Employment, Unemployment, and Non-Single Women: Three Essays

Dissertation

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Abstract

My dissertation examines the relationship between the rise of female labor supply and the rise of the service economy and studies how labor market and unemployment policies affect family labor decisions. There are three essays in my dissertation. The first essay quantifies the Buera and Kaboski’s (BK) service economy model and examines how the female labor supply is related to service growth. I discipline the model through calibration to assess how quantitatively plausible such an explanation is. By extending the BK model to a two-person household model, I incorporate a joint household decision on home and market production into the model, which provides a direct link between female labor supply and the growth of service economy. The calibrated analysis shows that both the BK model and the extended BK model are able to match nearly all of the growth in the service sector, and the channels emphasized in the BK model are quantitatively important. Using counterfactual experiments, I identify the rising efficient scale of service production and skill deepening of the labor force, particularly among the female population, as the most important channels of service growth.

The second essay uses British Household Panel Survey data to examine how marital instability and partners’ employment instability affect non-single mothers’ employment responses to the 1999 in-work benefit reform in the United Kingdom. Previous studies have found small employment responses overall, but I find large responses among these subpopulations. My difference-in-difference analysis suggests
that (1) there is about a 10 to 14 percentage point increase in the full-time employment of non-single mothers with unstable marriages relative to those with stable marriages as the result of the 1999 reform, and (2) there is about a 10 percentage point increase in the full-time employment of non-single mothers with unstably employed partners relative to those with stably employed partners. These results highlight the important interaction between household instability and the labor decisions of non-single mothers.

The third essay examines how means-tested unemployment benefits affect couple’s employment decisions. The literature has overly emphasized the negative work incentive of means-tested unemployment benefits, which does not provide full information for policy evaluation because the overall employment outcome matters more than the employment outcome of women with unemployed spouses. I show that means-tested unemployment benefits involve both negative and positive work incentives, the latter of which usually dominates to generate a higher employment rate, a greater proportion of dual-earner couples as well as a lower government expenditure on unemployment benefits.
Dedicated to my parents.
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Introduction

During the last 50 years, the share of the service sector in value-added has increased by about 20 percentage points in the United States. During the same period, there has been an increase of more than 25 percentage points in the female labor participation rate, while the male labor participation rate has dropped by more than 10 percentage points. Female labor in the service sector as a percent of the total labor force has increased from 0.28 to 0.42 between 1969 and 2005, while male labor in the good sector has dropped from 0.31 to 0.17. As a result, the growth in the service sector quantitatively mirrors the growth of female labor in services due to both changes in the labor supply of married woman and changes in marriage rates, while the decline of the good sector matches the decline of male labor in goods.

Buera and Kaboski (BK, 2009) has documented several observations about the rise of the US service economy in the post-1950 period and provided a plausible theoretical explanation that is qualitatively consistent with those observations. However, Buera and Kaboski (2009) neither provide a quantitative assessment of their service economy model nor address the issue of female labor supply. I discipline their model through calibration to fill in this gap. By extending their single household model to a two-person household model, I incorporate a joint household decision on home and market production into the BK model, which provides a direct link between female labor supply and the growth of service economy. The calibrated analysis shows that both the BK model and the extended
BK model are able to match nearly all of the growth in the service sector, and that the channels about the rising efficient scale of service production and skill deepening of the labor force emphasized in the models are quantitatively important.

In comparison to the US, Europe develops a much smaller service sector (Rogerson 2008). Moreover, it has persistently higher unemployment rates and a greater proportion of the inactive than the US after the 1970s. Clearly, a slower structural transformation is related to the deterioration of labor market outcomes in European countries. In order to improve their labor market outcomes, various labor market policy reforms have been implemented in the past 15 years. So, in my dissertation, I examine how the 1999 in-work benefit reform in the United Kingdom affected the labor supply decisions of non-single mothers. Previous studies have found small employment responses overall, though some found it positive (Leigh 2007) and others found it negative (Blundell et.al. 2000). However, in my dissertation, I find large responses among subpopulations who face different degrees of marital instability and partners’ employment instability. To be more precise, my difference-in-difference analysis suggests that (1) there is about a 10 to 14 percentage point increase in the full-time employment of non-single mothers with unstable marriages relative to those with stable marriages as a result of the 1999 reform, and (2) there is about a 10 percentage point increase in the full-time employment of non-single mothers with unstably employed partners relative to those with stably employed partners. Thus, my findings highlight the important interaction between household instability and the labor decisions of non-single mothers.
Another important labor market policy reform in Europe is the reduction of the duration of unemployment insurance. Once unemployment insurance is expired, unemployed workers will usually be given social or unemployment assistances, which are means-tested. As the duration of unemployment insurance is reduced, means-tested unemployment benefits will become more relevant to the long-term unemployed. So, the last part of my dissertation is to examine how means-tested unemployment benefits affect couples’ employment decisions. By using cross-country Census data, I show that the employment rates of married women with unemployed husbands are substantially lower than those of married women with employed husbands. This pattern displays a strong dependency in married women’s employment rates on their spouses’ employment statuses. Furthermore, the degree of dependency varies across countries, and it positively correlates with the net unemployment benefit replacement-rate gaps between those with dependent spouses and those with working spouses. Therefore, the means-tested nature of unemployment benefits seems to have a sizable explanatory power for the married women’s employment rates on their spouses’ employment statuses. Using a joint search model, I show that the negative work incentive of means-tested unemployment benefits is likely to encourage a larger proportion of workless couples as the literature has heavily emphasized. More importantly, I illustrate that means-tested unemployment benefits involve both negative and positive work incentives, the latter of which usually dominates to generate a higher employment rate, a greater proportion of dual-earner couples as well as a lower government expenditure on unemployment benefits.
Chapter 1: Home Production, Female Labor Supply and the Growth of the Service Economy – A Quantitative Study

1. Introduction

Over the past 40 years, the US economy has moved increasingly toward a service-based economy, with the share of services rising roughly from 60 percent to 80 percent from 1965 to 2003. Buera and Kaboski (2008, 2009) provide a plausible theoretical explanation in which the growth of the service economy is driven by an increase in the optimal scale of service production and a shift in demand toward more skill-intensive output, which lead to an increase in the proportion of services that are market-produced relative to home-produced. The theory is attractive in that it is qualitatively consistent with several observations: growth in both the relative price and quantity of services, changes in patterns of home production, and, most importantly, growth in the average scale of service establishments and the shift toward skill-intensive services.¹ This paper uses calibration to examine how quantitatively plausible such an explanation is.

In the Buera-Kaboski (BK, hereafter) model, specialization plays a key role in the growth of service economy. Specialized human capital is utilized more efficiently on the market, where workers may specialize in production. The increasing demand for skill-intensive services increases the returns to specialized human capital, so that households who become skilled earn increasingly higher wages. As the opportunity cost of

¹ The growth of the service economy actually begins around midcentury. Buera and Kaboski also focus on the late acceleration of the service economy.
their time increases, they spend less time in home production and demand increasingly more market services. In addition, specialized intermediate/capital goods give rise to more efficient, larger scale production of services on the market than at home. In this way, a rising efficient scale of services interacts with both labor supply and investment in specialized human capital.

In the context of the model, a quantitative analysis should address the fact that behavior in married households may differ from that of single households. In married households, one spouse may specialize predominantly in home production, while the other specializes in market production, and these decisions may be linked to decisions about human capital investment as well. Indeed, at the beginning of the period in question, women worked disproportionately in home production, while men worked disproportionately in the market. Indeed, shifts in female labor supply, due to both changes in the labor supply of married women and changes in marriage rates, are clearly linked to the growth of the service economy (see, for example, Lee and Wolpin, 2006). As Figures 1.1 and 1.2 show, the growth in service sector quantitatively mirrors the growth in female labor in services (as a percent of the total labor force), while the decline of the good sector matches the decline in male labor in goods. All four are roughly linear changes of 17 percentage points over the period in question.²

To add this element of realism, and examine its importance, I extend the model to allow for two-person households, and a different relative productivity in home production

² In comparison, the relative size of the labor force that is female and working in the goods sector decreased by just 4 percentage points, while that of males in the service sector increased by just 4.5 percentage points.
for men and women. I calibrate both the baseline model and this enhanced model to the U.S. experience. That is, I choose parameter values to target key facts of the economy and labor market in 1965, as well as growth in output, schooling, the relative wage of college educated workers, and the relative price of services over the period. A limitation of the calibration is that within the allowable parameter space, the model is unable to fully match the observed growth in schooling.

Remarkably, despite no free parameters, both versions of the calibrated model are able to match nearly all of the growth in the service sector. I therefore conclude that the channels emphasized in the BK model are quantitatively important. Indeed, using counterfactual experiments, I identify the efficient scale of service production and the increase in the skill intensity particularly among the female population as the most important channels of growth.

The models also produce corroborating evidence for the mechanism emphasized. That is, the model and calibration have additional implications that are consistent with the data.

First, the model has implications for the composition of employment changes in response to the increased demand for skill. High ability women become educated and increase labor supply at the fastest rate, while the labor supply of less educated men increases most slowly. In the data, the male-female ratio of college enrollment rates has roughly doubled from 1960 to 2003 (Goldin, 2006b). Mulligan and Rubinstein (2007) explain that the increase in female labor force participation (and the relative of women) has been driven by high ability, highly educated married women entering the labor force.
Second, as opposed to the BK model, biased productivity explanations for the
growth of services assume an inelastic substitution so that higher productivity growth in
the goods sector increases the growth of the service sector. These models predict a rising
relative price of services, but a counterfactual decline in relative real quantities. In the BK
model, a unique implication is that biased productivity in manufacturing actually reduces
the growth of the service sector, since market services economize on intermediate
goods/capital relative to home production. In contrast to biased productivity models, which
require counterfactually large biases, the BK calibration matches the growth in the relative
price of services with productivity growth in the service sector that is roughly 0.50
percentage points lower than in goods sector, comparable to productivity measurements by
Jorgensen and Stiroh (2000) over this period. Related, in the calibration, the relative price
of services rises in part because of the rising relative wage of college educated workers,
since services are intensive in skilled labor. This is consistent with time series data, which
shows a strong link between the college premium and the relative price of services.

The remaining paper is organized as follows. The BK model is introduced in
Section 2, and calibrated and evaluated in Section 3. Section 4 extends the model, and
Section 5 provides calibration, and quantitative analysis to address multi-member
households. Section 6 quantitatively evaluates additional empirical implications of the
model’s mechanisms. Section 7 concludes.

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3 See for example, Ngai and Pissarides (2006) and Baumol (1967).
4 In Jorgensen and Stiroh (2000), the weighted average of labor productivity growth in the goods sector is
2.07 percent vs. 1.41 percent in the service sector. The analogous TFP growth rates were 0.67 and 0.26
percent.
2. BK Model

This section summarizes the theory developed in Buera and Kaboski (2009) for the growth of the service economy. This presentation merely extends BK to allow for sector-specific technical change and time-varying efficient scale of services.

2.1 Production

There is a continuum of manufacturing goods and services, indexed by their complexity, \( z \in [0, \infty) \). Manufacturing goods are produced only on the market, but services can be produced either on the market or at home. Manufacturing goods serve as intermediate input for both home and market production of final services. Technological progress is assumed to be exogenous, sector-specific, and skilled-neutral.

2.2 Technologies

Manufactured goods are produced using low and/or high skilled labor, \( l_m \) and \( h_m \), respectively:

\[
y_m(z,t) = e^{g_m} \left[ \frac{A_l}{z} l_m + \frac{A_h}{z^\lambda} h_m \right]
\]

Here, productivity in manufactured goods grows exogenously at a rate of \( g_m \). \( A_l / z \) and \( A_h / z^\lambda \) are the \( z \)-specific productivities of low- and high-skilled labor, respectively. Since \( z \) represents complexity, productivities are decreasing in \( z \), but I assume \( \lambda \in (0,1) \), so that high-skilled work has a comparative advantage in more complex output.

Manufactured goods are used as inputs into production of services. Production of
service $z$ requires one unit of manufactured good $z$ as an intermediate. Given this intermediate, services of type $z$ are produced with constant labor productivity up to a maximum capacity. A simple example would be a maximum number of loads of laundry that can be performed by a washing machine per day, required a certain amount of labor for each load. Denoting the intermediate goods into services as $k_z$ and the maximum capacity as $n$, the production function is:

$$y_z(z,t) = \begin{cases} 0 & \text{if } k_z < 1 \\ \min\{n(t), e^{\gamma z/\alpha} [A_z I_z + \frac{\alpha}{z} h_z]\} & \text{if } k_z \geq 1 \end{cases}$$

The capacity $n(t)$ reflects the efficient output scale of a productive unit at which market services are run, which I allow to change over time. In equilibrium, this parameter $n(t)$ will also be strongly related to the workers per productive unit. Note that the labor requirements for service $z$ are symmetric to those for manufactured good $z$, except for its sector-specific rate of technical change $g_z$.

### 2.3 Firm’s Problem

It is assumed that both manufacturing and service firms operate at the minimum average cost curves due to free entry. Making low-skilled labor the numeraire, and denoting the relative price of high-skilled workers as $w$, equilibrium prices of $w$
manufactured goods and services are:

\[
p_m(z, t) = \min \left\{ \frac{e^{-\gamma z} z}{A_l}, w \frac{e^{-\gamma z} z^h}{A_h} \right\} \tag{1}
\]

\[
p_s(z, t) = \min \left\{ \frac{e^{-\gamma z} z}{A_l}, w \frac{e^{-\gamma z} z^h}{A_h} \right\} + \frac{1}{n(t)} \min \left\{ \frac{e^{-\gamma z} z}{A_l}, w \frac{e^{-\gamma z} z^h}{A_h} \right\} \tag{2}
\]

The competitive price of services include both the cost of intermediate goods (the \(1/n(t)\) term) and services value-added (the \(1\) term). The \(1/n\) term reflects the fact that intermediate goods are used at their efficient scale in market services.

The minimizations above reflect the choice between low- and high-skilled workers. Given the comparative advantage assumption, they define a threshold, \(\hat{z}\):

\[
\hat{z} = \left( w \frac{A_l}{A_h} \right)^{\frac{1}{w}}
\]

For \(z \leq \hat{z}\), firms will hire low-skilled workers. When \(z > \hat{z}\), firms will hire high-skilled workers instead. \(w\) is the relative wage of high-skilled to low-skilled workers. The low-skilled wage is normalized to 1. The threshold \(\hat{z}\) is an increasing function of \(w\).

2.4 Households

There is a continuum of infinitesimally-lived households that hold preferences over continuum of services \(z\), purchase manufactured goods and services, provide labor to market and home production, and decide whether or not to home produce services and whether or not to become high-skilled.
2.5 Preferences

The preferences over the continuum of discrete, satiable wants are indexed by the service that satisfies them, \( z \). Services are produced for the final consumption, and manufactured goods serve as the intermediate input to market or home production. Define the function \( C(z) : \mathbb{R}^+ \rightarrow \{0,1\} \), which takes the value of 1 if a particular want is being satisfied and 0 otherwise. There are two methods to satisfy wants either by procuring the service directly from the market, or purchasing the required manufactured goods to home produce the service. Let the function \( H(z) : \mathbb{R}^+ \rightarrow \{0,1\} \), indicate whether want \( z \) is satisfied by home production. The consumption set is defined by the set of indicator functions, \( C(z) \) and \( H(z) \), mapping \( \mathbb{R}^+ \) into \( \{0,1\}^2 \). The corresponding preferences can be represented by the following utility function:

\[
\tilde{u}(C,H) = \int_0^{\infty} [H(z) + \gamma(1-H(z))]C(z)dz
\]

where \( H(z) \leq C(z) \). The parameter \( \gamma \in (0,1) \) indicates that the service produced at home yields a greater utility than the same type of the service procured directly from the market because of the disutility of public consumption.

Given that a continuum of wants are satiated sequentially, home-produced services offer greater utility as compared to market-produced services, and production costs as well as the additional costs of home production are increasing in \( z \), the consumer’s problem can be simplified by the following step functions as the choice over the restricted consumption set.
\[ C(z) = \begin{cases} 1 & \text{if } z \leq \bar{z} \\ 0 & \text{if } z > \bar{z} \end{cases} \]

and

\[ H(z) = \begin{cases} 1 & \text{if } z \leq \underline{z} \\ 0 & \text{if } z > \underline{z} \end{cases} \]

where \( \bar{z} \) denotes the most complex want that can be satisfied, and \( \underline{z} \) denotes the most complex want that is produced at home.

The primitive preferences \([3]\) can then be simplified to the preferences over the restricted consumption set as represented in the following utility function with two thresholds \( z \) and \( \bar{z} \):

\[ u(z, \bar{z}) = z(1 - \gamma) + \gamma \bar{z} \quad [4] \]

where \( 0 \leq z \leq \bar{z} \). There are two ways for agents to increase utility: by increasing \( \bar{z} \) to satisfy a want not yet satiated or by increasing \( z \) to move previously market-produced services to be home produced.

### 2.6 Schooling

The schooling decision involves two choices: \( e \in \{l, h\} \). \( l \) denotes low-skilled, and \( h \) denotes high-skilled. When agents decide to become high-skilled workers, \( e = h \), they are required to spend a fraction \( \theta \) of their time endowments acquiring skills. The time required to acquire skills differs from agent to agent, which contributes to a heterogeneous population. More specifically, \( \theta \) falls between 0 and 1, distributed according to a c.d.f. \( F(\theta) \).
2.7 Household’s Problem

An agent with skill, $e$, solves the following problem to derive the optimal demand for market services and manufactured goods:

$$V^e(\Theta; t) = \max_{0 \leq z \leq \bar{z}_e} \left( 1 - r \right) z_e + rz_e$$

s.t.

$$\int_0^{\bar{z}_e} p_m(z, t) \, dz + \int_{\bar{z}_e}^{z_e} p_s(z, t) \, dz$$

$$= w_e \left( 1 - \int_0^{\bar{z}_e} e^{-z/t} \, dz - \theta \Xi(e) \right)$$

where $\Xi(e)$ is an indicator function that equals one if $e = h$ and zero otherwise. The left-hand side of the budget constraint includes expenditures on manufactured goods (as intermediates into the home production of services) and expenditures on market services. Note that home production of a single unit of service $z \in [0, \bar{z}_e]$ requires paying for an entire manufactured input, $p_m(z, t)$, rather than the $1/n(t)$ units used in market production. The right-hand side is income from market labor, which is the unit time allocation minus home production time and schooling time. Note, that because high-skilled workers are specialized, all home production (except for a measure zero) is done with the productivity of low-skilled workers.

At an interior optimum, $z_e$ and $\bar{z}_e$ solve the following first order conditions:

$$\mu \left[ 1 - \frac{1}{n(t)} \right] p_m(z_e, t) + e^{-z/t} \left( \frac{w_e z_e}{A_t} - \min \left\{ \frac{z_e}{A_t}, \frac{w_e z_e}{A_h} \right\} \right) \geq 1 - r$$

$$\mu p_s(\bar{z}_e, t) = r$$
where \( p(s) \) has been substituted using Equation [2], and \( \mu \) denotes the marginal utility of income.

Equation [6] is the marginal condition between home producing or market purchasing a service. The benefit of market services (left-hand side) includes the goods cost savings from the efficient utilization of intermediate goods and the potential labor cost savings that comes from hiring either more productive high-skilled labor, or low-wage, low-skilled labor. The cost of market services (right-hand side) is the disutility of market consumption. For any particular \( z \), the goods cost saving will decrease as the price of the manufactured good falls, and will increase as the efficient scale of services rises. The labor cost savings of market services are higher for high-skilled workers (\( w_e = w \)). Thus, a shift toward high-skilled workers decreases home production time in favor of market services. Moreover, the labor cost savings is increasing in the relative wage of high-skilled workers \( w \) for high-skilled workers, but decreasing for low-skilled workers (\( w_e = 1 \)), so that increases in the relative wage affect workers differentially.

The schooling decision depends on the time cost and the relative wage. Being high-skilled will allow workers to earn a higher wage (\( w > 1 \)), but it will reduce the time endowment to be \( 1 - \theta \), so the return to becoming high-skilled drops as \( \theta \) increases. There exists a threshold, \( \bar{\theta}(t) \), that equalizes that value of being high- and low-skilled \( v_h(\bar{\theta}) = v_l(\bar{\theta}) \). For \( \theta < \bar{\theta}(t) \), a household will be strictly better off being high-skilled, while for \( \theta \geq \bar{\theta}(t) \), a household remains low-skilled.
2.8 Equilibrium

Given \( w(t) \), a household decides whether to be high-skilled and decides the levels of \( z \) and \( \overline{z} \). If a household decides to be low-skilled \( (\theta \geq \hat{\theta}(t)) \), the levels of \( z_i(t) \) and \( \overline{z}_i(t) \) are independent of \( \theta \). If a household decides to be high-skilled \( (\theta < \hat{\theta}(t)) \), the levels of \( z_h(\theta, t) \) and \( \overline{z}_h(\theta, t) \) will increase as \( \theta \) decreases. Given \( w(t) \), each firm sets the prices \( p_m(z, t) \) and \( p_1(z, t) \) according to [1] and [2], respectively.

A competitive equilibrium consists of \( w(t) \) and \( \hat{\theta}(t), z_i(t), \overline{z}_i(t), z_h(\theta, t), \overline{z}_h(\theta, t), \hat{z}(t), \) and the price functions \( p_m(z, t) \) and \( p_1(z, t) \). The model can be solved in two steps recursively. The first step is to solve for the schooling threshold \( (\hat{\theta}(t)) \) and consumption thresholds \( (z_i(t), \overline{z}_i(t), z_h(\theta, t), \overline{z}_h(\theta, t)) \) given \( w(t) \). The price functions are determined by \( \hat{z}(t) \) and \( w(t) \). The second step is to solve for \( w(t) \) from a market clearing condition given the schooling threshold and consumption thresholds. Then, repeat the first and second steps until the solution converges.

This equilibrium has been shown to produce growth in the service sector that is qualitatively consistent with several features of the data (see Buera Kaboski, 2008, 2009). First, the growth of services is delayed. At low levels of income, growth leads to new services being consumed on the market, but old market services moving to home production as the cost of intermediates falls. This feature is least relevant for the quantitative analysis, since my analysis only covers the period of rising services. Second, and more relevant, the growth of services is driven by the growth of high-skilled services. As incomes continue to rise, demand shifts toward ever more complex output at which
specialized high-skilled workers have an ever increasing comparative advantage. Market services increase as these complex services are more difficult to move into home production. In turn, the demand for high-skilled workers increases, and more agents decide to specialize. Given \( F(\theta) \), the supply curve for skilled workers is upward sloping. As the relative wage increases, this increases the demand for market services among high-skilled workers, who constitute an ever increasing share of the economy. Third, since manufactured goods are produced on the market for the full range of \( z \) consumed, while only high \( z \) services are consumed on the market, market services are more intensive in high-skilled labor. Ceteris paribus, a rising relative wage \( w \) leads to increases in the relative price of services. Finally, the share of services is increasing in their efficient scale of production \( n(t) \), which has trended up. This growth in scale in turn decreases labor used in home production in favor of market production, and thereby also increases the incentives for acquiring skill. The following section calibrates the relevant features to quantify these effects.

3. Calibration of the BK Model

The BK model is sufficiently different from conventional structural change models. There is therefore no existing literature on the parameter values. My approach is to calibrate the model to match features of the 1965 economy, as well as relevant time trends, and evaluate the model based on how well it predicts the growth in services, and matches other features of the data. Specifically, I calibrate the BK model to match the service share, the intermediate manufacturing input ratio, the skill composition and the relative wage to
the 1965 level, as well as the relative wage in 2003, and the changes in real GDP per capita, the relative scale of service and manufacturing establishments, and the relative price of services over the period 1965-2003.

The cost of acquiring specialized skills is $\theta$. I assume that $\theta$ follows a Beta distribution, $\beta(a, b)$, which supports $\theta$ between 0 and 1 and assures an interior solution for the fraction of workers acquiring specialized skills. The calibrated distribution can be left-skewed or right-skewed as well as symmetric, depending on the values of $a$ and $b$. In this calibration exercise, I normalize $A_t$, to be 1.

As the service economy is expanding, the efficient scale $n$ is not expected to stay constant. Changes in $n$ translate into changes in workers per establishment in services. Once the initial efficient scale value, $n_o$, is calibrated, the remaining time series of $n$ can be constructed based on the growth rate of the workers per service establishment.

After normalizing $A_t$, there are nine parameters remained to be calibrated. Table 1.1 provides the information about the nine parameters and the corresponding data moments. Although all the parameter values are jointly determined, I choose each data moment that can potentially help pin down a corresponding parameter. More specifically, I use the initial service share for $\gamma$, the initial intermediate manufacturing input ratio for $n_0$, initial relative wage for $A_h$, the change in the relative prices of services to manufacturing for $g_s$, the real GDP per capita growth for $g_m$, the relative wage growth for $\lambda$, and the initial and ending fractions of high-skilled workers for $a$ and $b$. 

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3.1 Calibration Results

Table 1.2 provides the calibrated results for the BK model. As shown in the second column of Table 1.2, I can hit all the data moments except the ending fraction of high-skilled. This is caused by the lower bound that I set for $\lambda$. If I let $\lambda$ be unrestricted, all the data moments can be hit, but $\lambda$ will take a negative value. A negative value of $\lambda$ implies that the market price of good $z$ will approach to zero as $z$ approaches to infinity, and those goods will certainly be consumed first. Then, the reduced-form preference [4] will no longer be equivalent to the primitive preference [3]. The calibrated $\theta$ distribution is left-skewed (with a larger mass on the smaller values of $\theta$). The calibrated TFP growth rate in the service sector is 0.0167, which is slightly lower than the TFP growth rate in the manufacturing sector.

3.2 Prediction of Service Shares

Figure 1.3 compares the empirical service shares with the service shares predicted by the BK model (ignore the extended model for the moment). In 1965, the match between the empirical data and the BK model is perfect by construction. The quality of the model predictions should be examined based on the latter years. As shown in Figure 1.3, the prediction of service shares from the BK model is extremely well consistent with the empirical data. During 1965-2003, the actual service share is increased by 15.8 percentage points. The BK model only over-predicts the increase by 0.41 percentage points.

3.3 Determinants of Rising Service Shares

In this section, I carry out the three counterfactual experiments to examine how the rise in skill intensity, the relative decline of the home production, and the efficient scale of
service production can explain in terms of the service sector growth.

3.3.1 Experiment 1: Fix Skill Intensity to the 1965 Level

Skill intensity is determined by the threshold $\hat{\theta}$ in the BK model (high-skilled if $\theta < \hat{\theta}$). As explained in Buera and Kaboski (2009), there is a market provision biased for skill-intensive services because high skilled workers have a comparative advantage of producing more complex goods and consumers have skill-biased expansion paths. As the service sector expands, there will be a rising demand for high-skilled workers, which generates a higher skill premium to attract investment in human capital. Therefore, skill intensity is higher in 2003 than in 1965 ($\hat{\theta}$ increases during the period). If the labor supply side reduces the investment in human capital to the 1965 level in 2003, it will certainly limit the growth of the service sector.

In this counterfactual experiment, I first compute $\hat{\theta}$ for the year 1965. Then, I fix $\hat{\theta}$ as the threshold for the year 2003 and compute the corresponding nominal service share in 2003. Table 1.3 summaries the experiment result. As shown in the fourth column of Table 1.3, the predicted current-value service share decreases from 0.791 to 0.694. If skill intensity were fixed to the 1965 level, the BK model could only generate 41 percent of the original growth in nominal service shares.

3.3.2 Experiment 2: Fix the Efficient Scale of Service Production to the 1965 Level

A higher efficient scale of service production requires less amount of input from the manufacturing sector to produce the same amount of service goods. In this counterfactual experiment, I fix the efficient scale of service production to the 1965 level. The experiment result is provided in the fifth column of Table 1.3. The result indicates that if
there were no growth in the efficient scale of service production during 1965-2003, only about 60 percent of the original growth in current-value service shares would be generated. Thus, growth in the efficient scale of services is quantitatively important.

### 3.3.3 Experiment 3: Decompose Service Growth during 1965-2003

Service growth during 1965-2003 is decomposed into four elements:

1. **Base**: fix skill premium, skill intensity, and the efficient scale of service production to the 1965 level;
2. **Opportunity cost effect**: relax skill premium to the 2003 level;
3. **Skill-deepening effect**: relax skill intensity to the 2003 level;
4. **Scale of service production effect**: relax the efficient scale of service production to the 2003 level.

In each layer of decomposition, service and manufacturing goods are always evaluated at the ending prices, which are fixed to the 2003 level. Figure 1.4 displays the decomposition of service growth during 1965-2003. As shown in Figure 1.4, the increase in skill premium, skill intensity and the scale of service production have contributed 3.8, 6.2 and 6.1 percentage points in service growth during 1965-2003, respectively. The results show that the rising efficient scale of service production and skill deepening of the labor force are the most important channels of service growth.

### 4. Extended Model

I extend the BK model by adding a gender-specific component in home production, which generates a mechanism for household specialization. The increase in female labor supply is integrated in the process of structural change, which allows us to evaluate the

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6 Experiments 1 and 2 consider the general equilibrium effects, but Experiment 3 considers only the partial equilibrium effect.
model vis-a-vis its implications for female labor supply, and to assess the role of female labor supply on the quantitative predictions for the disproportionate growth of the service sector.

The production/technology side of the extended model is identical to the BK model presented in the previous section, so I only explain the household side of the extended model.

4.1 Households

There are three types of households in the extended model: single women, single men, and married couples. Each type of household is again infinitesimally-lived and differs by $\theta \in [0,1]$, where $\theta \sim F(\theta)$, but the fractions of each type of households in the overall population are exogenous given to the model. I have implicitly made the simplifying assumption that there is perfective assortative matching by ability in marriages.

Single male and single female households are identical to households in the previous section, except that they differ by gender-specific productivity of home production. There is an additional household decision to the BK model. Married couples decide schooling and labor supply decisions jointly, but may optimally choose for schooling and labor allocations between home and market production differed for the husband and wife. Based on comparative advantage, women will spend relatively more time in home production, while men supply relatively more labor to the market.

