

[C.5] and [C.18] have the same structure, so the comparisons between U_{UI} and U_{UA} depends on the value function of single-earner couples. According to [C.3], the value function of single-earner couples under case-one-type means-tested unemployment benefits is the same as $\Omega_{UI}^{0}(w)$. If $\Omega_{UI}(w)$ is replaced with $\Omega_{UI}^{0}(w)$ in [C.18], then the LHS of [C.18] will be bigger than the RHS of [C.18]. Since the LHS of [C.18] is strictly increasing in U_{UI} and the RHS of [C.18] is strictly decreasing in U_{UI}, U_{UI} has to be lowered in order to equate both sides of [C.18] after $\Omega_{UI}(w)$ is replaced with $\Omega_{UI}^{0}(w)$. In other words, the value function of workless couples under case-one-type means-tested unemployment benefits is smaller than U_{UI}: $U_{UI} > U_{UA}$, where $U_{UI} = T(\tilde{w}_{UI}, \tilde{w}_{UI})$ and $U_{UA} = T(\hat{w}_{UA}, \tilde{w}_{UA})$

Q.E.D.

Appendix D: Condition for the Existence of a Triple-Indifference Point

The purpose of Appendix D is to identify a set of parameter values that define the existence of a triple-indifference point, denoted in [D.1].

$$T(\bar{w}_{UA}, \bar{w}_{UA}) = \Omega(\bar{w}_{UA})$$
$$\Omega(\hat{w}_{UA}) = U$$
$$\bar{w}_{UA} = \hat{w}_{UA} \qquad \text{[D.1]}$$

$(\bar{w}_{UA}, \bar{w}_{UA})$ is a double-indifference point, which is uniquely defined in [17], but it may not be feasible if it falls within the region of workless couples. If the parameters values satisfy [D.1], $(\bar{w}_{UA}, \bar{w}_{UA})$ is also a triple-indifference point in the reservation-wage map. First, I characterize the reservation wage of a single-earner couple. Without loss of generality, I assume that agent 1 is employed and agent 2 is unemployed. I conjecture that it is never optimal for the employed agent to quit when the current wage is above $\bar{w}_{UA}$ (this will be verified in the proof). Under such conjecture, the reservation wage of agent 2, $\tilde{w}_{UA}(w_1)$, is defined as follows:

$$T\big(w_1, \tilde{w}_{UA}(w_1)\big) = \Omega(w_1)$$

Next, simplify Equation [14] as follows:

$$\Omega(w_1) = \frac{2b}{1-\beta} + \frac{\alpha\beta}{1-\beta}\left\{\int_{\tilde{w}_{UA}(w_1)} T(w_1, w_2) - \Omega(w_1) dF(w_2)\right\}$$
$$T\big(w_1, \tilde{w}_{UA}(w_1)\big) = \frac{2b}{1-\beta} + \frac{\alpha\beta}{1-\beta}\left\{\int_{\tilde{w}_{UA}(w_1)} \begin{pmatrix} T(w_1, w_2) - \\ T\big(w_1, \tilde{w}_{UA}(w_1)\big) \end{pmatrix} dF(w_2)\right\}$$
$$\tilde{w}_{UA}(w_1) = -w_1 + 2b + \frac{\alpha\beta}{1-\beta}\left\{\int_{\tilde{w}_{UA}(w_1)} w_2 - \tilde{w}_{UA}(w_1) dF(w_2)\right\} \qquad \text{[D.2]}$$

Take the derivative of both sides of [D.1] with respect to w_1, and it yields:

$$\frac{d\tilde{w}_{UA}(w_1)}{dw_1} = -1 + \frac{\alpha\beta}{1-\beta}\frac{d\tilde{w}_{UA}(w_1)}{dw_1}\left\{\int_{\tilde{w}_{UA}(w_1)} (-1) dF(w_2)\right\}$$
$$\frac{d\tilde{w}_{UA}(w_1)}{dw_1} = -\frac{1}{1 + \frac{\alpha\beta}{1-\beta}\Big(1 - F\big(\tilde{w}_{UA}(w_1)\big)\Big)} \qquad \text{[D.3]}$$

Given that $0 < \alpha < 1$ and the discount factor $\beta < 1$, it is easy to verify that $d\tilde{w}_{UA}(w_1)/dw_1$ is between -1 and 0, using Equation [D.3]. As the wage of a currently employed agent increases, the spouse's reservation wage drops. Given that $(\bar{w}_{UA}, \bar{w}_{UA})$ is the double-indifference point, $\widetilde{w}_{UA}(\overline{w}_{UA}) = \overline{w}_{UA}$. When $w_1 > \overline{w}_{UA}$, $\widetilde{w}_{UA}(w_1) < \overline{w}_{UA}$.Therefore, it is never optimal for the employed agent to quit whenever the current wage is above $\overline{w}_{UA}$, which confirms the initial conjecture.

