Are Partnered Women “Added Workers”?
Evidence from Women’s Labour Force Participation in the UK

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Abstract

I examine whether and how an inactive married or cohabiting woman’s participation decision is influenced by her partner’s different labour market activities and investigate the effect of the time she spends away from the labour market on her labour supply decision. Using a panel of couples’ monthly labour market histories that I constructed from the British Household Panel Survey 1991-2009, I show that there is significant negative duration dependence in woman’s participation, which is strongest in the first three years of her inactivity. A woman with an unemployed partner is 23% less likely to enter the labour market than a woman whose partner is employed, i.e. a negative added worker effect. On the other hand, a woman’s labour supply decision depends on her partner’s labour market activity, and a woman with an inactive partner is more likely to participate in the labour force than a woman whose partner is unemployed. The duration dependence and the added worker effect do not vary by the way a woman enters the labour force, i.e. via job-finding or job-search; however, claiming income support or unemployment benefit within an interview year has destination specific effects as it increases the probability of a woman’s participation via job-search rather than job-finding.

Keywords: added worker effect, female labour supply, discrete-time duration model, competing risks model, frailty

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1 Introduction

Theories of household labour supply predict that, under certain assumptions, a family member may increase his/her labour supply as a response to a lower household income due to the primary breadwinner's unemployment. This household insurance mechanism is referred as the added worker effect. In practice, any family member may become an added worker (Serneels, 2002; Baldini et al., 2017), however, the empirical literature mostly focuses on couples as the strongest interdependency in household labour supply decisions are between partners (Baslevent and Onaran, 2003).

In this paper, I examine the added worker effect by analysing whether and to what extent a woman's partner's different labour market activities, including his unemployment and other types of non-employment, influence her participation probability. Using a dataset on couples' monthly labour market histories that I constructed from the British Household Panel Survey 1991-2009 (BHPS), I model how the time a woman has spent out of the labour force affects her own labour supply decision (duration dependence). A woman may become active in the labour market by searching for or by directly finding a job, thus I further examine whether, and if so, by how much, the determinants of a woman's participation vary between these two mutually exclusive states. This approach enables me to examine whether women who participate by finding a job exit inactivity quicker than those who spend time searching for a job, and whether they are more likely to become added workers.

Previous literature has taken into account the timing of the male partner's job loss on woman's labour supply response (e.g. Ayhan, 2017; Bryan and Longhi, 2017), however the time until her participation in the labour force has not been considered as a part of the added worker effect story. There have been few studies that investigate the added worker effect within a duration framework (e.g. Lundberg, 1985; McGinnity, 2002), but these studies either assumed to the duration dependence to be constant or it is not explicitly modelled to show how a woman's participation probability varies over the time she spends away from the labour market. Measuring the duration dependence in women's inactivity contributes to a better understanding of their labour supply decisions and it is useful for policies that seek to reintroduce inactive women into work force that could be tailored for women in various stages of their inactivity.

The classical definition of the added worker effect involves examining the woman's labour supply response to her partner's unemployment or his job loss (Lundberg, 1985; Gong, 2011; Starr, 2014). Following this definition, the studies on the UK (Layard et al., 1980; Davies et al., 1992; Bingley and Walker, 2001) find negative added worker effect, i.e. a woman with an unemployed partner is less likely to participate in the labour force than a woman whose partner is employed. In addition to partner's unemployment, I control for a partner's other non-employment states such as inactivity, retirement or long-term sickness, which are left out of the analyses so far. The hypothesis is that the partner's different labour market activities may invoke different degrees of added worker effect. In other words, a woman's labour supply adjustment may depend on the permanence of her partner's non-employment, e.g. a woman with a discouraged (inactive) partner may be more likely to enter the labour market than a woman with an unemployed partner. This is expected if unemployment and non-participation are behaviourally different labour market states (Flinn and Heckman, 1983; Marzano, 2006). Considering different labour market states of partners sheds light into women's participation behaviour in different household compositions such as workless and single-earner couples, and it is also relevant for the UK as women's participation is an important mechanism to mitigate an increase in workless couples (Harkness and Evans, 2011).

This paper contributes to the literature by empirically modelling how women's participation probabilities change over the months they remain inactive, and by examining the added worker effect within a broader framework. Including different non-employment states of partners, which are also associated with low income, extends the scope of the classical added worker effect that focuses only on partners' unemployment. This broader definition allows me to compare a woman's propensity to become an added worker when their partners are in a persistent labour market state (e.g. inactivity) rather than in a transitory one (e.g. unemployment). The empirical evidence is based on new dataset, which is a longer panel at a higher frequency than the quarterly labour force surveys, and the detailed information about the labour market spells allows examining the added worker effect within duration framework.

I find that the time a woman spends in inactivity plays a significant role in her participation probability. The longer she stays away from the labour market, the less likely she is to participate, and this negative duration dependence is strongest in the first three years of woman's inactivity, which survives after controlling for unobserved heterogeneity. The empirical counterpart of the classical added worker effect in this paper is the difference between the participation probability of a woman when her partner is unemployed at the time of her transition to labour market and the same probability when the partner is employed. Accordingly, an inactive woman with an unemployed partner is 23% less likely to participate in the labour force than a woman with an employed partner. This negative added worker effect is captured as a contemporaneous effect of partner's unemployment, and is in line with the previous findings on the UK. Extending the classical definition of the added worker effect shows that a woman is more likely to become an added worker when her partner is inactive compared to a woman whose partner is unemployed. This complementary evidence on the added worker effect supports the findings of qualitative studies that argue women assume breadwinner responsibilities in a couple only after all other channels are exhausted by the male partner (Gush et al., 2015; Laurie et al., 2015). In a couple where either one of the partners claim income support or unemployment benefits lowers her participation probability, which is in line with previous findings (Dex et al., 1995; Bingley and Walker, 2001; McGinnity, 2002; Bredtmann et al., 2014). However, when participation is distinguished between job-finding and job-search, claiming benefits increases the probability of a woman's job-search, but not the probability of her participation via job-finding. On the other hand, there is no significant difference between the duration dependence and the added worker effect by the way women enter the labour market.

The organisation of the paper is as follows. The following section presents an overview of the related empirical literature on the added worker effect and describes the conceptual framework. Section 3 discusses the estimation strategy and section 4 introduces the dataset. The results are discussed in section 5, and section 6 concludes.

2 The Added Worker Effect: Background and Conceptual Framework

2.1 Background

The theories of household labour supply present various well-established channels for a woman to become an added worker.[1] However, the empirical literature shows mixed evidence on its existence or magnitude: while some studies show small but significant added worker effect (Lundberg, 1985; Juhn and Potter, 2007; Starr, 2014; Blundell et al., 2016 for the US; Kohara, 2010 for Japan; Gong, 2011 for Australia; Ayhan, 2017 for Turkey), others find no evidence to support its existence (Maloney 1987; 1991 for the US; Layard et al., 1980; Bingley and Walker, 2001 for the UK).

The mixed findings may be a result of variations in the definition of the added worker effect (Stephens, 2002; Gong, 2011). One of the differences stems from the margin of the woman's labour supply adjustment. For instance, in a country where the female labour force participation is low, i.e. women are mostly inactive, it is more likely to observe an added worker effect at the extensive margin than at the intensive margin. The intensive margin studies use the changes in a woman's working hours to measure her labour supply response to her partner's unemployment, whereas extensive margin studies are less in concordance in defining what constitutes a woman's participation response. Among extensive margin studies, a woman's labour supply response is defined as her job-search (Lundberg, 1985; Mattingly and Smith, 2010), or her job-finding (McGinnity, 2002;

[1] Ayhan (2017) provides an overview of the emergence of the added worker effect in different theoretical models such as in unitary models, where partners pool their income and maximise a joint utility, in life-cycle models (MaCurdy, 1985; Cullen and Gruber, 2000; Stephens, 2002), and in collective/bargaining household labour supply models (Chiappori, 1992; Manser and Brown, 1980).

Juhn and Potter, 2007; Kohara, 2010) or as both (Bryan and Longhi, 2017). A broader definition of participation, i.e. including both job-search and job-finding to measure a woman's response is important as restricting her job-finding is more likely to be affected by the demand side factors of the local labour market, which would underestimate her probability of becoming an added worker.

Previous empirical literature on the added worker effect in the UK shows that a woman who is partnered with an unemployed man is less likely to increase her labour supply than a woman whose partner is employed (Layard et al., 1980; Davies et al., 1992; Harkness and Evans, 2011), especially if her partner is unemployed for more than a year (Bingley and Walker, 2001; McGinnity, 2002). The studies also show that there is a reverse added worker effect in the UK as the probability of a woman to voluntarily quit her job is higher when her partner is unemployed rather than being employed (McGinnity, 2002; Bryan and Longhi, 2017). However, during the 2008 recession, women were more likely to retain their jobs when their partners became unemployed (Harkness and Evans, 2011; Bryan and Longhi, 2017), which suggests that macroeconomic conditions have an impact on woman's voluntary quits. Using the Quarterly Labour Force Survey, Bryan and Longhi (2017) show that there is a small added worker effect in the UK among inactive women in male-breadwinner households, yet the effect works through job-search rather than job-finding. The main explanation for a negative (and reverse) added worker effect is the potential complementarity of partners' leisure times. The literature also highlights the disincentivizing effect of the welfare system on women's labour force participation in the UK (Dex et al., 1995; Bingley and Walker, 2001; McGinnity, 2002; Harkness and Evans, 2011; Bredtmann et al., 2014). Sociological and qualitative evidence from the UK suggests that unless the couple faces serious economic hardship, women refrain from filling their partners' shoes and do not become added workers due to social conventions and established division of labour in the household (Gush et al., 2015; Laurie et al., 2015).

A potential positive added worker effect may be confounded by several other factors. One of the challenges in estimating the added worker effect is the discouraged worker effect, which works in the opposite direction (Davies et al., 1992; Baslevent and Onaran, 2003). This effect is observed when a woman is discouraged by her partner's unsuccessful job-search, and she believes that she may not be able to find a job. For instance, if partners are exposed to similar labour market conditions, it is more likely for the woman to become a discouraged worker rather than an added worker. While the mechanism behind the discouraged worker effect is usually not observed by the researcher, the effect is usually proxied by (regional) unemployment rates (Ayhan, 2017; Bryan and Longhi, 2017).

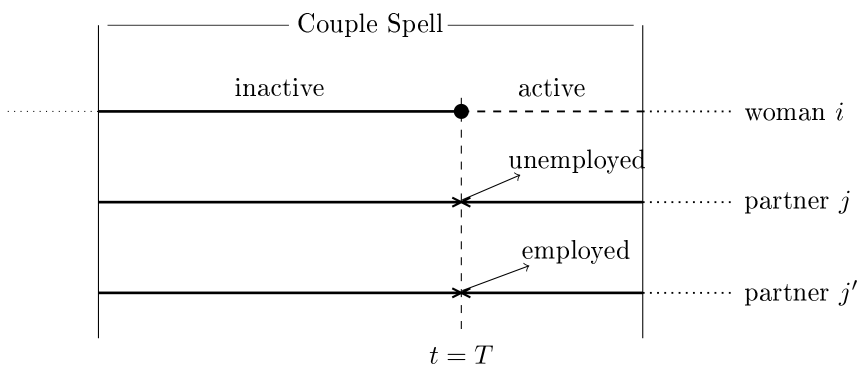
Another important challenge stems from the non-random formation of couples. The factors that play a role in couple formation, such as similar skills and preferences, may also affect a woman's labour supply decision (Devereux, 2004). Assortative mating is acknowledged as a source of endogeneity and discussed widely in the added worker effect literature (Cullen and Gruber, 2000; Harkness and Evans, 2011). Due to the simultaneity of decisions and assortative mating, it is a challenge to establish a causal relationship between partner's unemployment and a woman's labour supply decision, and there have been few empirical studies that address this issue (e.g Goux et al., 2014; Ayhan, 2017). The literature addresses the endogeneity of partner's unemployment in several ways such as estimating partners' labour supply decisions simultaneously (Lundberg, 1988; Baslevent and Onaran, 2003), adding a large set of observable characteristics to model specifications (Değirmenci and İlkkaracan, 2013), and/or controlling for previous labour market experiences of partners (Spletzer, 1997).

2.2 The Conceptual Framework

In this paper, I focus on the extensive margin of the added worker effect. Unlike previous literature, the estimation sample is not based on the male partners' labour market activities, i.e. the sample is not limited to the single-earner couples. Thus, the questions addressed in this paper are defined for the couples, in which the woman is inactive and her male partner is in one of the five labour market states: employment, unemployment, inactivity, retirement and long-term sickness.

The classical definition of the added worker effect concentrates on the woman's labour supply response to her partner's unemployment. Figure 1 illustrates the effect using a hypothetical couple.