4.2 Preferences

As before, a single-person household requires one unit of services to satiate want $z$, but married couple households now require 2 units. Formally:
\[ u(C, H) = \int_{0}^{+\infty} [H(z) + \gamma (1 - H(z))] \cdot C(z) \cdot Q \cdot dz \]  

[7]

The additional parameter \( Q \) equals 1 if it is a single-person household’s preference function and 2 if it is a married couple’s preference function.

4.3 Consumer’s Problem

A single household solves the following maximization problem by choosing \( z, \bar{z}, \) and \( e \):

\[
\max_{\bar{z}, \bar{z}, e \in \{l, h\}} v_{e, \bar{z}}(\theta) = (1 - \gamma)\bar{z} + \gamma \bar{z}
\]

s.t.

\[
\int_{0}^{\bar{z}} p_{m}(z, t)dz + \int_{\bar{z}}^{\bar{z}} p_{s}(z, t)dz = w_{e}[1 - \int_{0}^{\bar{z}} e^{-\theta, t}zdz - \theta(\epsilon)]
\]

All terms are identical to the BK model, with the exception of the home production time, \( \frac{e^{-\theta, t}z}{A_{G}} \), which now depends on the gender-specific productivity, \( A_{G} \), where \( G = f \) if female, and \( G = m \) if male. Given this difference, the threshold of the ability level being indifference between becoming high-skilled and low-skilled, \( \tilde{\theta}_{G} \), will now be gender-specific in equilibrium. Quantitatively, \( A_{f} \) is expected to be greater than \( A_{m} \) so that females have a comparative advantage in home production in order to match the gender-specific differences in home-production time.\(^7\)

A married couple’s problem is similar to a single-person household’s problem, but the consumption, schooling, market labor supply decisions, and home production decisions are jointly determined between a husband and wife. If \( A_{f} > A_{m} \), there will exist a

\(^{7}\) In principle, one might want to allow market productivity to vary with gender as well, in order to match observed differences in market wages.
threshold \( \bar{z} \) such that the wife will home produce services to satisfy the wants that are below \( \bar{z} \) and all the wants that above \( \bar{z} \) will be satisfied by the husband’s home production.\(^8\) I define \( t_m \) and \( t_f \) as the amount of time spent in home production, and I require that these be bounded (weakly) above zero and below the available labor supply of the individual. The couple’s problem is therefore:

\[
\max_{\bar{z} \in [0,z], e_m, e_f \in \{l,h\}} \nu_{e_m,e_f}(\theta) = 2(1-\gamma)\bar{z} + 2\gamma\bar{z}
\]

s.t.

\[
2\int_0^{\bar{z}} p_m(z,t)dz + 2\int_{\bar{z}}^z p_s(z,t)dz = w_p [1-t_m - \theta I(e_m)] + w_r [1-t_f - \theta I(e_f)]
\]

\[
t_m = 2\int_{\bar{z}}^z \frac{e^{-g'z}}{A_m}dz \geq 0,
\]

\[
t_f = 2\int_0^{\bar{z}} \frac{e^{-g'z}}{A_f}dz \geq 0
\]

\[
1-t_m - \theta I(e_m) \geq 0, 1-t_f - \theta I(e_f) \geq 0
\]

There are four schooling choices: 1) both husband and wife choose to be high-skilled (\( hh \)); 2) both husband and wife choose to be low-skilled (\( ll \)); 3) only a husband chooses to be high-skilled (\( hl \)); and 4) only a wife chooses to be high-skilled (\( lh \)).

Both the division of home production (\( \bar{z} \)) and education decisions will be driven by comparative advantage. If \( A_f > A_m \), the wife will have a comparative advantage in home production, which encourage the husband to spend more time in market production, and

\(^8\) This can be done without loss of generality, since all home production is done with low-skilled productivity, so the husband and wife are perfect substitutes in all home production activities.
the choice of \( lh \) (low-skilled husband, high-skilled wife) will be dominated by \( hl \) (high-skilled husband, low-skilled wife). Thus, there will exist two thresholds, \((\tilde{\theta}_1, \tilde{\theta}_2),\)

such that

\[
v_{hh}(\tilde{\theta}_1) = v_{hl}(\tilde{\theta}_1) \\
v_{hl}(\tilde{\theta}_2) = v_{ll}(\tilde{\theta}_2)
\]

For \( \theta \in [0, \tilde{\theta}_1) \), both husband and wife choose to be high-skilled. For \( \theta \in (\tilde{\theta}_1, \tilde{\theta}_2] \), only the husband chooses to be high-skilled. For \( \theta \in (\tilde{\theta}_2, 1] \), both will remain low-skilled.

**Proposition:** Given, \( A_m < A_f \), at least one spouse will fully specialize. If a husband does nonzero amount of home production, his wife will not work in the market. If a wife does nonzero amount of market production, her husband will not work at home.

### 4.4 Equilibrium

A competitive equilibrium consists of \( w(t), \tilde{\theta}_m, \tilde{\theta}_f, \tilde{\theta}_1, \), and \( \tilde{\theta}_2, \tilde{z}(t) \), the price functions \( p_m(z,t) \) and \( p_s(z,t) \), and the consumption thresholds \((\bar{z}_m(t), \bar{z}_f(t), \bar{z}_h(\theta,t), \bar{z}_l(\theta,t))\). The model can be solved in two steps recursively, in a fashion very similar to in the BK model. The derivations of a market clearing condition for high-skilled workers are provided in Appendix A.

### 5. Calibration of the Extended Model

In this section, I calibrate my extended model to match the initial relative market work hours of women to men in addition to the eight data moments targeted previously (see Table 1.1). The proportion of each type of households is obtained from the Current
Population Survey and exogenously imposed to the model in the calibration. I adopt the same normalization strategy as in the BK model, with $A_f = 1$. There are two additional parameters that I need to calibrate in the extended model: $A_f$ and $A_m$. Their corresponding data moments are the relative market hours of married women to married men, and the initial relative market work hours of single women to single men. Again, all parameters are jointly determined so that there is not a one-to-one relationship between the data moments and the parameters, but these data moments are key in identifying these parameters.

5.1 Calibration Results

The calibration results are summarized in Table 1.4. Again, I am able to hit all the data moments except for the fraction of high-skilled in 2003. The calibrated value of $\lambda$ reaches the lower bound that I set. The calibrated parameters will not be impacted with a lower positive value. Unless I let $\lambda$ take a negative value, I will not be able to hit all data moments perfectly, but a negative value of $\lambda$ is not admissible as explained in the calibration of the BK model. The calibrated $\theta$ distribution is also left-skewed. The calibrated TFP growth rate in the manufacturing sector is also slightly higher than the service sector.

5.2 Prediction of Service Shares

Figure 1.3 provides the comparison between the predictions from the BK and extended model against the actual data. As shown in Figure 1.3, both the BK and extended models can predict the growth of the service shares remarkably well although the extended model over-predicts the growth slightly more than the BK model. Nevertheless, given that
the demographic information are exogenously imposed in the extended model in each period, the extended model indeed performs quantitatively well in matching the service shares from the empirical data.

5.3 Prediction of Relative Market Work Hours

5.3.1 Relative Market Work Hours of Women to Men

Figure 1.5 provides the model predictions about the relative market work hours of women to men. Both the model predictions and the empirical data show a rising trend of relative market work hours between women and men. The extended model can capture about 60 percent of the growth in the relative work hours of women to men during 1965-1993. The explanatory power of the extended model increases to 75 percent for the period during 1965-2003.

5.3.2 Relative Market Work Hours of Women to Men by Marital Status

The left-hand side of Figure 1.6 documents the relative market work hours of married women to married men. There are increasing trends in both the empirical data and the model predictions. About 50 percent of the growth of relative market work hours between married women and married men can be explained by the extended model.

The right-hand side of Figure 1.6 documents the relative market work hours of single women to single men. In the extended model, the relative market work hours between single women and single men rose from 0.82 in 1965 to 0.86 in 2003, which is quite consistent with the empirical data. However, the extended model is not able to explain the slight decreases observed empirically in 1975 and 1985.
5.4 Counterfactual Experiments

In this section, I run counterfactual experiments to evaluate which factors are most important in explaining the growth of the service shares.

5.4.1 Experiment 1: Fix the Skill Intensity of Female Labor to the 1965 Level

In order to fix the skill intensity of female labor, I first compute the 1965 levels of \( \hat{\theta}_f \) and \( \hat{\theta}_1 \), and then I hold these two thresholds constant to carry out the optimization problem in 2003. Table 1.5 provides a summary about the experiment result. If the skill intensity of female labor were fixed to the 1965 level, the predicted service share in the model would decrease by 3.7 percentage points from 0.817 to 0.780 in 2003.

5.4.2 Experiment 2: Fix the Skill Intensity of Male Labor to the 1965 Level

I fix two threshold values, namely \( \hat{\theta}_m \) and \( \hat{\theta}_2 \), in order to keep the skill intensity of male labor fixed at the 1965 level. As shown in the fifth column of Table 1.5, the predicted current-value service share would decrease from 0.817 to 0.80 in 2003 if skill intensity of male labor were fixed to the 1965 level. The decrease is about half of the decrease in service shares from Experiment 1, which suggests that skill intensity of female labor plays a more important role than the skill intensity of male labor in the service sector growth.

5.4.3 Experiment 3: Fix the Skill Intensity of both Female and Male Labor to the 1965 Level

The 1965 levels of \( \hat{\theta}_f \), \( \hat{\theta}_m \), \( \hat{\theta}_1 \), and \( \hat{\theta}_2 \) are computed and held fixed in solving the optimization problem in 2003. The experiment result is provided in the sixth column of Table 1.5. When I fix the skill intensity of both female and male labor to the 1965 level,
the predicted service share would drop from 0.817 to 0.746 in 2003. The decrease is greater than the sum of the decreases from Experiment 1 and Experiment 2 (0.071 > 0.054). When the skill intensity of female (male) labor is fixed to the 1965 level, it will raise the relative wage due to skill scarcity, which will encourage more less-abled male (female) workers to acquire specialized skills and reduce the fall of service economy.

5.4.4 Experiment 4: Fix the Demographics to the 1965 Level

I fix the composition of single women, single men, and married couples to the 1965 level. The experiment result is provided in the seventh column of Table 1.5. As shown in Table 1.5, the predicted service share would drop from 0.817 to 0.80 if there were no composition change. The decrease in the service share is not substantial by fixing the demographics to the 1965 level, which is partly explained by the substantial increase in the engagement of the market production among married women.

6. Additional Empirical Implications of the Models

6.1 Skill Intensity

I measure skill intensity by the fraction of high-skilled in the population. Figure 1.7 documents the skill intensities predicted by both the BK and the extended models. As shown in Figure 1.7, both the BK and extended models are able to explain the rising trend of skill intensity. In terms of the magnitude, both of the models are able to explain about 50 percent of the increase in the skill intensity during 1965-2003.
6.2 Real GDP Per Capita Growth

The real GDP per capita growth is reported in Figure 1.8. Both the BK and the extended models can explain remarkably well the real GDP per capita growth over the three periods, 1965-1975, 1965-1985, and 1965-1993 (the average growth rate over the entire period is perfectly matched by construction).

6.3 Relative Prices of Services and Relative Wages of High-Skilled to Low-Skilled

In the BK and the extended models, there is only one relative wage measure (between high-skilled and low-skilled), so I compute the weekly wage series using the data of male workers from the Current Population Survey. In order to avoid the issue of female labor supply, I use the relative wage of college and high-school educated males as a measure of the relative wage of high-skilled to low-skilled. Figure 1.9 reports the relative prices of services and relative wages against this relative wage. Although the extended model as well as the BK model are not able to match the magnitude of the changes well, the increasing trend in the series seem to be reasonably well preserved in the models. In addition, the relative weekly wage series seems to have a cointegrated trend with the relative prices of services to commodities, as shown in Figure 1.9. The correlation between the relative weekly wage series and the relative prices series is above 0.9 in the empirical data. The extended model is able to explain the high correlation between these two series as well.

6.4 Relative Market Work hours of High-Skilled Female to High-Skilled Male

Figure 1.10 provides the comparison between the empirical data and the model predictions about the relative work hours of high-skilled females to high-skilled males.
Based on the American Time Use Survey, the relative market work hours of high-skilled female to high-skilled male increased from 0.45 to 0.70 during 1965-2003. The extended model predicts that the relative market work hours will increase from 0.74 to 0.90 during the same period. Although the extended model misses the levels, about 50% of the growth in the relative market work hours can be explained by the extended model.

6.5 Relative Market Work hours of Low-Skilled Female to Low-Skilled Male

Figure 1.11 provides the comparison between the empirical data and the model prediction about the relative work hours of low-skilled female to low-skilled male. The empirical data indicates a rising trend in the relative market work hours of low-skilled female to low-skilled male. The extended model again is able to explain about 50 percent of the growth in the relative market work hours between low-skill, female and male although the levels of the relative market work hours are also missed in the extended model.

7. Conclusion

I have shown that the BK model is a quantitatively plausible explanation for the observed growth in the share of services in the United States between 1965 and 2003. In particular, rising demand for skill, the rising scale of services, and skill deepening all play quantitatively important roles in the growth of services. Moreover, an extended model, which allows for gender and married couples, is able to replicate evidence of the particularly important role of female labor supply in the growth in services.
Table 1.1: Calibration Strategies

<table>
<thead>
<tr>
<th>Parameter</th>
<th>BK Model</th>
<th>Extended Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial relative wage</td>
<td>$A_h$</td>
<td>$A_h$</td>
</tr>
<tr>
<td>Relative wage growth, high/low skilled</td>
<td>$\lambda$</td>
<td>$\lambda$</td>
</tr>
<tr>
<td>Intermediate manuf. input to the value added of the service sector</td>
<td>$n_0$</td>
<td>$n_0$</td>
</tr>
<tr>
<td>Initial service share</td>
<td>$\gamma$</td>
<td>$\gamma$</td>
</tr>
<tr>
<td>Change in relative prices, services/manuf.</td>
<td>$g_s$</td>
<td>$g_s$</td>
</tr>
<tr>
<td>Real GDP per capita growth</td>
<td>$g_m$</td>
<td>$g_m$</td>
</tr>
<tr>
<td>Initial fraction of high-skilled</td>
<td>$beta : a$</td>
<td>$beta : a$</td>
</tr>
<tr>
<td>Ending fraction of high-skilled</td>
<td>$beta : b$</td>
<td>$beta : b$</td>
</tr>
<tr>
<td>Initial relative market work hours, married female/married male</td>
<td>$A_f$</td>
<td></td>
</tr>
<tr>
<td>Initial relative market work hours, single female/single male</td>
<td>$A_m$</td>
<td></td>
</tr>
</tbody>
</table>

Table 1.2: Calibration Results for the BK Model

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Residual (Model - Data)</th>
<th>Calibrated Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial relative wage</td>
<td>0</td>
<td>$A_h$ 1.3609</td>
</tr>
<tr>
<td>Relative wage growth, high/low skilled</td>
<td>0</td>
<td>$\lambda$ 1.00E-05*</td>
</tr>
<tr>
<td>Intermediate manuf. input to the value added of the service sector</td>
<td>0 $n_0$ 8.2440</td>
<td></td>
</tr>
<tr>
<td>Initial service share</td>
<td>0</td>
<td>$\gamma$ 0.6439</td>
</tr>
<tr>
<td>Change in relative prices, services/manuf.</td>
<td>0</td>
<td>$g_s$ 0.0167</td>
</tr>
<tr>
<td>Real GDP per capita growth</td>
<td>0</td>
<td>$g_m$ 0.0225</td>
</tr>
<tr>
<td>Initial fraction of high-skilled</td>
<td>0</td>
<td>$beta : a$ 1.6241</td>
</tr>
<tr>
<td>Ending fraction of high-skilled</td>
<td>-0.1424 (Data: 0.5556)</td>
<td>$beta : b$ 2.0199</td>
</tr>
<tr>
<td>Normalization: $A_f = 1$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: * The lower bound of $\lambda$ was reached. The calibrated parameter values will not be affected if I set a smaller positive bound for $\lambda$.  

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### Table 1.3: Counterfactual Experiments for the BK Model

<table>
<thead>
<tr>
<th></th>
<th>Data</th>
<th>the BK Model</th>
<th>Exp 1</th>
<th>Exp 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003 Nominal Service Share</td>
<td>0.7871</td>
<td>0.7913</td>
<td>0.6939</td>
<td>0.7274</td>
</tr>
</tbody>
</table>

**Notes:**
1. The 1965 nominal service share is 0.6287
2. Exp 1: fix skill intensity to the 1965 level.
3. Exp 2: fix the efficient scale of service production to the 1965 level.

### Table 1.4: Calibration Results for the Extended Model

<table>
<thead>
<tr>
<th></th>
<th>Residual (Model - Data)</th>
<th>Calibrated Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial relative wage</td>
<td>0</td>
<td>$A_h$ 1.5052</td>
</tr>
<tr>
<td>Relative wage growth, high/low skilled</td>
<td>0</td>
<td>$\lambda$ 1.00E-05*</td>
</tr>
<tr>
<td>Intermediate manuf. input to the value added of the service sector</td>
<td>0</td>
<td>$n_0$ 8.2440</td>
</tr>
<tr>
<td>Initial service share</td>
<td>0</td>
<td>$\gamma$ 0.5065</td>
</tr>
<tr>
<td>Change in relative prices, services/manuf.</td>
<td>0</td>
<td>$g_s$ 0.0150</td>
</tr>
<tr>
<td>Real GDP per capita growth</td>
<td>0</td>
<td>$g_m$ 0.0204</td>
</tr>
<tr>
<td>Initial fraction of high skilled</td>
<td>0</td>
<td>$\beta : a$ 1.3980</td>
</tr>
<tr>
<td>Ending fraction of high skilled</td>
<td>-0.1490 (Data: 0.5556)</td>
<td>$\beta : b$ 1.7585</td>
</tr>
<tr>
<td>Initial relative market work hours, married female/married male</td>
<td>0</td>
<td>$A_f$ 0.6196</td>
</tr>
<tr>
<td>Initial relative market work hours, single female/single male</td>
<td>0</td>
<td>$A_m$ 0.3725</td>
</tr>
<tr>
<td>Normalization: $A_i = 1$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:** * The lower bound of $\lambda$ was reached. The calibrated parameter values will not be affected if I set a smaller positive bound for $\lambda$.

### Table 1.5: Counterfactual Experiments for the Extended Model

<table>
<thead>
<tr>
<th></th>
<th>Data</th>
<th>Extended Model</th>
<th>Exp 1</th>
<th>Exp 2</th>
<th>Exp 3</th>
<th>Exp 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003 Nominal Service Share</td>
<td>0.7871</td>
<td>0.8170</td>
<td>0.7801</td>
<td>0.7999</td>
<td>0.7458</td>
<td>0.8010</td>
</tr>
</tbody>
</table>

**Notes:**
1. The 1965 nominal service share is 0.6287
2. Exp 1: fix the skill intensity of female labor to the 1965 level.
3. Exp 2: fix the skill intensity of male labor to the 1965 level.
4. Exp 3: fix the skill intensity of both female and male labor to the 1965 level.
5. Exp 4: fix the Demographics to the 1965 Level.
Data Source: National Income and Product Accounts. Commodities include agriculture, forestry, fishing, hunting, mining, utilities, construction, and manufacturing. Services include wholesale trade, retail trade, transportation and warehousing, information, finance, insurance, professional and business services, educational services, health care, social assistance, public administration and other services.

Figure 1.1: Risen in Services to Commodities

Figure 1.2: Sectoral Employment Share
Notes:
1. The empirical service share data were obtained from National Income and Product Accounts
2. The service share in 1965 is one of the data moments that I want to hit in the calibration, so the match between the data and the BK model is perfect in 1965 by construction.

**Figure 1.3: Service Shares**
Notes:
1. Base: Fix skill premium, skill intensity, and the scale of service production to the 1965 level.
2. Opportunity cost effect: relax skill premium to the 2003 level.
4. Scale of service production effect: relax the scale of service production to the 2003 level.
5. In each of the four elements, service and manufacturing goods are evaluated at the ending prices, which are fixed to the 2003 level.

Figure 1.4: Decomposition of Service Growth during 1965-2003
Notes:
1. The empirical relative market work hours are obtained from the American Time Use Survey.
2. I target the initial relative market work hours of married women to married men and the initial relative market work hours of single women to single men, so the predicted relative market work hours of women to men should be very close to the empirical data by construction in 1965.

Figure 1.5: Relative Market Work Hours of Women to Men
Notes:
1. The empirical relative market work hours are obtained from the American Time Use Survey.
2. I skip the year 1993 because the information about the marital status is not available from the 1993 American Time Use Survey.
3. The initial relative work hours of married women to married men and the initial relative work hours of single women to single men are targeted in the calibration.

**Figure 1.6: Relative Market Work Hours by Marital Status**
Notes:
1. The empirical data are obtained from the Current Population Survey.
2. Skill intensity is measured by the fraction of high-skilled in the population.
3. In the calibration exercise, I try to target both the initial and ending fractions of high-skilled, but I am not able to match the ending fraction of high-skilled due to the restriction on the parameter space of $\lambda_h$.

Figure 1.7: Skill Intensity
Note: The empirical data are obtained from Penn World Table 6.2.

**Figure 1.8: Real GDP Per Capita Growth**
Notes:
2. The model predictions are almost over-lapped between the extended model and the BK model, so I only report the extended model.
3. The initial and ending points are perfectly matched by construction.

Figure 1.9: Relative Prices and Relative Wages
Note: The empirical relative market work hours are obtained from the American Time Use Survey.

**Figure 1.10: Relative Market Work Hours of High-Skilled Female to High-Skilled Male**
Note: The empirical relative market work hours are obtained from the American Time Use Survey.

Figure 1.11: Relative Market Work Hours of Low-Skilled Female to Low-Skilled Male
Chapter 2: Marital Instability and Employment Instability: Evidence from the 1999 United Kingdom In-Work Benefit Reform

1. Introduction

In-work benefits in the United Kingdom (UK) are similar to the earned income tax credit in the United States. The goal is to reduce poverty by increasing work incentives of low-income families with dependent children. There have been several in-work benefit reforms since its introduction in 1971. The 1999 reform replaced the previous in-work policy, Family Credit (FC), with the Working Families’ Tax Credit (WFTC) which had substantially increased the generosity of in-work benefits and childcare support.

The 1999 in-work benefit reform is the most popularly studied program of its kind in the recent literature, but despite this attention, two important issues are ignored in the evaluation of the 1999 in-work benefit reform: (1) marital instability and (2) a partner’s employment instability. The impacts of the 1999 reform on non-single mothers are complicated by the fact that employment responses of couples are jointly determined, and so their employment decisions are not purely individual responses to higher effective wage rates and higher benefit levels to work. This joint determination process is likely affected by the degree of the stability of a marital relationship and the partner’s employment. In this paper, I use the 1999 reform as a natural experiment to examine
how the employment responses of non-single mothers are affected by marital instability and their partners’ employment instability.

The first issue is marital instability. The UK is among the countries with the highest proportions of single parents in Europe (Chambaz 2001). The rising number of single parents in the UK is the result of changing patterns of family formation and dissolution (Millar 2000). This reflects a rising degree of marital instability rather than delayed partnering. Empirical findings suggest that the anticipated risk of divorce can significantly increase a married women’s labor supply (e.g. Johnson and Skinner 1986, Gray 1995, Ono 1998, Sen 2000, Austen 2004, Papps 2006). This could be possibly due to the lack of compensation for marriage-specific investment (e.g., Peters 1986) or the lack of compensation for reduced human capital when a divorce or separation occurs (e.g., Parkman 1992). Thus they have an incentive to insure against future potential economic hardship. Moreover, the literature has shown that the 1999 reform has considerably increased the proportion and the hours worked of single mothers in employment (see, for example, the papers listed in Footnote 4). Non-single mothers facing substantially higher degree of marital instability tends to behave more like single mothers. One hypothesis tested in this paper is that non-single mothers in an unstable relationship respond more sensitively to the 1999 reform than those with a stable relationship.

The second issue is the partner’s employment instability. Employment instability includes uncertainties in labor income due to changes in job status and/or hours of work. Typically, the husband’s labor supply is taken as exogenous in estimating the married
women’s labor supply function. Much research based on this assumption has found that there was a dampening effect on wives’ work attachment when there was an increase in her husband’s earned income\(^1\) (e.g., Rosen 1976, Shapiro and Shaw 1983) or expected income (e.g., Eckstein and Wolpin 1989). By modeling the joint labor supply decisions of both husband and wife in a collective framework\(^2\), Zhang (2008) found that married couples adjust their labor supply in response to both permanent and transitory wage shocks faced by their spouses. Attanasio et al. (2005) pointed out that female labor supply played a quantitatively important role to serve as an insurance mechanism against idiosyncratic shocks to future family earnings. The second hypothesis tested is that non-single mothers with unstably employed partners respond more sensitively to the 1999 reform than do non-single mothers with stably employed partners.

I utilize a rich panel data set from the UK, the British Household Panel Survey, which covers 1997-2001 and spans significant policy changes in in-work benefits and can be used to study employment decisions of non-single mothers. The panel data set provides detailed information about the changes of marital or cohabiting statuses over the sample period, which I use to construct proxies for marital instability. The panel data set also provides detailed survey results about job security, which I use to construct a proxy for employment instability.

\(^1\) The husband’s earned income is often combined with other family income as non-labor income in the empirical analysis of married female labor supply. Although the size of income elasticity varies considerably from paper to paper, the sign is usually found to be negative, and the absolute value of income elasticity is usually bigger for women with children than for women without children. An extensive literature review about female labor supply can be found in Blundell and MaCurdy (2000).

\(^2\) The collective family labor supply model was initially developed by Chiappori (1988, 1992). It differs from the unitary model which treats the family as a single individual unit by relaxing the Slutsky symmetry and income pooling restrictions.
A difference-in-differences approach is used to examine how the employment responses to the 1999 reform differ across groups. During the 1990s, couples without dependent children were not eligible for in-work benefits. This provides two natural comparison groups: families with dependent children and families without dependent children. The difference-in-difference approach provides a simple and descriptive way to estimate the impacts of the 1999 reform. The results from the difference-in-difference approach are clearly reduced form, but provide insight about the impacts of marital and employment instability on the employment decisions of non-single mothers.³

My difference-in-difference analysis suggests that (1) there are about 10 to 14 percentage points of increase in the full-time employment of non-single mothers with unstable marriage relative to those with stable marriage as the result of the 1999 reform, and (2) there are about 10 percentage points of increase in the full-time employment of non-single mothers with unstably employed partners relative to non-single mothers with stably employed partners. Both marital and employment instability are important contributors in understanding heterogeneous employment responses among couples, and those two contributors could be potentially incorporated in a structural model to conduct more precise policy simulations.

³ The household budget constraint in the UK is well known to be nonlinear. If using a structural estimation, the common methods to deal with nonlinearity of budget constraints, such as the local linearization method and the Hausman method have been shown to be problematic (Heim and Meyer 2003). A more accepted method in the current literature is to segment continuous hours of work into a set of discrete choices, but this could ignore small changes in hours of work and it is difficult to implement marry and divorce features into the model.
1.1 Related Research

Most empirical findings suggest that the 1999 in-work reform has increased the employment rates of single parents considerably\(^4\). The findings on the employment responses of non-single parents to the 1999 in-work benefit reform are less conclusive, however. Some studies find positive employment responses (e.g., Leigh 2007), but some report that the WFTC has created work disincentives for non-single mothers (e.g., Blundell et al. 2000). While the overall effect of the 1999 reform on coupled parents is considered much smaller than on single parents (Brewer and Shephard, 2004), many suggest that non-single mothers with non-employed partners responds actively to the 1999 reform, once one conditions on partners’ current employment statuses, (e.g., Gregg et al. 1999, Blundell et al. 2005, Francesconi et al. 2009).

The existing studies in evaluating the 1999 reform assume the marital status and the partner’s employment status as exogenous and fixed. However, in reality, assuming fixed states is not realistic because non-single mothers make forward looking decisions and consider the expected durations of their marriage and their partners’ employment status in making current employment decisions. Haurin (1989) found that there was an increase in a woman’s labor supply in response to family disruptions, such as a divorce, a separation, or her husband’s unexpected unemployment. Klaauw (1996) pointed out that estimates of the labor supply function may be biased by ignoring the endogeneity of

marital status, and the same argument should also be applied to the case when ignoring the uncertainty in the partner’s employment status.

1.2 Outline of the Paper

The remaining sections are organized as follows. Section 2 provides background information about the in-work benefits system in the UK, the policy changes which I use as a natural experiment, and graphical explanations of each in-work benefit policy parameter. Section 3 explains the data set that I use for this analysis. Section 4 develops the statistical model, while Section 5 presents the empirical results. Section 6 concludes this paper.

2. The Work Benefits System in the UK

In October 1999, WFTC replaced FC and was fully phased in by April 2000. The qualifying conditions for the WFTC include three components: (1) family net assets are below £8000; (2) there is at least one dependent child in a family; (3) at least one of the family members works 16 hours or more per week.

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5 The in-work benefits system was first introduced in the UK in 1971. It was initially called Family Income Supplement (FIS) as a means-tested in-work benefit to low-income families with dependent children. FIS provided a greater economic incentive to work, but, due to the interaction with housing benefits, income tax and national insurance contribution, the effective marginal tax rate on labor income could often reach more than 100%. In order to lower the effective marginal tax rate and increase the generosity of welfare-to-work program, FIS was replaced by Family Credit (FC) in 1988. FC imposed a minimum hours of work requirement, 24 hours a week. In 1992, the minimum hours of work requirement were reduced to 16 hours a week. In 1995, an extra credit was introduced for those working more than 30 hours a week.