The existence of a triple-indifference point requires $\overline{w}_{UA} = \widehat{w}_{UA}$. By symmetry, it is equivalently to compare U with $\Omega(\overline{w}_{UA})$. There are three possible outcomes depending on the parameter values.

Outcome One: $U = \Omega(\overline{w}_{UA})$

If $U = \Omega(\overline{w}_{UA})$, then $\overline{w}_{UA} = \widehat{w}_{UA}$, which satisfy the existence condition for a triple-indifference point.

Given $\widetilde{w}_{UA}(\overline{w}_{UA}) = \overline{w}_{UA}$, [D.2] can be modified as follows:

$$2\overline{w}_{UA} = 2b + \frac{\alpha\beta}{1-\beta}\left\{\int_{\overline{w}_{UA}} w - \overline{w}_{UA} dF(w)\right\} \quad \text{[D.4]}$$

Given $\overline{w}_{UA} = \widehat{w}_{UA}$, Equation [15] can be reformulated as follows:

$$\frac{2\overline{w}_{UA}}{1-\beta} = \frac{2b}{1-\beta} + \frac{\beta}{1-\beta}\left\{2\alpha\int_{\overline{w}_{UA}} \Omega(w) - U dF(w)\right\} + G \quad \text{[D.5]}$$

where $G = \frac{\beta\alpha^2}{1-\beta}\{\iint Q(w_1, w_2) dF(w_1) dF(w_2)\}$

$$Q(w_1, w_2) = \max\begin{Bmatrix} T(w_1, w_2) - U, \\ \Omega(w_1) - U, \\ \Omega(w_2) - U, 0 \end{Bmatrix} - \begin{pmatrix} \max\{\Omega(w_1) - U, 0\} + \\ \max\{\Omega(w_2) - U, 0\} \end{pmatrix}$$

Given the existence of a triple-indifference point, I divide the reservation map into the following four regions:

(1) $w_1 \le \overline{w}_{UA}$ and $w_2 \le \overline{w}_{UA}$
(2) $w_1 > \overline{w}_{UA}$ and $w_2 \le \overline{w}_{UA}$
(3) $w_1 \le \overline{w}_{UA}$ and $w_2 > \overline{w}_{UA}$
(4) $w_1 > \overline{w}_{UA}$ and $w_2 > \overline{w}_{UA}$

Region (1) describes the workless-couple region, so $Q(w_1, w_2) = 0$. Region (2) has two sub-regions given that $-1 < \frac{d\widetilde{w}_{UA}(w_1)}{dw_1} < 0$: the dual-earner-couple region and the single-earner-couple region (agent 1 is employed). Therefore, the G function for Region (2) can be simplified as follows:

$$\frac{\beta\alpha^2}{1-\beta}\left\{\int_{\overline{w}_{UA}}^{\overline{w}}\int_{\widetilde{w}_{UA}(w_1)}^{\overline{w}_{UA}} T(w_1, w_2) - \Omega(w_1) dF(w_2) dF(w_1)\right\}$$
$$= \frac{\beta\alpha^2}{1-\beta}\left\{\int_{\overline{w}_{UA}}^{\overline{w}}\int_{\widetilde{w}_{UA}(w_1)}^{\overline{w}_{UA}} \frac{w_2 - \widetilde{w}_{UA}(w_1)}{1-\beta} dF(w_2) dF(w_1)\right\} \quad \text{[D.6]}$$

By symmetry, the value of G function for Region (3) is the same as [D.6]. Region (4) describes the dual-earner-couple region as follows:

$$Q(w_1, w_2) = T(w_1, w_2) - \Omega(w_1) - \Omega(w_2) + U$$
$$Q(w_1, w_2) = \frac{w_1 + w_2}{1-\beta} - \frac{w_1 + \widetilde{w}_{UA}(w_1)}{1-\beta} - \frac{\widetilde{w}_{UA}(w_2) + w_2}{1-\beta} + \frac{2\overline{w}_{UA}}{1-\beta}$$

$$Q(w_1, w_2) = \frac{2\overline{w}_{UA} - \widetilde{w}_{UA}(w_1) - \widetilde{w}_{UA}(w_2)}{1-\beta} \quad \text{[D.7]}$$