Figure 1: The Added Worker Effect



The horizontal lines in Figure 1 refer to the monthly labour market histories of individuals. The observation window is restricted to a couple spell, during which the woman is observed with the same male partner over consecutive months delineated by the vertical lines. The dotted lines demonstrate the labour market states that are outside the observation window. After a period of inactivity, woman i becomes active in the labour market at $t = T$, either by finding a job or searching for a job. Her partner may be in and out of employment throughout the couple spell, but the interest lies in his labour market state at the time of woman's transition into the labour force. At the time of her transition, her partner j is unemployed. As an individual cannot occupy two labour market states at the same time, the counterfactual is to assume a second partner j' who is employed at $t = T$. In this framework, woman i becomes an added worker if she exits inactivity when her partner is unemployed. Thus, the added worker effect is empirically defined as the difference between the participation probability of an inactive woman when her partner is unemployed at the time of her transition and the same probability when the partner is employed.

There are two points worth noting about this framework. Firstly, it adopts a simple definition of the added worker effect as it does not take into account partner's transitions from one state to the other during woman's inactivity. This leads to identifying the added worker effect at a point in time rather than a dynamic process. Hence, the effect is interpreted as the marginal effect of her partner's unemployment (or any other labour market activity) on the woman's probability of becoming an added worker, and not her response to an income shock. Also, in this framework, if a partner has been unemployed for a few months before woman's transition, i.e. $t < T$, but is employed at T, the woman is not considered to become an added worker. In other words, a contemporaneous effect is captured rather than a lagged one. Secondly, this framework assumes that a partner who has been unemployed for some time (stock sample) and a partner who loses his job recently (flow sample) affect the woman's participation in a similar fashion.[2]

This framework, on the other hand, captures the woman's transition from inactivity to activity, and takes into account whether her inactivity spell has started before she enters the observation window. Appendix A.1 describes the types of censoring in the sample, which is important for the empirical strategy in section 3.

Besides examining the added worker effect within a simple framework, I test several hypotheses on woman's labour force participation such as the effect of the benefit system, which is considered as one of the important factors for the lack of the added worker effect in the UK (Bingley and Walker, 2001; Bredtmann et al., 2014). Claiming income support or unemployment benefits may provide insurance for the couple and may partially crowd-out woman's labour supply adjustment (Cullen and Gruber, 2000). Thus, a woman becomes less likely to enter the labour force in a couple that claims such benefits. It is worth noting that the theories on household labour supply predict a change in woman's labour supply behaviour irrespective of the beliefs and attitudes towards gender roles (Laurie et al., 2015). However Fortin (2005) argues that attitudes to gender roles are persistent and play an important role in women's labour supply. Thus, another hypothesis is that a woman may be more likely to become active in the labour market if she is in

[2]This assumption is relaxed in further analysis by taking into account the total time the partner spends in unemployment until woman's labour force participation.

a gender-egalitarian couple that promotes woman's labour force participation than a traditional couple, where the woman is the carer and the male partner is the provider. In a traditional couple, a woman may tend to preserve the established division of labour when her partner is non-employed, and she would not become an added worker. Similar to egalitarian attitudes, a woman's perceptions and beliefs may be significant determinants of her labour force participation. Hence, I also test the hypothesis whether a woman's perceptions of her household's finances relative to her partner's influence her participation decision.

3 Methodology

The key concept in duration modelling is the hazard function, $h_{ikt} \equiv Pr(s_{ik} = t \mid s_{ik} \geq t)$, where s_{ik} is the inactivity duration of woman i in couple k. The hazard in this framework can be interpreted as the conditional probability of a woman i in couple k entering the labour force at time s, given that she has been inactive up until time t.

A woman's participation probability is conditional on her survival in inactivity, hence the stock and flow of her inactivity spells have varying effects on the participation hazard (see Appendix A.1). For instance, excluding the stock of inactivity spells from the sample may result in a selection of spells with shorter durations, which leads the sample to be length-biased (Kiefer, 1988). Therefore, I account for the difference between the flow and stock inactivity spells in the sample by resetting the clock of a woman's inactivity duration, s_{ik}, to start counting from the month she has been inactive until she is first observed in the sample (Jenkins, 2005). A woman's elapsed duration in inactivity for the first month she is observed in the sample is $s_{ik} > 1$ for the stock of inactivity spells, and $s_{ik} = 1$ for a woman who becomes inactive within the sample period. The risk intervals are formulated as gap-time with the clock being reset to 1 when the woman becomes inactive at any month t during the sample period. As the unit of observation is a couple, hereafter the woman subscript i is dropped for notational convenience.

The duration is measured in months, hence the appropriate statistical strategy is to model a partnered woman's participation in the labour force within a discrete-time proportional hazards framework, i.e. using the complementary log-log link function (Cameron and Trivedi, 2005; Jenkins, 2005).

A relatively flexible assumption on woman's duration dependence yields a non-parametric piece-wise constant discrete-time hazard model for a woman in couple k at time s, which can be written as

$$h_{ks} = 1 - exp\{-exp(\sum_{a=1}^{\tau} \gamma_a d_{a,ks} + \sum_{p=2}^{5} \delta_p P_{p,kt} + X_{kt}\beta)\}, \qquad (1)$$

where $(d_{1,ks}, \ldots, d_{\tau,ks})'$ are binary variables for woman's elapsed duration s_k. The γ_a-terms capture the duration dependence for each elapsed month of woman's inactivity until $s_k = a < 22$ months and the later durations are grouped into intervals of varying lengths assuming that the hazard is constant for $s_k \in (a-1, a]$, $a = 23, ..., \tau$. Estimating equation (1) without a constant yields the baseline hazard for each interval, $h_0(a)$.

The labour market activities of partners in couple k at time t are captured by the dummy variables $P_{p,kt}$, where $P_{1,kt}$ is partner's employment, and $p = \{2, 3, 4, 5\}$ refer to his unemployment, inactivity, retirement and long-term sickness, respectively. The covariate matrix X_{kt} includes woman's, her partner's, and household's characteristics, some of which are allowed to vary over time. The individual-level controls include the woman's and her partner's demographic characteristics such as their age groups and the highest qualification they achieved during their couple spell. It also includes woman's previous labour market experience, and a dummy variable to identify whether her inactivity spell started when she was single. These two variables aim to capture a woman's preferences towards labour force participation, e.g. her propensity to work. The covariate matrix also includes standard household controls such as the number of children in the household by age groups, and dummy variables for house-ownership to proxy wealth effects. In addition, the fully specified model contains dummy variables for whether a couple member has claimed income support or unemployment related benefits between two consecutive interviews, whether woman's perception of the household's current financial situation is more pessimistic than her partner's, and dummy variables each describing the couple's attitudes towards gender roles.

When there are many discrete-time periods, and when some of the risk sets (the number of exits from inactivity) is small, a common approach is to specify a parametric baseline hazard using the logarithm of the elapsed months in inactivity, $\log(s)$. This specification is analogous to the continuous-time Weibull model, $h(t) = \alpha t^{\alpha-1}\lambda$ where $\alpha > 0$ and $\lambda > 0$. The hazard function can be written as

$$h_{ks} = 1 - exp\{-exp[(\alpha-1)log(s_k) + \sum_{p=2}^{5} \delta_p P_{p,kt} + X_{kt}\beta]\}, \tag{2}$$

where $P_{p,kt}$ and X_{kt} are the same as described previously.

Assuming that $\log(1-h) \approx -h$, the estimated parameters have the marginal effects interpretation as in binary choice models (Andrews et al., 2011). Following the traditional definition, if there is an added worker effect among partnered inactive women in the UK, the participation probability should be higher when their partners are unemployed than they are employed. Then, the added worker effect is measured as the difference between the log-hazards when the partner is unemployed and employed:

$$\delta^{AWE} = log(h_s|P_2 = 1, \mathbf{X}) - log(h_s|P_2 = 0, \mathbf{X}),$$

and if $\delta^{AWE} > 0$, her partner's unemployment leads to an increase in the woman's hazard. The exponentiated coefficient is interpreted as the hazard ratio, and the parameters δ and β shift the predicted hazard upward or downward depending on the sign, representing a proportionate change in the risk associated with the individual elements of X_{kt}.

Two women who share the same observed characteristics may have different hazards. A woman may be better in some unobserved way (such as higher motivation, or willingness to work) that makes her exit inactivity quicker than the other. If this is the case, the sample becomes increasingly dominated by women who remain inactive at higher durations and lower the exit rates, i.e. there may be a selection effect. This leads overestimating the degree of duration dependence and confounds the baseline hazard. While controlling for unobserved factors in regular panel data models enables the estimation of unbiased parameters, in duration analysis, it allows researchers to uncover the true duration dependence in the hazard function (Lancaster, 1990; Van den Berg, 2001; Nicoletti and Rondinelli, 2010). The model specification is similar to equation (2), and the only difference is the inclusion of the unobserved random component to the model as

$$h_{iks}(\mathbf{P}_{kt}, \mathbf{X}_{kt}, \nu_k) = 1 - exp\{-exp[(\alpha - 1)log(s_k) + \sum_{p=2}^{5} \delta_p P_{p,kt} + X_{kt}\beta + \nu_k]\}, \quad (3)$$

where ν_k is the couple-specific heterogeneity term.

There is a wide discussion in econometrics literature on the specification of the unobserved heterogeneity distribution, and the techniques to integrate it out (Van den Berg, 2001; Cameron and Trivedi, 2005). The random effect in equation (3) is normally distributed with mean zero, and variance σ_ν^2. Since there is no closed form expression, I use numerical quadrature techniques to estimate the distribution parameters of ν_k. The practical implication of the normality assumption is that it leads to estimating a complementary log-log model with random effects. In terms of interpretation, the exponentiated estimates from equation (2) are interpreted as the hazard ratios for two randomly selected women, who are identical in every observable characteristics except one, whereas exp(β) from equation (3) compares two women with the same level of unobserved heterogeneity.

The event of interest is a woman's exit from inactivity at elapsed month s by entering the labour force, i.e. she becomes active in labour market either by searching for a job or finding one. The outcome variable, y_{ks}, takes into account the timing of woman's participation as well as the change in her labour market state and is defined as

$$y_{ks} = \begin{cases} 1 & \text{if woman becomes active at time } s \text{, and is inactive at } t < s \\ 0 & \text{otherwise.} \end{cases}$$

The dependent variable is also the censoring indicator, as $y_{ks} = 0$ for every month the woman is inactive except for the final month of the spell (until the event is experienced).

In this final month, $y_{ks} = 1$ if the woman participates in the labour force the following month, and $y_{ks} = 0$ if her inactivity spell is right-censored (see Appendix A.1). Therefore the sample log-likelihood function for the discrete-time hazard, $h_{ks} = Pr(y_{ks} = 1 \mid y_{kt} = 0,\, t < s)$, can be written as

$$LL = \sum_{k} \sum_{s_k} \left[y_{ks} log \left\{ h_s(\cdot) \right\} + (1 - y_{ks}) log \left\{ 1 - h_s(\cdot) \right\} \right],$$

which essentially has the same form as the discrete choice model for an unbalanced panel. The likelihood contributions of completed, left-truncated and right-censored spells are further discussed in Appendix A.2.

An inactive woman may be at risk of participation via job-search ($r = 1$) or via job-finding ($r = 2$). Therefore besides a single-risk analysis, from inactivity to labour force participation, two forms of exits are considered in a competing risks framework. Thus, I examine whether some covariates have risk-specific effects, and analyse the effect of the covariates on the probability of participation via employment compared to via unemployment. In terms of the added worker effect, it is worth examining the probability of woman's participation via each risk and the effect of her partner's unemployment. The outcome variable for the competing risks model is defined in a similar fashion as in previous section, and $y_{r,ks}$ is 0 unless exit from inactivity is via risk r, i.e. the other destination states are treated as being right-censored.

Following the same specification as in equation (2), the hazard function is defined for each exit type, $h_{r,s}$ and $r = 1, 2$. However, the parameter estimates from $h_{1,s}$ and $h_{2,s}$ do not have a direct interpretation on the probability of transition via risk r (Lancaster, 1990; Thomas, 1996). The underlying reason is that for each hazard, a woman's participation is censored when the other event takes place. Therefore the alternative outcome is not limited to no-participation, but also woman's labour force participation via the other risk. For proportional hazard models, Thomas (1996) shows that the estimated coefficients of a competing risks model do not only depend on the likelihood of a specific event r, but also on the overall survivor function (Andrews et al., 2011). For instance, if the probability of interest is a woman's participation via employment, it requires calculating the probability by taking into account her unemployment hazard. Moreover, it is of interest to examine the effect of a particular covariate on the participation probability of a woman via risk r, conditional on exiting inactivity at elapsed duration s.