6 Dependent children: aged under 16, or aged 16-18 never married and in school or non-advanced further education. Family: single-parent families, married or cohabiting families with dependent children.
There are three policy parameters that determine the amount of the tax credit: the maximum credit (B), the withdraw threshold (T), and the withdraw rate (r). The formula for calculating the WFTC is specified as follows:

$$\max \{0, B - r \max\{TI - T, 0\}\}$$

where \(TI\) denotes the total family income. If the total family income is below the withdraw threshold, the maximum credit will be awarded. The total family income that is above the withdraw threshold is subject to the withdraw rate which is an implicit tax. The amount of the maximum credit depends on the number of dependent children and the total hours of work.

The WFTC reduced the withdraw rate from 70% to 55% and increased the withdraw threshold from £80.65 to £90.\(^7\) In addition, under the WFTC, 70% of childcare expenses, up to £100 (£150) a week for a family with one (more than one) dependent child, would be compensated as a payable credit if both couples work more than 16 hours per week. Under the FC, it only covered up to £60 (£100) of childcare expenses for a family with one (more than one) dependent child, and the childcare coverage was treated as the income disregard. Income disregard allowed families who use childcare services to deduct some of the childcare costs from the income assessed by the FC, so income disregard could only benefit those who earn more than the withdraw threshold. The WFTC replaced income disregard with childcare credit. The award of childcare supplement still requires both couples to work more than 16 hours a week.

\(^7\) The average annual increase in the withdraw threshold is about £1.79 during 1995 and 1999, so WFTC had substantially increased the withdraw threshold in the 1999 reform.
The WFTC substantially reduced the withdraw rate and increased the maximum credit and the withdraw threshold. In order to graphically illustrate the impact of each policy parameter, I analyze a non-single mother’s budget constraint given two separate assumptions of her partner’s fixed labor supply: (1) her partner is working at least 16 hours per week; (2) her partner is not working or is working less than 16 hours per week. In order to further simplify the illustration, I ignore the 30-hour bonus. In reality, both couples’ labor supply decisions are jointly determined, and each couple’s optimal labor supply decision is likely affected by the changes of policy parameters. Nevertheless, the graphical illustration from this section can serve as a preliminary step to examine the impact of each policy parameter.

Assuming the partner’s labor supply as fixed and given, the calculation of the WFTC can be specified as follows:

\[
\max \{0, B - r \max[I + wh - T, 0]\}
\]

where \(I\) is the partner’s labor income, \(w\) and \(h\) are the non-single mother’s wage and hours of work, respectively. Figures 2.1 and 2.2 construct a hypothetical budget constraint for Case (1) and Case (2), respectively. In both figures, line \(\overline{AB}\) denotes the budget constraint in the absence of tax credit. The horizontal axis denotes the non-single mother’s leisure, which is equal to the total available leisure minus \(h\). The vertical axis denotes the total family net income. Case (2) requires the non-single mother to work at least 16 hours per week in order to be eligible for the working tax credit. If the partner’s labor income is less than the threshold, there will exist a line segment \(\overline{ED}\), parallel to the budget constraint in the absence of working tax credit. When the total family income,
$I + wh$, exceeds the withdraw threshold, the effective wage rate of the non-single mother will be smaller than $w$. $\bar{L}$ in both Figures 2.1 and 2.2 denotes the maximum amount of leisure in which the tax credit is reduced to zero. If the non-single mother’s wage rate is low enough, it is possible for $\bar{L}$ to be smaller than zero.

Figure 2.3 illustrates a policy change when there is an increase in the maximum tax credit, $B$. The expected changes in the non-single mother’s hours of work as the result of the policy change are provided in Table 2.1. In this analysis, I assume that leisure is a normal good, so the income effect will lead to a decrease in hours of work. If the non-single mother’s initial employment choice falls within the region $\bar{CE}$ as in Figure 2.3, the non-single mother will decrease the hours of work after the policy change. It is possible for the non-single mother to lower the hours of work to zero if her partner is working at least 16 hours per week. However, if her partner is not working or is working less than 16 hours per week, it is not likely for the non-single mother to lower the hours of work to be smaller than 16.

Another observation about Figure 2.3 is that those who are in the region $\bar{C'C}$ will not be eligible for a tax credit initially, but they will be able to receive a tax credit after the policy change. The single mother who is in the region $\bar{C'C}$ is expected to decrease her hours of work after the policy change assuming that leisure is a normal good. In addition, those who are initially in the region $\bar{AC'}$ will not be eligible for tax under either the old or new policy. It is possible that some of them from the region $\bar{AC'}$ might lower their hours of work in order to take the advantage of increased tax credit and consume more leisure, but the increased tax credit will not encourage them to work longer hours.
Figures 2.4 and 2.5 illustrate the policy changes when there is an increase in the withdraw threshold and when there is a decrease in the withdraw rate, respectively. The expected changes in the single mother’s hours of work as the result of the policy changes are provided in Table 2.2 and Table 2.3, respectively. If the non-single mother initially chooses the region $\overline{DE}$ as in Figures 2.4 and 2.5, the increase in the withdraw threshold and the decrease in the withdraw rate will not affect her employment choices.

Under the policy alternatives illustrated in Figures 2.4 and 2.5, some initial employment choices are associated with both a higher tax credit and higher effective wage rate after the policy changes. This possibility does not arise under the policy alternatives illustrated in Figure 2.3. Whether the non-single mother increases or reduces her work hours will depend on the relative magnitudes of substitution and income effects.

The comparisons across Figures 2.3-2.5 show that the increase in the generosity of working tax credit can provide a greater work incentive for some individuals with non-employed partners or partners who are working less than 16 hours per week. However, if the primary earner is able to satisfy the minimum hours of work to be eligible for the working tax credit, an increase in the generosity of working tax credit can possibly encourage the secondary earner (often the wife) to switch activities from market production to domestic production. Under these conditions, an increase in the working tax credit can induce more specialized division of labor within a household production.

Whether partners choose to specialize to a greater or less degree is likely to depend on the perceived riskiness of the relationship and the partner’s expected employment status. If the relationship is fragile, each partner will likely take into account
of the possible disruption in the future and make current employment decisions accordingly. If the partner’s employment is unstable, the non-single mother will tend to put less weight on her partner’s current employment status when making her own current employment decision. Assuming the cost associated with finding a new job is not prohibitively high, non-single mothers with an unstable marital relationship or an unstably employed partner are likely to respond more sensitively to the increase in the generosity of working tax credit than are those who view their relationship as stable.

3. Data

I use the 1997-2001 British Household Panel Survey (BHPS) data collected by the ESRC UK Longitudinal Studies Centre. The BHPS consists of a nationally representative sample of more than 5000 households and includes more than 10,000 individual interviews. The first BHPS survey was conducted in 1991, and the original sample individuals have been surveyed annually. Any members (16 years or older) of new households formed by original sample individuals were surveyed as well. The sample period begins in 1997 to avoid the unemployment benefit reform that occurred in October 1996: national insurance unemployment benefits and supplementary benefits were replaced by the Jobseeker’s Allowance. The sample period ends in 2001 because in-work benefits were extended to families without dependent children in April 2003 and the 2002 BHPS survey data were collected during October 2002 and May 2003.
3.1 Composition Bias

In order to reduce composition bias, I limit the sample to non-single women who were surveyed throughout the entire sample period. As explained in Blundell and MaCurdy (2000), the validity of the difference-in-difference approach requires a stable composition of treatment and control groups before and after a policy change. If individuals in the sample are not the same before and after a policy change, individual effects might not be entirely differenced out, which can contaminate the difference-in-difference coefficient estimates. This section explores whether the estimation results might be affected by composition bias, and whether such bias might be severe enough to lead to the inconclusive findings about the policy responses of non-single mothers reported in the literature.

Figure 2.6 plots the employment rates of single mothers and non-single mothers. The employment rate of non-single mothers is substantially and persistently higher than that of single mothers. This observation holds true regardless whether we focus on a broadly or narrowly defined age group. This employment gap is puzzling, because a large number of single mothers started out as non-single mothers. There are two possible explanations for this persistently large employment gap: (1) Non-single mothers would tend to work substantially less after they become single mothers; (2) non-single mothers who are likely to become single mothers would tend to work substantially less than non-single mothers who are unlikely to become single mothers. The British

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8 Hobcraft (1989) explained that the greatest source of single parents came from divorce. Bradshaw and Millar (1991) conducted the first major survey of lone-parent families in the UK (widows and widowers were excluded in the survey), and they reported that about 66 percent of respondents had first become lone parents following a marital or cohabitating relationship.
Household Panel Survey data provides longitudinal employment histories that permit examination of the relative importance of explanations (1) and (2).

Table 2.4 reports the employment rates of non-single mothers conditional on the partnership statuses in the next two years. The non-single mothers who would be separated or divorced in the next two years have a lower employment rate than the non-single mothers who would remain as a couple in the next two years. The employment gap between them ranges from 3 to 8 percentage points. There are some non-single mothers who cannot be classified to either group because of missing statuses, as shown in the last column of Table 2.4. Although those missing data might affect the outcome in some way, the results from Table 2.4 seem to provide some evidence for (2).

Table 2.5 reports the progression of the employment rates of non-single mothers transitioning to single mothers within the next two years. All the individuals were non-single mothers at time $t$. Some of the non-single mothers became single mothers at time $t+1$, and the others became single mothers at time $t+2$. Table 2.5 shows no signs of the declining employment rates except in one out of ten cases, but the drop was fully recovered after one year. In other words, there seems to be a tendency for non-single mothers to continue engaging in the labor force after they became single mothers. The results from Table 2.5 would appear to reject (1). In Table 2.5, I only include the individuals who were observed in each of the three periods. If this restriction is relaxed, the results stay roughly the same.

Both Tables 2.4 and 2.5 show that the employment rates of non-single mothers differ by the risk of marital dissolution, which seems to be one important source for the
large and persistent employment gap between non-single mothers and single mothers. Since there are no sampling schemes to ensure a stable composition of individuals facing different risks of marital dissolution in the data collection, it is not surprising to see why some papers report negative employment responses and some papers report positive employment responses of non-single mothers to the 1999 reform. Those papers use either repeated cross-sectional data or longitudinal data without imposing any restrictions on the entry to or exit from marriage and cohabitation.

Without controlling the composition of different risk groups, the direction of the bias in the estimation of treatment effects can go either way. For example, the downward bias can be generated if there is a greater proportion of non-single mothers with a high risk of marital dissolution after the policy change than before the policy change. By the same argument, it can generate the upward bias if instead a greater proportion of non-single mothers with a high risk of marital dissolution occurred before the policy change.

3.2 Sample

In BHPS, there is a sample of 3,670 non-single mothers in 1997. Non-single mothers include those who were married or cohabiting with a partner. Although cohabiting couples share less statutory rights, they are allowed to claim social security benefits, such as the working tax credit, under the Supplementary Benefits Act 1976. My sample includes non-single women aged 18-55, which reduces the sample to 2,756 non-single mothers. I exclude the non-single mothers if they were full-time students or long-term sick or disabled during 1997-2001, which further reduces the sample to 2,540 non-
single mothers. In addition, I exclude the non-single mothers if their marital or cohabitating relationships were broken during 1998-2001, which eliminates 538 more observations. Also excluded are 355 non-single mothers with missing employment statuses during 1997-2001 and 82 with missing data on hours of work during 1997-2001, leaving a final sample of 1667 non-single mothers (8335 observations) for the analysis of participation decisions, and a final sample of 1585 non-single mothers (7925 observations) for the analysis of work-hours decisions.

3.3 Variables

I use two different measures for the marital instability. The first measure is a dummy variable that indicates whether a non-single mother is in a married or cohabiting relationship. Axinn and Thornton (1992) examined the relationship between cohabitation and vulnerability to divorce, and they found that cohabitation is selective of those who are less committed to marriage and more accepting of divorce. This self-selection argument is reported in a number of other papers (e.g., Booth and Johnson 1988, Bennett et al. 1988, Bumpass et al. 1991, Thomson and Colella 1992, DeMaris and MacDonald 1993, Lillard et al. 1995). The second measure of marital instability is a dummy variable that indicates whether a married mother has engaged in a premarital cohabitation. There is ample empirical evidence to that married couples with premarital cohabitation face higher risks of marital dissolution than married couples without premarital cohabitation (e.g., Balakrishnan et al. 1987, Teachman and Polonko 1990, DeMaris and Rao 1992,
Employment instability is measured by a survey question about job security. In each survey year, the BHPS asks every employed respondent about his or her satisfaction level of the job security in his or her present job. It is based on the scale of 1 to 7, from completely dissatisfied to completely satisfied. I use “4” as the cut-off point to separate employed respondents into two groups (“4” denotes neither satisfied nor dissatisfied in the survey question): a respondent is considered facing a low risk of employment instability if the scale level is above 4.

Regional unemployment rates are computed from the quarterly UK labor force survey. I merged those data with the BHPS data set by the corresponding surveyed quarter and region. Where there are missing data on region or home ownership in the BHPS data set, I replace the missing values with the available data nearest in time for each respondent.

I compute the maximum potential unemployment benefit that each non-single mother would be able to receive given her partner’s labor income. There are several steps involved. The first step is to estimate their partners’ full-time wage equation. A number of non-single mothers’ partners did not report their wages in each year, so I use their predicted wages instead of their actual wages to compute unemployment benefits. The estimation procedure is similar to Blau (1997). It is a fixed-effect regression. The full-time wage equation is specified as quartic in age and quadratic in years of experience and in years of tenure. The regression result is provided in Table 2.18. The fixed effect
of each respondent is included in his predicted wage in order to preserve wage variations as much as possible. The median of the predicted wages is assigned to the partners with missing full-time wages according to their education groups and survey years. The second step is to compute the partners’ net labor income by taking into account of tax and national insurance contribution. The third step is to compute the unemployment benefit given the partner’s net labor income, assuming that non-single mothers are working zero hours. This unemployment benefit variable is used in the robustness check by controlling the changes in the unemployment policy during 1997-2001.

Summary statistics of the variables used in this paper are provided in Table 2.6. There are about 87 percent of the observations that were married in the sample. Among the (currently) married women, there are about 43 percent of the observations who had cohabited prior to marriage. About 21 percent of the observations were employed during 1997-2001. In the sample population, about 43 percent of the observations worked more than 30 hours a week. There are about 37 percent of observations who had received A-level education or above. Among non-single women, about 63 percent of them were non-single mothers. There were about 25 percent of non-single women’s partners who were not satisfied with the job security of their present jobs (scale 1 to 4).

4. Statistical Model

I use difference-in-difference estimators to examine the employment responses of non-single mothers to the 1999 WFTC tax credit reform in the UK. The basic idea of difference-in-difference estimators is to compare the outcomes of two groups: the
treatment group that is affected by the reform, and the control group that is not affected by the reform. The purpose of using the control group is to provide a reference point for the changes in the treatment group as if the reform were not put in place. Once the total changes observed from the treatment group are netted out by the changes observed from the control group, the remaining part could be considered as the response to the reform.

Non-single women without dependent children are used as the control group because they were not eligible for the working tax credit (at least not until 2003). The treatment group is defined as non-single mothers. Let $y$ be an employment outcome variable, $I$ be the indicator of the post-reform period (= 1 if it is in the post-reform period; 0 otherwise), and $d$ be the group indicator (= 1 if treatment group; 0 otherwise). Then, the treatment effect can be specified as follows:

$$E[y|I = 1, d = 1] - E[y|I = 0, d = 1] - E[y|I = 1, d = 0] - E[y|I = 0, d = 0]$$

More specifically, the treatment effect can be directly estimated based on the following regression:

$$y = \alpha_0 + \alpha_1 d + \alpha_2 I + \beta d \cdot I + u$$  \[1\]

where $\alpha_0$, $\alpha_1$, $\alpha_2$, and $\beta$ are the coefficients and $u$ represents an unobservable component of the regression. $\beta$ captures the treatment effect.

The goal of this paper is to estimate the difference in the employment responses between two sub-groups, for example, non-single mothers with high marital instability vs. non-single mothers with low marital instability. Another example is the comparison

---

9 There are three different employment outcome variables studied: (1) employment, which is equal to 1 if employed, 0 otherwise; (2) eligible employment, which is equal to 1 if working 16 hours or more a week, 0 otherwise; (3) full-time employment, which is equal to 1 if working 30 hours or more a week, 0 otherwise.
between non-single mothers with unstably employed partners and non-single mothers with stably employed partners. Let $Q$ be 1 if a non-single mother faces high marital instability (or has an unstably employed partner), and zero otherwise.

$$y = \alpha_0 + \alpha_1 d + \alpha_2 I + \alpha_3 Q + \alpha_4 Q \cdot I + \alpha_5 Q \cdot d + b d \cdot I + \beta Q \cdot d \cdot I + u \quad [2]$$

The treatment effect for $Q = 0$ is $b$, and the treatment effect for $Q = 1$ is $b + \beta$. Therefore, $\beta$ captures the difference between the two treatment effects, which is the interest of my study. $\beta$ can be considered as a different-in-difference-in-difference estimator below.

$$\left\{ \frac{(E[y|I = 1, d = 1, Q = 1] - E[y|I = 0, d = 1, Q = 1])}{E[y|I = 1, d = 0, Q = 1] - E[y|I = 0, d = 0, Q = 1]} \right\} - \left\{ \frac{(E[y|I = 1, d = 1, Q = 0] - E[y|I = 0, d = 1, Q = 0])}{E[y|I = 1, d = 0, Q = 0] - E[y|I = 0, d = 0, Q = 0]} \right\}$$

In order for a difference-in-difference estimator to identify the impacts of the in-work benefit reform, it requires that there are no other policy shocks that would affect control and treatment groups differently during the sample period. As pointed out by Blundell et al. (2005), this assumption is not likely to be satisfied because there was an increase in the child benefits from the income support and the jobseeker’s allowance (unemployment benefits) between 1998 and 1999 and the National Minimum Wage was implemented in April 1999. The National Minimum Wage may not affect the control group and the treatment group differently. However, it might not be true for the changes in unemployment benefits because the amount of unemployment benefits increases as the number of dependent children increases. Therefore, the increase in the generosity of unemployment benefits could possibly attenuate the treatment effect. As a robustness
check, I include the measure of the unemployment benefits in the regression in order to capture the changes in the unemployment benefits policy.

Another assumption about the difference-in-difference estimator is that the change in the treatment group would be identical to the change in the control group if the reform had not occurred. In other words, the time effects must be common in both the treatment and control groups. This is a relatively strong assumption, but it becomes more reasonable when the observable characteristics and the individual fixed effects are controlled for in the regressions. The extension of [2] is specified as follows.

$$y_{it} = \alpha_0 + \eta_i + X'_{it} \gamma + \alpha_1 d_{it} + \alpha_2 I(1999 < t) + \alpha_3 Q_{it} + \alpha_4 Q_{it} \cdot I(1999 < t) + \alpha_5 Q_{it} \cdot d_{it} + b d_{it} \cdot I(1999 < t) + \beta Q_{it} \cdot d_{it} \cdot I(1999 < t) + u_{it} \quad [3]$$

where $\beta$ captures the differences between $Q = 1$ and $Q = 0$ in the employment responses to the 1999 reform and $\eta_i$ denotes the individual dummies. $X$ is a vector of control variables, which include regional female unemployment rates, number of dependent children in four age-groups, housing tenure, quartic polynomials in ages. In order to accommodate group-specific time trends, I further augment equation [3] as follows:

$$y_{it} = \alpha_0 + \eta_i + v_t + X'_{it} \gamma + \delta_t d_{it} + \phi_t Q_{it} + \alpha_3 Q_{it} \cdot d_{it} + \beta Q_{it} \cdot d_{it} \cdot I(1999 < t) + u_{it} \quad [4]$$

where $v_t$ denotes the time dummies. The direct dummy, $I(1999 < t)$, is no longer needed since [4] includes a full set of time dummies. One key difference between [3] and [4] is that [4] allows $d_{it}$ and $Q_{it}$ to interact with a full set of time dummies. Both [3] and
[4] are estimated by least squares\textsuperscript{10}. The standard errors are corrected using a robust covariance estimator as developed by Liang and Zeger (1986).

5. Empirical Results

I test the hypothesis that non-single mothers in less stable relationships have a greater employment response to the 1999 reform. I use two measures of marital stability: (1) cohabitation vs. marriage, and (2) with premarital cohabitation vs. without premarital cohabitation among married women. I also test the hypothesis that non-single mothers with less stably employed partners have a greater employment response to the 1999 reform. Employment instability is measured by the reported satisfaction level of job security. The estimation results are presented in Tables 2.7-2.17. The coefficients of $\beta$ from those tables are not the total effects of the employment responses to the 1999 reform. Those coefficients measure the differences between the group with $Q = 1$ and the group with $Q = 0$ in the employment responses to the 1999 reform.

5.1 Marital Instability: Cohabitation vs. Marriage

A. Benchmark Estimates

The estimation results are reported in Table 2.7. $Q$ is set to be 1 if the non-single women are in cohabiting relationships, and zero otherwise. There are three employment

\textsuperscript{10} Fixed effects in a nonlinear model generally cause inconsistency as the number of individuals increases with the number of time periods fixed. This problem is usually called the incidental parameters problem. By estimating [3] and [4] using least squares, I treat them as a linear probability model. Although the model does not bound probabilities between 0 and 1, it is free of the incidental parameters problem. A binary panel logit model is an alternative, but fixed effects will drop all the individuals who did not alter their employment statuses throughout the sample period.
outcomes studied: employment, eligible employment, and full-time employment. Eligible employment refers to the requirement of at least 16 hours of work in order to be eligible for the working tax credit. There is an additional bonus if recipients of the working tax credit move from eligible employment to full-time employment (30 hours or above per week).

As shown in Table 2.7, there are about 10 percentage points of increase in the full-time employment among cohabiting mothers relative to married mothers. However, the estimates of the treatment effects for employment and eligible employment are not statistically significant. It implies that the source of the increase in the relative full-time employment is likely from those who had initially worked between 16 and 30 hours a week before the reform was implemented.

In Table 2.7, all the coefficient estimates of the number of young children, aged below 11, are negative and statistically significant. Those estimates imply that non-single women with young children tend to be less employed or work substantially less than the non-single women without young children. However, the differences in the employment outcomes become smaller or statistically insignificant in terms of the presence of older children, aged 11 or above.

B. Heterogeneous Responses

This section reports the estimation results by the two age groups and by the two education groups. I use age 35 to divide the sample population into two age groups. The estimation results are provided in the upper panel of Table 2.8. Among the younger
population, there is a substantial increase in the employment rate of cohabiting mothers relative to married mothers. The increase is the largest in the relative full-time employment. However, among the older population, none of the estimates of treatment effect are statistically significant. The comparison between the younger and older populations is consistent with an explanation that younger cohabiting mothers might face greater marital instability than older cohabiting mothers in general, which could have motivated the younger ones to respond more actively to the 1999 reform.

The lower panel of Table 2.8 reports the estimation results by the two education groups. The more educated group is defined of those who have received A-level education or above. As shown in Table 2.8, among the more educated group, there is a substantial increase in the full employment of cohabiting mothers relative to married mothers. However, among the less educated group, there is a substantial increase in the relative eligible employment, but not the relative full-time employment. The observations from Table 2.8 are similar to the employment behavior of single women who tend to engage in more regular full-time jobs with a higher degree of education (see Figure 2.7). If a marital dissolution occurs, a non-single mother would transition to single-mother status. Non-single mothers with a greater degree of marital instability appear to behave more like single mothers in their employment decisions.
5.2 Marital Instability: Premarital Cohabitation

A. Benchmark Estimates

This section focuses on only married mothers by examining the impacts of premarital cohabitation on the employment responses to the 1999 reform. As explained in Section 3.3, a large number of studies show that married couples with premarital cohabitation face a higher risk of marital dissolution than those who marry directly. Many explanations are provided from the literature. Two of them are the most common explanations: (1) self-selection, and (2) the cohabitation experience that could change their views about the commitment to the marital institution. By the same arguments as in Section 5.1, married mothers with premarital cohabitation would respond more actively to the 1999 reform than married mothers without premarital cohabitation.

Besides premarital cohabitation, many papers report that the risk of dissolution becomes smaller as the duration of union increases (e.g., Thornton and Rodgers 1987). The impact of premarital cohabitation could be attenuated with a longer duration of union. Therefore, in this analysis, I only include those who began living with their partners after 1990. The estimation results are provided in Table 2.9. \( Q \) is set to be 1 if the married women have engaged in cohabitation prior to their marriages, and zero otherwise. As shown in Table 2.9, married mothers with premarital cohabitation respond much more substantially to the reform than married mothers who marry directly without cohabitation. The increase in the relative full-time employment is about 14 percentage points which is roughly comparable to the estimate from Section 5.1.
B. Heterogeneous Responses

Similar to Section 5.1.B, I report the estimation results by two age groups and by two education groups. The estimation results by the two age groups are reported in the upper panel of Table 2.10. Among the younger population, there are substantial increases in the three relative employment outcomes, but only the increase in the relative employment rate of married mothers with premarital cohabitation is statistically significant.

The estimation results by the two education groups are reported in the lower panel of Table 2.10. Among the more educated group, married mothers with premarital cohabitation respond more substantially to the reform in the full-time employment than married mothers without premarital cohabitation. This finding is similar to the comparison based on the cohabitation and marriage as in Section 5.1.B. Among the less educated group, married mothers with premarital cohabitation respond more actively in the eligible employment, but not the full-time employment. This also echoes the finding from Section 5.1.B. Although Sections 5.1 and 5.2 measure the marital instability in different dimensions, the qualitative conclusions from these two sections are the same.

5.3 Employment Instability: Job Security

A. Benchmark Estimates

The reported satisfaction level of job security is used as a proxy for the employment instability. I restrict the sample to non-single women with partners who were employed during 1991-2001. Non-single women with self-employed partners are
excluded\textsuperscript{11}. The estimation results are reported in Table 2.11. $Q$ is set to be 1 if the partners of non-single women are unstably employed, and zero otherwise. As shown in Table 2.11, there is about a 9 percentage point of increase in the eligible employment of non-single mothers with unstably employed partners relative to non-single mothers with stably employed partners. The relative increase in the full-time employment is also statistically significant, which is about 10 percentage points. However, the estimate of the treatment effect for the employment decision is not significant. Those estimates imply that the source of the increases might be mainly from those who had initially worked between 0 and 16 hours a week before the reform was implemented.

All the coefficient estimates of the numbers of young children, aged 11 or below, are negative and statistically significant. It is similar to the findings from Sections 5.1 and 5.2 about young children. The coefficient estimate of the number of young children, aged between 16 and 19, is positive and statistically significant in the full-time employment. It implies that non-single women with employed partners have a greater tendency to work full-time in the presence of older children.

\textit{B. Heterogeneous Responses}

The estimation results by the two age groups are reported in the upper panel of Table 2.12. In both age groups, there are significant and substantial increases in the full-time employment of non-single mothers with unstably employed husbands compared to non-single mothers with stably employed husbands. It is a different finding from section

\textsuperscript{11} In section 5.4, I provide the estimation results by including the self-employed partners as a robustness check.
5.1 and 5.2 because the increases in the relative full-time employment are not significant among the older age group in the analysis of marital stability.

The estimation results by the two education groups are reported in the lower panel of Table 2.12. Among the more educated group, there are substantial and significant increases in the employment rate and the full-time employment of non-single mothers with unstably employed partners relative to non-single mothers with stably employed partners. Among the less educated group, the increase in the relative eligible employment is substantial and significant, which is similar to the finding from marital instability. However, unlike women in the unstable marital category, the increase in the relative full-time employment among the less educated group is also substantial and significant.

5.4 Robustness Check

During the sample period, unemployment benefits became more generous over time. Since the amount of unemployment benefits varies with the number of dependent children, the changes in the unemployment benefits could affect the estimates of treatment effect. As a robustness check, I compute the maximum amount of unemployment benefits that a non-single mother could receive given her partner’s labor income, and I use it as an additional regressor. The estimation results are provided in Table 2.13. The coefficient estimates of unemployment benefits are negative as expected, but none of them are statistically significant. The estimates of the treatment effects are close to those reported in Table 2.7.
In the sample population, some of the cohabiting women had become married. As a robustness check, I redefine \( Q \), which is set to be 1 if the non-single women are in cohabitation relationships *consistently* during the sample period, zeros otherwise. Those who switched from cohabitation to marriage will be counted to the group with \( Q = 0 \). By this definition, there will be no switches between the group with \( Q = 0 \) and the group with \( Q = 1 \) during the sample period. The estimation results are provided in Table 2.14. By comparing the results from Tables 2.7 and 2.14, they are very similar, especially the estimates of the treatment effect on full-time employment.

During the sample period, not all the partners of non-single women are consistently satisfied or dissatisfied with their job security. As a robustness check, I redefine \( Q \), which is set to be 0 if the partners of non-single women are *continuously* satisfied with their job security during the sample period, ones otherwise. By the new definition of \( Q \), there will be no switches between the two different \( Q \) groups during the sample periods. The estimation results are provided in Table 2.15. The estimates of the treatment effects on the full-time employment are almost the same between Tables 2.11 and 2.15. The estimates of the treatment effects on the part-time employment are still highly statistically significant, but its values are about 2.5 percentage-points larger than those reported in Table 2.11.

In Section 5.3, I use the current satisfaction level of job security as a proxy for employment instability. It is likely that non-single mothers might respond more to a perceived permanent change in their partners’ employment instability than to a perceived temporary change. As a robustness check, I redefine \( Q \) as follows: set \( Q \) to be 1 if the
partners of non-single women are not satisfied with their job security in both current and previous years. The estimation results are provided in Table 2.16. The estimates of the treatment effect in the full-time employment are significant as in Table 2.11, but it is about 5 percentage-points larger than the estimates reported in Table 2.11. This is consistent with the hypothesis that non-single mothers should respond more to perceived persistent employment instability of their partners than to transitory episodes.

In section 5.3, I exclude the non-single women with self-employed partners. As a robustness check, I include those observations and re-run the regressions reported in Table 2.11. The estimation results are provided in Table 2.17. The estimates of the treatment effects in the full-time employment are still significant, but their values are 3 percentage-points smaller than those reported in Table 2.11. Unlike Table 2.11, the treatment effects on the eligible employment category are no longer significant, but their estimates are still relatively close to those reported in Table 2.11.