Using [D.7], the G function for Region (4) can be simplified as follows:

$$\frac{2\beta\alpha^2}{1-\beta}(1 - F(\overline{w}_{UA}))\int_{\overline{w}_{UA}}^{\overline{w}} \frac{\overline{w}_{UA} - \widetilde{w}_{UA}(w)}{1-\beta} dF(w) \quad \text{[D.8]}$$

Next, by substituting [D.4] into [D.5], it yields:

$$0 = \beta\left\{2\alpha\int_{\overline{w}_{UA}} \Omega(w) - UdF(w)\right\} + (1-\beta)G - \frac{\alpha\beta}{1-\beta}\left\{\int_{\overline{w}_{UA}} w - \overline{w}_{UA}dF(w)\right\} \quad \text{[D.9]}$$

Using [D.6] and [D.8], [D.9] can be simplified as follows:

$$0 = \left\{\int_{\overline{w}_{UA}} \begin{pmatrix} w - \overline{w}_{UA} + (2 - 2\alpha(1 - F(\overline{w}_{UA})))(\widetilde{w}_{UA}(w) - \overline{w}_{UA}) \\ +2\alpha\int_{\widetilde{w}_{UA}(w)}^{\overline{w}_{UA}} w_2 - \widetilde{w}_{UA}(w)dF(w_2) \end{pmatrix} dF(w)\right\} \quad \text{[D.10]}$$

[D.10] is the condition for the existence of a triple-indifference point where $\widetilde{w}_{UA}(w)$ is defined in [D.2] and $\overline{w}_{UA}$ is defined in [D.4].

Outcome Two: $U > \Omega(\overline{w}_{UA})$

If $U > \Omega(\overline{w}_{UA})$, $\widehat{w}_{UA} > \overline{w}_{UA}$. Given that $\widetilde{w}_{UA}(\overline{w}_{UA}) = \overline{w}_{UA}$ and $d\widetilde{w}_{UA}(w)/dw$ is between -1 and 0, it is easy to show that $\widetilde{w}_{UA}(\widehat{w}_{UA}) < \overline{w}_{UA} < \widehat{w}_{UA}$.

If $U > \Omega(\overline{w}_{UA})$, the double-indifference point falls strictly within the region of workless couples. If U is replaced by $\Omega(\overline{w}_{UA})$ in [15], then the LHS of [15] will be smaller than U, but the RHS of [15] will be bigger than U.[1] In other words, the RHS of [D.10] will be positive.

Outcome Three: $U < \Omega(\overline{w}_{UA})$

If $U < \Omega(\overline{w}_{UA})$, $\widehat{w}_{UA} < \overline{w}_{UA}$. It also means that the double-indifference point falls strictly outside the region of workless couples. If U is replaced by $\Omega(\overline{w}_{UA})$ in [15], then the LHS of [15] will be bigger than U, but the RHS of [15] will be smaller than U. In other words, the RHS of [D.10] will be negative.

Appendix E: Proof of Proposition 3

***Proposition* 3**: Sub-case One (RHS of [19] > 0)

(i) $\widetilde{w}_{UA}(\widehat{w}_{UA}) < \widehat{w}_{UA}$

(ii) $-1 < \frac{d\widetilde{w}_{UA}(w)}{dw} < 0$ when $w \geq \widehat{w}_{UA}$

(iii) $(\breve{w}_1, \breve{w}_2)$ is the set of reservation wages for a workless couple to become a dual-earner couple: $\breve{w}_1 = -\breve{w}_2 + \widetilde{w}_{UA}(\widehat{w}_{UA}) + \widehat{w}_{UA}$, where $\widetilde{w}_{UA}(\widehat{w}_{UA}) \leq \breve{w}_2 \leq \widehat{w}_{UA}$

(iv) $U_{UI} > U_{UA}$, where $U_{UI} = T(\widetilde{w}_{UI}, \widetilde{w}_{UI})$ and $U_{UA} = T(\widehat{w}_{UA}, \widetilde{w}_{UA}(\widehat{w}_{UA}))$

[1] The values of $T(w_1, w_2)$ and $\Omega(w)$ are solely determined by [13] and [14]. Therefore the RHS of [15] is decreasing in U.