The conditional probabilities and the marginal effects are computed as in Andrews et al. (2011). Accordingly, the probability of an inactive woman to find a job, conditional on her participation at elapsed month s, $Pr(r = 2 \mid \cdot)$ is

$$Pr_{2,s} \equiv \frac{h_{2,s}}{h_{1,s} + h_{2,s}}. \tag{4}$$

Since the key controls are binary variables, i.e. partner's labour market activities, the marginal effect of a binary covariate x_b on the conditional probability of woman's participation via employment is

$$Pr_{2,s}(x_b = 1|\cdot) - Pr_{2,s}(x_b = 0|\cdot) = \frac{h_{1,s}h_{2,s}}{(h_{1,s} + h_{2,s})^2}(\beta_2 - \beta_1) \tag{5}$$

and the standard errors are calculated as

$$\frac{h_{1,s}h_{2,s}}{(h_{1,s} + h_{2,s})^2}[se(\beta_1) + se(\beta_2)]. \tag{6}$$

4 Data

The BHPS collected data annually from 1991 to 2009 by interviewing individuals (aged 16 and over), and followed them through time once they entered the survey's sample pool (see Taylor et al, 2010). Despite being an appropriate dataset to study individual's labour market outcomes with its long panel structure and rich set of observable characteristics, there are only limited number of studies that use the BHPS to examine the added worker effect in the UK (e.g. McGinnity, 2002; Benito and Saleheen, 2013).

Using the annual and short-term retrospective job histories of the BHPS, I construct a panel of couples' monthly labour market histories This unbalanced panel has the advantage of capturing shorter labour market spells (such as unemployment) that may occur any time between two consecutive interviews, and also recording exits from longer spells such as inactivity. More importantly, the dataset contains information on the timing of changes in one's labour market state as calendar month and year that enables identifying censored and completed spells, which is usually not available in short-term panels. This information is especially useful in current framework, as one of the key parameters is the time a woman spends in inactivity. Appendix B discusses the merits of this dataset and outlines its construction.

The dataset contains demographic and labour market information on couples, in which both women and their partners are at least 16 years old and not in full-time education or at school when they are first observed. There are 7,261 uninterrupted couples over 611,786 couple-month observations between September 1990 and April 2009.

The labour market activities are grouped into five categories as employment, unemployment, inactivity, retirement and long-term sickness.[3] Women and male partners are

[3]The ONS definitions are used to create employment and inactivity, which are aggregated labour market states in current framework. Employment includes self-employment, part-time and full-time employment as well as government training. For women, employment also includes maternity leaves. Inactivity consists of family carers, students and others. In the sample, 94% of woman's inactivity is due to family-caring.

more likely to be employed, and on average, an employment spell lasts for 85 months for women and 118 months for male partners. As presented in Table 1, men are twice more likely to experience unemployment than women, however the likelihood of being inactive is seven times higher for women. On average, women spend 64 months in inactivity with a median duration of 19 months. In other words, the distribution of women's inactivity duration (in months) is right-skewed, i.e. there are some women who remain inactive for longer periods.

More than half of the couples are observed to be dual-earners in any given month. These couples enter the estimation sample if the woman withdraws from the labour market, but does not retire or become long-term sick. In this case, the couple becomes either a single-earner household, or becomes a workless household if the partner loses his job. A woman is observed in a single-earner couple in around 24% of the couple-month observations, of which 75% consists couples in which only the male partner works. The couple-month observations in which either woman (0.7%) or both partners are retired (15%) are excluded from the estimation sample, as well as couples in which the woman is active in the labour market. Thus, the estimation sample includes only those couples in which the woman has been inactive at least for one month during the observation period. There are 2,838 couple spells with 2,780 women, who are observed over 107,131 couple-month observations. On average, a couple is observed for 103 months in the sample, and 83% of the couples are reported to be together by the end of their observation period, whereas 5% of the women become widowed and the rest of the couples dissolve.

There are 4,187 inactivity spells experienced by women during the sample period. In 30% of the couples, some women experience multiple inactivity episodes. Among these couples, 88% include women with at most 3 inactivity spells. While there are 3,204 exits from inactivity, only 69% of these transitions are from inactivity to the labour force as shown in Table 2. It is worth noting that 88% of the completed spells end with a transition to employment, of which 60% is part-time jobs, 23% is full-time jobs, and the rest is self-employment.

The other half of the inactivity spells are right-censored, either due to transition to another inactive state (45%) or due to the end of observation/sample period. Almost three-quarters of the inactivity spells belong to a flow sample, i.e. the inactivity spell starts within the observation window. For 7% of these flow spells, the beginning of the inactivity spells coincides with the first time the couple is observed in the sample. For the rest, 65% of the transitions into inactivity are from employment, whereas 9% are from unemployment. This latter group can be considered as discouraged workers, who may have given up on job-search and become inactive. On average a flow inactivity spell lasts for 21 months, while a stock inactivity spell lasts almost 8 times longer. The difference is due to the correction for delayed entry spells (see Appendix A). The average monthly rate of a woman's participation is 1.94%, which can be interpreted as the sample estimate of the “raw hazard”, i.e. the probability that an inactive woman participates in the labour force from one month to the next.During women's inactivity, partners are observed over 4,369 labour market spells, of which 16.5% is unemployment, 3.7% is inactivity, and 22% is other non-employment states.

The summary statistics for the selected characteristics from the estimation sample are presented in Table 3. The estimation sample includes relatively older couples. On average, a woman is 44 years old and a male partner is around 3 years older. For most of the couples, a woman either has some or no qualifications or obtained A-levels. In 60% of the couples, the woman had been in the labour market (either employed or unemployed) before she became inactive during her duration with the BHPS, and in 56% of the couples, the woman has some work experience.

An advantage of using the BHPS is its collection of information on respondents' beliefs and attitudes towards gender roles, which may play important roles in woman's labour supply decision. On average a woman is more optimistic than her partner about the household's financial situation at the time of the interview. Only 12% of the time an inactive woman report that the financial situation is worse than what her partner believes it to be. The last five rows of Table 3 present the distribution of couples' egalitarian tendencies, which is constructed from the battery of questions asked about the gender roles in the BHPS.[4] For 52% of the couples, both women and their partners hold traditional views towards gender roles, which identifies the man as the provider and the woman as the carer. This high ratio should be expected as the sample consists of women who are inactive and mostly take on carer roles. In mixed-egalitarian couples, it is more likely that women have egalitarian attitude.

5 Results and Discussion

The duration framework allows me to analyse three aspects of the added worker effect. Firstly, I model the timing of woman's entry to labour market explicitly, and uncover the true duration dependence by controlling for observable and unobserved characteristics. Secondly, I estimate the effects of partners' different labour market activities on women's participation probability, conditional on her entry to the labour market in following month. If a woman is more likely to participate when her partner is unemployed, she is considered to be an added worker (at the extensive margin). Each month an inactive woman is at risk of becoming active via two mutually exclusive events: employment

[4] The gender egalitarian attitudes of a couple is assessed using a battery of questions from the BHPS, e.g. "All in all, family life suffers when the woman has a full-time job", "Both the husband and wife should contribute to the household income", "A husband's jobs is to earn money; a wife's job is to look after the home and family". The answers are provided in a Likert-scale for six statements, and the sum is used to create a measure of couple's egalitarian attitude (Berrington (2004)). A couple member is considered egalitarian if his/her summed value is greater than 20.

and unemployment. Therefore, thirdly, within a competing risks framework, I address whether some factors, e.g. partner's unemployment and benefit claims, have different effects that are specific to the form of woman's participation.

5.1 Duration Dependence

The non-parametric (piece-wise constant) raw hazard is obtained by estimating equation (1) by leaving out all covariates except duration dummies. As the solid step function in Figure 2(a) illustrates, the raw hazard on woman's labour force participation declines in her elapsed months in inactivity. In other words, women's inactivity exhibits negative duration dependence, as the hazard drops from 0.049 in her first month of inactivity to 0.016 within two years.

An interesting finding is that the predicted non-parametric raw hazard displays jumps around 12-month-durations.[5] The most significant jump occurs when the woman is at risk of participation at $s = 12$, a year after becoming inactive, as the predicted hazard increases to 0.052. Notice that this is slightly higher than the predicted hazard for $s = 1$. These fluctuations in the hazard can be attributed to so-called seam effects, which occur due to spurious transitions recorded at the time of the interview (Halpin, 2000; Maré, 2006). A potential reason for these seam effects in this sample may be due to the construction of the couples' labour market histories, which uses multiple sources of records and information from interviews collected at different times. According to Jäckle (2008), this process alone may create seam effects. She also notes that, in practice, some respondents may provide contradictory reports about their labour market activity for the same month in consecutive interviews. This may be due to recall errors whilst completing the short-term retrospective questionnaires or respondents may switch priority from one state to another at different points in time. The increases in the raw hazard at and around multiples of 12-month-durations suggest that there is some effect due to the design of the data collection. Another potential explanation is that some respondents report a transition at the full-interview rather than completing the job-history questionnaire, which would lead the change to be observed later than its original occurrence.[6]

As demonstrated in Figure 2(a), characterizing the duration dependence parametrically as discrete-time analogue of the Weibull distribution smooths the seam effects that arise in the non-parametric piece-wise constant specification. The predicted raw hazard declines from 0.059 in the first month to 0.031 in six months, and to 0.019 in two years. The rate of a change in the raw hazards from one month to the next is similar to non-

[5] Figure 3 demonstrates the jumps in a larger scale.

[6] The BHPS conducted most of its fieldwork during autumn (Taylor *et al.*, 2010), thus it is reasonable to argue that there may be higher transitions observed from August to November compared to other months when the interviews take place. The dashed step function in 3(a) shows that jumps at and around 12-month-periods become less prominent in the baseline hazard when the model is controlled for the months when field work is carried out intensively.

parametric model except around 12-month-durations. One advantage of working with the parametric specification is that the discrete-time Weibull model characterizes the shape of the hazard using a single parameter. This makes the interpretation of duration dependence and covariate effects on the hazard straightforward. The shape parameter, α, of the raw discrete-time Weibull hazard is 0.635 indicating that the longer a woman stays inactive, the less likely she is to enter in labour force. The null hypothesis that $\alpha = 1$ is rejected, hence woman's participation hazard is not constant in time.

The raw hazards are indicative of the pattern of the duration dependence in the sample, but they do not convey information whether this negative duration dependence is genuine. For instance, women who are younger, more educated or have labour market experience are expected to move from inactivity to participation quicker than others, whereas being responsible for a child may prevent or delay women's entry to the labour market. Controlling for observed characteristics increases the Weibull shape parameter to 0.739 (Model 2 in Table 4), which is significantly greater than the α obtained from the raw hazard. This indicates that when observed characteristics are controlled for, the degree of negative duration dependence decreases. As shown in Figure 2(b), the solid baseline hazard is slightly flatter, and shifts downward as a result of adding covariates to the model specification. Notice that there may be a selection effect due to unobserved heterogeneity, which may confound the baseline hazard. For example, women with higher motivation to work may exit inactivity quicker than others. To uncover the genuine duration dependence, the hazard is re-estimated using equation (3) with 8 quadrature points. The duration dependence remains significantly negative, albeit at a lower degree, which is shown by the flattened baseline hazard demonstrated with short-dashed line in Figure 2(b). The couple-specific unobserved heterogeneity variance is not particularly high ($\sigma_\nu^2 = 0.328$), yet it is significantly different than zero, i.e. the observable characteristics alone do not tell the whole story behind women's duration in inactivity.

The findings show that women who are inactive for longer periods have lower participation probability as time evolves. A potential explanation for the negative duration dependence may be that over time, women's attitudes, tastes and preferences towards market work changes. The time a woman spends in inactivity may introduce a disincentive for her, as her skills relevant to the market may depreciate over time. This may narrow down her employment prospects and may prevent her searching for a job. This especially holds for women whose skill sets are not easily transferable across different sectors or whose skills are more vulnerable to technological shocks. Another explanation is that there are two types of inactive women in the sample: women with some desire to work (marginally detached) and those without. Since labour market states are self-reported, women with some willingness to work, but not actively searching for a job, may consider themselves as unemployed rather than inactive (as family carers). As the question is defined for women who are inactive, these women are left out from the estimation sample. In other words, the sample may over-represent the inactive women with no intention to work as unemployed women are considered as being active in the labour market and excluded from the analysis. Thus, inactive women with some intention to work exit the sample faster rendering the sample dominated by inactive women at higher durations, who are more likely to be inactive women with no intention to work.

5.2 The Added Worker Effect

The first two columns of Table 4 present the selected estimates from equation (2) with different model specifications.[7] The last column has the same set of covariates as model 2, but it controls for the selection effect with Gaussian mixing. As discussed in the previous section, incorporating the random effects into model specification has an impact on the degree of woman's duration dependence in inactivity. The last column of Table 4 shows that there is not much dependence between the hazard of a woman's multiple inactivity episodes (within couple spell) as the estimated residual correlation among inactivity spells within a couple is 16.6%. Thus, there is a small upward scaling of estimates (and hazard ratios) in model 3, however most of the estimates are close to those presented in model 2 due to the small unobserved heterogeneity variance.