6. Conclusion

This paper uses British Household Panel Survey data to examine how marital instability and employment instability affect the employment responses of non-single mothers to the 1999 in-work benefit reform. Using a difference-in-difference approach, I find that non-single mothers with unstable marriage responded more actively to the reform than do non-single mothers with stable marriage. The increase in relative full-time employment responses is about 10 to 14 percentage points. I also find that the full-time employment response to the reform is about 10 percentage-points larger among non-
single mothers with unstably employed partners than among non-single mothers with stably employed partners. Through the investigation of the different sub-population groups, I document substantially heterogeneous employment responses across ages and education levels to the 1999 in-work benefit reform.

My results provide a potential explanation for the inconclusive findings about the effect of the 1999 reform on the employment of non-single mothers in previous research. The persistent and large employment gap between non-single mothers and single mothers is, at least partly, arising from the fundamentally lower employment rate of non-single mothers who are likely to leave their relationship in the near future. Thus, estimates of treatment effects on non-single mothers can easily be contaminated by the heterogeneous composition of non-single mothers according to variation in the risk of dissolution of their relationships. For the papers that use repeated cross-sectional data (e.g., Blundell et al. 2005) or the papers that use unbalanced panel data (e.g., Francesconi et al. 2009), it is likely that the heterogeneous composition of non-single mothers would not remain stable before and after a policy change. This will cause either upward or downward bias in the estimates of treatment effects depending on whether the proportion of the high risk group is smaller or bigger after the policy change than before the policy change.

My results support the hypothesis that marital instability and employment instability are important contributors to substantial differences in employment responses among non-single mothers to the 1999 in-work benefit reform. These contributors are strong candidates for incorporation in structural models for conducting policy simulations on the in-work benefit reforms. My results suggest that the success of the 1999 in-work
benefit reform to boost the employment rate of single mothers is related in an important way to the substantial increase in the work attachment of non-single mothers in unstable relationships. Blundell (2002) explained that a central stimulus for the in-work benefit reforms in the UK is due to the persistently low work attachment of single mothers. My paper provides an important message for designing the policies that aim to increase the work incentives of single mothers: non-single mothers cannot be ignored because the low employment rate of single mothers is partly related to the low employment rate of non-single mothers facing high risk of marital dissolution.
### Table 2.1: Increase in the maximum tax credit

<table>
<thead>
<tr>
<th>Wife’s initial hours of work</th>
<th>Expected changes in the wife’s hours of work after the policy change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case one: Husband’s Hours of Work Per Week ≥ 16</td>
<td></td>
</tr>
<tr>
<td>0 ≤ h ≤ L − L̅</td>
<td>Decrease</td>
</tr>
<tr>
<td>L − L̅ ≤ h ≤ L − L′</td>
<td>Decrease</td>
</tr>
<tr>
<td>L − L′ ≤ h ≤ L</td>
<td>Non-increase</td>
</tr>
</tbody>
</table>

| Case two: Husband’s Hours of Work Per Week < 16 |
| 0 ≤ h ≤ 16 | Increase to 16 or more hours a week, or stay the same |
| 16 ≤ h ≤ L − L̅ | Decrease |
| L − L̅ ≤ h ≤ L − L′  | Decrease |
| L − L′ ≤ h ≤ L        | Non-increase |

Notes:
1. See the corresponding Figure 2.3 for more details
2. I assume that the leisure is a normal good.

### Table 2.2: Increase in the withdraw threshold

<table>
<thead>
<tr>
<th>Wife’s initial hours of work</th>
<th>Expected changes in the wife’s hours of work after the policy change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case one: Husband’s Hours of Work Per Week ≥ 16</td>
<td></td>
</tr>
<tr>
<td>0 ≤ h ≤ L − L_1</td>
<td>No Change</td>
</tr>
<tr>
<td>L − L_1 ≤ h ≤ L − L_2</td>
<td>Undetermined</td>
</tr>
<tr>
<td>L − L_2 ≤ h ≤ L − L̅</td>
<td>Decrease</td>
</tr>
<tr>
<td>L − L̅ ≤ h ≤ L − L′</td>
<td>Decrease</td>
</tr>
<tr>
<td>L − L′ ≤ h ≤ L</td>
<td>Non-increase</td>
</tr>
</tbody>
</table>

| Case two: Husband’s Hours of Work Per Week < 16 |
| 0 ≤ h ≤ 16 | Increase to 16 or more hours a week, or stay the same |
| 16 ≤ h ≤ L − L_1 | No Change |
| L − L_1 ≤ h ≤ L − L_2 | Undetermined |
| L − L_2 ≤ h ≤ L − L̅  | Decrease |
| L − L̅ ≤ h ≤ L − L′  | Decrease |
| L − L′ ≤ h ≤ L        | Non-increase |

Notes:
1. See the corresponding Figure 2.4 for more details
2. I assume that the leisure is a normal good.
Table 2.3: Decrease in the withdraw rate

<table>
<thead>
<tr>
<th>Wife’s initial hours of work</th>
<th>Expected changes in the wife’s hours of work after the policy change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case one: Husband’s Hours of Work Per Week ≥ 16</td>
<td></td>
</tr>
<tr>
<td>0 ≤ h ≤ L_1</td>
<td>No Change</td>
</tr>
<tr>
<td>L_1 ≤ h ≤ L_1</td>
<td>Undetermined</td>
</tr>
<tr>
<td>L ≤ L_1 ≤ h ≤ L</td>
<td>Decrease</td>
</tr>
<tr>
<td>L ≤ L_1 ≤ h ≤ L</td>
<td>Non-increase</td>
</tr>
<tr>
<td>Case two: Husband’s Hours of Work Per Week &lt; 16</td>
<td></td>
</tr>
<tr>
<td>0 ≤ h ≤ 16</td>
<td>Increase to 16 or more hours a week, or stay the same</td>
</tr>
<tr>
<td>16 ≤ h ≤ L_1</td>
<td>No Change</td>
</tr>
<tr>
<td>L_1 ≤ h ≤ L_1</td>
<td>Undetermined</td>
</tr>
<tr>
<td>L ≤ L_1 ≤ h ≤ L</td>
<td>Decrease</td>
</tr>
<tr>
<td>L ≤ L_1 ≤ h ≤ L</td>
<td>Non-increase</td>
</tr>
</tbody>
</table>

Notes:
1. See the notes of Figure 2.5 for more details
2. I assume that the leisure is a normal good.

Table 2.4: Employment rates of non-single mothers conditional on the partnership statuses in the next two years

<table>
<thead>
<tr>
<th></th>
<th>Remained as a couple in the next two years</th>
<th>Divorced or separated in the next two years</th>
<th>Missing Statuses in the next two years</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997</td>
<td>0.69</td>
<td>0.65</td>
<td>0.59</td>
</tr>
<tr>
<td>N</td>
<td>1140</td>
<td>91</td>
<td>39</td>
</tr>
<tr>
<td>1998</td>
<td>0.70</td>
<td>0.67</td>
<td>0.69</td>
</tr>
<tr>
<td>N</td>
<td>1136</td>
<td>78</td>
<td>49</td>
</tr>
<tr>
<td>1999</td>
<td>0.70</td>
<td>0.64</td>
<td>0.70</td>
</tr>
<tr>
<td>N</td>
<td>1119</td>
<td>70</td>
<td>50</td>
</tr>
<tr>
<td>2000</td>
<td>0.70</td>
<td>0.62</td>
<td>0.57</td>
</tr>
<tr>
<td>N</td>
<td>1126</td>
<td>82</td>
<td>44</td>
</tr>
<tr>
<td>2001</td>
<td>0.70</td>
<td>0.67</td>
<td>0.65</td>
</tr>
<tr>
<td>N</td>
<td>1132</td>
<td>101</td>
<td>46</td>
</tr>
</tbody>
</table>

Notes:
1. The employment rates are computed from the British Household Panel Survey data.
2. The 1999 Scotland and Wales booster sample and the 2001 Northern Ireland booster sample are excluded because their data are not available before 1999.
Table 2.5: Employment rates of non-single mothers transitioning to single mothers within the next two years

<table>
<thead>
<tr>
<th>Year</th>
<th>t</th>
<th>t + 1</th>
<th>t + 2</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997</td>
<td>0.67</td>
<td>0.71</td>
<td>0.74</td>
<td>66</td>
</tr>
<tr>
<td>1998</td>
<td>0.65</td>
<td>0.60</td>
<td>0.67</td>
<td>63</td>
</tr>
<tr>
<td>1999</td>
<td>0.64</td>
<td>0.64</td>
<td>0.66</td>
<td>59</td>
</tr>
<tr>
<td>2000</td>
<td>0.62</td>
<td>0.74</td>
<td>0.74</td>
<td>61</td>
</tr>
<tr>
<td>2001</td>
<td>0.66</td>
<td>0.68</td>
<td>0.71</td>
<td>77</td>
</tr>
</tbody>
</table>

Notes:
1. The employment rates are computed from the British Household Panel Survey data.
2. The 1999 Scotland and Wales booster sample and the 2001 Northern Ireland booster sample were excluded because there are no data for those sampled individuals before 1999.
3. At time t, all the individuals were non-single mothers; some of them became single mothers at time t+1, and the others became single mothers at time t+2.
4. Only the individuals who existed in the entire three periods are included. If this restriction is relaxed, the results will stay roughly the same, and the employment rate from the second column of Table 2.5 will be exactly the same as the third column of Table 2.4.
Table 2.6: Summary Statistics

<table>
<thead>
<tr>
<th>Category</th>
<th>Num.</th>
<th>Percent</th>
<th>Category</th>
<th>Num.</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Married</td>
<td>7252</td>
<td>87.01</td>
<td>Without dependent Children</td>
<td>3143</td>
<td>37.71</td>
</tr>
<tr>
<td>With Premarital Cohabitation(^1)</td>
<td>2782</td>
<td>42.95</td>
<td>With dependent Children</td>
<td>5192</td>
<td>62.29</td>
</tr>
<tr>
<td>Without Premarital Cohabitation(^1)</td>
<td>3695</td>
<td>57.05</td>
<td>Age: [0, 1)</td>
<td>487</td>
<td>5.84</td>
</tr>
<tr>
<td>Cohabitation</td>
<td>1083</td>
<td>12.99</td>
<td>Age: [1, 11)</td>
<td>3710</td>
<td>44.51</td>
</tr>
<tr>
<td>Employment</td>
<td></td>
<td></td>
<td>Age: [11, 16)</td>
<td>2164</td>
<td>25.96</td>
</tr>
<tr>
<td>Non-employed</td>
<td>1727</td>
<td>20.72</td>
<td>Age: [16, 19)</td>
<td>483</td>
<td>5.79</td>
</tr>
<tr>
<td>Employed</td>
<td>6608</td>
<td>79.28</td>
<td>Housing tenure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employed, (\geq 16) h per week</td>
<td>5454</td>
<td>66.25</td>
<td>Owner</td>
<td>6795</td>
<td>81.52</td>
</tr>
<tr>
<td>Employed, (\geq 30) h per week</td>
<td>3543</td>
<td>43.04</td>
<td>In Social Housing</td>
<td>1104</td>
<td>13.25</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td>In privately rented housing</td>
<td>436</td>
<td>5.23</td>
</tr>
<tr>
<td>Higher Degree</td>
<td>180</td>
<td>2.17</td>
<td>Partner's Job Security</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st Degree</td>
<td>822</td>
<td>9.92</td>
<td>1 (completely dissatisfied)</td>
<td>187</td>
<td>2.77</td>
</tr>
<tr>
<td>HNC/HND, teaching qualifications</td>
<td>604</td>
<td>7.29</td>
<td>2</td>
<td>234</td>
<td>3.47</td>
</tr>
<tr>
<td>A Levels</td>
<td>1521</td>
<td>18.36</td>
<td>3</td>
<td>528</td>
<td>7.82</td>
</tr>
<tr>
<td>O Levels</td>
<td>2763</td>
<td>33.35</td>
<td>4 (neither satisfied nor dissatisfied)</td>
<td>717</td>
<td>10.62</td>
</tr>
<tr>
<td>CSE</td>
<td>728</td>
<td>8.79</td>
<td>5</td>
<td>1433</td>
<td>21.22</td>
</tr>
<tr>
<td>No qualification</td>
<td>1667</td>
<td>20.12</td>
<td>6</td>
<td>2422</td>
<td>35.87</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td>7 (completely satisfied)</td>
<td>1231</td>
<td>18.23</td>
</tr>
<tr>
<td>18-30</td>
<td>1466</td>
<td>17.59</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30-40</td>
<td>3339</td>
<td>40.06</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40-55</td>
<td>3530</td>
<td>42.35</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>8335</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes:
1. In 1999, Scotland and Wales booster sub-samples were added to the BHPS. I exclude them in computing the proportions of married women with premarital cohabitation or without premarital cohabitation because the booster sub-samples do not provide marital history data.
### Table 2.7: The Impacts of Marital Instability Based on Cohabitation vs. Marriage

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Basic</td>
<td>Extended</td>
<td>Basic</td>
<td>Extended</td>
</tr>
<tr>
<td><strong>Treatment Effect, ( \beta )</strong></td>
<td>0.047 (0.037)</td>
<td>0.041 (0.037)</td>
<td>0.059 (0.049)</td>
<td>0.057 (0.049)</td>
</tr>
<tr>
<td>Female Unemployment Rate</td>
<td>0.226 (0.441)</td>
<td>0.241 (0.442)</td>
<td>-0.103 (0.494)</td>
<td>-0.084 (0.496)</td>
</tr>
<tr>
<td>Number of Dep. Children</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age: [0, 1)</td>
<td>-0.118*** (0.023)</td>
<td>-0.118*** (0.023)</td>
<td>-0.112*** (0.023)</td>
<td>-0.111*** (0.023)</td>
</tr>
<tr>
<td>Age: [1, 11)</td>
<td>-0.057*** (0.017)</td>
<td>-0.057*** (0.017)</td>
<td>-0.103*** (0.018)</td>
<td>-0.103*** (0.018)</td>
</tr>
<tr>
<td>Age: [11, 16)</td>
<td>-0.006 (0.016)</td>
<td>-0.009 (0.016)</td>
<td>-0.043** (0.018)</td>
<td>-0.044** (0.018)</td>
</tr>
<tr>
<td>Age: [16, 19)</td>
<td>-0.011 (0.017)</td>
<td>-0.014 (0.017)</td>
<td>0.001 (0.018)</td>
<td>0.000 (0.018)</td>
</tr>
<tr>
<td>Housing Tenure</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In Social Housing</td>
<td>-0.047 (0.036)</td>
<td>-0.045 (0.035)</td>
<td>-0.066* (0.036)</td>
<td>-0.065* (0.036)</td>
</tr>
<tr>
<td>In privately rented housing</td>
<td>-0.031 (0.028)</td>
<td>-0.033 (0.028)</td>
<td>-0.009 (0.031)</td>
<td>-0.011 (0.031)</td>
</tr>
<tr>
<td>Observations</td>
<td>8335 (0.028)</td>
<td>8335 (0.028)</td>
<td>7925 (0.031)</td>
<td>7925 (0.031)</td>
</tr>
</tbody>
</table>

Notes:
1. “Basic” refers to the regression model [3] in the text, which includes individual dummies. “Extended” refers to the regression model [4] in the text, which includes individual dummies, time dummies, interaction terms between group indicators and a full set of time dummies. The coefficient estimates of the time dummies, the individual dummies, the interaction terms and the age variables are not reported. The default category in Housing Tenure is Owner.
2. Dependent variables: (1) employment, which is equal to 1 if employed, 0 otherwise; (2) eligible employment, which is equal to 1 if working 16 hours or more a week, 0 otherwise; (3) full-time employment, which is equal to 1 if working 30 hours or more a week, 0 otherwise.
4. \( \beta \) captures the difference between the cohabiting mothers and the married mothers in their employment responses to the 1999 reform.
5. * significant at 10%; ** significant at 5%; *** significant at 1%. Cluster-robust standard errors are in parentheses.
Table 2.8: The Impacts of Marital Instability Based on Cohabitation vs. Marriage, by Subgroups

<table>
<thead>
<tr>
<th>Age: 18-35</th>
<th>(1) Employed</th>
<th>(2) Employed, ≥ 16h a week</th>
<th>(3) Employed, ≥ 30h a week</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Basic</td>
<td>Extended</td>
<td>Basic</td>
</tr>
<tr>
<td>Treatment Effect, β</td>
<td>0.141***</td>
<td>0.130**</td>
<td>0.136**</td>
</tr>
<tr>
<td>(0.051)</td>
<td>(0.051)</td>
<td>(0.060)</td>
<td>(0.060)</td>
</tr>
<tr>
<td>Observations</td>
<td>2295</td>
<td>2295</td>
<td>2225</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age: 35-55</th>
<th>(1) Employed</th>
<th>(2) Employed, ≥ 16h a week</th>
<th>(3) Employed, ≥ 30h a week</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Basic</td>
<td>Extended</td>
<td>Basic</td>
</tr>
<tr>
<td>Treatment Effect, β</td>
<td>-0.038</td>
<td>-0.039</td>
<td>0.002</td>
</tr>
<tr>
<td>(0.059)</td>
<td>(0.059)</td>
<td>(0.087)</td>
<td>(0.087)</td>
</tr>
<tr>
<td>Observations</td>
<td>4510</td>
<td>4510</td>
<td>4245</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Education: A level or above</th>
<th>(1) Employed</th>
<th>(2) Employed, ≥ 16h a week</th>
<th>(3) Employed, ≥ 30h a week</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Basic</td>
<td>Extended</td>
<td>Basic</td>
</tr>
<tr>
<td>Treatment Effect, β</td>
<td>0.060</td>
<td>0.058</td>
<td>-0.010</td>
</tr>
<tr>
<td>(0.071)</td>
<td>(0.068)</td>
<td>(0.082)</td>
<td>(0.081)</td>
</tr>
<tr>
<td>Observations</td>
<td>3055</td>
<td>3055</td>
<td>2815</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Education: below A level</th>
<th>(1) Employed</th>
<th>(2) Employed, ≥ 16h a week</th>
<th>(3) Employed, ≥ 30h a week</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Basic</td>
<td>Extended</td>
<td>Basic</td>
</tr>
<tr>
<td>Treatment Effect, β</td>
<td>0.010</td>
<td>0.006</td>
<td>0.104*</td>
</tr>
<tr>
<td>(0.046)</td>
<td>(0.046)</td>
<td>(0.061)</td>
<td>(0.062)</td>
</tr>
<tr>
<td>Observations</td>
<td>5090</td>
<td>5090</td>
<td>4930</td>
</tr>
</tbody>
</table>

Notes:
1. “Basic” refers to the regression model [3] in the text, which includes individual dummies. “Extended” refers to the regression model [4] in the text, which includes individual dummies, time dummies, interaction terms between group indicators and a full set of time dummies. The coefficient estimates of the dummy variables, the interaction terms and the control variables are not reported.
2. Dependent variables: (1) employment, which is equal to 1 if employed, 0 otherwise; (2) eligible employment, which is equal to 1 if working 16 hours or more a week, 0 otherwise; (3) full-time employment, which is equal to 1 if working 30 hours or more a week, 0 otherwise.
4. β captures the difference between the cohabiting mothers and the married mothers in their employment responses to the 1999 reform.
5. + significant at 11%; * significant at 10%; ** significant at 5%; *** significant at 1%. Cluster-robust standard errors are in parentheses.
Table 2.9: The Impacts of Marital Instability Based on Premarital Cohabitation

<table>
<thead>
<tr>
<th></th>
<th>(1) Employed</th>
<th>(2) Employed, ≥ 16h a week</th>
<th>(3) Employed, ≥ 30h a week</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Basic</td>
<td>Extended</td>
<td>Basic</td>
</tr>
<tr>
<td><strong>Treatment Effect, ( \beta )</strong></td>
<td>0.124**</td>
<td>0.128**</td>
<td>0.131**</td>
</tr>
<tr>
<td></td>
<td>(0.058)</td>
<td>(0.060)</td>
<td>(0.064)</td>
</tr>
<tr>
<td>Female Unemployment Rate</td>
<td>0.663</td>
<td>0.671</td>
<td>0.514</td>
</tr>
<tr>
<td></td>
<td>(1.271)</td>
<td>(1.277)</td>
<td>(1.288)</td>
</tr>
<tr>
<td>Number of Dep. Children Age: [0, 1)</td>
<td>-0.123***</td>
<td>-0.125***</td>
<td>-0.102**</td>
</tr>
<tr>
<td></td>
<td>(0.042)</td>
<td>(0.043)</td>
<td>(0.045)</td>
</tr>
<tr>
<td>Age: [1, 11)</td>
<td>-0.063</td>
<td>-0.067</td>
<td>-0.115**</td>
</tr>
<tr>
<td></td>
<td>(0.041)</td>
<td>(0.042)</td>
<td>(0.045)</td>
</tr>
<tr>
<td>Age: [11, 16)</td>
<td>-0.017</td>
<td>-0.020</td>
<td>-0.025</td>
</tr>
<tr>
<td></td>
<td>(0.067)</td>
<td>(0.067)</td>
<td>(0.058)</td>
</tr>
<tr>
<td>Age: [16, 19)</td>
<td>-0.129</td>
<td>-0.124</td>
<td>-0.064</td>
</tr>
<tr>
<td></td>
<td>(0.089)</td>
<td>(0.089)</td>
<td>(0.106)</td>
</tr>
<tr>
<td>Housing Tenure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In Social Housing</td>
<td>0.186***</td>
<td>0.185***</td>
<td>0.087</td>
</tr>
<tr>
<td></td>
<td>(0.066)</td>
<td>(0.065)</td>
<td>(0.075)</td>
</tr>
<tr>
<td>In privately rented housing</td>
<td>0.053</td>
<td>0.052</td>
<td>0.011</td>
</tr>
<tr>
<td></td>
<td>(0.064)</td>
<td>(0.066)</td>
<td>(0.072)</td>
</tr>
<tr>
<td>Observations</td>
<td>1515</td>
<td>1515</td>
<td>1465</td>
</tr>
</tbody>
</table>

Notes:
1. “Basic” refers to the regression model [3] in the text, which includes individual dummies. “Extended” refers to the regression model [4] in the text, which includes individual dummies, time dummies, interaction terms between group indicators and a full set of time dummies. The coefficient estimates of the time dummies, the individual dummies, the interaction terms and the age variables are not reported. The default category in Housing Tenure is Owner.
2. Dependent variables: (1) employment, which is equal to 1 if employed, 0 otherwise; (2) eligible employment, which is equal to 1 if working 16 hours or more a week, 0 otherwise; (3) full-time employment, which is equal to 1 if working 30 hours or more a week, 0 otherwise.
4. \( \beta \) captures the difference between the married mothers with premarital cohabitation and the married mothers without premarital cohabitation in their employment responses to the 1999 reform.
5. In 1999, Scotland and Wales booster sub-samples were added to the BHPS. I exclude them in the regressions above because the booster sub-samples do not provide marital history data.
6. * significant at 10%; ** significant at 5%; *** significant at 1%. Cluster-robust standard errors are in parentheses.
Table 2.10: The Impacts of Marital Instability Based on Premarital Cohabitation, by Subgroups

<table>
<thead>
<tr>
<th></th>
<th>(1) Employed</th>
<th>(2) Employed, ≥ 16h a week</th>
<th>(3) Employed, ≥ 30h a week</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Basic</td>
<td>Extended</td>
<td>Basic</td>
</tr>
<tr>
<td>Age: 18-35</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment Effect, $\beta$</td>
<td>0.122*</td>
<td>0.132**</td>
<td>0.084</td>
</tr>
<tr>
<td></td>
<td>(0.063)</td>
<td>(0.065)</td>
<td>(0.069)</td>
</tr>
<tr>
<td>Observations</td>
<td>860</td>
<td>860</td>
<td>820</td>
</tr>
<tr>
<td>Age: 35-55</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment Effect, $\beta$</td>
<td>0.143</td>
<td>0.147</td>
<td>0.187</td>
</tr>
<tr>
<td></td>
<td>(0.118)</td>
<td>(0.119)</td>
<td>(0.128)</td>
</tr>
<tr>
<td>Observations</td>
<td>395</td>
<td>395</td>
<td>385</td>
</tr>
<tr>
<td>Education: A level or above</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment Effect, $\beta$</td>
<td>0.020</td>
<td>0.025</td>
<td>0.038</td>
</tr>
<tr>
<td></td>
<td>(0.087)</td>
<td>(0.090)</td>
<td>(0.087)</td>
</tr>
<tr>
<td>Observations</td>
<td>710</td>
<td>710</td>
<td>685</td>
</tr>
<tr>
<td>Education: below A level</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment Effect, $\beta$</td>
<td>0.222**</td>
<td>0.226**</td>
<td>0.210**</td>
</tr>
<tr>
<td></td>
<td>(0.087)</td>
<td>(0.092)</td>
<td>(0.101)</td>
</tr>
<tr>
<td>Observations</td>
<td>760</td>
<td>760</td>
<td>735</td>
</tr>
</tbody>
</table>

Notes:
1. “Basic” refers to the regression model [3] in the text, which includes individual dummies. “Extended” refers to the regression model [4] in the text, which includes individual dummies, time dummies, interaction terms between group indicators and a full set of time dummies. The coefficient estimates of the dummy variables, the interaction terms and the control variables are not reported.
2. Dependent variables: (1) employment, which is equal to 1 if employed, 0 otherwise; (2) eligible employment, which is equal to 1 if working 16 hours or more a week, 0 otherwise; (3) full-time employment, which is equal to 1 if working 30 hours or more a week, 0 otherwise.
4. $\beta$ captures the difference between the married mothers with premarital cohabitation and the married mothers without premarital cohabitation in their employment responses to the 1999 reform.
5. In 1999, Scotland and Wales booster sub-samples were added to the BHPS. I exclude them in the regressions above because the booster sub-samples do not provide marital history data.
6. + significant at 11%; * significant at 10%; ** significant at 5%; *** significant at 1%. Cluster-robust standard errors are in parentheses.
Table 2.11: The Impacts of Employment Instability Based on Job Security

<table>
<thead>
<tr>
<th></th>
<th>(1) Employed</th>
<th>(2) Employed, ≥ 16h a week</th>
<th>(3) Employed, ≥ 30h a week</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Basic</td>
<td>Extended</td>
<td>Basic</td>
</tr>
<tr>
<td>Treatment Effect, $\beta$</td>
<td>0.029</td>
<td>0.029</td>
<td>0.087**</td>
</tr>
<tr>
<td></td>
<td>(0.036)</td>
<td>(0.036)</td>
<td>(0.043)</td>
</tr>
<tr>
<td>Female Unemployment Rate</td>
<td>0.312</td>
<td>0.312</td>
<td>-0.182</td>
</tr>
<tr>
<td></td>
<td>(0.540)</td>
<td>(0.543)</td>
<td>(0.595)</td>
</tr>
<tr>
<td>Number of Dep. Children</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age: [0, 1)</td>
<td>-0.128***</td>
<td>-0.127***</td>
<td>-0.106***</td>
</tr>
<tr>
<td></td>
<td>(0.028)</td>
<td>(0.028)</td>
<td>(0.031)</td>
</tr>
<tr>
<td>Age: [1, 11)</td>
<td>-0.050**</td>
<td>-0.051**</td>
<td>-0.105***</td>
</tr>
<tr>
<td></td>
<td>(0.024)</td>
<td>(0.024)</td>
<td>(0.026)</td>
</tr>
<tr>
<td>Age: [11, 16)</td>
<td>0.008</td>
<td>0.005</td>
<td>-0.056**</td>
</tr>
<tr>
<td></td>
<td>(0.021)</td>
<td>(0.021)</td>
<td>(0.025)</td>
</tr>
<tr>
<td>Age: [16, 19)</td>
<td>-0.008</td>
<td>-0.010</td>
<td>0.019</td>
</tr>
<tr>
<td></td>
<td>(0.020)</td>
<td>(0.020)</td>
<td>(0.026)</td>
</tr>
<tr>
<td>Housing Tenure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In Social Housing</td>
<td>-0.040</td>
<td>-0.038</td>
<td>-0.066</td>
</tr>
<tr>
<td></td>
<td>(0.051)</td>
<td>(0.051)</td>
<td>(0.052)</td>
</tr>
<tr>
<td>In privately rented housing</td>
<td>-0.038</td>
<td>-0.043</td>
<td>-0.039</td>
</tr>
<tr>
<td></td>
<td>(0.039)</td>
<td>(0.039)</td>
<td>(0.045)</td>
</tr>
<tr>
<td>Observations</td>
<td>4780</td>
<td>4780</td>
<td>4565</td>
</tr>
</tbody>
</table>

Notes:
1. “Basic” refers to the regression model [3] in the text, which includes individual dummies. “Extended” refers to the regression model [4] in the text, which includes individual dummies, time dummies, interaction terms between group indicators and a full set of time dummies. The coefficient estimates of the time dummies, the individual dummies, the interaction terms and the age variables are not reported. The default category in Housing Tenure is Owner.
2. Dependent variables: (1) employment, which is equal to 1 if employed, 0 otherwise; (2) eligible employment, which is equal to 1 if working 16 hours or more a week, 0 otherwise; (3) full-time employment, which is equal to 1 if working 30 hours or more a week, 0 otherwise.
3. Period: 1997-2001; Age: 18-55; non-single women with self-employed partners are excluded.
4. $\beta$ captures the difference between the non-single mothers with unstably employed partners and the non-single mothers with stably employed partners in their employment responses to the 1999 reform. Unstably employed: do not satisfy the job security in their present jobs (scale from 1 to 4).
5. * significant at 10%; ** significant at 5%; *** significant at 1%. Cluster-robust standard errors are in parentheses.
Table 2.12: The Impacts of Employment Instability Based on Job Security, by Subgroups