Proof. See Appendix D for the proof of Proposition 3(i).

Proposition 3(ii) can be easily proven using the exactly same approach as in Appendix D (see [D.2] and [D.3]).

Given that $T(\breve{w}_1, \breve{w}_2) = U$, it yields

$$\frac{\breve{w}_1 + \breve{w}_2}{1-\beta} = U = \Omega(\widehat{w}_{UA}) = \frac{\widehat{w}_{UA} + \widetilde{w}_{UA}(\widehat{w}_{UA})}{1-\beta} \quad [E.1]$$

$$\breve{w}_1 = -\breve{w}_2 + \widehat{w}_{UA} + \widetilde{w}_{UA}(\widehat{w}_{UA})$$

Given that $T(\breve{w}_1, \widehat{w}_{UA}) \geq \Omega(\widehat{w}_{UA})$ and $T(\widehat{w}_{UA}, \breve{w}_2) \geq \Omega(\widehat{w}_{UA})$, it yields Proposition 3(iii).

Proposition 3(iv) is proven using the same approach as in Appendix C. The first step is to show that $\widetilde{w}_{UI} > \widetilde{w}_{UA}(\widehat{w}_{UA})$.

Given Proposition 3(i)-(iii), $\Omega(\widehat{w}_{UA})$ can be simplified as follows:

$$\Omega(\widehat{w}_{UA}) = \frac{2b}{1-\beta} + \frac{\alpha\beta}{1-\beta}\left\{\int_{\widetilde{w}_{UA}(\widehat{w}_{UA})} T(\widehat{w}_{UA}, w_2) - \Omega(\widehat{w}_{UA}) dF(w_2)\right\}$$

$$\widetilde{w}_{UA}(\widehat{w}_{UA}) + \widehat{w}_{UA} = 2b + \frac{\alpha\beta}{1-\beta}\left\{\int_{\widetilde{w}_{UA}(\widehat{w}_{UA})} w - \widetilde{w}_{UA}(\widehat{w}_{UA}) dF(w)\right\} \quad [E.2]$$

By re-arranging [B.4], it yields:

$$2\widetilde{w}_{UI} = 2b + \frac{2\alpha\beta}{1-\beta}\left\{\int_{\widetilde{w}_{UI}} w_2 - \widetilde{w}_{UI} dF(w_2)\right\} \quad [E.3]$$

Then, by subtracting [E.3] from [E.2], it yields:

$$\widetilde{w}_{UA}(\widehat{w}_{UA}) + \widehat{w}_{UA} - 2\widetilde{w}_{UI} = \frac{\alpha\beta}{1-\beta}\left\{\begin{array}{c}\int_{\widetilde{w}_{UA}(\widehat{w}_{UA})} w - \widetilde{w}_{UA}(\widehat{w}_{UA}) dF(w) \\ -2\int_{\widetilde{w}_{UI}} w - \widetilde{w}_{UI} dF(w)\end{array}\right\} \quad [E.4]$$

Using [E.4], it can easily show that $\widetilde{w}_{UI} > \widetilde{w}_{UA}(\widehat{w}_{UA})$ by contradiction. Assume that $\widetilde{w}_{UI} \leq \widetilde{w}_{UA}(\widehat{w}_{UA})$. Then, the LHS of [E.4] is positive while the RHS of [E.4] is negative, which leads to a contradiction. Therefore, $\widetilde{w}_{UI} > \widetilde{w}_{UA}(\widehat{w}_{UA})$.

Under Sub-case One, $\Omega_{UA}(w) = T\big(w, \widetilde{w}_{UA}(w)\big)$. Under unemployment insurance, $\Omega_{UI}(w) = T(w, \widetilde{w}_{UI})$. Given that $\widetilde{w}_{UI} > \widetilde{w}_{UA}(\widehat{w}_{UA})$, it is easy to show that $\Omega_{UI}(w) > \Omega_{UA}(w)$.