The estimation results indicate that a woman with an unemployed partner has a lower participation probability than a woman whose partner is employed. The model with the full set of covariates, second column in the table, shows that an inactive woman whose partner is searching for a job is 23% less likely to enter the labour market than an otherwise identical woman with a working partner. The hazard ratio of these two women is 0.771 ($= \exp(-0.260)$), which is constant over the elapsed duration due to the proportional hazards assumption. In other words, the effect of partner's unemployment on woman's participation does not change between two identical women over months, but woman's hazard varies by the time woman spends in inactivity and graphically shown in Figure 4. While finding a negative added worker effect is counter-intuitive, the results are consistent with the earlier literature on the UK (Layard et al., 1980; Bingley and Walker, 2001; McGinnity, 2002).

Controlling for partners' other non-employment states into the model enables me to test whether any of these states leads to a higher participation probability for women, i.e. increased likelihood of becoming added workers. The effect of partner's different labour market activities are jointly significant marginally at $p - value = 0.047$ in model 2. A woman with an inactive partner is 18% more likely to participate than a woman

[7] The standard controls include woman's and her partner's age in categories, their highest qualifications, a dummy on whether woman ever had work-experience, dummy variables for house-ownership, number of children in the household by age, and controls for region, calendar month and year. The additional set of covariates consists of dummy variables indicating couple's benefit claim, whether woman's inactivity had begun when she was single, caring responsibilities for an adult, woman's relative financial perception, and couple egalitarianism.

with an employed partner, yet the effect is imprecisely estimated. In terms of the added worker effect, it is important to understand whether a woman perceives and evaluates her partner's unemployment and his inactivity differently. Testing the null hypothesis $H_0 : \delta_2 = \delta_3$ indicates that the effect of partner's unemployment and his inactivity on woman's hazard are statistically different at 5%. A woman with an inactive partner is 1.5 times more likely to participate than an otherwise identical woman whose partner is unemployed. This may suggest that women act only if the partner has exhausted every opportunity of finding a job as he reports himself as being inactive or becomes discouraged.

As expected, an inactive woman with a retired or long-term sick partner is less likely to enter the labour market than a woman with an employed partner. While the effect of partner's retirement or long-term sickness is not statistically different than partner's unemployment, the underlying mechanisms for the woman's participation response may be different. The male partner's pension or sickness benefits may provide some source of income which may exceed woman's reservation wage, hence she may not become active in the labour market. Another potential explanation for the lower participation hazard for a woman whose partner is long-term sick may be her informal care for her partner.

5.2.1 Other Covariates

According to other studies on the UK (Dilnot and Kell, 1987; Bingley and Walker, 2001; Bredtmann et al., 2014; McGinnity, 2002), the welfare benefit system works as a disincentive against woman's labour force participation. The results agree with previous research, as the probability of a woman's labour force participation is lower by 22.5% if she and/or her partner has claimed income support or unemployment benefits between two consecutive interviews. Notice that the magnitude of the effect of a benefit claim on a woman's hazard is as high as the effect of partner's unemployment.

The theories of household labour supply predict an added worker effect irrespective of gender roles, hence any family member may choose to allocate his/her time between leisure and work, and become an added worker. However, in practice, gender roles and established division of labour matter in couple's labour supply decisions (Fortin, 2005). The additional set of controls include couple's egalitarianism to measure the effect of the couple environment where the labour supply decisions are made. The findings suggest that in a modern couple, in which both partners have egalitarian views towards gender roles, the woman is 1.7 times more likely to become active than a woman in a traditional couple. This result quantifies the findings from Laurie et al. (2015) and Gush et al. (2015), which separately emphasize the importance of gender roles. These studies also argue that unless the couple faces extreme hardship or exhausts all other outside options, an inactive woman in a traditional environment may not participate in the labour force.

In a traditional couple, it is reasonable to assume that the male partner may search for a job more intensively, and takes up the first job that comes along rather than shifting the established division of labour within the couple. An egalitarian woman is 30% more likely to participate in the labour force if her partner also has an egalitarian attitude toward gender roles. The egalitarianism composition of a couple does not have a significant effect if either one of the couple members are gender-egalitarian.[8]

A woman's perception of the couple's financial stability may affect her labour supply behaviour (Benito and Saleheen, 2013). For instance, if a woman believes that the couple is financial stable to survive partner's non-employment, then she may not incur the search cost and enter the the labour market, especially if she believes that partner's non-employment is transitory. A woman who believes that the couple is not as better off as her partner presumes is 16% more likely to become active in the labour market.

The standard individual and household controls have the expected effects on a woman's hazard as shown in Table 5. While in model 1, the probability of a young (16-24) woman's participation is higher than that of young-adult (24-35) women by 25%, this significant relationship disappears when additional controls are included in the model specification. In each model, the hazard of women who are at or above retirement age is predicted to be a quarter of that of young-adult women, and only slightly more than one-third of women who are close to retirement age (45-60). There is a positive monotonic relationship between a woman's highest qualification and the probability of her labour force participation, but having an educated partner (A-levels or above) significantly decreases her participation probability. The latter can be explained by the positive relationship between education and income. A male partner with a higher educational attainment is likely to earn more or less likely to stay unemployed for longer durations and she may afford to remain inactive.

Similar to education, there is a positive correlation between one's labour market experience and employment. A woman with previous work-experience is around 1.5 times more likely to be active in the labour market than a woman who has not been employed before. Similar to a life-cycle model's prediction, if the couple faces fixed consumption constraints such as paying mortgage or rent, it is more likely that woman's participation serves as a viable insurance mechanism against her partner's non-employment. As shown in Table 5, if the house the couple lives in is not owned-outright, a woman is around 30% more likely to enter the labour market. The effects of house ownership by mortgage and

[8]To understand why the effect of partner's unemployment on woman's participation probability varies between different types of couple egalitarianism, a separate model with interactions of the egalitarianism dummies with partner's unemployment is estimated. The results show that in an egalitarian couple, a woman is around one-third less likely to be active when her partner is unemployed than he is employed. For a traditional couple, the same difference drops to 18.5%. This would suggest that while attitudes toward gender roles are an important determinant of woman's participation-decision, it may not directly influence how the woman responds to her partner's unemployment. The estimation results are not presented in the chapter, but are available upon request.

paying rent on woman's participation hazard are not significantly different. Having at least one child below primary school age decreases a woman's participation probability, but if there is a child aged between 5-11 years-old in the household, a woman is more likely to participate. This may be a result of the increased non-market time of a woman as children are of school-age.

5.2.2 Potential Explanations

The analyses show that an inactive woman is less likely to become an added worker when her partner is unemployed than a woman whose partner is employed. There are some potential explanations for this negative relationship.

Firstly, while unemployment is usually perceived as a negative experience, it may provide an opportunity for the couple to put their life-plans into action or focus on major life events, such as fertility decisions (Gush et al., 2015). Secondly, the non-market time of British couples may not be substitutes as assumed in the unitary household labour supply model, but can be complements (Bryan and Longhi, 2017). Thirdly, as the results show, the probability of participation of an inactive woman with an employed partner is higher than that of a woman with a non-employed partner as she may benefit from her partner's network to find a job (Bryan and Longhi, 2015). At the same time, partner's unemployment may discourage her even to start searching for a job, i.e. the discouraged worker effect.[9] This argument holds especially for couples, where the members share similar market-skill and/or can be potentially employed in the same sector. There may be assortative mating that is not captured by the observable characteristics and the attitudes toward gender roles. A woman with lower willingness to work may pair with a man who is more likely to be unemployed. If this is the case, partner's unemployment does not induce women to become active in the labour market.

There are some other potential explanations for the lack of support for a positive added worker effect due to data limitations. Using savings is a viable coping mechanism against lower income, especially if this financial situation is considered to be temporary. However, the dataset does not have information on the amount of couples' savings. The data also does not contain information on the nature of a partner's unemployment (when the histories are constructed), e.g. whether he lost his job involuntarily, or quitted from a full-time job, or the job terminated because it was a casual/temporary work. If partner's unemployment is expected, or partner voluntarily quits his job, then a woman may be less likely to enter the labour market as a couple may take necessary measures to maintain

[9] A common approach in measuring this dampening effect is to control for local unemployment rates. In models presented in Table 4, the local labour market conditions are captured by the inclusion of the region, calendar month and year dummies. Controlling for the annual unemployment rates at local level do not change the results significantly, which gives confidence to use calendar time and time-varying region dummies in original model to account for the local labour market conditions. The results are not presented, but available upon request.

its standards of living.

5.2.3 Sensitivity Analyses

As outlined in section 3, the statistical strategy is based on the proportional hazards assumption, i.e. the effect of the covariates is constant for all time periods. A common way to address the non-proportionality in this framework is to re-estimate equation (2) by replacing the constant with the dummies indicating each quartile of the woman's elapsed months in inactivity, and interacting these with the male partner's unemployment. As the effect of the covariate is allowed to vary as a function of elapsed duration, i.e. quartiles, it introduces non-proportionality to the model and allows one to test whether the effect of her partner's unemployment on a woman's hazard changes over her duration in inactivity. Figure 5 illustrates the predicted baseline hazards by quartiles of the elapsed duration for two identical women, except their partners' labour market activity. The effect of partner's unemployment does not change by the time woman spends inactive, except for the second quartile. If a woman is inactive for 12 to 39 months, her participation probability decreases by 31.1% when her partner is unemployed, which is 8.1 percentage points greater than the effect estimated under proportionality assumption. The results from the non-proportional hazard model suggest that characterizing the duration dependence by logarithm of elapsed duration may be a weak assumption, and requires further analysis.

The literature on the added worker effect usually restricts the estimation sample to the working-age population. It is reasonable to argue that the effect would be expected for those who are able or more willing to work, and are not entitled to pensions. As the dataset used in this paper allows me to distinguish between retirement from inactivity, all couples with an inactive women is included in the estimation sample. While the self-reports provide information on these spells, it ushers a disadvantage as the definition of retirement is subjective (Banks and Smith, 2006). The results might be biased if some women who are at or above retirement age identify themselves as inactive, but are retired in reality. Therefore the effect of partner's unemployment may be underestimated, as these women receive pension as a source of income. To check the sensitivity of the results, the sample is restricted to women who are under 60 years old. While the sample size drops by almost twenty percent, the hazard ratio of women with unemployed and employed partners remains the same with 0.778, as shown in the second column of Table 6. This suggests that the results are not driven by women who are at or above retirement age. On the other hand, the effect of partner's retirement on woman's hazard drops by half, yet it is not significantly different than partner's employment when the sample is restricted to working-age women. This is expected, as in the sample an inactive retirement-age woman is observed with a retired partner 70% of the time, and these couple-month observations are dropped in re-estimation.

5.2.4 Further Analyses

The main models of this paper do not take into account the months the partner spends in his current labour market activity, which is shown to be a determinant of the British women's labour supply (Bingley and Walker, 2001). For instance, if a woman believes that her partner may find a job relatively quickly, she may rely on savings or external support networks to maintain the couple's standards of living. One way to test this hypothesis and to control for the stock and flow of unemployed partners is to distinguish the male partner's unemployment by his duration in unemployment during woman's inactivity spell. A partner may be unemployed for a short-term (≤ 6 months), medium-term ($7-12$ months), or long-term (13+ months). More specifically, partner's unemployment durations are calculated as the difference between the last date the woman is observed to be inactive and the start date of the partner's current unemployment spell, and they do not vary by the months he spends unemployed. As defined this way, 42% of the unemployment episodes experienced by male partners during woman's inactivity episodes are observed for at most 6 months, whereas 20% is mid-term, and the rest is long-term unemployment.

Table 7(a) shows that a woman whose partner is unemployed for at most six months is almost twice more likely to participate in the labour force than a woman whose partner is employed. On the other hand, a woman whose partner is unemployed for more than a year is reduced by 53.3%. The effect of partner's unemployment by duration are significantly different than each other. The analysis suggests that a positive added worker effect is observed as a response to partner's short-term unemployment.

As discussed in section 2.2, the definition of the added worker effect also does not account for the changes in the male partner's labour market activity, but focuses on what they do at the time of women's transition to activity. This definition can be relaxed by controlling for partner's transitions and examining woman's response to a change in her partner's labour market activity. As there are five different labour market states, there are 20 possible transitions and it is difficult to estimate the model. Therefore, the model is specified by using a broader classification of partners' labour market activities as employment, non-employment (unemployed and inactive), and out-of-labour-force (retired or long-term sick). There are 6 dummy variables each identifying a transitions from one state to another from $t-1$ to t. In this framework, partners may remain in the same labour market state during women's inactivity, and the effect is picked up by the dummy variable on partner's labour market state and not by the transition dummies.