<table>
<thead>
<tr>
<th></th>
<th>(1) Employed</th>
<th>(2) Employed, ≥ 16h a week</th>
<th>(3) Employed, ≥ 30h a week</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Basic</td>
<td>Extended</td>
<td>Basic</td>
</tr>
<tr>
<td>Age: 18-35</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment Effect, $\beta$</td>
<td>0.047</td>
<td>0.038</td>
<td>0.064</td>
</tr>
<tr>
<td></td>
<td>(0.073)</td>
<td>(0.073)</td>
<td>(0.076)</td>
</tr>
<tr>
<td>Observations</td>
<td>1490</td>
<td>1490</td>
<td>1450</td>
</tr>
<tr>
<td>Age: 35-55</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment Effect, $\beta$</td>
<td>0.031</td>
<td>0.033</td>
<td>0.058</td>
</tr>
<tr>
<td></td>
<td>(0.045)</td>
<td>(0.045)</td>
<td>(0.059)</td>
</tr>
<tr>
<td>Observations</td>
<td>2395</td>
<td>2395</td>
<td>2275</td>
</tr>
<tr>
<td>Education: A level or above</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment Effect, $\beta$</td>
<td>0.095*</td>
<td>0.096*</td>
<td>0.048</td>
</tr>
<tr>
<td></td>
<td>(0.052)</td>
<td>(0.052)</td>
<td>(0.065)</td>
</tr>
<tr>
<td>Observations</td>
<td>1885</td>
<td>1885</td>
<td>1755</td>
</tr>
<tr>
<td>Education: below A level</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment Effect, $\beta$</td>
<td>-0.007</td>
<td>-0.010</td>
<td>0.104*</td>
</tr>
<tr>
<td></td>
<td>(0.051)</td>
<td>(0.051)</td>
<td>(0.060)</td>
</tr>
<tr>
<td>Observations</td>
<td>2790</td>
<td>2790</td>
<td>2710</td>
</tr>
</tbody>
</table>

Notes:
1. “Basic” refers to the regression model [3] in the text, which includes individual dummies. “Extended” refers to the regression model [4] in the text, which includes individual dummies, time dummies, interaction terms between group indicators and a full set of time dummies. The coefficient estimates of the dummy variables, the interaction terms and the control variables are not reported.
2. Dependent variables: (1) employment, which is equal to 1 if employed, 0 otherwise; (2) eligible employment, which is equal to 1 if working 16 hours or more a week, 0 otherwise; (3) full-time employment, which is equal to 1 if working 30 hours or more a week, 0 otherwise.
3. Period: 1997-2001; Age: 18-55; non-single women with self-employed partners are excluded.
4. $\beta$ captures the difference between the non-single mothers with unstably employed partners and the non-single mothers with stably employed partners in their employment responses to the 1999 reform. Unstably employed: do not satisfy the job security in their present jobs (scale from 1 to 4).
5. * significant at 10%; ** significant at 5%; *** significant at 1%. Cluster-robust standard errors are in parentheses.
Table 2.13: Robustness Check on Marital Instability: Unemployment Benefits

<table>
<thead>
<tr>
<th></th>
<th>(1) Employed</th>
<th>(2) Employed, ≥ 16h a week</th>
<th>(3) Employed, ≥ 30h a week</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Basic</td>
<td>Extended</td>
<td>Basic</td>
</tr>
<tr>
<td>Treatment Effect, ( \beta )</td>
<td>0.026</td>
<td>0.022</td>
<td>0.047</td>
</tr>
<tr>
<td></td>
<td>(0.041)</td>
<td>(0.041)</td>
<td>(0.060)</td>
</tr>
<tr>
<td>Female Unemployment Rate</td>
<td>0.004</td>
<td>0.027</td>
<td>-0.582</td>
</tr>
<tr>
<td></td>
<td>(0.463)</td>
<td>(0.464)</td>
<td>(0.521)</td>
</tr>
<tr>
<td>Number of Dep. Children</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age: [0, 1)</td>
<td>-0.114***</td>
<td>-0.114***</td>
<td>-0.109***</td>
</tr>
<tr>
<td></td>
<td>(0.025)</td>
<td>(0.025)</td>
<td>(0.025)</td>
</tr>
<tr>
<td>Age: [1, 11)</td>
<td>-0.062***</td>
<td>-0.063***</td>
<td>-0.107***</td>
</tr>
<tr>
<td></td>
<td>(0.019)</td>
<td>(0.019)</td>
<td>(0.021)</td>
</tr>
<tr>
<td>Age: [11, 16)</td>
<td>-0.013</td>
<td>-0.016</td>
<td>-0.056***</td>
</tr>
<tr>
<td></td>
<td>(0.017)</td>
<td>(0.018)</td>
<td>(0.020)</td>
</tr>
<tr>
<td>Age: [16, 19)</td>
<td>-0.015</td>
<td>-0.018</td>
<td>-0.004</td>
</tr>
<tr>
<td></td>
<td>(0.018)</td>
<td>(0.018)</td>
<td>(0.020)</td>
</tr>
<tr>
<td>Housing Tenure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In Social Housing</td>
<td>-0.022</td>
<td>-0.021</td>
<td>-0.044</td>
</tr>
<tr>
<td></td>
<td>(0.039)</td>
<td>(0.038)</td>
<td>(0.036)</td>
</tr>
<tr>
<td>In privately rented housing</td>
<td>-0.012</td>
<td>-0.014</td>
<td>0.009</td>
</tr>
<tr>
<td></td>
<td>(0.030)</td>
<td>(0.031)</td>
<td>(0.034)</td>
</tr>
<tr>
<td>Unemployment Benefits (£10/week)</td>
<td>-0.003</td>
<td>-0.003</td>
<td>-0.004</td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
<td>(0.002)</td>
<td>(0.003)</td>
</tr>
<tr>
<td>Observations</td>
<td>6980</td>
<td>6980</td>
<td>6660</td>
</tr>
</tbody>
</table>

Notes:
1. Table 2.13 differs from Table 2.7: include the maximum amount of unemployment benefits that a non-single mother could receive given her partner labor income.
2. “Basic” refers to the regression model [3] in the text, which includes individual dummies. “Extended” refers to the regression model [4] in the text, which includes individual dummies, time dummies, interaction terms between group indicators and a full set of time dummies. The coefficient estimates of the time dummies, the individual dummies, the interaction terms and the age variables are not reported. The default category in Housing Tenure is Owner.
3. Dependent variables: (1) employment, which is equal to 1 if employed, 0 otherwise; (2) eligible employment, which is equal to 1 if working 16 hours or more a week, 0 otherwise; (3) full-time employment, which is equal to 1 if working 30 hours or more a week, 0 otherwise.
4. Period: 1997-2001; Age: 18-55; * significant at 10%; ** significant at 5%; *** significant at 1%. Cluster-robust standard errors are in parentheses.
5. \( \beta \) captures the difference between the cohabiting mothers and the married mothers in their employment responses to the 1999 reform.
Table 2.14: Robustness Check on Marital Instability: No Switching Between the group with $Q = 1$ and the group with $Q = 2$

<table>
<thead>
<tr>
<th></th>
<th>(1) Employed</th>
<th></th>
<th>(2) Employed, $\geq 16$ h a week</th>
<th></th>
<th>(3) Employed, $\geq 30$ h a week</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Basic</td>
<td>Extended</td>
<td>Basic</td>
<td>Extended</td>
<td>Basic</td>
<td>Extended</td>
</tr>
<tr>
<td><strong>Treatment Effect, $\beta$</strong></td>
<td>0.053</td>
<td>0.047</td>
<td>0.063</td>
<td>0.060</td>
<td>0.095*</td>
<td>0.098*</td>
</tr>
<tr>
<td></td>
<td>(0.041)</td>
<td>(0.041)</td>
<td>(0.053)</td>
<td>(0.053)</td>
<td>(0.050)</td>
<td>(0.050)</td>
</tr>
<tr>
<td><strong>Female Unemployment Rate</strong></td>
<td>0.236</td>
<td>0.246</td>
<td>-0.095</td>
<td>-0.077</td>
<td>-0.081</td>
<td>-0.049</td>
</tr>
<tr>
<td></td>
<td>(0.442)</td>
<td>(0.444)</td>
<td>(0.496)</td>
<td>(0.497)</td>
<td>(0.519)</td>
<td>(0.521)</td>
</tr>
<tr>
<td><strong>Number of Dep. Children</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age: [0, 1)</td>
<td>-0.117***</td>
<td>-0.116***</td>
<td>-0.110***</td>
<td>-0.109***</td>
<td>-0.067***</td>
<td>-0.067***</td>
</tr>
<tr>
<td></td>
<td>(0.023)</td>
<td>(0.023)</td>
<td>(0.023)</td>
<td>(0.023)</td>
<td>(0.020)</td>
<td>(0.020)</td>
</tr>
<tr>
<td>Age: [1, 11)</td>
<td>-0.056***</td>
<td>-0.056***</td>
<td>-0.103***</td>
<td>-0.103***</td>
<td>-0.108***</td>
<td>-0.105***</td>
</tr>
<tr>
<td></td>
<td>(0.017)</td>
<td>(0.017)</td>
<td>(0.018)</td>
<td>(0.018)</td>
<td>(0.018)</td>
<td>(0.018)</td>
</tr>
<tr>
<td>Age: [11, 16)</td>
<td>-0.005</td>
<td>-0.008</td>
<td>-0.043**</td>
<td>-0.044**</td>
<td>-0.028</td>
<td>-0.022</td>
</tr>
<tr>
<td></td>
<td>(0.016)</td>
<td>(0.016)</td>
<td>(0.018)</td>
<td>(0.018)</td>
<td>(0.019)</td>
<td>(0.019)</td>
</tr>
<tr>
<td>Age: [16, 19)</td>
<td>-0.011</td>
<td>-0.014</td>
<td>0.000</td>
<td>-0.000</td>
<td>0.033</td>
<td>0.034*</td>
</tr>
<tr>
<td></td>
<td>(0.017)</td>
<td>(0.017)</td>
<td>(0.018)</td>
<td>(0.018)</td>
<td>(0.020)</td>
<td>(0.020)</td>
</tr>
<tr>
<td><strong>Housing Tenure</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In Social Housing</td>
<td>-0.046</td>
<td>-0.044</td>
<td>-0.064*</td>
<td>-0.064*</td>
<td>-0.099***</td>
<td>-0.099***</td>
</tr>
<tr>
<td></td>
<td>(0.036)</td>
<td>(0.035)</td>
<td>(0.035)</td>
<td>(0.035)</td>
<td>(0.037)</td>
<td>(0.037)</td>
</tr>
<tr>
<td>In privately rented housing</td>
<td>-0.032</td>
<td>-0.035</td>
<td>-0.011</td>
<td>-0.013</td>
<td>-0.041</td>
<td>-0.037</td>
</tr>
<tr>
<td></td>
<td>(0.027)</td>
<td>(0.027)</td>
<td>(0.030)</td>
<td>(0.030)</td>
<td>(0.035)</td>
<td>(0.035)</td>
</tr>
<tr>
<td><strong>Observations</strong></td>
<td>8335</td>
<td>8335</td>
<td>7925</td>
<td>7925</td>
<td>7925</td>
<td>7925</td>
</tr>
</tbody>
</table>

Notes:
1. Table 2.14 differs from Table 2.7: $Q = 1$ if the non-single women are in cohabitation relationships consistently during the sample period, zeros otherwise.
2. “Basic” refers to the regression model [3] in the text, which includes individual dummies. “Extended” refers to the regression model [4] in the text, which includes individual dummies, time dummies, interaction terms between group indicators and a full set of time dummies. The coefficient estimates of the time dummies, the individual dummies, the interaction terms and the age variables are not reported. The default category in Housing Tenure is Owner.
3. Dependent variables: (1) employment, which is equal to 1 if employed, 0 otherwise; (2) eligible employment, which is equal to 1 if working 16 hours or more a week, 0 otherwise; (3) full-time employment, which is equal to 1 if working 30 hours or more a week, 0 otherwise.
4. Period: 1997-2001; Age: 18-55; * significant at 10%; ** significant at 5%; *** significant at 1%. Cluster-robust standard errors are in parentheses.
5. $\beta$ captures the difference between the cohabiting mothers and the married mothers in their employment responses to the 1999 reform.
Table 2.15: Robustness Check on Employment Instability: No Switching Between the group with $Q = 1$ and the group with $Q = 2$

<table>
<thead>
<tr>
<th></th>
<th>(1) Employed</th>
<th>(2) Employed, $\geq 16$ h a week</th>
<th>(3) Employed, $\geq 30$ h a week</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Basic</td>
<td>Extended</td>
<td>Basic</td>
</tr>
<tr>
<td>Treatment Effect, $\beta$</td>
<td>0.010</td>
<td>0.009</td>
<td>0.112***</td>
</tr>
<tr>
<td></td>
<td>(0.032)</td>
<td>(0.032)</td>
<td>(0.036)</td>
</tr>
<tr>
<td>Female Unemployment Rate</td>
<td>0.321</td>
<td>0.328</td>
<td>-0.147</td>
</tr>
<tr>
<td></td>
<td>(0.541)</td>
<td>(0.542)</td>
<td>(0.594)</td>
</tr>
<tr>
<td>Number of Dep. Children</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age: [0, 1)</td>
<td>-0.129***</td>
<td>-0.128***</td>
<td>-0.107***</td>
</tr>
<tr>
<td></td>
<td>(0.028)</td>
<td>(0.028)</td>
<td>(0.031)</td>
</tr>
<tr>
<td>Age: [1, 11)</td>
<td>-0.051**</td>
<td>-0.053**</td>
<td>-0.105***</td>
</tr>
<tr>
<td></td>
<td>(0.024)</td>
<td>(0.024)</td>
<td>(0.027)</td>
</tr>
<tr>
<td>Age: [11, 16)</td>
<td>0.007</td>
<td>0.003</td>
<td>-0.055**</td>
</tr>
<tr>
<td></td>
<td>(0.021)</td>
<td>(0.021)</td>
<td>(0.026)</td>
</tr>
<tr>
<td>Age: [16, 19)</td>
<td>-0.010</td>
<td>-0.012</td>
<td>0.016</td>
</tr>
<tr>
<td></td>
<td>(0.020)</td>
<td>(0.020)</td>
<td>(0.026)</td>
</tr>
<tr>
<td>Housing Tenure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In Social Housing</td>
<td>-0.041</td>
<td>-0.040</td>
<td>-0.068</td>
</tr>
<tr>
<td></td>
<td>(0.051)</td>
<td>(0.050)</td>
<td>(0.052)</td>
</tr>
<tr>
<td>In privately rented housing</td>
<td>-0.036</td>
<td>-0.042</td>
<td>-0.035</td>
</tr>
<tr>
<td></td>
<td>(0.039)</td>
<td>(0.039)</td>
<td>(0.044)</td>
</tr>
<tr>
<td>Observations</td>
<td>4780</td>
<td>4780</td>
<td>4565</td>
</tr>
</tbody>
</table>

Notes:
1. Table 2.15 differs from Table 2.11: $Q = 0$ if the partners of non-single women are continuously satisfied with their job security during the sample period, ones otherwise.
2. “Basic” refers to the regression model [3] in the text, which includes individual dummies. “Extended” refers to the regression model [4] in the text, which includes individual dummies, time dummies, interaction terms between group indicators and a full set of time dummies. The coefficient estimates of the time dummies, the individual dummies, the interaction terms and the age variables are not reported. The default category in Housing Tenure is Owner.
3. Dependent variables: (1) employment, which is equal to 1 if employed, 0 otherwise; (2) eligible employment, which is equal to 1 if working 16 hours or more a week, 0 otherwise; (3) full-time employment, which is equal to 1 if working 30 hours or more a week, 0 otherwise.
4. Period: 1997-2001; Age: 18-55; * significant at 10%; ** significant at 5%; *** significant at 1%. Cluster-robust standard errors are in parentheses.
5. $\beta$ captures the difference between the non-single mothers with unstably employed partners and the non-single mothers with stably employed partners in their employment responses to the 1999 reform. Unstably employed: do not satisfy the job security in their present jobs (scale from 1 to 4).
Table 2.16: Robustness Check on Employment Instability: Persistency in Employment Instability

<table>
<thead>
<tr>
<th></th>
<th>(1) Employed</th>
<th>(2) Employed, ≥ 16h a week</th>
<th>(3) Employed, ≥ 30h a week</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Basic</td>
<td>Extended</td>
<td>Basic</td>
</tr>
<tr>
<td><strong>Treatment Effect, β</strong></td>
<td>-0.074</td>
<td>-0.071</td>
<td>-0.005</td>
</tr>
<tr>
<td></td>
<td>(0.059)</td>
<td>(0.059)</td>
<td>(0.080)</td>
</tr>
<tr>
<td><strong>Female Unemployment Rate</strong></td>
<td>0.106</td>
<td>0.061</td>
<td>0.376</td>
</tr>
<tr>
<td></td>
<td>(0.623)</td>
<td>(0.624)</td>
<td>(0.682)</td>
</tr>
<tr>
<td><strong>Number of Dep. Children</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age: [0, 1)</td>
<td>-0.146***</td>
<td>-0.145***</td>
<td>-0.139***</td>
</tr>
<tr>
<td></td>
<td>(0.033)</td>
<td>(0.033)</td>
<td>(0.035)</td>
</tr>
<tr>
<td>Age: [1, 11)</td>
<td>-0.060**</td>
<td>-0.061**</td>
<td>-0.123***</td>
</tr>
<tr>
<td></td>
<td>(0.025)</td>
<td>(0.025)</td>
<td>(0.028)</td>
</tr>
<tr>
<td>Age: [11, 16)</td>
<td>0.026</td>
<td>0.024</td>
<td>-0.053*</td>
</tr>
<tr>
<td></td>
<td>(0.021)</td>
<td>(0.022)</td>
<td>(0.027)</td>
</tr>
<tr>
<td>Age: [16, 19)</td>
<td>-0.007</td>
<td>-0.008</td>
<td>0.012</td>
</tr>
<tr>
<td></td>
<td>(0.022)</td>
<td>(0.022)</td>
<td>(0.030)</td>
</tr>
<tr>
<td><strong>Housing Tenure</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In Social Housing</td>
<td>0.054</td>
<td>0.057</td>
<td>0.037</td>
</tr>
<tr>
<td></td>
<td>(0.069)</td>
<td>(0.068)</td>
<td>(0.057)</td>
</tr>
<tr>
<td>In privately rented housing</td>
<td>0.045</td>
<td>0.041</td>
<td>0.056</td>
</tr>
<tr>
<td></td>
<td>(0.050)</td>
<td>(0.051)</td>
<td>(0.060)</td>
</tr>
<tr>
<td><strong>Observations</strong></td>
<td>3790</td>
<td>3790</td>
<td>3615</td>
</tr>
</tbody>
</table>

**Notes:**
1. Table 2.16 differs from Table 2.11: \( Q = 1 \) if the partners of non-single mothers are not satisfied their job security in both current and previous years, zeros otherwise.
2. “Basic” refers to the regression model [3] in the text, which includes individual dummies. “Extended” refers to the regression model [4] in the text, which includes individual dummies, time dummies, interaction terms between group indicators and a full set of time dummies. The coefficient estimates of the time dummies, the individual dummies, the interaction terms and the age variables are not reported. The default category in Housing Tenure is Owner.
3. Dependent variables: (1) employment, which is equal to 1 if employed, 0 otherwise; (2) eligible employment, which is equal to 1 if working 16 hours or more a week, 0 otherwise; (3) full-time employment, which is equal to 1 if working 30 hours or more a week, 0 otherwise.
5. \( \beta \) captures the difference between the non-single mothers with unstably employed partners and the non-single mothers with stably employed partners in their employment responses to the 1999 reform. Unstably employed: do not satisfy the job security in their present jobs (scale from 1 to 4).
6. * significant at 10%; ** significant at 5%; *** significant at 1%. Cluster-robust standard errors are in parentheses.
Table 2.17: Robustness Check on Employment Instability: Include Non-single Women with Self-employed Partners

<table>
<thead>
<tr>
<th></th>
<th>(1) Employed</th>
<th>(2) Employed, ≥ 16h a week</th>
<th>(3) Employed, ≥ 30h a week</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Basic</td>
<td>Extended</td>
<td>Basic</td>
</tr>
<tr>
<td>Treatment Effect, $\beta$</td>
<td>0.017</td>
<td>0.017</td>
<td>0.051</td>
</tr>
<tr>
<td></td>
<td>(0.031)</td>
<td>(0.031)</td>
<td>(0.038)</td>
</tr>
<tr>
<td>Female Unemployment Rate</td>
<td>0.035</td>
<td>0.033</td>
<td>-0.572</td>
</tr>
<tr>
<td></td>
<td>(0.522)</td>
<td>(0.526)</td>
<td>(0.576)</td>
</tr>
<tr>
<td>Number of Dep. Children</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age: [0, 1)</td>
<td>-0.133***</td>
<td>-0.132***</td>
<td>-0.117***</td>
</tr>
<tr>
<td></td>
<td>(0.029)</td>
<td>(0.029)</td>
<td>(0.028)</td>
</tr>
<tr>
<td>Age: [1, 11)</td>
<td>-0.059***</td>
<td>-0.060***</td>
<td>-0.112***</td>
</tr>
<tr>
<td></td>
<td>(0.022)</td>
<td>(0.022)</td>
<td>(0.024)</td>
</tr>
<tr>
<td>Age: [11, 16)</td>
<td>-0.006</td>
<td>-0.010</td>
<td>-0.067***</td>
</tr>
<tr>
<td></td>
<td>(0.019)</td>
<td>(0.020)</td>
<td>(0.023)</td>
</tr>
<tr>
<td>Age: [16, 19)</td>
<td>-0.016</td>
<td>-0.018</td>
<td>0.002</td>
</tr>
<tr>
<td></td>
<td>(0.020)</td>
<td>(0.020)</td>
<td>(0.024)</td>
</tr>
<tr>
<td>Housing Tenure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In Social Housing</td>
<td>-0.046</td>
<td>-0.043</td>
<td>-0.047</td>
</tr>
<tr>
<td></td>
<td>(0.045)</td>
<td>(0.045)</td>
<td>(0.044)</td>
</tr>
<tr>
<td>In privately rented</td>
<td>-0.040</td>
<td>-0.044</td>
<td>-0.007</td>
</tr>
<tr>
<td>housing</td>
<td>(0.035)</td>
<td>(0.035)</td>
<td>(0.041)</td>
</tr>
<tr>
<td>Observations</td>
<td>5860</td>
<td>5860</td>
<td>5585</td>
</tr>
</tbody>
</table>

Notes:
1. Table 2.17 differs from Table 2.11: include non-single women with self-employed partners.
2. “Basic” refers to the regression model [3] in the text, which includes individual dummies. “Extended” refers to the regression model [4] in the text, which includes individual dummies, time dummies, interaction terms between group indicators and a full set of time dummies. The coefficient estimates of the time dummies, the individual dummies, the interaction terms and the age variables are not reported. The default category in Housing Tenure is Owner.
3. Dependent variables: (1) employment, which is equal to 1 if employed, 0 otherwise; (2) eligible employment, which is equal to 1 if working 16 hours or more a week, 0 otherwise; (3) full-time employment, which is equal to 1 if working 30 hours or more a week, 0 otherwise.
5. $\beta$ captures the difference between the non-single mothers with unstably employed partners and the non-single mothers with stably employed partners in their employment responses to the 1999 reform. Unstably employed: do not satisfy the job security in their present jobs (scale from 1 to 4).
6. * significant at 10%; ** significant at 5%; *** significant at 1%. Cluster-robust standard errors are in parentheses.
### Table 2.18: Log Real Full-Time Wage Regression

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>0.728***</td>
<td>(0.129)</td>
</tr>
<tr>
<td>Age(^2/10)</td>
<td>-0.253***</td>
<td>(0.055)</td>
</tr>
<tr>
<td>Age(^3/100)</td>
<td>0.039***</td>
<td>(0.0102)</td>
</tr>
<tr>
<td>Age(^4/1000)</td>
<td>-0.0022***</td>
<td>(0.0007)</td>
</tr>
<tr>
<td>Tenure/10</td>
<td>0.008**</td>
<td>(0.003)</td>
</tr>
<tr>
<td>Tenure(^2/100)</td>
<td>-0.0002</td>
<td>(0.00014)</td>
</tr>
<tr>
<td>Experience/10</td>
<td>0.043***</td>
<td>(0.019)</td>
</tr>
<tr>
<td>Experience(^2/100)</td>
<td>-0.00033***</td>
<td>(0.00013)</td>
</tr>
<tr>
<td>Sample Size</td>
<td>13779</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
1. Period: 1997-2001; Age: 18-55
2. Tenure and Experience are measured in months, and Age is measured in years.
3. Coefficient estimates of fixed effects are not reported.
4. Cluster-robust standard errors are in parentheses.
Notes:
1. The horizontal axis denotes the non-single mother’s leisure, and the vertical axis denotes the total family net income.
2. $L$ denotes the total leisure, $I$ denotes the partner’s labor income, $B$ denotes the maximum tax credit, $T$ denotes the withdraw threshold, and $\bar{L}$ denotes the maximum amount of leisure in which the tax credit is reduced to zero.
3. Line $\overline{AB}$ denotes the budget constraint in the absence of tax credit. Line $\overline{CD}$ does not necessarily intercept with line $\overline{AB}$, and it is possible that line $\overline{CD}$ intercepts with the vertical axis.
4. I assume that the partner’s labor income is smaller than the withdraw threshold. If the partner’s labor income is greater than the withdraw threshold, line $\overline{CD}$ will intercept directly with line $\overline{EB}$, and the line segment $\overline{ED}$ will not exist.

Figure 2.1: The non-single mother’s budget constraint when the partner is working at least 16 hours a week
Notes:
1. The horizontal axis denotes the non-single mother’s leisure, and the vertical axis denotes the total family net income.
2. \( L \) denotes the total leisure, \( I \) denotes the partner’s labor income, \( B \) denotes the maximum tax credit, \( T \) denotes the withdraw threshold, \( w \) denote his or her partner’s wage rate, and \( \bar{L} \) denotes the maximum amount of leisure in which the tax credit is reduced to zero.
3. Line \( \bar{A} \bar{B} \) denotes the budget constraint in the absence of tax credit. Line \( \bar{C} \bar{D} \) does not necessarily intercept with line \( \bar{A} \bar{B} \). It is possible that line \( \bar{C} \bar{D} \) intercepts with the y axis where it is above \( A \).
4. I assume that the partner’s labor income is smaller than the withdraw threshold. If the partner’s labor income is greater than the withdraw threshold, line \( \bar{C} \bar{D} \) will intercept directly with line \( \bar{E} \bar{F} \), and the line segment \( \bar{E} \bar{D} \) will not exist.

Figure 2.2: The non-single mother’s budget constraint when the partner is working less than 16 hours a week
Spouse’s Hours of Work Per Week ≥ 16

Spouse’s Hours of Work Per Week < 16

Note: See the notes of Figures 2.1 and 2.2.

**Figure 2.3: Increase in the maximum tax credit**
Note: See the notes of Figures 2.1 and 2.2.

**Figure 2.4: Increase in the withdraw threshold**
Spouse's Hours of Work Per Week $\geq 16$

Spouse's Hours of Work Per Week $< 16$

Note: See the notes of Figures 2.1 and 2.2.

**Figure 2.5: Decrease in the withdraw rate**
Age: 18-55

Note: The employment rates are computed using each second quarter of the UK labor force survey.

Figure 2.6: Employment rates of single mothers and non-single mothers
Notes:
1. Highest qualification: (1) degree or equivalent; (2) higher education; (3) GCE A Level or equivalent; (4) GCSE grades A-C or equivalent; (5) other qualification; (6) no qualification.
2. Population: aged 18-55; single women; both employed and non-employed
3. Data: second quarter of the UK labor force survey

**Figure 2.7: Proportion of Single Women Working Full-Time**
Chapter 3: How Means-tested Unemployment Benefits Affect Couple’s Employment Decisions?

1. Introduction

In labor economics, unemployment benefits have always been one of central research areas, both at the micro and macro levels. However, means-tested unemployment benefits have not been received as much attention as non-means-tested unemployment benefits. In the micro labor literature, most papers focus only on the negative work incentive of means-tested unemployment benefits by studying employment decisions of women with unemployed spouses. In the micro labor literature, to my best knowledge, no paper has examined how means-tested unemployment benefits affect couples’ employment decisions. Thus, there is a lack of direct comparison between means-tested and non-means-tested benefits, and it is not clear how these benefits contribute to aggregate employment outcomes. This paper tries to fill in this important gap by providing some empirical evidences as well as a

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2 Most macro labor papers focus 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). However, none of them focuses on the issues of means-tested unemployment benefits.
theoretical examination at the micro level and conducting a simple quantitative analysis on employment rates and government expenditures at the macro level.

Most developed countries have both means-tested benefits and non-means-tested unemployment benefits. The former is often called unemployment assistance or social assistance, the latter unemployment insurance. Unemployed workers are initially given unemployment insurance if they satisfy certain past employment conditions. Those who do not satisfy the eligibility conditions or have been unemployed for more than a certain number of periods will be given means-tested benefits instead. Facing extensive long-term unemployment problems, many European countries have substantially reduced the duration of unemployment insurances in the past decade, which means that means-tested unemployment benefits would become more and more relevant to the long-term unemployed. Moreover, some countries, such as Australia, only provide means-tested benefits to unemployed workers.

Given the increasing importance of means-tested unemployment benefits, the results from the unemployment insurance literature can be partly transferred to study the impacts of means-tested unemployment benefits. However, the impacts of means-tested unemployment benefits are far more complex than those of unemployment insurance. Under unemployment insurance, there is no dependency in computing unemployment benefits on spouses’ earnings. If unemployment insurance is substantially lower than previous earnings of unemployed agents, the “added worker effect” hypothesis expects other family members to increase their labor supply serving as a consumption-smoothing response especially when the expected duration of those agents’ unemployment becomes
longer. However, if there is an increase in unemployment insurance, it can reduce the “added worker effect”, crowding out the family self-insurance. Cullen and Gruber (2000) find there is a sizable and significant crowd-out effect of unemployment insurance on the labor supply of wives with unemployed husbands. On the other hand, under means-tested unemployment benefits, unemployment benefits are tied to spouses’ earnings. The effect of unemployment benefits no longer operates in a single direction because both the receipt of unemployment benefits and the spouses’ labor supply decisions are jointly determined.