The second step is to compare the values between U_{UI} and U_{UA} by expanding [7] as follows:

$$U_{UI} = \frac{2b}{1-\beta} + \frac{\beta}{1-\beta}\left\{2\alpha(1-\alpha)\int \max\{\Omega_{UI}(w) - U_{UI}, 0\}\, dF(w)\right\} + \tilde{G} \quad [E.5]$$

$$\text{where } \tilde{G} = \frac{\beta\alpha^2}{1-\beta}\left\{\iint \max\left\{\begin{array}{c}T(w_1, w_2) - U_{UI}, \\ \Omega_{UI}(w_1) - U_{UI}, \\ \Omega_{UI}(w_2) - U_{UI}, 0\end{array}\right\} dF(w_1) dF(w_2)\right\}$$

U_{UA} has exactly the same specification as in [E.5]. If $\Omega_{UI}(w)$ is replaced by $\Omega_{UA}(w)$ in [E.5], the LHS of [E.5] will be bigger than the RHS of [E.5] because $\Omega_{UI}(w) > \Omega_{UA}(w)$. Given that the LHS of [E.5] is strictly increasing in U_{UI} and the RHS of [E.5] is strictly decreasing in U_{UI}, U_{UI} has to be lowered in order to equate both sides of [E.5] after $\Omega_{UI}(w)$ is replaced with $\Omega_{UA}(w)$. In other words, $U_{UI} > U_{UA}$.

Q.E.D.

Appendix F: Proof of Proposition 4

Proposition 4: Sub-case Two (the RHS of [19] < 0)

(i) $\overline{w}_{UA} > \widehat{w}_{UA}$

(ii) $-1 < \frac{d\widetilde{w}_{UA}(w)}{dw} < 0$ when $w \geq \overline{w}_{UA}$

(iii) $\widetilde{w}_{UA}(w) = w$ when $\widehat{w}_{UA} \leq w \leq \overline{w}_{UA}$

(iv) $\overline{w}_{UA} < \widetilde{w}_{UI}$

Proof. See Appendix D for the proof of Proposition 4(i).

As shown in Appendix D, $d\widetilde{w}_{UA}(w)/dw$ is between -1 and 0 for $w \geq \widehat{w}_{UA}$. Proposition 4(ii) follows naturally since $\overline{w}_{UA} > \widehat{w}_{UA}$.

Given that $\overline{w}_{UA} > \widehat{w}_{UA}$, it is not optimal for both agents to work unless one of them receives a job offer that pays $\overline{w}_{UA}$ or above. On the other hand, no job offers will be accepted if paid below $\widehat{w}_{UA}$. Therefore, a single-earner couple will not become a dual-earner couple if the employed agent earns between $\widehat{w}_{UA}$ and $\overline{w}_{UA}$. By symmetry, $\widetilde{w}_{UA}(w) = w$ for $\widehat{w}_{UA} \leq w \leq \overline{w}_{UA}$.

Given $T(\overline{w}_{UA}, \overline{w}_{UA}) = \Omega(\overline{w}_{UA})$, $\overline{w}_{UA}$ is defined as follows:

$$2\overline{w}_{UA} = 2b + \frac{\alpha\beta}{1-\beta}\left\{\int_{\overline{w}_{UA}} w - \overline{w}_{UA} dF(w)\right\} \quad [F.1]$$

By re-arranging [B.4], it yields:

$$2\widetilde{w}_{UI} = 2b + \frac{2\alpha\beta}{1-\beta}\left\{\int_{\widetilde{w}_{UI}} w - \widetilde{w}_{UI} dF(w)\right\} \quad [F.2]$$

By subtracting [F.1] from [F.2], it yields:

$$2(\widetilde{w}_{UI} - \overline{w}_{UA}) = \frac{\alpha\beta}{1-\beta}\left\{2\int_{\widetilde{w}_{UI}} w - \widetilde{w}_{UI} dF(w) - \int_{\overline{w}_{UA}} w - \overline{w}_{UA} dF(w)\right\} \quad [F.3]$$

Proposition 4(iv) can be proven by contradiction. Assume $\overline{w}_{UA} \geq \widetilde{w}_{UI}$. Then, the LHS of [F.3] ≤ 0, but the RHS of [F.3] > 0, which leads to a contradiction. Therefore, $\overline{w}_{UA} < \widetilde{w}_{UI}$.

Q.E.D.

Appendix G: Proof of Proposition 5

Proposition 5: There exists a threshold value of b above which the RHS of [19] is negative.