Table 7(b) shows the estimated effect of partner's broader labour market activities and his transitions on woman's participation hazard. A woman with a non-employed partner is less likely to participate in the labour force if he is non-employed at $t-1$ than a woman with an employed partner, and 5% more likely to become active if the partner becomes non-employed. This indicates a positive, but insignificant, added worker effect when partners' transition used to identify a woman's response to an employment shock.

5.3 Woman's Participation via Job Search and Job Finding

In the competing risks framework, participation is distinguished between unemployment, $r = 1$, and employment, $r = 2$. This section presents whether some covariates have risk-specific effects on a woman's participation hazard.

The dataset is expanded as if there are two identical panel datasets indexed by the risk type. Using this expanded dataset, the risk-specific effects are first tested with $H_0 : \alpha_1 = \alpha_2, \delta_1 = \delta_2, \beta_1 = \beta_2$. The hazard is estimated using two binary responses, each for one exit type and once an event is experienced the other is treated as censored. While partner's labour market states do not have significantly different risk-specific effects, the joint test shows that there are at least some covariate effects that vary by the woman's exit type. Therefore, equation (2) is estimated for both exit types separately, using the standard and additional sets of controls.

Using the reference categories, the risk-specific hazard of a woman who becomes active by searching for a job is $h_1 = exp(-7.228)t^{-0.320}$, and $h_2 = exp(-3.411)t^{-0.249}$ if she directly finds a job right after a period of inactivity. Conditional on woman's participation after six months of inactivity and her partner's employment, her probability to participate by finding a job, $Pr_{2,6}$, is 98.1% in 1990. Pr_2 does not significantly vary by the time a woman spends in inactivity in a given year, but there are some significant changes over the years as demonstrated in Figure 6. The drops in probability of woman's employment may reflect the effects of recessions in the early 1990s and the 2008 recession, which lowered inactive women's probability of finding a job (Bryan and Longhi, 2017). Note that individual hazards provide information on exit via r, but they do not shed light on the overall probability of an inactive woman to become unemployed or employed, conditional on her participation in the labour force.

The probability of woman's participation via employment is high, but is she more likely to move in employment or unemployment when her partner is in different labour market states? Table 8 shows that a woman who spends more time being inactive is less likely to participate via either risk, and the degree of negative duration dependence is not significantly different between two exit types. Her partner's unemployment has a marginally significant negative effect on a woman's participation via unemployment and his different labour market states are jointly significant. The second column shows that partner's unemployment does not have a significant effect on woman's participation via job-finding. The probability differences in the last column of Table 8 indicate that partner's different labour market activities do not have significant impact on a woman's probability via employment compared to her participation via job-search. Notice that the probability difference is 0.05 percentage points, and partner's unemployment does not have an impact on the way the woman becomes active in the labour force.

As expected, a woman with some previous work experience is more likely to find a job rather than being unemployed. The effect is significant, albeit small at 1.1 percentage points. This may be due to the fact that experience is valued in labour market, which makes her more likely to find a job. Having an additional younger child makes a woman more likely to find a job rather than searching for a job by 1.5 percentage points. A potential explanation is that a woman with younger children would participate in the labour force if she secures a job to afford childcare.

An interesting result is that receiving benefits has different qualitative and quantitative risk-specific effects on woman's participation. As shown in the first two columns of Table 8, the hazard on woman's unemployment suggests that a woman in a couple that claims benefit between two consecutive interviews is twice more likely to start searching for a job. On the contrary, it is less likely for a woman in a benefit receiving couple to find employment. Conditional on receiving benefit, it is more likely for a woman who enters the labour market to start searching for a job rather than finding a job by 2.1 percentage points. Thus, benefits have the expected effect on woman's participation as it works through making her more likely to engage in job-searching, but lowers her probability of finding a job.

The probability of participation via unemployment is very low for each duration, and the estimates are mostly insignificant. This may be a result of the lower transition rate from inactivity to unemployment in the sample (10%). Observing only a small number of participation behaviour via unemployment may be due to short-search period, which is not captured by the data. On the other hand, if short-search is related to observed characteristics such as education, age and previous work experience, these are controlled for in analysis and should not lead to any bias. Alternatively, it is possible that inactive woman who directly participates were searching for a job, but have not reported themselves as being inactive. As discussed in section 5.1, this may lead to an overestimated degree of negative duration dependence, as a woman becomes active earlier than observed in the dataset.

6 Conclusion

In this paper, I examine the extensive margin of the added worker effect in the UK, and model the inactive women's time until their labour force participation explicitly. By investigating different labour market states of partners, the aim is to extend the scope of the traditional definition of the added worker effect, which previously only focused on partner's unemployment. To construct a panel of couples' labour market histories between 1990-2009 from the BHPS, and estimate a discrete-time duration model of woman's labour force participation. As a woman may enter the labour market by searching for a job or directly by finding one, I distinguish between these two destination states and investigate whether duration dependence and partner's labour market activities have risk-specific effects.

Previous studies on the added worker effect within a duration framework either do not explicitly model the duration dependence or assume the dependence to be constant. However, I show that this is not empirically supported as a woman is less likely to participate in the labour force, the longer she spends time in inactivity. There is significant negative duration dependence in woman's participation, and it is strongest in the first three years of a woman's inactivity, when the raw hazard exhibits a steeper decline. This finding is consistent with the idea that women's skills that are valuable to market work may deteriorate over time. The negative pattern persists, albeit at a lower degree, after controlling for couple-specific unobserved heterogeneity.

A woman with an unemployed partner is 23% less likely to become active in the labour market than a woman whose partner is employed. Thus, there is a negative (traditional) added worker effect for inactive partnered women in the UK, which complies with previous empirical findings. The analysis further shows that partner's retirement or long-term sickness have negative effects on a woman's participation probability compared to her partner's employment. However, a woman whose partner is inactive is more likely to enter the labour force than a woman whose partner is unemployed. This is perhaps not surprising as a woman would take up breadwinner responsibilities once her partner gives up searching for a job. This is an additional piece of information on the added worker effect in the UK, and suggests that including other non-employment activities of partners would provide better understanding on women's propensity to become added workers.

As argued in the literature, claiming income support or unemployment benefit disincentivizes women's labour force participation. I show that this is true only when participation is considered as an aggregated response. I find that when woman's participation is distinguished between unemployment and employment, benefit claims have a positive impact on the probability of woman's job search, conditional on her participation. On the other hand, a woman's time in inactivity and her partner's labour market activity do not have varying effects on her participation probability via employment or unemployment.

The analyses also show that the duration of her partner's unemployment has a significant effect on the woman's labour supply decision at the extensive margin, and a woman is more likely to become active when her partner is unemployed for a relatively short period than a woman whose partner is employed. This indicates the importance of distinguishing between stock and flow of unemployed partners to examine the added worker effect.

The empirical model estimates the relationship between a woman's labour force participation and her partner's labour market state at the time of the her transition, i.e. the added worker effect is estimated as a contemporaneous effect of her partner's unemployment (and his non-employment). Thus, this paper adopts a simple definition of the added worker effect, and the sensitivity of results are controlled for by examining the partner's labour market transitions. When partner's transitions are also taken into account, I find a small positive effect of partner's transition from employment to non-employment, yet the effect is imprecisely estimated. While the labour market transitions are defined on a monthly basis in this paper, it may take a more than a month for a woman to respond to her partner's unemployment, e.g a quarter as shown in previous literature on the UK (Bryan and Longhi, 2017). It is also worth noting that this study assumes that the partner's labour market activity to be exogenous to the woman's labour supply decision. This is an assumption to simplify the model, but it ignores potential sources of endogeneity and interdependence between partner's labour supply such as simultaneity in labour supply decisions and assortative mating, which is left for future research.

Table 1: Women's and Their Partners' Labour Market Activities

	Women				Partners			
	Number of Spells (%)	Mean Duration	Std Dev.	Median	Number of Spells (%)	Mean Duration	Std. Dev.	Median
Employed	7434 (46.58)	85.59	83.64	60	7385 (56.19)	118.29	109.85	88
Unemployed	1219 (7.64)	9.63	27.70	4	2011 (15.30)	13.61	26.65	5
Inactive	4187 (26.23)	63.54	111.88	19	602 (4.58)	16.80	31.11	9
Retired	2364 (14.81)	91.73	110.96	49	2237 (17.02)	106.53	92.96	84
Long-term Sick	756 (4.74)	47.37	71.48	17	907 (6.90)	54.81	70.41	24
Total	15960 (100)	73.10	95.66	35	13142 (100)	91.24	102.29	52

Notes: The unit of measurement is a spell. The durations are measured in months, and calculated as $t_{spell\,end} - t_{spell\,start} + 1$. If the spell is not ended during the observation period, i.e. during the couple spell, the end date of the labour market spell, $t_{spell\,end}$, is replaced by the time the partners are last observed together.

Table 2: Inactivity Spells and Censoring

	Number of Spells	Mean Duration	Std. Dev.
Completed inactivity spells (a)	2,081	34.93	53.64
Right-censored inactivity spells (b)	2,106	91.81	142.96
Delayed entry inactivity spells (c)	1,206	168.25	162.56
Flow of inactivity spells (d)	2,981	21.18	25.77
Total ($a + b = c + d$)	4,187	63.54	111.88

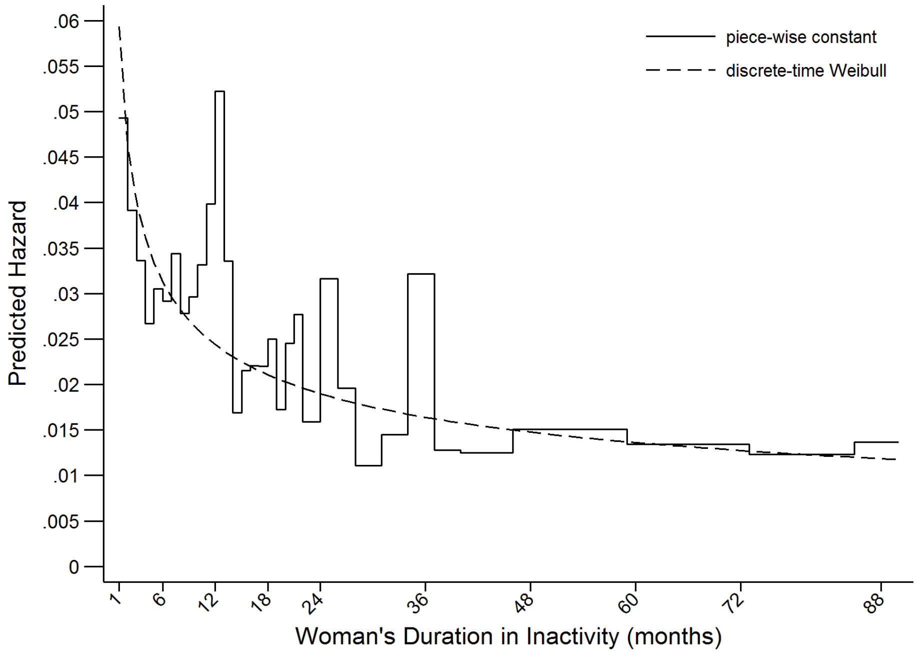
Table 3: Summary Statistics for Selected Characteristics, Estimation Sample

	Women		Partners		
	Mean	Std. Dev.	Mean	Std. Dev.	N
Individual Characteristics					
Age Categories					
[16, 24)	0.043	0.204	0.023	0.150	107,131
[24, 35)	0.264	0.441	0.211	0.408	107,131
[35, 45)	0.258	0.438	0.273	0.445	107,131
[45, 60)	0.272	0.445	0.277	0.447	107,131
60+	0.162	0.369	0.216	0.412	107,131
Highest Education[a]					
No or some quals.	0.391	0.488	0.326	0.469	2,838
GCSEs	0.176	0.381	0.149	0.356	2,838
A levels	0.321	0.467	0.399	0.490	2,838
First degree or higher	0.102	0.303	0.113	0.317	2,838
Missing	0.010	0.097	0.013	0.114	2,838
Ever Participated Before	0.600	0.491			2,838
Ever Employed Before	0.562	0.496			2,838
Child$\leq$ 16 Responsibility[b]	0.590	0.492			103,902
Cares for an Adult[b]	0.115	0.319			103,902
Financial Perception					
Worse than partner's[b]	0.120	0.325			102,539
Household Characteristics					
Number of Children[b]					
Aged [0, 3)	0.208	0.437			103,999
Aged [3, 5)	0.199	0.424			103,999
Aged [5, 12)	0.522	0.815			103,999
House-ownership[b]					
Owned outright	0.253	0.434			104,260
Owned with mortgage	0.446	0.497			104,260
Rented	0.300	0.458			104,260
Missing	0.002	0.040			104,260
Benefit Claimed (since last interview)[b]	0.175	0.380			103,436
Egalitarianism[a]					
Both egalitarian	0.158	0.364			2,838
Woman is, partner not	0.173	0.378			2,838
Woman not, partner is	0.108	0.310			2,838
Neither egalitarian	0.520	0.500			2,838
Unknown	0.042	0.201			2,838