The crowd-out effect is expected to be larger under means-tested unemployment benefits than under unemployment insurance because the reduction of means-tested benefits lowers effective wages of spouses of the unemployed. I show that means-tested unemployment benefits generally encourage a larger proportion of workless couples, but the crowd-out effect is not always larger than that under unemployment insurance, which depends on the maximum size of unemployment benefits. Moreover, means-tested unemployment benefits can generate positive work incentives, which is absent under unemployment insurance. For example, when one of the couple is unemployed and the other one is not willing to give up the employment opportunity, the unemployed one will have greater incentive to look for work under means-tested unemployment benefits, which can lead to a greater proportion of dual-earner couples than under unemployment insurance.

Without imposing an income test in computing unemployment benefits, unemployment insurance is unlikely to generate substantially different employment rates
between those with employed spouses and those with unemployed spouses. Census data from IPUMS-International are used to document substantial differences in the employment rates conditional on spouses’ employment statuses. I also link those differences to the net replacement-rate gaps between those with dependent spouses and those with working spouses and find a relatively strong positive relationship. I find further empirical support using the UK quarterly labor force survey data, using the policy break that occurred in 1996 in the UK (the reduction of the duration of unemployment insurance from one year to six months) to conduct a difference-in-difference analysis. I find that the job searching rate among non-employed women with partners or husbands unemployed between six months and one year is reduced by more than 4 percentage points after the policy break.

By constructing a simple discrete-time version of labor search model, I examine how means-tested unemployment benefits and unemployment insurance affect couples’ reservation wages. When the maximum size of unemployment benefits is below some threshold, likely to be true in many countries, I show that means-tested unemployment benefits generate higher reservation wages of those with unemployed spouses and lower reservation wages of those with employed spouses than unemployment insurance. When the maximum size of unemployment benefits is beyond some threshold, there exists a breadwinner cycle under means-tested unemployment benefits. Later, the model is extended and calibrated to match features of the UK economy. The counterfactual experiments show that means-tested unemployment benefits generate a higher employment rate, a greater proportion of the dual-earner couples, a greater proportion of
the workless couples, and lower government expenditures on unemployment benefits than unemployment insurance.

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

2. Empirical Evidence

In this section, I use Census data and Martin’s (1996) net unemployment benefit replacement rates to examine the relationship between the dependency in computing unemployment benefits and the dependency of women’s employment rates on their spouses’ employment statuses. In many countries, such as the UK and Australia, women’s employment rates differ substantially when their spouses are employed instead of unemployed. Those substantial differences in women’s employment rates might not necessarily link to the structure of unemployment benefit systems, but just due to a spurious relationship such that both partners face similar economic environments or both partners are low skilled facing similar degree of job instability (e.g., Garcia 1991, and Davies et al. 1992). However, my cross-country comparison and a case study based on the UK labor force survey data show that the argument of a spurious relationship alone is not sufficient to explain the variations across countries and the variations across time within the UK.

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3 Another explanation is that some social norms might have discouraged wives from taking a breadwinner role when their husbands are unemployed (e.g., Barrere-Maurisson et al. 1985, McKee and Bell 1985).
2.1 Cross-country Comparison

I use the Census data obtained from IPUMS-International to conduct a cross-country comparison. I focus on the US and the European countries in their early 1990s because those data can be linked to the net unemployment benefit replacement rate data calculated by Martin (1996). The population is restricted to married couples aged between 18 and 60. The choice of 60 is to exclude the retired population, which might be more affected by the pension benefits than unemployment benefits.

Table 3.1 documents the employment rates of married women conditional on their spouses’ employment statuses. As shown in Table 3.1, the employment rates of married women with unemployed husbands are substantially higher than those with employed husbands. The variations across countries in the employment-rate gap are also quite substantial. The gaps are more than 30 percentage points in Australia and the UK, but less than 10 percentage points in Portugal, the U.S., and Spain.

If a spurious relationship is the only explanation for the large employment rate gaps, the spurious relationship has to be country-specific. Otherwise, it is impossible to explain the large cross-country variations observed from Table 3.1. In order to examine whether it is mainly due to a spurious relationship, I conduct a simple difference-in-difference analysis, using the husbands’ employment rate gaps as a control. This simple difference-in-difference comparison filters out any persistent impacts from the spurious

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4 The Australian data is computed from an Australian Bureau of Statistics report (1994).
relationship. In other words, the variations from the difference-in-difference estimates should be substantially smaller. Table 3.2 provides the results of that simple difference-in-difference analysis. As shown in Table 3.2, there are still about ten-percentage-point differences in France, UK and Australia. Given the comparison on the coefficient of variations in Table 3.2, there is no sign of reduction in the variation of employment rate gaps. Thus, the spurious relationship alone does not seem sufficient to explain the dependency pattern.

Davies et al. (1992) quantifies how much the observed discrepancy in wives’ employment status belonged to the cross-couple state dependence instead of a spurious relationship, and they conclude that the effect from the cross-couple state dependence was substantial and suggest a further investigation on an economic process underlying such a causal mechanism. The means-tested nature of unemployment benefits has been suggested as an important causal mechanism to explain such large employment rate gaps. 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 margin (i.e., Garcia 1991, and Dex et al. 1995) and extensive margin5 (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 they do not agree upon the magnitudes of the effects.

5 Budget constraints are usually not convex due to means-tested nature of the benefits. Many papers that study the extensive margin usually divide continuous hours into a few discrete states (i.e., non-participation, part-time, and full-time).
Figure 3.1 plots the married women’s employment-rate gap against the net unemployment benefit replacement rate gap. The net unemployment benefit replacement rate data are obtained from Martin (1996). Martin (1996) estimates the averages of net unemployment benefit replacement rates that are comparable across countries. His data not only consider country-specific tax structures but also take into account other related benefits such as housing benefits. Though not specifically designed for unemployed workers, housing benefits are certainly one of the important components in benefit packages to unemployed workers\(^6\). The net unemployment benefit replacement rate gap is computed as the difference between the following two groups: one with dependent spouses and the other one with working spouses. In Australia, the unemployment benefits are all means-tested, so their gap in net replacement rates is the largest in my sample. Spain does not provide the most generous unemployment benefit package, but their net replacement rates stay roughly the same regardless of whether the spouse is working or not. Figure 3.1 displays a positive relationship between married women’s employment rate gap and the net unemployment benefit replacement rate gap. It seems that the dependency of married women on their spouses’ employment statuses increases with the dependency in computing unemployment benefits.

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\(^6\) Doris (1999) shows that ignoring housing benefits is not likely to detect the effects of means-tested unemployment benefits by simply relying on the differences between unemployment insurance and unemployment assistance.
2.2 Case Study: United Kingdom

There are both means-tested and non-means-tested unemployment benefits in the UK. Prior to October 1996, the non-means-tested one is called national insurance unemployment benefits (UB), and the means-tested one is called supplementary benefit (SB). Both UB and SB paid flat rate. The duration of UB is one year. If UB is expired or unemployed workers are not eligible for UB (which do not have a sufficient contribution to national insurance in one of the two tax years which the claim is based on), they can apply for SB.

Since October 1996, UB and SB have been replaced by the contribution-based Jobseeker’s Allowance (JSA) and the income-based JSA, respectively. 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 if claimants have no dependent children and one of the partners was 25 year-old or younger. In October 2002, the age for the joint claim requirement was extended to 45. Before the joint claim legislation was introduced, only one partner was required to satisfy JSA rules in order to claim allowance for dependent adult. In other words, the eligibility for means-tested dependent allowances would not be affected if the partners of claimants are voluntarily unemployed.

The UK is an interesting candidate for examining the effects of means-tested benefits. As shown in Table 3.1 and Figure 3.1, the UK has very large gaps in both
conditional employment rates and net unemployment benefit replacement rates. The unemployed population in the UK is more reliant on means-tested benefits. During 1997-2009, the average proportion of claimers (including both singles and couples) receiving the income-based JSA is 0.83 (IFS, 2010). The majority of claimers rely on the income-based JSA partly because the contribution-based JSA does not provide allowance for dependent adult. Even if unemployed workers are eligible for the contribution-based JSA, they will be better off to switch to the income-based JSA when having dependent spouses.

In this section, I use the UK quarterly labor force survey data obtained from the UK Data Archive to examine the impacts of means-tested unemployment benefits. The sample population is restricted to married or cohabitating couples aged between 18 and 60. The reason to include cohabitating couples is because cohabitating couples are treated the same as married couples when applying for unemployment benefits in the UK.

2.2.1. Conditional Employment Rates

Figure 3.2 displays the employment rates of women conditional on their spouses’ employment statuses. As shown in Figure 3.2, the employment rate gap between women with employed spouses and women with unemployed spouses is substantially large. However, the gaps have been reducing over time. The main contributing factor is the rising employment rate of women with unemployed spouses given that the employment rate of women with employed spouses is much more stable. This might be partially explained by the following policy reforms marked in Figure 3.2: (1) the duration of non-
means-tested benefits is reduced from one year to six months in October 1996; (2) The Working Families’ Tax Credit (WFTC) reform took place in October 1999, which had substantially increased the generosity of in-work benefits and childcare support; (3) Jobseeker’s Allowance imposed a joint claim requirement in March 2001; (4) WFTC was replaced by Working Tax Credit, which extends in-work support to families without children in March 2001. A spurious relationship might be able to explain the large employment rate gap, but it alone could not be sufficient to explain the reduction in the employment rate gap over time unless the spurious relationship varied at a high frequency. As shown in Figure 3.2, economic agents do seem to respond to the unemployment and in-work benefit reforms to some degree.

Figure 3.3 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 six months; (2) greater than one year. When workers have been unemployed within six months, it is possible that some of them are receiving unemployment insurance throughout the sample period. Those who have been unemployed for more than one year are certainly not eligible to receive unemployment insurance. Interestingly, employment rate patterns in Figure 3.3 are similar to those in Figure 3.2. The employment rate gaps are very large between women whose spouses have not been unemployed for more than six months and women whose spouses have been unemployed for more than one year. Similarly, the employment rate gaps have also been shrinking over time.

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7 In-work benefits in the UK are similar to the earned income tax credit in the United States.
In order to further examine the spurious relationship, I divide the sample population into four groups: (1) low-educated women married or cohabiting with low-educated men; (2) low-educated women married or cohabiting with high-educated men; (3) high-educated women married or cohabiting with low-educated men; (4) high-educated women married or cohabiting with high-educated men. The low-educated are defined as those who have not received “GCE A-level or equivalent”\(^8\), and the high-educated are defined as those who have received “GCE A-level or equivalent” or above. Figures 3.4 and 3.5 display the employment rates of low-educated women and high-educated women, respectively, conditional on their spouses’ educational attainments. Substantially large employment rate gaps still exist in each educational-attainment category, and all show a long run decline.

Figure 3.6 compares the relative sizes of employment rate gaps across educational-attainment categories. The employment rate gap is the largest where both couples belong to the low-educated group and the smallest where both couples belong to the high-educated group. That pattern is consistent with the impacts of means-tested unemployment benefits although means-tested unemployment effects are not likely to be the only explanation. High-educated workers are likely to be more attached to the labor market so they usually display a lower job separation rate and are less likely to become long-term unemployed workers than low-educated workers. Means-tested unemployment benefits will affect the couples more where both of them face shorter expected duration of employment and greater probability of being long-term

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\(^8\) GCE A-level is similar to the American Advanced Placements. Most countries consider it as the equivalent to the first year courses of the four-year university degrees.
unemployed. If an unemployed worker is not expected to stay long-term unemployed, the spouse will put much less weight in the reduction of means-tested unemployment benefits when the spouse is looking for a job.

2.2.2. Difference-in-Difference Analysis

Figures 3.1-3.6 provide some evidences that the UK’s unemployment and in-work benefits might be the important factors to explain dependency in married or cohabiting women’s employment rates on their spouses’ employment statuses. In order to provide more direct evidence on the impacts of the means-tested unemployment benefits, I use the 1996 policy break to conduct a difference-in-difference analysis. Since the introduction of JSA in October 1996, the duration of non-means-tested benefits was reduced from one year to six months. If the spouses had been unemployed between six months and one year, some of them might be able to receive non-means-tested unemployment benefits before October 1996, but none of them would be able to receive non-means-tested unemployment benefits after October 1996. Therefore, I use women whose spouses have been unemployed between six months and one year as the treatment group, and women whose spouses have been unemployed for more than one year as the control group. The control group is not perfect, but it should at least filter out some unobservable changes of economic environments. Women from the treatment group are expected to face a smaller incentive to work after October 1996 because they would be subject to means-tested unemployment benefits after October 1996.
I use the two consecutively quarterly labor force survey data before and after the third quarter of 1996 to conduct the difference-in-difference analysis. The time period spans from January 1996 to March 1997, which covers the policy break. The difference-in-difference results (DID) are provided in Table 3.3. As shown in Table 3.3, the DID results indicate that the reduction in the duration of non-means-tested benefits has contributed 4.6 percentage point drop in the proportion of non-employed women looking for paid work in the last four weeks. In addition, the DID results show the policy break does not seem to have a significant impact on the employment rate, which dropped by 0.49 percentage with a large standard error. This result is not unreasonable. Facing a greater opportunity cost of working does not necessarily mean that workers will quit their jobs immediately. For those who spend less effort on looking for a job, it might not have a substantial impact on employment rate immediately given a relative short period of time.

Table 3.4 provides a robustness check on the difference-in-difference results. As shown in Table 3.4, inclusion or exclusion of the third quarter of 1996, which covers the policy break, will not affect the conclusion. The difference-in-difference results also seem to be robust even when we extend one more quarter before and after the sample period.
3. Reservation Wage Map

Most empirical studies related to means-tested unemployment benefits focus on only its negative incentive by restricting samples to women with unemployed spouses. However, a married couple’s labor supply decision is more complex than a single individual’s. The labor supply decisions of a married couple are made jointly, which takes into account of not only the spouse’s current employment status but also the expected duration of the spouse’s current employment status. Means-tested unemployment benefits are likely to generate a greater work disincentive among those with unemployed spouses than among those with employed spouses. However, the impacts of means-tested unemployment benefits can be reversed or strengthened depending on the likelihood of unemployed spouses to obtain jobs and the likelihood of employed spouses to lose their jobs in the future. Moreover, those with unemployed spouses might or might not respond to the impacts of means-tested unemployment benefits: (1) if they are currently employed, a expected cost to obtain an acceptable job in the future can be too high to encourage them to quit their current jobs; (2) if they are currently unemployed, same statuses as their spouses, their expected duration of unemployment can be lengthened because the means-tested nature of unemployment benefits can push up their reservation wages. Thus, a joint search model is more appropriate to study a married couple’s labor supply decision.

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9 See, for example, the papers listed in Footnote 1. either ignore that a married couple’s labor supply decision is a joint decision-making process by conditioning on spouses’ employment outcomes or
10 The expected duration of a marital relationship will also affect the labor supply decision of a married couple. Marital instability is certainly an important issue, but it is ignored in this chapter in order to reduce the complexity of the analysis. I expect that the impact of the means-tested nature of unemployment benefits would be attenuated among the couples facing high degree of marital instability because each of them would behave more like a single individual.
In this section, I modify Guler et al.’s (2010) joint search model to examine how means-tested unemployment benefits and unemployment insurance affect married couples’ reservation wages. In order to facilitate the interpretation, I call one household member agent 1, and the other one agent 2. I only consider two employment statuses: unemployed and employed. Therefore, there are three types of couples in the economy: dual-earner couples, single-earner couples, and workless couples. Single-earner couples refer to couples of which only one is employed.

The time dimension of the model is discrete\(^{11}\). The job arrival rate is assumed to be \(\alpha\). The job separation risk is assumed to be zero, so 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 given the saving option.

I assume an exogenous wage offer distribution, \(F(w)\), known to each economic agent, as in McCall’s (1970) job search model. 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 \(\alpha\). If the agent accepts the offer, he or she earns \(w\). Otherwise, he or she stays unemployed.

\(^{11}\) The labor search model I use is essentially the same as in Guler et al. (2010) except on the time dimension. Guler et al. (2010) construct the continuous-time version 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 the selection of job locations is introduced to the model, they show that the equivalency will no longer hold except in some cases where on-the-job search is allowed or borrowing limits are looses in exponential preferences. 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 (2010) results, my paper show that the equivalency will also break when unemployment insurance is replaced by means-tested unemployment benefits.
3.1 Unemployment Insurance

Under unemployment insurance, I assume that each unemployed agent will be given a flat rate, \( b \). The duration of unemployment insurance is assumed to be unlimited.

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

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

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 decide to be employed, they will reach an absorbing state in the absence of job separation risk.

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

\[
\Omega(w_1) = w_1 + b + \beta \left\{ \alpha \int \max\{T(w_1, w_2), \Omega(w_1), \Omega(w_2)\} dF(w_2) \right\} + \left(1 - \alpha\right)\Omega(w_1)
\]  \[2\]

\( \Omega(w_1) \) describes the situation where agent 1 is employed and agent 2 is unemployed. When agent 2 receives a job offer, two decisions needed to be made jointly: (1) whether agent 1 quits his job or not (2) whether agent 2 accepts the job offer.
or not. Their final choices depend on the current wage of agent 1 and the wage offer of agent 2. \( \Omega(w_2) \) describes the situation where agent 1 is unemployed and agent 2 is employed. By symmetry, the function form of \( \Omega(w_2) \) is exactly the same as that of \( \Omega(w_1) \).

The value function of a workless couple is denoted as follows:

\[
U = 2b + \beta \left\{ 2\alpha(1 - \alpha) \int \max\{\Omega(w), U\} dF(w) + \right. \\
\left. \alpha^2 \int \int \max\{T(w_1, w_2), \Omega(w_1), \Omega(w_2), U\} dF(w_1)dF(w_2) + (1 - 2\alpha(1 - \alpha) - \alpha^2)U \right\} \tag{3}
\]

There are four possible 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. If the problem is formulated as a continuous-time problem, the probability for both agents receiving a job offer will be zero. Whether or not to allow both agents to receive a job offer at the same time is not important for the case of unemployment insurance, but it turns out to be important for means-tested unemployment benefits because some of the job offers will be rejected if not arriving at the same time, but will be accepted if given to a workless couple at the same time.

There are two sets of reservation wages, characterized as follows: (1) moving from unemployed to employed when the spouse is currently unemployed and (2) moving from unemployed to employed when the spouse is currently employed.

Let \( \hat{\omega}_{UI} \) denote the reservation wage of a workless couple. \( \hat{\omega}_{UI} \) is the same for both agent 1 and agent 2 by symmetry.
\[ \Omega(\tilde{w}_{UI}) = U \]  

Let \( \tilde{w}_{UI}(w_1) \) be agent 2’s reservation wage when agent 1 is currently employed, earning \( w_1 \). There are two cases in this situation. If it is not optimal for agent 1 to quit, then the reservation wage is characterized as follows:

\[ \Omega(w_1) = T(w_1, \tilde{w}_{UI}(w_1)) \]  

Equation [5] is needed for agent 1 to stay in his current job. As long as Equation [5] is satisfied, it will never be optimal for agent 1 to quit his job regardless of whether agent 2 will accept the new job offer or not. The reservation wage of the second case is characterized as follows:

\[ \tilde{w}_{UI}(w_1) = w_1 \]  

Equation [6] follows naturally from the fact that the \( \Omega \) function is constructed to be symmetric between agent 1 and agent 2. As long as Equation [5] is satisfied, the minimum wage for agent 1 and agent 2 to switch their employment status is the current wage of agent 1. Therefore, \( \tilde{w}_{UI}(w_1) = w_1 \).

**Proposition 1**: Under unemployment insurance, \( \tilde{w}_{UI}(w_1) \) is a constant, which does not depend on \( w_1 \), and \( \tilde{w}_{UI}(w_1) \) is equal to \( \tilde{w}_{UI} \).

**Proof**: See Appendix C.

Figure 3.7 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 not lower than $w_{UI}$ regardless of the employment outcome of the spouse. $w_{UI}$ is like a double indifference point, namely $U = T(w_{UI}, w_{UI}) = \Omega(w_{UI})$. As shown in Proposition 1 and Figure 3.7, there is no employment dependency on spouses under unemployment insurance where the employment rate of those with unemployed spouses will be equal to that of those with employed spouses, holding other things constant and symmetric.

### 3.2 Means-Tested Unemployment Benefits

Under means-tested unemployment benefits, I assume that 2b will be given to a couple as soon as one of them becomes unemployed. The final amount of unemployment benefit is determined by the following formulas:

$$\begin{align*}
2b & \quad \text{if both unemployed} \\
\max \{2b - w_1, 0\} & \quad \text{if agent 1 is employed} \\
\max \{2b - w_2, 0\} & \quad \text{if agent 2 is employed}
\end{align*}$$

This type of means-tested unemployment benefits is closely related to the UK’s jobseeker’s allowance. In 2010, the contribution-based jobseeker’s allowance (like unemployment insurance) for a qualified individual aged 25 or above is £65.45. They are not allowed to claim additional allowance for dependent adults unless they switch to income-based jobseeker’s allowance (means-tested unemployment insurance) which provides £102.75. A couple will have the first £10.00 of their earnings disregarded, and then the benefits will be reduced 1 pence for 1 pence of any additional earnings, which is
similar to [9]. Therefore, the comparison between Section 3.1 and Section 3.2 has some policy relevance.

Because of the max operator involved in the benefit calculation, it is not easy to characterize the reservation wages by using [9] directly, so I divide them into two cases: (1) no unemployment benefits for single-earner couples, and (2) \(2b\) is the only household income for single-earner couples. In case (1), the unemployment benefit, \(2b\), will be lost immediately as soon as one of the couple has accepted a job offer. In case (2), any wage earning will not contribute to household income for single-earner couples. The characterization of the reservation wage map based on [9] is the mixture of cases (1) and (2), as explained in Section 3.2.3.

### 3.2.1 Case One: No Unemployment Benefits for Single-earner couples

The corresponding labor search model is modified as follows:

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

\[
\Omega(w_1) = \frac{w_1}{1 - \beta} + \frac{\alpha \beta}{1 - \beta} \left\{ \max \left( \frac{T(w_1, w_2) - \Omega(w_1)}{\Omega(w_2) - \Omega(w_1)}, 0 \right) \right\} dF(w_2) \tag{11}
\]

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

Let the reservation wage of a job searcher from a single-earner couple be denoted as \(\tilde{w}_{UA}(w_1)\). Let the reservation wage of moving to work for a workless couple be denoted as \(\tilde{w}_{UA}\) when there is only one wage offer received. Let the reservation wage for
a workless couple to accept the job offers at the same time be denoted as 
\[ [\tilde{w}_{UA}(w_2, U), w_2]. \]

**Proposition 2**: Under case one:

(i) \( \tilde{w}_{UA}(w_1) \) is a constant, and \( \tilde{w}_{UA}(w_1) < \tilde{w}_{UI} \)

(ii) \( \tilde{w}_{UA} > \tilde{w}_{UI} \)

(iii) The slope of \( \tilde{w}_{UA}(w_2, U) \) is -1, and the line segment of \( \tilde{w}_{UA}(w_2, U) \) is below the double indifference point under unemployment insurance to the left.

**Proof**. See Appendix D.

Figure 3.8 provides a graphical presentation of Proposition 2. In order to provide a direct comparison between unemployment insurance and the case-one-type of means-tested unemployment benefits, the two white-color lines denote the case under unemployment insurance. As shown in Figure 3.8, under the case-one-type of means-tested unemployment benefits, the region of dual-earner couples expands, but the region of single-earner couples shrinks. The region of workless couples is likely to expand, but the exact change will depend on actual empirical wage distributions.

**3.2.2 Case Two: 2b is the Only Household Income for Single-earner couples**

The corresponding labor search model is modified as follows:

\[
T(w_1, w_2) = \frac{w_1 + w_2}{1 - \beta} \tag{13}
\]
\[
\Omega(w_1) = \frac{2b}{1-\beta} + \frac{\alpha \beta}{1-\beta} \left\{ \int \max\{T(w_1, w_2) - \Omega(w_1), 0\} dF(w_2) \right\}
\]  

[14]

\[
U = \frac{2b}{1-\beta} + \frac{\beta}{1-\beta} \left\{ \alpha^2 \int \max\{T(w_1, w_2) - \Omega(w_1), 0\} dF(w_1) dF(w_2) \right\}
\]  

[15]

Let \( \tilde{w}_{UA}(w_1) \) denote the reservation wage of a single-earner couple. Let \( \tilde{w}_{UA} \) denote the reservation wage of a workless couple when only one wage offer is received.

**Proposition 3**: Under case two:

(i) \(-1 < \frac{\partial \tilde{w}_{UA}(w_1)}{\partial w_1} < 0\)

(ii) \(\tilde{w}_{UA} < \tilde{w}_{UA} \), where \(T(\tilde{w}_{UA}, \tilde{w}_{UA}) = \Omega(\tilde{w}_{UA})\)

(iii) \(\tilde{w}_{UA} < w_{UL}\)

**Proof**: See Appendix E.

Figure 3.9 provides a graphical presentation of Proposition 3. The two white-color lines indicate the case under unemployment insurance. As shown in Figure 3.9, under the case-two-type of means-tested unemployment benefits, the region of dual-earner couples expands, and the region of both unemployed couples shrinks. Under the case-two-type of means-tested unemployment benefits, only joint employment can help couples to be better off. Therefore, workless couples will have a greater work incentive than under unemployment insurance. One of the couple will be willing to accept a low wage and let the other one keep search for a better job offer. There is an interesting breadwinner cycle in this case. Figure 3.9 shows a possible path for a breadwinner cycle.
When agent 1 receives a job offer that falls between $\bar{w}_{UA}$ and $\bar{w}_{UA}$ and agent 2 does not receive a job offer, agent 1 will accept the job offer and agent 2 keeps searching at point A. Initially, agent 1 is a breadwinner at point A. When agent 2 receive a job offer higher than the agent 1’s current wage at point B, agent 2 will accept the job offer and agent 1 will quit and search for a better job. Then, agent 2 becomes a breadwinner at point B. When agent 1 receives a better job offer, both of them become employed at point C. Thus, they climb up a wage ladder through switching the roles of breadwinners.

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

Case one and case two provide the backbones to construct the reservation wage map based on the original benefit function, $\max\{2b - w, 0\}$. When $b$ is relatively small, the reservation wage map will resemble the one observed from case one. As $b$ increases, the reservation wage map is a mixture of case one and case two. As $b$ continues to increase, the reservation wage map will more and more resemble the one observed under case two.

It is difficult to identify the exact threshold values for $b$ where it will switch from case one to the mixture of the two cases and then to case two. In this section, I provide graphical presentation of reservation wage maps by changing the $b$ values and holding the remaining parameter values constant. The comparison across $b$ values is provided in Figure 3.8. Again, the two white-color lines from each graph denote the case under unemployment insurance. As expected, $w_{UI}$ increases as the value of $b$ increases. The regions of dual-earner couples under means-tested unemployment benefits are always
bigger than those under unemployment insurance. In other words, means-tested unemployment benefits encourage more dual-earners than unemployment insurance.

When $b = 0$, there will be no difference between means-tested unemployment benefits and unemployment insurance. Figure 3.8 shows that the regions of workless couples are initially bigger under means-tested unemployment benefits than those under unemployment insurance. However, as $b$ continues increasing, the regions of both unemployed couples become bigger under unemployment insurance than those under means-tested unemployment benefits. Eventually, means-tested unemployment benefits will lead to a breadwinner cycle as $b$ continues rising.

Figure 3.10 shows that means-tested unemployment benefits have both positive and negative effects on employment outcomes. When $b$ is relatively small, means-tested unemployment benefits encourage a greater proportion of workless couples than unemployment insurance. However, when $b$ reaches some threshold value, this negative incentive disappears, and eventually means-tested benefits will encourage a smaller proportion of workless couples than unemployment insurance. Regardless of $b$ values, means-tested unemployment benefits always provide greater work incentives for couples to switch from both-unemployed to both-employed than unemployment insurance.

4. Model and Calibration

In this section, I first expand the model developed in Section 3 and then calibrate it to match some important features of the UK economy. There are two elements added to the model: (1) exogenous job separation rate, $\lambda$, and (2) income tax rate, $\tau$. Without
job separation, it is impossible to match any sensible employment rates from the data.

The income tax is endogenously determined so that government expenditure on
unemployment benefits will be equal to tax revenue.

The model I calibrate is presented as follows:

\[ T(w_1, w_2) = (w_1 + w_2)\tau + \beta \left\{ \begin{array}{l}
\lambda(1 - \lambda) \max\{\Omega(w_1), U\} + \\
\lambda(1 - \lambda) \max\{\Omega(w_2), U\} + \\
\lambda^2 U + \\
(1 - 2\lambda(1 - \lambda) - \lambda^2)T(w_1, w_2) \end{array} \right\} \]  \tag{[16]}

\[ \Omega(w_1) = \tau w_1 + \max\{2b - \tau w_1, 0\} \]  \tag{[17]}

\[ + \beta \left\{ (1 - \lambda) \left\{ \alpha \int \max\{T(w_1, w_2), \Omega(w_1), \Omega(w_2)\} dF(w_2) \right\} + \\
(1 - \alpha)\Omega(w_1) \right\} \]

\[ + \lambda \left\{ \alpha \int \max\{\Omega(w_2), U\} dF(w_2) \right\} + (1 - \alpha)U \}

\[ U = 2b + \beta \left\{ \begin{array}{l}
2\alpha(1 - \alpha) \int \max\{\Omega(w), U\} dF(w) + \\
\alpha^2 \int \max\{T(w_1, w_2), \Omega(w_1), \Omega(w_2), U\} dF(w_1)dF(w_2) + \\
(1 - 2\alpha(1 - \alpha) - \alpha^2)U \end{array} \right\} \]  \tag{[18]}

\[ \int (w_1 + w_2)\tau d\Delta^T(w_1, w_2) + \int (w_1)\tau d\Delta^{\Omega_1}(w_1) + \int (w_2)\tau d\Delta^{\Omega_2}(w_2) \]  \tag{[19]}

\[ = \int 2b d\Delta^U + \int \max\{2b - \tau w_1, 0\} d\Delta^{\Omega_1}(w_1) + \int \max\{2b - \tau w_2, 0\} d\Delta^{\Omega_2}(w_2) \]

Equation [19] is the government budget constraint. \( \Delta^T(w_1, w_2) \) is the invariant
distribution of dual-earner couples. \( \Delta^U \) is the invariant distribution of workless couples.
\( \Delta^{\Omega_1}(w_1) \) and \( \Delta^{\Omega_2}(w_2) \) are the invariant distribution of single-earner couples where agent 1
and agent 2 are employed, respectively.
Unemployment benefits are means-tested in the model. It does not perfectly match with the UK unemployment benefit system. However, given that the majority of claimers receive means-tested benefits (namely, income-based JSA) in the UK, as explained in Section 2, the model above provides a good approximation.