Proof. The RHS of [19] is denoted as follows:

$$\text{RHS of [19]} = \int_{\overline{w}_{UA}} G(w)dF(w) \quad [G.1]$$

$$\text{where } G(w) = \begin{pmatrix} w - \overline{w}_{UA} + (2 - 2\alpha(1 - F(\overline{w}_{UA})))(\widetilde{w}_{UA}(w) - \overline{w}_{UA}) \\ +2\alpha \int_{\widetilde{w}_{UA}(w)}^{\overline{w}_{UA}} w_2 - \widetilde{w}_{UA}(w) dF(w_2) \end{pmatrix}$$

By taking the first derivative of $G(w)$ with respect to w, it yields:

$$G'(w) = 1 + 2\left[1 - \alpha\left(1 - F\left(\widetilde{w}_{UA}(w)\right)\right)\right]\frac{d\widetilde{w}_{UA}(w)}{dw} \quad [G.2]$$

By substituting [D.3] into [G.2], it yields:

$$G'(w) = \frac{-1 + (\frac{\alpha}{1-\beta} + \alpha)\left(1 - F\left(\widetilde{w}_{UA}(w)\right)\right)}{1 + \frac{\alpha\beta}{1-\beta}\left(1 - F\left(\widetilde{w}_{UA}(w)\right)\right)} \quad [G.3]$$

By taking the first derivative of $G'(w)$ with respect to w, it yields:

$$G''(w) = \frac{-\frac{2\alpha}{1-\beta} f\left(\widetilde{w}_{UA}(w)\right)\frac{d\widetilde{w}_{UA}(w)}{dw}}{\left[1 + \frac{\alpha\beta}{1-\beta}\left(1 - F\left(\widetilde{w}_{UA}(w)\right)\right)\right]^2} > 0 \quad [G.4]$$

Given that $\widetilde{w}_{UA}(\overline{w}_{UA}) = \overline{w}_{UA}$, $G(\overline{w}_{UA}) = 0$. A sufficient condition to guarantee a negative value of the RHS of [19] is $G'(\overline{w}) < 0$, where $\overline{w}$ is the upper bound of a wage offer distribution:

$$-1 + \left(\frac{\alpha}{1-\beta} + \alpha\right)\left(1 - F\left(\widetilde{w}_{UA}(\overline{w})\right)\right) < 0 \quad [G.5]$$

Given [D.2], $\widetilde{w}_{UA}(\overline{w})$ is defined as follows:

$$\widetilde{w}_{UA}(\overline{w}) = -\overline{w} + 2b + \frac{\alpha\beta}{1-\beta}\left\{\int_{\widetilde{w}_{UA}(\overline{w})} w_2 - \widetilde{w}_{UA}(\overline{w})dF(w_2)\right\} \quad [G.6]$$

It is clear that $\widetilde{w}_{UA}(\overline{w})$ is an increasing function of b. If [G.5] holds for a benefit level, b_0, then [G.5] should hold for any b that is greater than b_0.

As b approaches $\overline{w}$, [G.6] shows that $\widetilde{w}_{UA}(\overline{w})$ will approach $\overline{w}$. As $\widetilde{w}_{UA}(\overline{w})$ approaches $\overline{w}$, $1 - F\left(\widetilde{w}_{UA}(\overline{w})\right)$ approaches zero, which guarantees the validity of [G.5].

Q.E.D.

Appendix H: The value function of a single-earner couple is strictly increasing in w.

Proof by contradiction.

Unemployment Insurance

Equation [2] can be re-written as follows:

$$\Omega(w_1) - \frac{w_1 + b}{1-\beta} = \frac{\alpha\beta}{1-\beta}\int Q(w_1, w_2)dF(w_2) \quad [H.1]$$

Where $Q(w_1, w_2) = \max\{T(w_1, w_2) - \Omega(w_1), \Omega(w_2) - \Omega(\mathrm{w}_1), 0\}$

Assume $\Omega'(w) \leq 0$. Then, $\frac{\partial Q(w_1,w_2)}{\partial w_1} < 0$ because the LHS of [E.1] is strictly less than zero.

Given $\Omega'(w) \leq 0$, the first term of $Q(w_1, w_2)$ is strictly increasing in w_1, and the second term of $Q(w_1, w_2)$ is non-decreasing in w_1. This implies that $\frac{\partial Q(w_1,w_2)}{\partial w_1} \geq 0$, which leads to a contradiction.

Means-tested Unemployment Benefits: Case (1)

Equation [11] can be re-written as follows:

$$\Omega(w_1) - \frac{w_1}{1-\beta} = \frac{\alpha\beta}{1-\beta}\int Q(w_1, w_2)dF(w_2) \quad \text{[H.2]}$$

Where $Q(w_1, w_2) = \max\{T(w_1, w_2) - \Omega(w_1), \Omega(w_2) - \Omega(\mathrm{w}_1), 0\}$

The proof is exactly identical to the one under unemployment insurance.