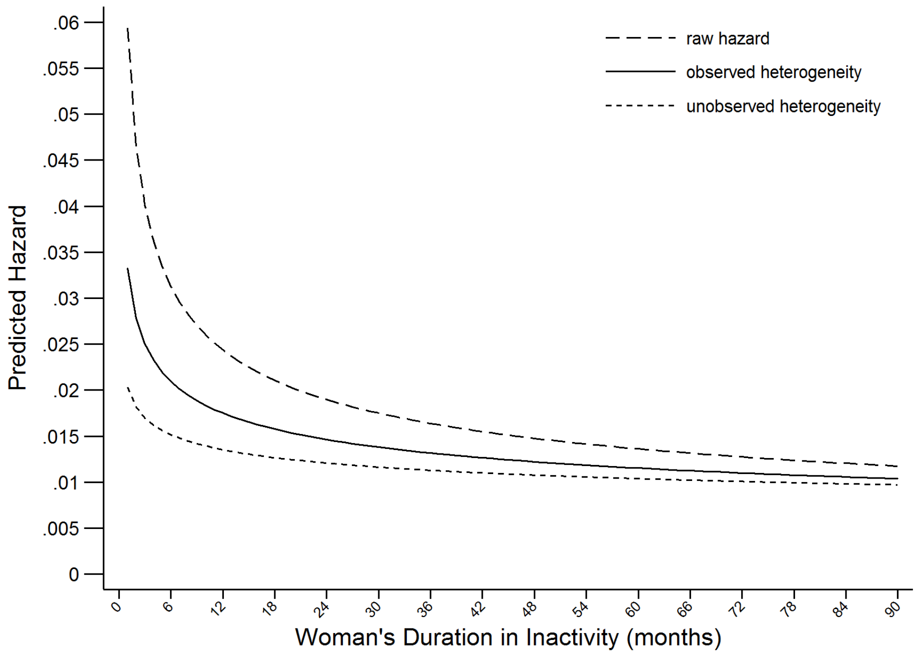
Notes: Except for respondents' age and their labour market activities, their time-varying characteristics such as benefit claims, number of children in the household, and house-ownership are held constant between two consecutive interviews. [a] These are time-invariant characteristics. Thus, the descriptive statistics are based on couples rather than couple-month observations. [b] Some respondent's labour market spells span before their first interview with the BHPS. This results in long-term retrospective couple-month observations for which some of the time-varying information is missing.

Figure 2: Predicted Discrete-time Proportional Hazards

(a) Raw Hazards



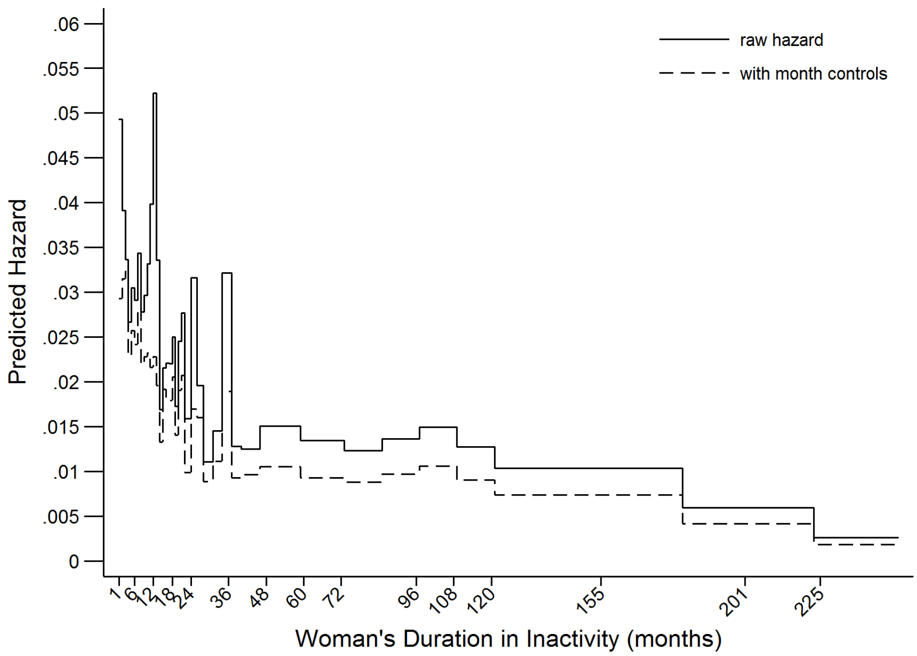
(b) Discrete-time Weibull Hazards



Notes: Panel (a) - The piece-wise constant raw hazard and the raw hazard denoted as discrete-time Weibull are estimated is estimated using equation (1) and equation (2) controlling for duration intervals and $log(s)$, respectively. Panel (b) - The predicted baseline hazards are based on Model 2 for "observed heterogeneity", and Model 3 for "unobserved heterogeneity" as shown in Table 4. See Table 4 for the reference categories. The unobserved heterogeneity is evaluated at its mean value using the model with unobserved heterogeneity (- - - -).

Figure 3: Seam Effects

(a) Non-parametric Raw Hazard and Month Controls



(b) Non-parametric and Weibull Raw Hazards: Jumps around 12-month durations

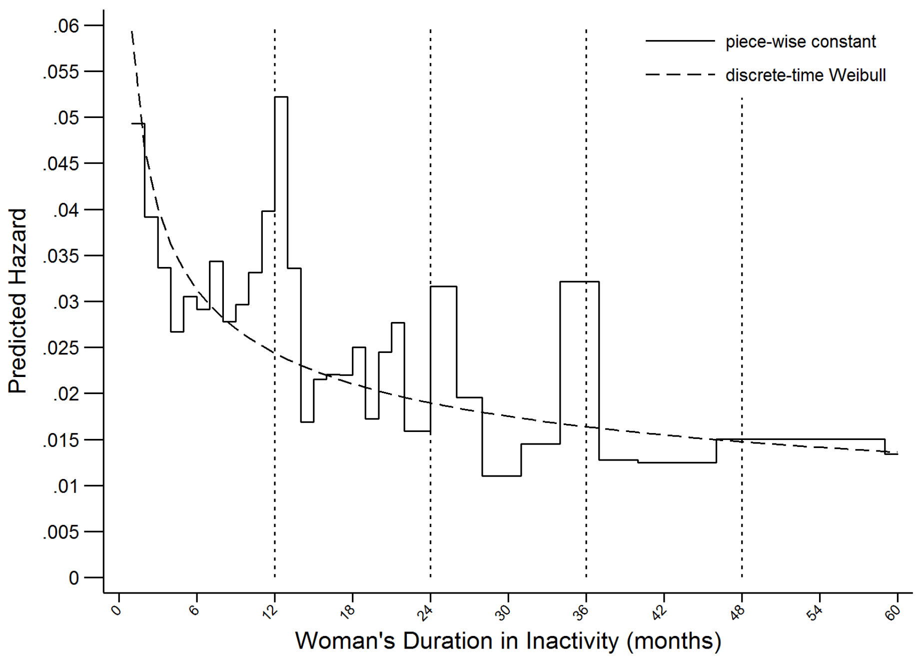
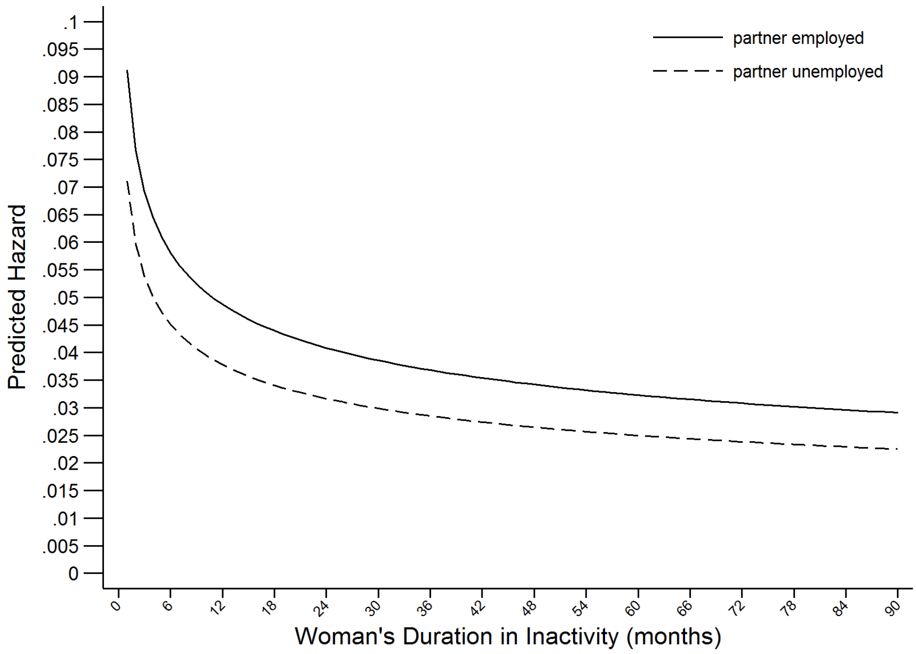


Table 4: Hazard to Labour Force Participation, Selected Estimates

	Model 1	Model 2	Model 3
Weibull α	0.724***	0.739***	0.835***
	(0.019)	(0.019)	(0.025)
Partner's LM, ref: Employed			
Unemployed	-0.361***	-0.260**	-0.264**
	(0.112)	(0.122)	(0.124)
Inactive	0.055	0.187	0.283
	(0.207)	(0.189)	(0.178)
Retired	-0.567***	-0.566***	-0.659***
	(0.204)	(0.207)	(0.174)
Long-term Sick	-0.552***	-0.365***	-0.419***
	(0.128)	(0.139)	(0.142)
Couple Claimed Benefits		-0.255***	-0.280***
		(0.085)	(0.087)
Egalitarianism, ref: W: egal, P: not			
Both egalitarian		0.276***	0.334***
		(0.078)	(0.092)
W: not, P: egal		0.110	0.119
		(0.087)	(0.103)
Neither egalitarian		-0.296***	-0.365***
		(0.071)	(0.080)
Financial Perception		0.153**	0.154**
		(0.065)	(0.069)
Inactivity Start Single		0.337*	0.355**
		(0.175)	(0.169)
Constant	-3.463***	-3.387***	-3.885***
	(0.270)	(0.275)	(0.302)
σ_ν			0.573
			(0.056)
Standard controls	yes	yes	yes
Additional controls	no	yes	yes
Log-likelihood	-8844.517	-8784.876	-8761.789

Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are clustered at couple level and presented in parentheses. For all models the number of couple-month observations is 103,084, and there are 2,042 exits from inactivity, $y_{iks} = 1$. The reference categories are: woman and partner is between 24 and 35 years old, both has GCSEs, partner is employed, woman has no previous work experience and does not look after an adult. The couple lives in London. There are no children aged below 12 in the household, and the house is owned outright. Woman's inactivity spell starts within her couple spell, she is egalitarian whereas her partner holds traditional attitudes on gender roles. Neither woman nor her partner claim benefits between two interviews. The reference year is 1990, and the month is January. Other estimates are reported in Table 5.

Figure 4: The Estimate of the Added Worker Effect



Notes: The hazards are predicted using the full-specification without Gaussian mixing, Model 2 in Table 4. The reference categories are the same as noted in Table 4, except the calendar month and year are set to September and 1999 for illustrative purposes.