**Calibration.** The data I use to calibrate the model are the five-quarter longitudinal data from the UK labor force survey (April, 1995 – June, 1996). In my model, there are only two employment statuses. In order to connect the model with the data, I classify the inactive and the unemployed under the same group called non-employment. The model period is set to be one quarter. I set the discount factor $\beta$ to 0.9879, making the annual interest rate 5 percent. The quarterly empirical transition probability from employment to non-employment is 0.0238, which is set to the value of $\lambda$. The wage offer distribution is set to be a truncated normal between 0 and 1 with a mean of 0.7 and a variance of 0.1. During the sample period, the average of weekly gross pay is about £286.2, and the means-tested unemployment benefit for a couple is about £75 per week. I set $2b$ to be $0.7* (75/286.2)$, where $(75/286.2)$ is the replacement rate for the average weekly gross pay. The job arrival rate, $\alpha$, is calibrated to match the average employment rate of 0.774 during the sample period. The calibrated value of $\alpha$ is 0.127.

Table 3.5 compares the model prediction about the proportions of workless couples and dual-earner couples with the actual data. As shown in Table 3.5, the model under-predicts the proportion of workless couples by 1.87 percentage points and under-predicts the proportion of dual-earner couples by 6.99 percentage points. The model
prediction is obviously not perfect, but given the simplicity of the model without any gender specific parameters, the prediction quality is reasonably good.

4.1 Comparison between Unemployment Insurance and Means-Tested Unemployment Benefits

Table 3.6 provides the comparison between unemployment insurance and means-tested unemployment benefits. The government expenditure spent on unemployment benefits is almost three-times higher under unemployment insurance, but both of the benefit systems achieve similar employment rates. It seems to be more cost-effective to use means-tested unemployment benefits if the policy goal is to tackle employment problems. Under unemployment insurance, the proportion of workless couples is 0.68 percentage point higher and the proportion of dual-earner couples is 2.36 percentage points higher than those under means-tested unemployment benefits. Under unemployment insurance, there are no differences between conditional and unconditional employment rates. However, under means-tested unemployment benefits, the employment rate gap is about 6 percentage points between those with employed spouses and those with non-employed spouses.

Table 3.7 provides the comparison between means-tested unemployment benefits and unemployment insurance, under alternative benefit levels. The first scenario is to increase $b$ to 2.5 times its initial value. The government expenditure is again substantially larger under unemployment insurance, about 2-times higher than that under
means-tested unemployment benefits. Under unemployment insurance, both the proportions of workless couples and dual-earner couples are lower than those under means-tested unemployment benefits. The employment rate gap increases from 6 to 15 percentage points under means-tested unemployment benefits.

The second scenario is to increase $b$ to 5 times its initial value. As shown in Table 3.7, the government expenditure will be cut in half, and the employment rate will increase by 9 percentage points if using means-tested unemployment benefits instead of unemployment insurance. In terms of the proportions of workless and dual-earner couples, there is an interesting pattern that differs from the first scenario. Under means-tested unemployment benefits, the proportion of workless couples is actually 1.8 percentage-points lower than that under unemployment insurance. There is also a very substantial increase in the proportion of dual-earner couples, about 16.2 percentage points, once the system is switched from unemployment insurance to means-tested unemployment benefits. This interesting pattern is consistent with the theory presented in Section 3.2. This has a very important policy implication. First, by switching from unemployment insurance to means-tested unemployment benefits, it is likely to create a greater work disincentive for workless couples, but the increase in the proportion of workless couples is not likely to be large, and the gain from other factors, such as the substantial reduction in the government expenditure on unemployment benefits and the large increase in the proportion of dual-earner couples as well as the employment rate, is likely to be much larger than the loss. Second, if the degree of generosity of unemployment insurance is very large, by switching from unemployment insurance to
means-tested unemployment benefits, it may not produce any negative work incentive on workless couples because the emergence of a breadwinner cycle will encourage workless couples to lower their reservation wages through switching the breadwinner roles to climb up the wage ladder.

4.2 Means-Tested Unemployment Benefits vs. In-Work Benefits

Means-tested unemployment benefits target unemployed workers, while in-work benefits target employed workers. In-work benefits are usually means-tested as well\textsuperscript{14}. The latter belongs to “making work pay” policies, which has become one of the major focuses of recent welfare policy reforms. In this section, I provide a simple comparison between these two types of benefits and derive some relevant policy implications.

The formula for in-work benefits usually differs from country to country. In order to simplify the comparison, I use the following formula to compute in-work benefits, which is the same formula to compute means-tested unemployment benefits:

$$\max \{b_E - w, 0\} \tag{20}$$

where $b_E$ denotes the maximum amount of in-work benefits and $w$ denotes family income. The withdraw rate from additional income is one to one, which is higher than that used in the actual formula.

Under either system, I assume a workless couple will always receive $2b$. Under means-tested unemployment benefits, a single-earner couple will receive $\max\{2b - w, 0\}$ as their unemployment benefits, and a dual-earner couple receives zero benefits.

\textsuperscript{14} In-work benefits are called Earned Income Tax Credit in the U.S. In the UK, it is called Working Tax Credit.
Under in-work benefits, but both single-earner couples and dual-earner couples receive \( \max \{b_E - w, 0\} \) as their in-work benefits.

Table 3.8 provides the comparison between means-tested unemployment benefits and in-work benefits. Three different initial levels of \( b \) are examined. There are three observations related to Table 3.8. First, if the benefit level is very small to begin with, the employment outcome may not be significantly affected by switching from means-tested unemployment benefits to in-work benefits. Second, if the generosity of in-work benefits is set to be the same as that of unemployment benefits \( (b_E = 2b) \), it does not have any policy gain by switching means-tested unemployment benefits to in-work benefits. Third, if a country wants to improve her employment outcome by increasing her in-work benefits while at the same time increasing unemployment benefits to the same level, the employment problem is likely to be deteriorating instead of improving. The results from this section should be interpreted with caution because actual formulas to compute in-work benefits are much more complex than Equation [20]. A further investigation on this issue is needed in future studies.

5. Conclusion

The literature has overly emphasized the negative work incentive of means-tested unemployment benefits, which does not provide full information for policy evaluation because the overall employment outcome matters more than the employment outcome of women with unemployed spouses. This chapter shows that the positive work incentive generated from means-tested unemployment benefits usually outweighs the negative
work incentive, which can encourage a greater proportion of dual-earner couples, a higher employment rate, and a lower government expenditure on unemployment benefits.

This chapter provides a direct comparison between unemployment insurance and means-tested unemployment benefits at the micro level as well as at the macro level. I show how these two benefit systems affect a couple’s reservation wage differently, and I examine quantitatively how the micro incentives generated from these two benefit systems have contributed to the differences in government expenditures, conditional and unconditional employment rate as well as the proportions of workless and dual-earner couples.

My quantitative analysis in this paper is limited because I do not consider home production, asset accumulation, or human capital accumulation. Home production likely serves as an amplifier to the negative work incentive of means-tested unemployment benefits. To allow risk reverse preference and saving, it will help us to better understand how means-tested unemployment benefits affect couples’ employment decisions when facing liquidity constraints. To allow human capital accumulation, the reservation wage function will depend not only on the spouse’s current and expected employment outcome but also on their skill levels. Workers with different skill levels may face different job separation risks or job acceptance rates, which can lead to different expected duration of employment and unemployment. Means-tested unemployment benefits generally affects couples more when they face shorter expected duration of employment or longer expected duration of unemployment. Moreover, the actual rules, except in a small number of the countries (e.g., the UK), to calculate unemployment benefits are much
more complex than the ones studied in this chapter. Those interesting components will be left for future research.
Table 3.1: Conditional Employment Rates of Married Women

| Country | Year 1 | Employment Rate | Year 2 | Employment Rate | Gap
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>1994</td>
<td>24.37</td>
<td>65.41</td>
<td></td>
<td>41.04</td>
</tr>
<tr>
<td>UK</td>
<td>1991</td>
<td>35.25</td>
<td>68.69</td>
<td></td>
<td>33.44</td>
</tr>
<tr>
<td>France</td>
<td>1990</td>
<td>43.17</td>
<td>61.42</td>
<td></td>
<td>18.25</td>
</tr>
<tr>
<td>Portugal</td>
<td>1991</td>
<td>47.71</td>
<td>57.01</td>
<td></td>
<td>9.30</td>
</tr>
<tr>
<td>US</td>
<td>1990</td>
<td>59.92</td>
<td>68.13</td>
<td></td>
<td>8.21</td>
</tr>
<tr>
<td>Spain</td>
<td>1991</td>
<td>23.18</td>
<td>28.94</td>
<td></td>
<td>5.76</td>
</tr>
</tbody>
</table>

Notes:
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 and above.

Table 3.2: Simple Difference-in-Difference Analysis on Employment Rate Gaps

<table>
<thead>
<tr>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>1994</td>
<td>41.04</td>
<td>29.50</td>
<td></td>
<td>11.55</td>
</tr>
<tr>
<td>UK</td>
<td>1991</td>
<td>33.44</td>
<td>25.05</td>
<td></td>
<td>8.39</td>
</tr>
<tr>
<td>France</td>
<td>1990</td>
<td>18.25</td>
<td>7.84</td>
<td></td>
<td>10.41</td>
</tr>
<tr>
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<td>6.07</td>
<td></td>
<td>3.23</td>
</tr>
<tr>
<td>US</td>
<td>1990</td>
<td>8.21</td>
<td>9.01</td>
<td></td>
<td>-0.80</td>
</tr>
<tr>
<td>Spain</td>
<td>1991</td>
<td>5.76</td>
<td>9.23</td>
<td></td>
<td>-3.47</td>
</tr>
<tr>
<td><strong>Coefficient of variation</strong></td>
<td><strong>0.76</strong></td>
<td><strong>0.70</strong></td>
<td><strong>1.27</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes:
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 and above.
3. Husbands’ employment rate gap = married husbands’ employment rate with employed wives – married husbands’ employment rate with unemployed wives.
4. Wives’ employment rate gap = married women’ employment rate with employed husbands – married women’ employment rate with unemployed husbands.
Table 3.3: Difference-in-Difference Analysis on the Reduction in the Duration of Non-Means-Tested Unemployment Benefits

<table>
<thead>
<tr>
<th></th>
<th>Control Group</th>
<th>Treatment Group</th>
<th>DID (percentage points)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1,96-Q2,96</td>
<td>Q4,96-Q1,97</td>
<td>Q1,96-Q2,96</td>
<td>Q4,96-Q1,97</td>
</tr>
<tr>
<td>Employment rate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>22.53</td>
<td>24.45</td>
<td>36.87</td>
</tr>
<tr>
<td></td>
<td>(0.56)</td>
<td>(0.57)</td>
<td>(0.64)</td>
</tr>
<tr>
<td>Whether looking for paid work in last four weeks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>17.00</td>
<td>17.97</td>
<td>24.82</td>
</tr>
<tr>
<td></td>
<td>(0.50)</td>
<td>(0.51)</td>
<td>(0.58)</td>
</tr>
</tbody>
</table>

Notes:
2. Q1 denotes the first quarter (January-March), and Q4 denotes the fourth quarter (October-December).
3. Treatment Group: women whose spouses have been unemployed between six months and one year.
4. Control Group: women whose spouses have been unemployed for more than one year.
5. Standard errors are in parentheses.
6. In October 1996, the duration of non-means-tested benefits was reduced from previously one year to six months.
### Table 3.4: Robust Check on the Difference-in-Difference Analysis

<table>
<thead>
<tr>
<th></th>
<th>DID (percentage points)</th>
<th>Employment rate</th>
<th>Whether looking for work</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1,96-Q2,96 vs. Q4,96-Q1,97</td>
<td>-0.49</td>
<td>(1.22)</td>
<td>(1.07)</td>
</tr>
<tr>
<td>Q1,96-Q2,96 vs. Q3,96-Q1,97</td>
<td>0.33</td>
<td>(1.08)</td>
<td>(0.96)</td>
</tr>
<tr>
<td>Q4,95-Q2,96 vs. Q4,96-Q2,97</td>
<td>-1.23</td>
<td>(1.10)</td>
<td>(0.97)</td>
</tr>
<tr>
<td>Q4,95-Q2,96 vs. Q3,96-Q2,97</td>
<td>-0.39</td>
<td>(1.00)</td>
<td>(0.88)</td>
</tr>
</tbody>
</table>

**Notes:**
2. Q1 denotes the first quarter (January-March); Q3 denotes the third quarter (July-September); Q4 denotes the fourth quarter (October-December).
3. Treatment Group: women whose spouses have been unemployed between six months and one year.
4. Control Group: women whose spouses have been unemployed for more than one year.
5. Standard errors are in parentheses.
6. In October 1996, the duration of non-means-tested benefits was reduced from previously one year to six months.

### Table 3.5: Prediction of the Calibrated Model

<table>
<thead>
<tr>
<th></th>
<th>Proportion of workless couples</th>
<th>Proportion of dual-earner couples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>0.0617</td>
<td>0.6097</td>
</tr>
<tr>
<td>Data</td>
<td>0.0804</td>
<td>0.6796</td>
</tr>
</tbody>
</table>

**Notes:**
2. The model is defined in Section 4.
Table 3.6: Comparison between Means-Tested Unemployment Benefits and Unemployment Insurance

<table>
<thead>
<tr>
<th></th>
<th>Means-Tested</th>
<th>Unemployment Insurance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government Expenditure</td>
<td>0.0114</td>
<td>0.0431</td>
</tr>
<tr>
<td>Proportion of workless couples</td>
<td>0.0617</td>
<td>0.0549</td>
</tr>
<tr>
<td>Proportion of dual-earner couples</td>
<td>0.6097</td>
<td>0.5861</td>
</tr>
<tr>
<td>Employment Rate</td>
<td>0.7740</td>
<td>0.7656</td>
</tr>
<tr>
<td>Employment Rate: spouses non-employed</td>
<td>0.7269</td>
<td>0.7656</td>
</tr>
<tr>
<td>Employment Rate: spouses employed</td>
<td>0.7877</td>
<td>0.7656</td>
</tr>
</tbody>
</table>

Table 3.7: Comparison between Means-Tested Unemployment Benefits and Unemployment Insurance, Under Alternative Benefit levels

<table>
<thead>
<tr>
<th></th>
<th>Government Expenditure</th>
<th>Proportion of workless couples</th>
<th>Proportion of dual-earner couples</th>
<th>Employment Rate</th>
<th>Employment Rate: spouses non-employed</th>
<th>Employment Rate: spouses employed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase $b$ to 2.5 times its initial value</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UI</td>
<td>0.1159</td>
<td>0.0638</td>
<td>0.5586</td>
<td>0.7474</td>
<td>0.7474</td>
<td>0.7474</td>
</tr>
<tr>
<td>MT</td>
<td>0.0395</td>
<td>0.0858</td>
<td>0.6029</td>
<td>0.7586</td>
<td>0.6445</td>
<td>0.7948</td>
</tr>
<tr>
<td>Increase $b$ to 5 times its initial value</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UI</td>
<td>0.3453</td>
<td>0.1418</td>
<td>0.3886</td>
<td>0.6234</td>
<td>0.6234</td>
<td>0.6234</td>
</tr>
<tr>
<td>MT</td>
<td>0.1787</td>
<td>0.1231</td>
<td>0.5504</td>
<td>0.7137</td>
<td>0.5702</td>
<td>0.7712</td>
</tr>
</tbody>
</table>

Notes: UI = unemployment insurance; MT = means-tested unemployment benefits
Table 3.8: Comparison between Means-Tested Unemployment Benefits and In-Work Benefits

<table>
<thead>
<tr>
<th></th>
<th>Government Expenditure</th>
<th>Proportion of workless couples</th>
<th>Proportion of dual-earner couples</th>
<th>Employment Rate: spouses non-employed</th>
<th>Employment Rate: spouses employed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>b = 0.1</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Means-Tested Unemp. Benefits</td>
<td>0.0125</td>
<td>0.0617</td>
<td>0.6097</td>
<td>0.7740</td>
<td>0.7269</td>
</tr>
<tr>
<td>Means-Tested Emp. Benefits</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$b_E = 2b$</td>
<td>0.0125</td>
<td>0.0617</td>
<td>0.6097</td>
<td>0.7740</td>
<td>0.7269</td>
</tr>
<tr>
<td>Means-Tested Emp. Benefits</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$b_E = 2.5b$</td>
<td>0.125</td>
<td>0.0617</td>
<td>0.6097</td>
<td>0.7740</td>
<td>0.7269</td>
</tr>
<tr>
<td><strong>b = 0.3</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Means-Tested Unemp. Benefits</td>
<td>0.0632</td>
<td>0.1052</td>
<td>0.5913</td>
<td>0.7431</td>
<td>0.5907</td>
</tr>
<tr>
<td>Means-Tested Emp. Benefits</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$b_E = 2b$</td>
<td>0.0632</td>
<td>0.1052</td>
<td>0.5913</td>
<td>0.7431</td>
<td>0.5907</td>
</tr>
<tr>
<td>Means-Tested Emp. Benefits</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$b_E = 2.5b$</td>
<td>0.0598</td>
<td>0.0760</td>
<td>0.6021</td>
<td>0.7630</td>
<td>0.6792</td>
</tr>
<tr>
<td><strong>b = 0.4</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Means-Tested Unemp. Benefits</td>
<td>0.1040</td>
<td>0.1044</td>
<td>0.5876</td>
<td>0.7416</td>
<td>0.5961</td>
</tr>
<tr>
<td>Means-Tested Emp. Benefits</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$b_E = 2b$</td>
<td>0.1040</td>
<td>0.1044</td>
<td>0.5876</td>
<td>0.7416</td>
<td>0.5961</td>
</tr>
<tr>
<td>Means-Tested Emp. Benefits</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$b_E = 2.5b$</td>
<td>0.1950</td>
<td>0.0398</td>
<td>0.5193</td>
<td>0.7398</td>
<td>0.8472</td>
</tr>
</tbody>
</table>
Notes:
2. The net unemployment benefit replacement rate data are obtained from Table 2 in Martin (1996). I compute the net unemployment benefit replacement rate gap given that the unemployment duration is within one year. 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.

Figure 3.1: Married Women’s Employment Rate Gap versus Net Unemployment Benefit Replacement Rate Gap
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; (4) In April 2003, WFTC was replaced by Working Tax Credit, which extends in-work support to families without children.

Figure 3.2: 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; (4) In April 2003, WFTC was replaced by Working Tax Credit, which extends in-work support to families without children.

**Figure 3.3: 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; (4) In April 2003, WFTC was replaced by Working Tax Credit, which extends in-work support to families without children.
3. Low educational attainments: Below “GCE, A-level or equivalent”
4. High educational attainments: “GCE, A-level or equivalent” or above

**Figure 3.4: Employment Rates of Low-Educated Women in the UK, Conditional on Spouses’ Educational Attainments**
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; (4) In April 2003, WFTC was replaced by Working Tax Credit, which extends in-work support to families without children.
3. Low educational attainments: Below “GCE, A-level or equivalent”
4. High educational attainments: “GCE, A-level or equivalent” or above

Figure 3.5: Employment Rates of High-Educated Women in the UK, Conditional on Spouses’ Educational Attainments
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; (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.
7. “M: High; W: Low”: high-educated men married or cohabiting with low-educated women.
8. “M: High; W: High”: high-educated men married or cohabiting with high-educated women.

Figure 3.6: Employment Rate Gaps across Educational Attainments
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 3.7: 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.
3. The two white-color lines denote the case under unemployment insurance.

Figure 3.8: Reservation Wage Map under the Case-One-Type of 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 case under unemployment insurance.

Figure 3.9: Reservation Wage Map under the Case-Two-Type of 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 case under unemployment insurance.

Figure 3.10: Reservation Wage Map under Means-Tested Unemployment Benefits
Conclusion

I have examined the following three questions: (i) how the rise of female labor supply contributes to the rise of service economy; (ii) how marital instability and partners’ employment affect the employment responses of non-single mothers to the 1999 in-work benefit reform; (iii) how means-tested unemployment benefits affect couples’ employment decisions. The major findings are as follows. First, both Buera and Kaboski’s (BK) service economy model and the extended model which allows for gender and married couples are able to match nearly all of the growth in the service sector. Using counterfactual experiments, I identify both the efficient scale of service production and the increase in the skill intensity, particularly among the female population, as the most important channels of growth. Second, I find fairly substantial employment responses – 10 to 14 percentage points – among mothers in unstable marital relationships relative to those with stable marriages, and among mothers whose partners have unstable employment relative to those whose partners have stable employment. Third, I show that the positive work incentive generated from means-tested unemployment benefits usually outweighs its negative work incentive, which can lead to a greater proportion of dual-earner couples, a higher employment rate, and a lower government expenditure on unemployment benefits.

My first finding shows that the BK service economy model is a quantitatively plausible explanation for the observed growth in the share of services in the United States.
between 1965 and 2003. Furthermore, the extended model has an important implication for the composition of employment changes in response to the increased demand for skilled labor. High ability women become educated and increase labor supply at the fastest rate, while the labor supply of less educated men increases most slowly. Therefore, the increase in female labor force participation has been driven by high ability, highly-educated married women entering the labor force, which is consistent with Mulligan and Rubinstein (2007). However, one limitation of my first finding is that within the allowable parameter space, both the BK model and the extended model are unable to fully match the observed growth in schooling. Thus, in my future study, different normalization methods or production technologies of service and manufacturing goods could be explored to improve the quality of calibration.

My second finding highlights the important interaction between household instability and the labor decisions of non-single mothers, which fills in an important gap in the literature. As explained in Blundell, Francesconi, and van der Klaauw (2010), relatively little work has been done to examine how anticipation of shocks affect individual responses to welfare reforms although expectations are central to economic studies. My results show that both expected duration of marriages and expected duration of partners’ employment statuses affect employment responses of non-single mothers to the 1999 in-work benefit reform. Therefore, both marital and employment instability are important contributors in understanding heterogeneous employment responses among couples. In my second finding, I use cohabitation as a proxy for marital instability and reported satisfaction level of job security as a proxy for employment instability. In my future
study, the probability of separation in marriages or jobs could be estimated to improve the quality of marital instability measure and employment instability measure.

My third finding offers both empirical and theoretical investigation for explaining how means-tested unemployment benefits affect couples’ employment decisions. Moreover, I show that the negative work incentive of means-tested unemployment benefits, emphasized in the literature, does not provide full information for policy evaluation because the overall employment outcome matters more than the employment outcome of women with unemployed spouses. However, one limitation of this finding is that I use a very simple unemployment benefit rule despite of the fact that it still closely approximates the UK unemployment benefit system. In general, unemployment benefit rules are much more complex than those I use. For example, (1) not all the unemployed are eligible for unemployment insurance, depending on both whether they have entered unemployment voluntarily and whether they have sufficient employment history; (2) there is an interesting interaction between unemployment insurance and means-tested unemployment benefits because some of unemployed workers will be first given unemployment insurance and then means-tested unemployment benefits; (3) benefits are not necessarily paid at a flat rate and can be related to past earnings; (4) the duration of unemployment insurance is usually limited. Those interesting issues can be incorporated in the joint search model, and they are left for future research.

In my dissertation, I do not employ a unified framework to examine the impacts of in-work and unemployment benefits and the relationship between the rise of female labor supply and the rise of service economy in order to reduce the modeling complexity. This
certainly comes at cost of ignoring some important factors. For example, marital decision is not incorporated into the service economy model as well as the joint search model although empirical data has clearly shown that not all marriages can last until death. Thus, how marital instability affects women’s employment responses to means-tested unemployment benefits and their decisions in market production are also left for future research.
References


Appendix A: The Market Clearing Condition for High-Skilled Workers

\[
p_1 \int \frac{\partial}{\partial \theta} f(\theta) d\theta + p_2 \int \frac{\partial}{\partial \theta} f(\theta) d\theta + \frac{1}{2} p_3 \int \frac{\partial}{\partial \theta} f(\theta) d\theta + \int f(\theta) d\theta
\]

\[
= p_1 \int \frac{\partial}{\partial \theta} f(\theta) d\theta + \frac{1}{\theta_h} \int \frac{\partial}{\partial \theta} f(\theta) d\theta + p_2 \int \frac{\partial}{\partial \theta} f(\theta) d\theta + \frac{1}{\theta_h} \int \frac{\partial}{\partial \theta} f(\theta) d\theta
\]

\[
+ \frac{1}{2} p_3 \int \frac{\partial}{\partial \theta} f(\theta) d\theta + \frac{1}{\theta_2} \int \frac{\partial}{\partial \theta} f(\theta) d\theta + \frac{1}{\theta_5} \int \frac{\partial}{\partial \theta} f(\theta) d\theta
\]

Case one: \( \bar{z} \leq z(\theta) \leq z(\theta) \)

\[
H_1m(\theta) = \theta + \int \frac{e^{-\theta z}}{A_2} dz + \frac{1}{\theta_2} \int \frac{e^{-\theta z}}{A_2} dz + \int \frac{e^{-\theta z}}{A_2} dz + \int \frac{e^{-\theta z}}{A_2} dz
\]

\[
= \theta + \frac{e^{-\theta z}}{A_2} (z(\theta) - z(\theta) + 1) + \frac{1}{\theta_2} \left( \frac{1}{n} e^{-\theta z} + e^{-\theta z} \right) (z(\theta) - z(\theta) + 1) + \frac{e^{-\theta z}}{A_2}
\]

\[
H_2m(\theta) = \int \frac{e^{-\theta z}}{A_2} dz + \frac{1}{\theta_2} \int \frac{e^{-\theta z}}{A_2} dz + \frac{1}{\theta_2} \int \frac{e^{-\theta z}}{A_2} dz
\]

\[
= \frac{e^{-\theta z}}{A_2} (z(\theta) - z(\theta) + 1) + \frac{1}{\theta_2} \left( \frac{1}{n} e^{-\theta z} + e^{-\theta z} \right) (z(\theta) - z(\theta) + 1), \ z(\theta) \ and \ z(\theta) \ are \ fixed
\]

\( H_1f(\theta) \) and \( H_2f(\theta) \): functional forms are the same as \( H_1m(\theta) \) and \( H_2m(\theta) \) except that \( A_m \) is changed to \( A_f \).
\[ H_1(\theta) = 2\theta + 2\int \frac{z(\theta)}{z} e^{-\frac{z - z}{A_h}} dz + 2\left[ \frac{1}{n} \int \frac{z(\theta)}{z} e^{-\frac{z - z}{A_h}} dz + \int \frac{\zeta(\theta)}{z(\theta)} e^{-\frac{z - z}{A_h}} dz \right] + t_m(\theta) + t_f(\theta) \]

\[ = 2\theta + 2 e^{-\frac{z - z}{A_h}}(z(\theta)^{\lambda + 1} - z^{\lambda + 1}) + 2 \frac{1}{A_h(\lambda + 1)} (\frac{1}{n} e^{-z} + e^{-z})(z(\theta)^{\lambda + 1} - z(\theta)^{\lambda + 1}) + t_m(\theta) + t_f(\theta) \]

\[ H_2(\theta) = \theta + 2\int \frac{z(\theta)}{z} e^{-\frac{z - z}{A_h}} dz + 2\left[ \frac{1}{n} \int \frac{z(\theta)}{z} e^{-\frac{z - z}{A_h}} dz + \int \frac{\zeta(\theta)}{z(\theta)} e^{-\frac{z - z}{A_h}} dz \right] + t_m(\theta) \]

\[ = \theta + 2 e^{-\frac{z - z}{A_h}}(z(\theta)^{\lambda + 1} - z^{\lambda + 1}) + 2 \frac{1}{A_h(\lambda + 1)} (\frac{1}{n} e^{-z} + e^{-z})(z(\theta)^{\lambda + 1} - z(\theta)^{\lambda + 1}) + t_m(\theta) \]

\[ H_3(\theta) = 2\int \frac{z(\theta)}{z} e^{-\frac{z - z}{A_h}} dz + 2\left[ \frac{1}{n} \int \frac{z(\theta)}{z} e^{-\frac{z - z}{A_h}} dz + \int \frac{\zeta(\theta)}{z(\theta)} e^{-\frac{z - z}{A_h}} dz \right] \]

\[ = 2 e^{-\frac{z - z}{A_h}}(z(\theta)^{\lambda + 1} - z^{\lambda + 1}) + 2 \frac{1}{A_h(\lambda + 1)} (\frac{1}{n} e^{-z} + e^{-z})(z(\theta)^{\lambda + 1} - z(\theta)^{\lambda + 1}), \quad \zeta(\theta) \text{ and } z(\theta) \text{ are fixed} \]

Case two: \( \zeta(\theta) \leq z \leq \zeta(\theta) \)

\[ H_{1m}(\theta) = \theta + \frac{1}{n} \int \frac{z(\theta)}{z} e^{-\frac{z - z}{A_h}} dz + \int \frac{\zeta(\theta)}{z} e^{-\frac{z - z}{A_h}} dz \]

\[ = \theta + \frac{1}{A_h(\lambda + 1)} (\frac{1}{n} e^{-z} + e^{-z})(z(\theta)^{\lambda + 1} - z^{\lambda + 1}) + e^{-z} \frac{z(\theta)^{\lambda + 1}}{A_h(x + 1)} \]

\[ H_{2m}(\theta) = \frac{1}{n} \int \frac{z(\theta)}{z} e^{-\frac{z - z}{A_h}} dz + \int \frac{\zeta(\theta)}{z} e^{-\frac{z - z}{A_h}} dz \]

\[ = \frac{1}{A_h(\lambda + 1)} (\frac{1}{n} e^{-z} + e^{-z})(z(\theta)^{\lambda + 1} - z^{\lambda + 1}), \quad \zeta(\theta) \text{ and } \zeta(\theta) \text{ are fixed} \]

\[ H_{1A_A}(\theta) \text{ and } H_{2A_A}(\theta) : \text{ functional forms are the same as } H_{1a}(\theta) \text{ and } H_{2a}(\theta), \text{ except} \]

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that $A_m$ is changed to $A_f$.

\[ H_1(\theta) = 2\theta + 2\left[ \frac{1}{n} \int \frac{z^{mz} e^{z_0 z}}{A_0} dz \right] \]

\[ = 2\theta + 2\left[ \frac{1}{A_0(\lambda + 1)} \left( \frac{1}{n} e^{-g^{-f} + e^{-g^{-f}}}(z(\theta)^{\lambda} + -z^{\lambda+1}) + t_m(\theta) + t_f(\theta) \right) \right] \]

\[ H_2(\theta) = \theta + 2\left[ \frac{1}{n} \int \frac{z^{mz} e^{z_0 z}}{A_0} dz \right] \]

\[ = \theta + 2\left[ \frac{1}{A_0(\lambda + 1)} \left( \frac{1}{n} e^{-g^{-f} + e^{-g^{-f}}}(z(\theta)^{\lambda} + -z^{\lambda+1}) + t_m(\theta) \right) \right] \]

\[ H_3(\theta) = 2\left[ \frac{1}{n} \int \frac{z^{mz} e^{z_0 z}}{A_0} dz \right] \]

\[ = 2\left[ \frac{1}{A_0(\lambda + 1)} \left( \frac{1}{n} e^{-g^{-f} + e^{-g^{-f}}}(z(\theta)^{\lambda} + -z^{\lambda+1}) \right), \right] \]

$z(\theta)$ and $\bar{z}(\theta)$ are fixed.
Appendix B: Proof of the Equivalence

Equation [3] of Chapter 3 is denoted as follows:

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

Equation [C.5] of Chapter 3 is denoted as follows:

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

The first step is to prove the uniqueness and the existence of $U$ in both Equations [3] and [C.5]. When $U = 0$, the LHS of Equations [3] and [C.5] are equal to zero, and the RHS are equal to a positive number. When $U$ increases, the LHS is strictly increasing in $U$, but the RHS is non-increasing in $U$. When $U$ approaches to infinity, the LHS approaches to infinity, but the RHS approaches to $\frac{2b}{1-\beta}$. Therefore, the LHS and RHS must cross and cross only once.

Given the uniqueness and the existence of $U$, if the $U$ from Equation [C.5] solves Equation [3], then they must be identical to each other.

The second step is to show that the following component, which is the difference between Equation [C.5] and [3], is equal to zero given that the $U$ from Equation [3] is equal to the $U$ from Equation [C.5].
\[ G = \alpha^2 \left( \iint \max\{T(w_1, w_2) - U, \Omega(w_1) - U, \Omega(w_2) - U, 0\} dF(w_1)dF(w_2) + \right. \]
\[ \left. -2 \int \max\{\Omega(w) - U, 0\} dF(w) \right) \tag{B.1} \]

Since the \( U \) from Equation [3] is assumed to be equal to the \( U \) from Equation [C.5], the reservation wage, \( w_{u1} \), obtained from Equations [1], [2] and [C.5] of Chapter 3 would be equal to the reservation wage obtained from Equations [1], [2] and [3] of Chapter 3. Then, I can expand the first component of [B.1] as follows (\( \underline{w} \) and \( \bar{w} \) are the lower and upper supports of \( F(w) \), respectively):

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

\[ = \int_{w_{u1}}^{\bar{w}} \int_{w_{u1}}^{\bar{w}} \Omega(w_1) - UdF(w_1)dF(w_2) + \int_{w_{u1}}^{\bar{w}} \int_{w_{u1}}^{\bar{w}} \Omega(w_2) - UdF(w_1)dF(w_2) + \]

\[ \int_{w_{u1}}^{\bar{w}} \int_{w_{u1}}^{\bar{w}} T(w_1, w_2) - UdF(w_1)dF(w_2) \]

\[ = 2 \int_{w_{u1}}^{\bar{w}} (\Omega(w) - U) F(w_{u1})dF(w) + \int_{w_{u1}}^{\bar{w}} \int_{w_{u1}}^{\bar{w}} T(w_1, w_2) - UdF(w_1)dF(w_2) \]

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

\[ G = \alpha^2 \left( 2 \int_{w_{u1}}^{\bar{w}} (\Omega(w) - U) F(w_{u1})dF(w) + \int_{w_{u1}}^{\bar{w}} \int_{w_{u1}}^{\bar{w}} T(w_1, w_2) - UdF(w_1)dF(w_2) \right. \]
\[ \left. -2 \int_{w_{u1}}^{\bar{w}} (\Omega(w) - U)dF(w) \right) \]

\[ = \alpha^2 \left( \int_{w_{u1}}^{\bar{w}} \int_{w_{u1}}^{\bar{w}} T(w_1, w_2) - UdF(w_1)dF(w_2) \right. \]
\[ \left. -2(1 - F(w_{u1})) \int_{w_{u1}}^{\bar{w}} (\Omega(w) - U)dF(w) \right) \]

\[ = \alpha^2 \left( \int_{w_{u1}}^{\bar{w}} \int_{w_{u1}}^{\bar{w}} T(w_1, w_2) - UdF(w_1)dF(w_2) \right. \]
\[ \left. -2 \int_{w_{u1}}^{\bar{w}} \int_{w_{u1}}^{\bar{w}} \Omega(w_1) - UdF(w_1)dF(w_2) \right) \tag{B.3} \]

\[ = \alpha^2 \left( \int_{w_{u1}}^{\bar{w}} \int_{w_{u1}}^{\bar{w}} T(w_1, w_2) - U - 2(\Omega(w_1) - U)dF(w_1)dF(w_2) \right) \]
\[ \alpha^2 \left( \int_{\omega_{u1}}^{\omega_{u2}} T(w_1, w_2) - 2\Omega(w_1) + UdF(w_1) dF(w_2) \right) \]

\[ = \alpha^2 \left( \int_{\omega_{u1}}^{\omega_{u2}} T(w_1, w_2) - \Omega(w_1) - \Omega(w_2) + UdF(w_1) dF(w_2) \right) \]

Equation [2] of Chapter 3 can be expressed as follows:

\[ (1 - \beta)\Omega(w_1) = w_1 + b + \alpha\beta \int_{\omega_{u1}}^{\omega} T(w_1, w_2) - \Omega(w_1) dF(w_2) \]  \[ \text{[B.4]} \]

Equation [C.5] can be expressed as follows:

\[ (1 - \beta)U = 2b + 2\alpha\beta \int_{\omega_{u1}}^{\omega} \Omega(w_2) - UdF(w_2) \]  \[ \text{[B.5]} \]

By multiplying [B.4] by 2 and then subtracting [B.5] from it, the equation becomes

\[ (1 - \beta)(2\Omega(w_1) - U) = 2w_1 + 2\alpha\beta \int_{\omega_{u1}}^{\omega} T(w_1, w_2) - \Omega(w_1) - \Omega(w_2) + UdF(w_2) \]

\[ \frac{(1-\beta)(2\Omega(w_1) - U) - 2w_1}{2\alpha\beta} = \int_{\omega_{u1}}^{\omega} T(w_1, w_2) - \Omega(w_1) - \Omega(w_2) + UdF(w_2) \]  \[ \text{[B.6]} \]

By integrating [B.6] from \( \omega_{u1} \) to \( \omega \) based on \( w_1 \), it yields

\[ \int_{\omega_{u1}}^{\omega} \frac{(1-\beta)(2\Omega(w_1) - U) - 2w_1}{2\alpha\beta} dF(w_1) \]  \[ \text{[B.7]} \]

\[ = \int_{\omega_{u1}}^{\omega} \int_{\omega_{u1}}^{\omega} T(w_1, w_2) - \Omega(w_1) - \Omega(w_2) + UdF(w_1) dF(w_2) \]

By substituting [B.7] into [B.3], it yields

\[ G = \alpha^2 \left( \int_{\omega_{u1}}^{\omega} \frac{(1-\beta)(2\Omega(w_1) - U) - 2w_1}{2\alpha\beta} dF(w_1) \right) \]  \[ \text{[B.8]} \]

\[ = \frac{\alpha}{\beta} \left( \int_{\omega_{u1}}^{\omega} (1 - \beta) \left( \Omega(w_1) - \frac{U}{2} \right) - w_1 dF(w_1) \right) \]

\[ = \frac{\alpha}{\beta} \left( \int_{\omega_{u1}}^{\omega} (1 - \beta) \left( \Omega(w_1) - \frac{\Omega(w_{u1})}{2} \right) - w_1 dF(w_1) \right) \]

\[ = \frac{\alpha}{\beta} \left( \int_{\omega_{u1}}^{\omega} (1 - \beta) \left( T(w_1, w_{u1}) - \frac{T(w_{u1}, w_{u1})}{2} \right) - w_1 dF(w_1) \right) \]

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According to (B.8), the $\zeta$ from Equation (C.5) is the solution to Equation [3].


Q.E.D.
Appendix C: Proof of Proposition 1 of Chapter 3

**Proposition 1**: Under unemployment insurance, \( \hat{w}_{UI}(w_1) \) is a constant, which does not depend on \( w_1 \), and \( \hat{w}_{UI}(w_1) \) is equal to \( \hat{w}_{UI} \).

**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:

\[
T(w_1, w_2) = \frac{w_1 + w_2}{1 - \beta} \quad \text{[C.1]}
\]

Equation [2] can be rearranged as follows:

\[
\Omega(w_1) = \frac{w_1 + b}{1 - \beta} + \frac{\alpha \beta}{1 - \beta} \left\{ \int \max\left\{ T(w_1, w_2) - \Omega(w_1), 0 \right\} dF(w_2) \right\} \quad \text{[C.2]}
\]

For a single-earner couple, it is possible for the currently employed spouse to quit the job. First, I assume that it is never optimal for the currently employed spouse to do so, and then I verify the validity of that assumption at the end. Given that assumption, Equation [C.2] can be simplified as follows:

\[
\Omega(w_1) = \frac{w_1 + b}{1 - \beta} + \frac{\alpha \beta}{1 - \beta} \left\{ \int_{\hat{w}_{UI}(w_1)} T(w_1, w_2) - \Omega(w_1) dF(w_2) \right\} \quad \text{[C.3]}
\]

By substituting Equation [5] into [C.2], the reservation wage of \( \hat{w}_{UI}(w_1) \) can be solved out in the following steps:
\[
T(w_1, \tilde{w}_{UI}(w_1)) = \frac{w_1 + b}{1 - \beta} + \frac{\alpha \beta}{1 - \beta} \left\{ \int_{\tilde{w}_{UI}(w_1)} T(w_1, w_2) - T(w_1, \tilde{w}_{UI}(w_1)) dF(w_2) \right\}
\]

\[
\tilde{w}_{UI}(w_1) = b + \frac{\alpha \beta}{1 - \beta} \left\{ \int_{\tilde{w}_{UI}(w_1)} w_2 - \tilde{w}_{UI}(w_1) dF(w_2) \right\}
\]  \[\text{[C.4]}\]

Equation [C.4] provides an implicit function for \( \tilde{w}_{UI}(w_1) \). It is clear that \( \tilde{w}_{UI}(w_1) \) is a constant, which does not depend on \( w_1 \). Let \( \tilde{w}_{UI} \) be the constant value \( \tilde{w}_{UI}(w_1), \forall w_1 \).

The next step is to compare \( \tilde{w}_{UI} \) with \( \tilde{w}_{UI} \). In order to simplify the comparison, I first reformate the value function, \( U \), by dropping the possibility for both agents to receive a job at the same time. Then, I prove the equivalency between the reformulated and the original value functions. Equation [3] is reformulated as follows

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

By substituting Equation [4] into [C.5], it yields

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

By replacing \( w_1 \) with \( \tilde{w}_{UI} \) in Equation [C.3], I obtain the following equation:

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

By symmetry, the following two equations hold:

\[
\Omega(\tilde{w}_{UI}) = T(\tilde{w}_{UI}, \tilde{w}_{UI}) = \frac{2 \tilde{w}_{UI}}{1 - \beta}
\]  \[\text{[C.8]}\]

\[
T(\tilde{w}_{UI}, w_2) = \Omega(w_2)
\]  \[\text{[C.9]}\]

By substituting Equations [C.8] and [C.9] into [C.7] and then multiplying it by 2, it yields:
\[ \Omega(\tilde{w}_{UI}) = -\Omega(w_{UI}) + 2 \frac{\tilde{w}_{UI} + b}{1 - \beta} + 2 \alpha \beta \left\{ \int_{\tilde{w}_{UI}} \Omega(w) - \Omega(w_{UI}) dF(w) \right\} \]

\[ \Omega(\tilde{w}_{UI}) = \frac{2b}{1 - \beta} + 2 \alpha \beta \left\{ \int_{\tilde{w}_{UI}} \Omega(w) - \Omega(w_{UI}) dF(w) \right\} \]  

[C.10]

By subtracting Equation [C.8] from [C.6], it yields

\[ \Omega(\tilde{w}_{UI}) - \Omega(\tilde{w}_{UI}) = \]

[C.11]

Based on Equation [C.3], \( \Omega(w) \) is increasing in \( w \). If \( \tilde{w}_{UI} > \tilde{w}_{UI} \), the LHS of Equation [C.11] is positive, while the RHS of Equation [C.11] is negative. If \( \tilde{w}_{UI} < \tilde{w}_{UI} \), the LHS of Equation [C.11] is negative, while the RHS of Equation [C.11] is positive. Therefore, \( \tilde{w}_{UI} \) must be equal to \( \tilde{w}_{UI} \). Let \( w_{UI} = \tilde{w}_{UI} = \hat{w}_{UI} \)

For a workless couple, either agent will not accept the job offer unless it is not lower than \( w_{UI} \). For a single-earner couple, the unemployed one will not accept the job offer lower than \( w_{UI} \), and the employed one will never have an incentive to quit, which confirms my initial assumption. The reason is as follows:

\[ T(w_1, w_2) \geq T(w_{UI}, w_2) \geq \Omega(w_2) \]

[C.12]

Proposition 1 holds if the problem is described by Equation [1], [2], and [C.5]. However, the original problem is described by Equation [1], [2], and [3]. If Equation [3] is equivalent to [C.5], then Proposition 1 should also hold for the original problem.

Given the recursive structure of the problem, Equation [1] and [2] are not affected by either Equation [C.5] or [3]. Appendix B provides a mathematical proof for the equivalence between Equations [3] and [C.5]. Although the proof is a little bit tedious, the intuition for the equivalence is straightforward. The probabilities for each agent to
receive a job offer are the same in both [3] and [C.5] because the wage drawn from $F(w)$
is independent and identically-distributed. Given the same value functions, $T(w_1, w_2)$
and $\Omega(w)$, either [3] or [C.5] should produce the identical $U$. Q.E.D.
Appendix D: Proof of Proposition 2 of Chapter 3

**Proposition 2**: Under case one:

(i) \( \tilde{w}_{UA}(w_1) \) is a constant, and \( \tilde{w}_{UA}(w_1) < \tilde{w}_{UI} \)

(ii) \( \tilde{w}_{UA} > \tilde{w}_{UI} \)

(iii) The slope of \( \tilde{w}_{UA}(w_2, U) \) is -1, and the line segment of \( \tilde{w}_{UA}(w_2, U) \) is below the double indifference point under unemployment insurance to the left.

**Proof.** If a job searcher from a single-earner couple accepts a job offer, the following reservation wage condition must be met:

\[
\Omega(w_1) = T(w_1, \tilde{w}_{UA}(w_1)) = \frac{w_1 + \tilde{w}_{UA}(w_1)}{1 - \beta} \tag{D.1}
\]

Again, there are two possibilities. Agent 1 who is currently employed might decide to quit or keep his job when there is a job offer that pays \( w_2 \) to his spouse. Let’s assume that it is never optimal for agent 1 to quit his job for the moment. Once (ii) is proved, it is clear that \( \tilde{w}_{UA} > \tilde{w}_{UI} > \tilde{w}_{UA}(w_1) \), so agent 1 will never quit his job. Then, Equation [C.3] can be simplified as follows:

\[
\Omega(w_1) = \frac{w_1}{1 - \beta} + \frac{\alpha\beta}{1 - \beta} \left\{ \int_{\tilde{w}_{UA}(w_1)} T(w_1, w_2) - \Omega(w_1) F(w_2) \right\} \tag{D.2}
\]

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

\[
\frac{w_1 + \tilde{w}_{UA}(w_1)}{1 - \beta} = \frac{w_1}{1 - \beta} + \frac{\alpha\beta}{1 - \beta} \left\{ \int_{\tilde{w}_{UA}(w_1)} \frac{w_1 + w_2}{1 - \beta} - \frac{w_1 + \tilde{w}_{UA}(w_1)}{1 - \beta} F(w_2) \right\}
\]
\[ \tilde{w}_{UA}(w_1) = \frac{\alpha \beta}{1 - \beta} \left\{ \int_{\tilde{w}_{UA}(w_1)} w_2 - \tilde{w}_{UA}(w_1) F(w_2) \right\} \]  \hspace{1cm} \text{[D.3]}

Given Equation [D.3], it is clear that \( \tilde{w}_{UA}(w_1) \) is a constant. By comparing Equation [D.3] with [C.4], we can see that they are the same except for an additional \( \beta \) in the RHS of [C.4]. Given that the LHS is increasing in \( \tilde{w}_{UA}(w_1) \) and the RHS is decreasing in \( \tilde{w}_{UA}(w_1) \), \( \tilde{w}_{UA}(w_1) \) must be smaller than \( \tilde{w}_{UI} \). If the spouse is already employed, there will be a greater likelihood 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 better facilitate the proof in the remaining section, let \( \tilde{w}_{UA}(w_1) \) be denoted as \( \tilde{w}_{UA} \) which explicitly indicates that \( \tilde{w}_{UA} \) is not dependent on \( w_1 \).

In order to prove (ii), it will be easier to reformulate Equation [C.4] by dropping the possibility where both unemployed couples receive a job offer at the same time. As explained in Section 3.1, the reformulated model is the same as the original model because wage draws are IID. Then, Equation [C.4] can be simplified as follows:

\[ U = \frac{2b}{1 - \beta} + \frac{\beta}{1 - \beta} \left\{ 2\alpha \int \max\{\Omega(w) - U, 0\} dF(w) \right\} \]  \hspace{1cm} \text{[D.4]}

Given that \( U = \Omega(\tilde{w}_{UA}) \), Equation [D.4] can be modified as follows:

\[ \Omega(\tilde{w}_{UA}) = \frac{2b}{1 - \beta} + \frac{2\alpha \beta}{1 - \beta} \left\{ \int_{\tilde{w}_{UA}} \Omega(w) - \Omega(\tilde{w}_{UA}) dF(w) \right\} \]  \hspace{1cm} \text{[D.5]}

Using Equation [D.1], \( \Omega(w) = \frac{w + \tilde{w}_{UA}}{1 - \beta} \), Equation [D.5] can be further simplified as follows:

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\[
\frac{\hat{w}_{UA} + \tilde{w}_{UA}}{1 - \beta} = \frac{2b}{1 - \beta} + \frac{2\alpha\beta}{1 - \beta} \left\{ \int_{\tilde{w}_{UA}} w + \hat{w}_{UA} - \hat{w}_{UA} dF(w) \right\}
\]

\[
\hat{w}_{UA} = 2b + \frac{2\alpha\beta}{1 - \beta} \left\{ \int_{\hat{w}_{UA}} w - \hat{w}_{UA} dF(w) \right\} - \tilde{w}_{UA} \quad \text{[D.6]}
\]

Let’s multiply Equation [C.4] by 2 and subtract it from Equation [D.6]. It yields:

\[
\hat{w}_{UA} - 2\tilde{w}_{UI} = \frac{2\alpha\beta}{1 - \beta} \left\{ \int_{\hat{w}_{UA}} w - \hat{w}_{UA} dF(w) - \int_{\tilde{w}_{UL}} w - \tilde{w}_{UL} dF(w) \right\} - \tilde{w}_{UA} \quad \text{[D.7]}
\]

The (ii) of Proposition 2 can be proved by contradiction. Assume \(\hat{w}_{UA} \leq \tilde{w}_{UI}\).

When \(\hat{w}_{UA} = \tilde{w}_{UI}\), Equation [D.7] can be reduced to \(\tilde{w}_{UI} = \tilde{w}_{UA}\), which is not correct according to the (i) of Proposition 2. When \(\hat{w}_{UA} < \tilde{w}_{UI}\), Equation [D.7] can be reduced to as follows:

\[
\hat{w}_{UA} - 2\tilde{w}_{UI} > -\tilde{w}_{UA}
\]

\[
\hat{w}_{UA} - \tilde{w}_{UI} > \tilde{w}_{UI} - \tilde{w}_{UA} \quad \text{[D.8]}
\]

The LHS of Equation [D.8] is less than zero, but the RHS of Equation [D.8] is greater than zero, which again leads to a contradiction. Therefore, \(\hat{w}_{UA} > \tilde{w}_{UI}\).

Under the case-one-type of means-tested unemployment benefits, the reservation wage for a workless couple to switch to a sole-unemployed couple is higher than that under unemployment insurance. However, as soon as one of the couples starts working, the reservation wage of the other one is the same as that under unemployment insurance when \(b = 0\) due to the complete reduction in the unemployment benefits. Therefore, it is not necessary to have \((\hat{w}_{UA}, \tilde{w}_{UA})\) for a workless couple to switch to a dual-earner couple.

When the probability for a workless couple to receive a job offer at the same time is added back to [D.4], it is clear that it will never be optimal to choose to be a single-
earner couple over a dual-earner couple. Therefore, the reservation wage for a workless couple to switch to a dual-earner couple should satisfy the following condition:

\[ T(w_1, w_2) = U \]  \hspace{1cm} \text{[D.9]}

Given the definition of \( T(w_1, w_2) \), \( \bar{w}_{UA}(w_2, U) \) can be derived as follows:

\[ \bar{w}_{UA}(w_2, U) = -w_2 + (1 - \beta)U \]  \hspace{1cm} \text{[D.10]}

Therefore, the slope of \( \bar{w}_{UA}(w_2, U) \) is -1. The second part of the (iii) of Proposition 2 can be proven as follows. Under the case-one-type of means-tested unemployment benefits, \( U \) falls strictly between the \( U \) under unemployment insurance when the benefit is zero and the \( U \) under unemployment insurance when the benefit is \( b \). Then, \( U \) must be fallen below \( T(w_{UI}, w_{UI}) \), which moves the line segment of \( \bar{w}_{UA}(w_2, U) \) to be below the double indifference point under unemployment insurance to the left.

Q.E.D.
Appendix E: Proof of Proposition 3 of Chapter 3

**Proposition 3**: Under case two:

(i) \(-1 < \frac{\partial \bar{w}_{UA}(w_1)}{\partial w_1} < 0\)

(ii) \(\hat{w}_{UA} < \bar{w}_{UA}\), where \(T(\bar{w}_{UA}, \bar{w}_{UA}) = \Omega(\bar{w}_{UA})\)

(iii) \(\bar{w}_{UA} < w_{UI}\)

**Proof.** For a single-earner couple, I conjecture that it will never be optimal for the currently employed agent to quit if his or her wage is \(\bar{w}_{UA}\) or above. Assume \(w_1 \geq \bar{w}_{UA}\).

Using that \(T(w_1, \bar{w}_{UA}(w_1)) = \Omega(w_1)\), Equation [36] can be modified as follows:

\[
\Omega(w_1) = \frac{2b}{1-\beta} + \frac{\alpha \beta}{1-\beta} \left\{ \int_{\bar{w}_{UA}(w_1)} T(w_1, w_2) - \Omega(w_1) dF(w_2) \right\}
\]

\[
T(w_1, \bar{w}_{UA}(w_1)) = \frac{2b}{1-\beta} + \frac{\alpha \beta}{1-\beta} \left\{ \int_{\bar{w}_{UA}(w_1)} T(w_1, w_2) - T(w_1, \bar{w}_{UA}(w_1)) dF(w_2) \right\}
\]

\[
\hat{w}_{UA}(w_1) = -w_1 + 2b + \frac{\alpha \beta}{1-\beta} \left\{ \int_{\hat{w}_{UA}(w_1)} w_2 - \bar{w}_{UA}(w_1) dF(w_2) \right\} \tag{E.1}
\]

Take the derivate of [E.1] with respect to \(w_1\) on the both sides, and it yields as follows:

\[
\frac{\partial \hat{w}_{UA}(w_1)}{\partial w_1} = -1 + \frac{\alpha \beta}{1-\beta} \frac{\partial \hat{w}_{UA}(w_1)}{\partial w_1} \left\{ \int_{\hat{w}_{UA}(w_1)} (-1) dF(w_2) \right\}
\]

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\[
\frac{\partial \tilde{w}_{UA}(w_1)}{\partial w_1} = -\frac{1}{1 + \frac{\alpha \beta}{1 - \beta} (1 - F(\tilde{w}_{UA}(w_1)))}
\]  

[E.2]

Given that \(0 < \alpha < 1\) and the discount factor \(\beta < 1\), it is easy to show that \(\frac{\partial \tilde{w}_{UA}(w_1)}{\partial w_1}\) is between -1 and 0 using Equation [E.2]. As the wage of a currently employed agent increases, the spouse’s reservation wage drops, which confirms my conjecture.

Both \(\tilde{w}_{UA}(w_1)\) and \(\tilde{w}_{UA}(w_2)\) cross at \(\tilde{w}_{UA}\). If \(w_1 < \tilde{w}_{UA}\) in a single-earner couple \([\Omega(w_1)\]), depending on the wage draw, \(w_2\), it is not always optimal for agent 1 to keep his job because \(\tilde{w}_{UA}(w_2)\) is above \(\tilde{w}_{UA}(w_1)\) when \(w_2 > \tilde{w}_{UA}\). However, when \(w_1 \geq \tilde{w}_{UA}\), \(\tilde{w}_{UA}(w_2)\) is always below \(\tilde{w}_{UA}(w_1)\), so it is always optimal for agent 1 to keep his job regardless of any wage draw of \(w_2\).

The (ii) of Proposition 3 can be proven by contradiction. Assume \(\tilde{w}_{UA} \geq \tilde{w}_{UA}\). It is easy to rule out the case where \(\tilde{w}_{UA} > \tilde{w}_{UA}\) because it implies that both agent 1 and agent 2 would need to accept a job offer that provides a lower total utility than \(U\), which is not an optimal choice. When \(\tilde{w}_{UA} = \tilde{w}_{UA}\), it will also lead to a contradiction, shown as below.

Given that \(T(\tilde{w}_{UA}, \tilde{w}_{UA}) = \Omega(\tilde{w}_{UA})\), equation [E.1] can be modified as follows:

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

[E.3]

As explained in Section 3.1, Equation [37] can be simplified as follows:

\[
U = \frac{2b}{1 - \beta} + \frac{2\alpha \beta}{1 - \beta} \left\{ \int_{\tilde{w}_{UA}} \Omega(w) - UdF(w) \right\}
\]

[E.4]

Given the assumption, \(\tilde{w}_{UA} = \tilde{w}_{UA}\), the following conditions must hold:
\[ U = \Omega(\bar{\omega}_{UA}) = \Omega(\bar{\omega}_{UA}) = T(\bar{\omega}_{UA}, \bar{\omega}_{UA}) = \frac{2\bar{\omega}_{UA}}{1 - \beta} \quad \text{[E.5]} \]

Using [E.5] and \( T(w_1, \bar{\omega}_{UA}(w_1)) = \Omega(w_1) \), Equation [E.4] can be modified as follows:

\[ 2\bar{\omega}_{UA} = 2b + \frac{2\alpha \beta}{1 - \beta} \left\{ \int_{\bar{\omega}_{UA}} w - \bar{\omega}_{UA}dF(w) \right\} \quad \text{[E.6]} \]

By subtracting [E.3] from [E.6], it yields;

\[ 0 = \frac{\alpha \beta}{1 - \beta} \left\{ \int_{\bar{\omega}_{UA}} w - \bar{\omega}_{UA}dF(w) \right\} > 0 \quad \text{[E.7]} \]

When \( \bar{\omega}_{UA} = \bar{\omega}_{UA} \), it leads to a contradiction, \( \theta > 0 \). Therefore, \( \bar{\omega}_{UA} < \bar{\omega}_{UA} \).

By multiplying [C.4] by 2 and subtracting it from [E.3], it yields:

\[ 2(\bar{\omega}_{UA} - w_{UI}) = \frac{\alpha \beta}{1 - \beta} \left\{ \int_{\bar{\omega}_{UA}} w - \bar{\omega}_{UA}dF(w) - 2\int_{w_{UI}} w - w_{UI}dF(w) \right\} \quad \text{[E.8]} \]

When \( \bar{\omega}_{UA} = w_{UI} \), the LHS of [E.8] is zero while the RHS of [E.8] is negative.

When \( \bar{\omega}_{UA} > w_{UI} \), the LHS of [E.8] is positive while the RHS of [E.8] is negative. Only when \( \bar{\omega}_{UA} < w_{UI} \), can Equation [E.8] be possibly satisfied. Q.E.D.