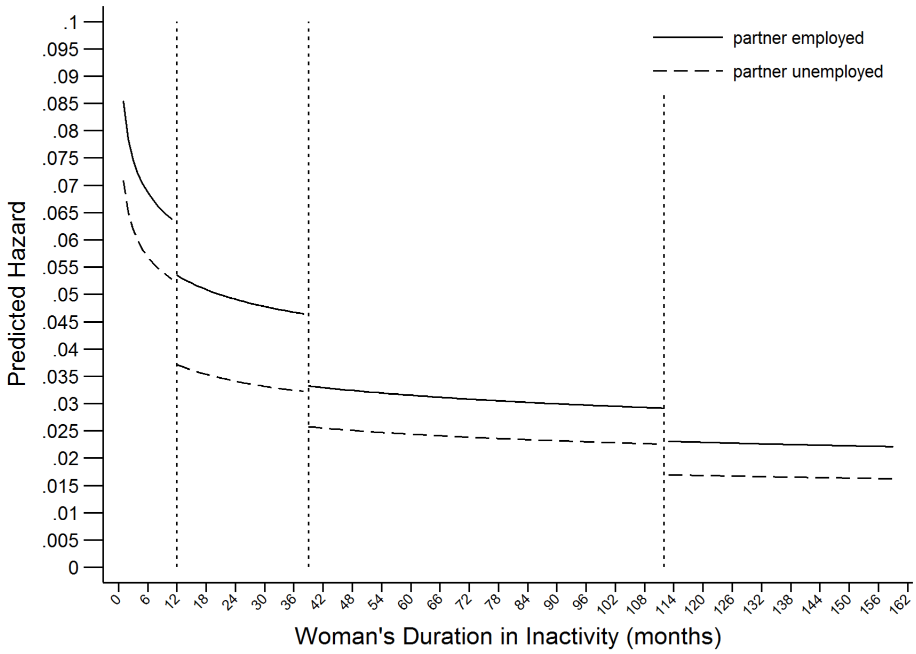
Table 5: Estimates for Hazard to Labour Force Participation

	Model 1	Model 2	Model 3
Woman's Characteristics			
Age Categories, ref:[24,35)			
[16, 24)	0.224**	0.151	0.171
	(0.106)	(0.108)	(0.121)
[35, 45)	-0.120	-0.086	-0.081
	(0.074)	(0.074)	(0.075)
[45, 60)	-0.230*	-0.177	-0.203*
	(0.122)	(0.123)	(0.115)
+60	-1.452***	-1.409***	-1.381***
	(0.244)	(0.246)	(0.231)
Education, ref: GCSEs			
No or some quals	-0.242***	-0.215**	-0.268***
	(0.083)	(0.084)	(0.089)
A-levels	0.334***	0.343***	0.390***
	(0.071)	(0.071)	(0.078)
First degree or higher	0.586***	0.480***	0.542***
	(0.091)	(0.096)	(0.104)
Ever Employed Before	0.426***	0.400***	0.495***
	(0.071)	(0.070)	(0.078)
Cares for an Adult in HH		-0.345***	-0.403***
		(0.108)	(0.114)
Partner's Characteristics			
Age Categories, ref:[24,35)			
[16, 24)	-0.182	-0.219	-0.290*
	(0.151)	(0.154)	(0.163)
[35, 45)	0.067	0.116	0.148*
	(0.073)	(0.073)	(0.076)
[45, 60)	0.045	0.102	0.166
	(0.110)	(0.110)	(0.110)
+60	-0.200	-0.116	-0.106
	(0.178)	(0.183)	(0.179)
Education, ref: GCSEs			
No or some quals	-0.072	-0.109	-0.120
	(0.089)	(0.088)	(0.093)
A-levels	-0.165**	-0.194***	-0.218***
	(0.073)	(0.074)	(0.080)
First degree or higher	-0.387***	-0.387***	-0.432***
	(0.097)	(0.099)	(0.105)
Household Characteristics			
House-owner, ref: Outright			
Owned with mortgage	0.287***	0.264***	0.283***
	(0.086)	(0.086)	(0.089)
Rented	0.305***	0.242**	0.232**
	(0.097)	(0.099)	(0.101)
Not-known	0.781*	0.774*	0.853*

	Model 1	Model 2	Model 3
	(0.408)	(0.424)	(0.493)
Number of children aged			
[0, 3)	-0.417***	-0.385***	-0.420***
	(0.056)	(0.056)	(0.060)
[3, 5)	-0.251***	-0.236***	-0.281***
	(0.057)	(0.057)	(0.060)
[5, 12)	0.082***	0.103***	0.088***
	(0.030)	(0.029)	(0.032)
Standard controls	yes	yes	yes
Additional controls	no	yes	yes

Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are clustered at couple level and presented in parantheses. The reference categories are the same as noted in Table 4. In each model region, calendar month and calendar year are controlled, but are not reported in the table. The dummy variables for not-known highest education, and couple egalitariansim are not significantly different than zero and are not reported.

Figure 5: Sensitivity Analysis: Non-proportional Hazards and the Added Worker Effect



Notes: See the notes under Figure 4.

Table 6: Sensitivity Analysis: Age Restriction

	All Inactive Women	Inactive Women < 60
Weibull, α	0.739***	0.736***
	(0.019)	(0.019)
Partner's LM, ref: Employed		
Unemployed	-0.260**	-0.251**
	(0.122)	(0.123)
Inactive	0.187	0.161
	(0.189)	(0.193)
Retired	-0.566***	-0.224
	(0.207)	(0.198)
Long-term Sick	-0.365***	-0.323**
	(0.139)	(0.139)
N	103,084	86,036

Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are clustered at couple level and presented in parentheses. The control variables are the same as in Model 2 in Table 4.

Table 7: Further Analyses: Partner's Labour Market Activity

(a) Distinguishing Partner's Unemployment Durations

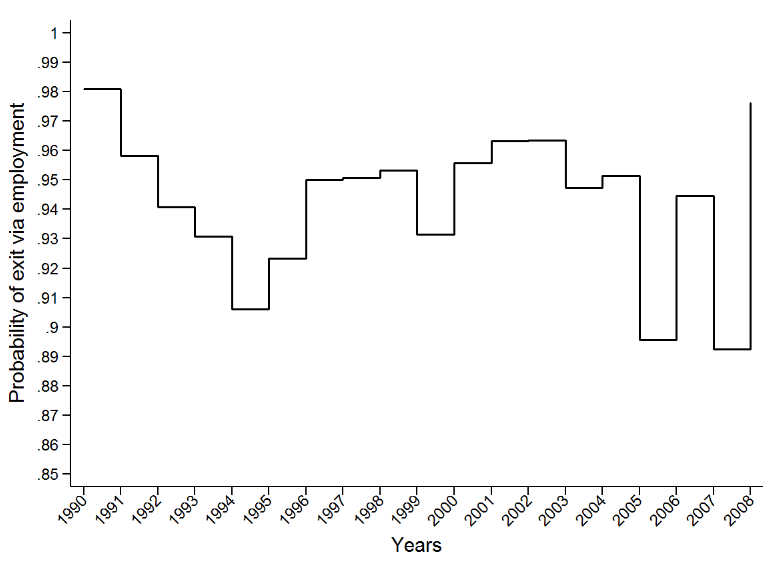
	Estimate	Std. Error
Weibull, α	0.741***	(0.019)
Partner's LM, ref: Employed		
Short-term Unemployed	0.684***	(0.167)
Mid-term Unemployed	-0.239	(0.222)
Long-term Unemployed	-0.762***	(0.175)
Inactive	0.175	(0.190)
Retired	-0.575***	(0.208)
Long-term Sick	-0.392***	(0.139)
Constant	-3.401***	(0.275)
N	103,084	

(b) Partner's Broader Labour Market States and His Transitions

	Estimate	Std. Error
Weibull α	0.745***	(0.019)
Partner's LM at t, ref: Employed (1)		
Non-Employed (2)	-0.123	(0.114)
Out-of-Labour-Force (3)	-0.398***	(0.124)
Partner's Transition from $t-1$ to t, ref: No transition		
(1) $\rightarrow$ (2)	0.174	(0.295)
(1) $\rightarrow$ (3)	-0.516	(0.999)
(2) $\rightarrow$ (1)	0.253	(0.247)
(2) $\rightarrow$ (3)	-0.213	(0.983)
(3) $\rightarrow$ (1)	-0.321	(1.008)
(3) $\rightarrow$ (2)	-0.018	(1.023)
Constant	-3.293***	(0.320)
N	101,844	

Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are clustered at couple level. The control variables are the same as in Model 2 in Table 4, except partner's unemployment.

Figure 6: Probability of Woman's Participation by Finding A Job, over sample years



Notes: Probabilities are calculated for $s = 6$ for each year separately, and $Pr_{2,6}$ is calculated by equation (4).

Table 8: Competing Risks: Participation via Unemployment and Employment

Variable	Estimates for exit via unemployment		Estimates for exit via employment		Difference in probabilities	
Weibull α	0.680***	(0.050)	0.751***	(0.020)		
Partner Unemployed	-0.452*	(0.271)	-0.201	(0.137)	0.005	(0.008)
Partner Retired	-0.747**	(0.427)	-0.543**	(0.235)	0.004	(0.012)
Woman has A-levels	0.239	(0.209)	0.358***	(0.076)	0.002	(0.005)
Ever employed before	-0.113	(0.191)	0.477***	(0.074)	0.011	(0.005)
Children aged 3-4	-0.968***	(0.233)	-0.178***	(0.059)	0.015	(0.006)
Benefit = 1	0.694***	(0.201)	-0.438***	(0.095)	-0.021	(0.006)

Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The standard errors are clustered at couple level and are in parentheses. The number of couple-month observations are 102,706. The hazards are evaluated at $s = 6$. The probability difference and standard errors are calculated by equations (5) and (6), respectively. The model specification is the same as Model 2 in Table 4.

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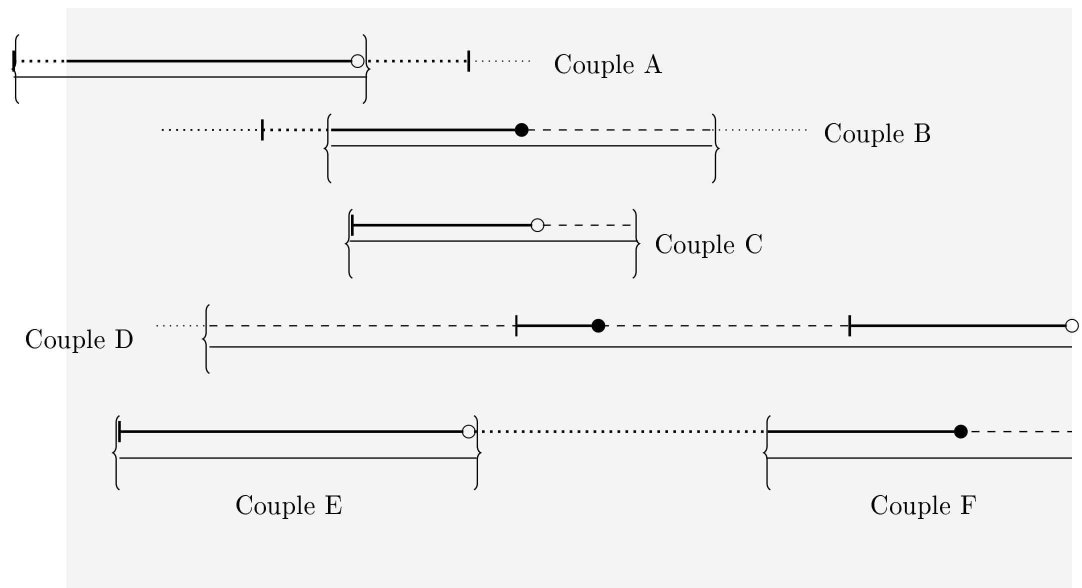
A Censoring of Inactivity Spells and the Likelihood Function

A.1 Types of Censoring in the Sample for Inactivity Spells

Censoring is an important issue, and has an impact on the observed duration of women's inactivity spells in the sample. Figure A.1 illustrates the types of censoring observed for partnered women's inactivity spells. The upper line in each couple refers to the woman's labour market timeline and the other corresponds to her partner's. The shaded area indicates the sample period between September 1990 and April 2009, during which both partners' labour market histories are observed on a monthly basis. Having constructed the dataset in couple-month format means that there is a record for each month for an inactive cohabiting or married woman. This woman is "at risk" of entering the labour market at every month she remains inactive. The solid lines in the figure illustrate women's inactivity spells, whereas the dotted lines represent the periods when the individuals' labour market histories are known, but lay either outside the observation window (couple spell) or the sample period (data collection). The dashed lines demonstrate other labour market states women may occupy during their couple spells.

Figure A.1: Different Types of Censoring on Women's Inactivity Spells



One type of censoring that is prevalent in this framework is left-truncation. A woman's inactivity spell is left-truncated (delayed entry) if the beginning of her inactivity episode does not coincide with the start of the sample and observation period. This means that she has been at risk of experiencing a transition from inactivity to the labour market for some time either before she enters the sample, or forms a couple spell. Couple A in Figure A.1 is an example for the former case, in which the woman has been inactive and at risk of participating in the labour force before the beginning of the sample period, September 1990. In the figure, women in couples B and F present two examples of delayed entry spells due to couple formation.[1] In couple B, the woman's inactivity spell has begun before she is first observed with her partner. As the observation window is restricted to the couple spells, her inactivity spell is observed as a delayed entry. On the other hand, the inactivity spell in couple F is due to a newly formed couple. The woman has been at risk since her previous partnership (couple E), and she remains at risk until and after when she is observed with another partner.

Notice that a left-truncated inactivity spell contributes to a stock sample, whereas if a woman becomes at risk within the observation window (and the sample period), her inactivity spell belongs to a flow sample. Let s_{ikn} be the elapsed months of the nth inactivity spell of woman i in couple k. The elapsed months of an inactivity spell with delayed entry is obtained by starting to count the months in inactivity from $s_b + 1$, where s_b is the number of months a woman has been inactive before she enters the observation period. For example, in the data when the women in couples A, B, and F are first observed in the data, their elapsed months start counting from $s_{ik} > 1$, whereas it is $s_{ik} = 1$ for women in couples C, D, and E.

Notice that both inactivity episodes of the woman in couple D are flow-sample spells. While her first inactivity spell ends with her transition to the labour force, denoted with "•", her second inactivity spell is right-censored. In Figure A.1, the right-censored spells are depicted with "◦", and are observed if a woman does not exit inactivity before the end of the sample period or couple dissolution. The second spell of the woman in couple D illustrates an example of the former, whereas the inactivity episodes of women in couples A and E are right-censored due to couple dissolution.[2] Another form of right-censoring is shown in couple C, where the woman stops being at risk before the end of observation, but she experiences a transition to a labour market state other than labour market activity.[3]

A.2 Likelihood Contributions of Left-truncated and Completed Inactivity Spells

As noted in section 3, it is important to take into account the structure of the data when writing down the likelihood function. In the estimation sample, there are three

[1] Note that couple formation here is used to refer to the earliest time a woman and her partner report to be together.

[2] As in couple formation, couple dissolution includes separation of partners, death of one partner and one partner's attrition. When a partner is lost to follow-up, even if the woman reports to be with the same partner, the couple spell terminates. The reason behind is that there is no labour market history for partner corresponding to the months in woman's labour market history to examine the added worker effect.

[3] From a statistical point, if the censoring mechanism is non-informative, the reason for right-censoring is not important (Allison, 2014). The assumption is that the month woman's inactivity spell is censored does not provide any additional information on woman's probability to exit inactivity.

types of inactivity spells:

(i) those that start with woman's transition to inactivity from another state within the observation period (flow sample),

(ii) those that begun before woman is first observed in a couple spell or in the BHPS (stock sample), and

(iii) those that are right-censored due to couple dissolution, transition to another non-participating state, or end of the sample period.

The aim of this appendix is to discuss the likelihood contributions of different types of inactivity spells with examples. This appendix is based on Jenkins (2005) and Cameron and Trivedi (2005) (Chapters 17 and 18), and a similar exposition is that of Andrews et al. (2011) who acknowledge the same sources.

To illustrate how the right-censored spells contribute to the likelihood function, consider the following case: suppose that the first inactivity spell of woman in couple k belongs to the flow sample. The start of her inactivity spell may coincide with the observation period, or she may become inactive during the couple spell. In either case, the elapsed duration of her first inactivity spell starts with $s_{k1} = 1$. There are two possibilities for how her spell could end: Either she becomes active, and her inactivity spell is completed, $c_{k1} = 1$, or her inactivity spell is right-censored, $c_{k1} = 0$, where c_{kn} is the censoring indicator for n^{th} inactivity spell of a woman in couple k.

Therefore, the likelihood contribution of a completed spell is through the discrete time density function, whereas the right-censored spells contribute through the survivor function (Jenkins, 2005). The log-likelihood for these spells is written as (Jenkins, 2005, equation (6.9)):

$$log(L) = \sum_k \sum_s log \left[\left(\frac{h_{s_{kn}}(X_{kt})}{1 - h_{s_{kn}}(X_{kt})} \right)^{c_k} \prod_{s_k=1}^{s_{kn}} \{1 - h_s(X_{kt})\} \right], \tag{A.1}$$

where s_{kn} is the completed duration for n^{th} inactivity spell of woman in couple k. For example, a woman exits inactivity at observed duration s_k, the likelihood contribution of her inactivity spell is $(1 - h_{k1})(1 - h_{k2})(1 - h_{k3}) \ldots (1 - h_{ks-1})h_{ks}$. On the other hand, if there is no observed transition, i.e. if her spell is right-censored at s_k, then her spell's contribution is $(1 - h_{k1})(1 - h_{k2})(1 - h_{k3}) \ldots (1 - h_{ks-1})(1 - h_{ks})$.

As discussed in section 2.2, some inactivity spells are subject to delayed entry. Note that these women have already been at risk of exiting inactivity for some time. When delayed entry is taken into account, the duration of stay in inactivity increases, leading one to observe longer durations than shorter ones. An inactive woman's likelihood function is conditioned on the survival in the same state until s_b, which is the number of months she has been at risk before she is first observed in the sample. This means equation (A.1) is divided by the survival probability of woman until $s_{b,k}+1$. As shown in Jenkins (2005) equation (6.20), this leads to the following log-likelihood function

$$log(L) = \sum_k \sum_s log \left[\left(\frac{h_{s_{kn}}(X_{kt})}{1 - h_{s_{kn}}(X_{kt})} \right)^{c_k} \prod_{s=s_{b,k}+1}^{s_{kn}} \{1 - h_{s_{kn}}(X_{kt})\} \right], \qquad \text{(A.2)}$$

The only difference between equations (A.1) and (A.2) is on the product term, which runs from the elapsed duration of the inactivity spell of a woman when she enters the sample (Andrews et al., 2011). In other words, the clock is re-set to start with the beginning of the inactive spell, when the spell is left-truncated, given that her first spell's start date is known.

An example illustrates: assume that a woman enters the observation period as being inactive for the last 6 months, i.e. her inactivity spell is left-truncated (delayed entry) and $s_b = 6$. She is observed to be inactive in the sample for another 4 months, and then she participates in the labour force. Therefore, her elapsed months in inactivity starts with $s = 7$ when she is first observed in the sample due to delayed entry, and s counts onward until she becomes active. In this scenario, the outcome variable is $\{y_7, y_8, y_9, y_{10}\} = \{0, 0, 0, 1\}$. On the other hand, if her spell is right-censored, e.g. the couple dissolves before a change is observed, or she retires after being inactive, then $\{y_7, y_8, y_9, y_{10}\} = \{0, 0, 0, 0\}$. Alternatively, for a woman who becomes inactive during the sample period, the outcome variable starts with her first month in inactivity as $\{y_1, y_2, \ldots, y_\tau\}$, where τ is the last month the woman is observed to be inactive.

In terms of likelihood contributions, her delayed inactivity spell is through the survival function (Jenkins, 2005), i.e. $(1-h_7)(1-h_8)(1-h_9)h_{10}$. If her inactivity spell belongs to the flow sample, then $s_b = s = 1$, and her likelihood contribution is the same as discussed above. Therefore equation (A.2) accounts for stock (due to delayed entry) and flow inactivity spells.

Notice that there are some women in the sample who experience more than one inactivity episode within a single couple spell, which is denoted by subscript n, and included in the log-likelihood function. The gap-time formulation of the risk interval enables one to account for these as flow inactivity spells, and the same baseline hazard is assumed for repeated events.

B Construction of the Dataset

The dataset is constructed using the annual records and job-history records of the BHPS. The dataset is an unbalanced panel of women in couples between September 1990 and April 2009. Currently, there is no such dataset that matches the labour market histories of couple members for public access in the UK Data Archive.[4]

The merits of constructing this dataset can be summarized as follows: firstly, the individual questionnaires of the BHPS collected information only on the respondent's main labour market activity at the time of the interview. In practice, respondents may change their job or labour market activity at any time between two consecutive interviews. Using the short-term retrospective job histories allows me to observe the labour market spells between two interviews. This is particularly important for labour market states that are of shorter or transitory nature, e.g. unemployment, which may not be captured by the annual records. Additionally, constructing respondent's labour market histories enables me to measure the duration of the labour market spells more precisely, as the start and end date of spells are recorded as calendar month and year. This allows me to identify censored and completed labour market spells, which makes the dataset well suited for duration analysis for couple's labour market histories. Thirdly, as couples and their labour supply decisions are of interest in this research, it is essential to know who is together with whom (either cohabiting or legally married), and the partners' labour market activities during their partnership. I construct a single record for individuals' partnership histories, which is used to match partners for the period the partners report to be together.

Construction of couples' labour market histories involves three main steps: First, individuals' labour market histories are created irrespective of gender and marital status. Second, the partnership histories of respondents are collated, and updated using the panel information when necessary. Third, the marriage and cohabitation histories of individuals are combined with their labour market histories. The panel on individuals' histories is restricted to women, and merged with unrestricted panel using three key variables: woman-identifier, partner- identifier and partner's partner-identifier. The last variable ensures defining a couple spell for the period that both partners agree on being together.

Individuals' Labour Market Histories. The construction of the individuals' labour market histories benefits greatly from Maré (2006; 2015).[5] However, the final dataset is different than of Mare's in several ways.

[4] This is a shorter version of onstruction of the Couples' Monthly Labour Market Histories 1990-2009 from the BHPS, which is the first chapter in my PhD thesis.

[5] I would like to thank David Maré for sharing his Stata codes with me. At the time of construction of this dataset, Maré (2015) was not available in the UKDA.

The work-life history of Maré (2006; 2015) includes the long-term retrospective histories, i.e. the employment histories of respondents after they have left full-time education. I do not use these histories, firstly because the questionnaires are conducted only in three waves throughout the BHPS, and using these files would reduce the sample size. Secondly, the time-varying demographic and socio-economic characteristics cannot be retrieved for these observations as these date back long before the respondents first interview with the BHPS. Another difference between Maré's and my dataset is on the initial sample selection. Maré (2006; 2015) includes the observed histories of the original sample members of the BHPS and excludes history segments after a wave of non-response. I construct histories for all respondents, including those from regional extension samples. A final difference between these two datasets is on the data structure. While Maré's final individual-work life histories in person-spell form, I expand the labour market spells to create a monthly panel with person-month observations.
The earliest month in the sample is set to September 1990, even though respondent's history may date back long before. Therefore some labour market spells are left-truncated.

Individuals' Partnership Histories. Since the focus is on couples, the data set requires matching partners who report to be together. The BHPS collects information on marital status and relationship between individuals within an household at each wave. The respondents are asked to report their marital and cohabitation histories only once in the BHPS. Therefore, while for some individuals the partnership histories may date back before his/her entry to the BHPS, some partnerships are reported to begin at the time respondent is first observed in the sample.
First I identify partners for each wave using the BHPS' annual records, which contain information on respondents' marital status and time of changes. These are also cross-validated by using files that contains the relationships between the household members at each wave, and append waves to create a panel. I use unique household, person number and partner identifiers of each individual questionnaire to match partners and to create couple spells, which is the suggested strategy in Taylor et al. (2010).
To account for the period between two consecutive interviews and to construct partnership histories, I use Nazio (2010) and Pronzato (2011), who separately deposited marriage, cohabitation and fertility histories from the BHPS to the UK Data Archive. Pronzato (2011) covers all waves of the BHPS, however it does not provide a harmonized history for couples. In other words, couple members may report different times for their partnership. On the other hand, using an earlier version of Pronzato's dataset, Nazio (2010) provides a harmonized marital and cohabitation histories panel between 1991-2005. I synthesize these datasets, restructure them to panel format by expanding the union spells to create monthly panel for partnerships. I update this synthesized dataset by matching partner's from panel interviews, and by tracking their marital status each wave. This update

resolves some conflicting reports among partners, and overlaps between couple spells. However there are still some unharmonized couple spells either due to conflicting reports on formation and/or dissolution dates by partners.

Combining Histories, and Creating the Couple's Labour Market Histories. The panel on individuals' monthly labour market history is combined with information on individual's partnership histories and their observed characteristics using the unique person identifier and calendar time (month year). This individual's panel is restricted to individuals, who are observed with an identified partner, i.e. the partner has a unique identifier with the BHPS. As the focus of this study is to examine the woman's labour supply behaviour, the main dataset is restricted to women, and merged with the unrestricted panel using woman's, partner's, partner's partner identifier and calendar time to ensure the couple spells are created for the period both partners reported each other as their cohabitant or legal partner. Same-sex couples, couples with interrupted histories, and couples in which partner's labour market history is unknown are excluded from the sample.

A couple spell is defined over the consecutive months, during which both couple members report to be in the same partnership. If there are varying reports on couple's start and end date, the latest start date and earliest couple end date are used to create the couple spell.[6] Even though the sample is restricted in women in partnership, the unit of observation is couple-month, since some women have multiple couple spells (with different partners) over their presence in the BHPS. The labour supply behaviour of a woman may change when she is observed with a different partner, as she may adopt new tastes and preferences, or changes in social environment.

In this dataset, a row of observation includes woman's and her partner's demographic, socio-economic characteristics, and their labour market activities. In other words, for each couple k in the panel, there is a sequence of time-varying or fixed labour market, l_{kt}, and other characteristics x_{kt}, $\{l^w_{kt}, l^p_{kt}, x^w_{kt}, x^p_{kt}\}^T_{t=1}\}$ for woman, w and partner, p.

[6]The varying reports on start dates are mostly due to late-entry to the BHPS or due to sample selection, which is used to construct individuals' labour market histories. A couple spell ends when at least one partner reports separation or divorce, suffers from attrition, or the other partner dies.