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IZA DP No. 14968

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ABSTRACT

Do Changes in Employment and Hours Worked Contribute to a Decreasing in the Mental Health of Single Mothers during a Period of Welfare Reform in the UK? A Longitudinal Analysis (2009-2019)

We investigate the role of employment in explaining changes in the mental health of single mothers compared to partnered mothers and single childless women during the period of welfare reform in the UK. We employ a time allocation framework to explore if reductions in benefit income led to a sub-optimal consumption bundle, resulting in lower in mental health, higher employment, and longer working hours. We estimate a Heckman selection model for employment and hours worked. A difference-in-difference model is used to explore if reform periods were associated with increased inequalities. Results show that employment was associated with better mental health for all women. Higher job hours were associated with lower mental health for all women but the association was not statistically significant for single mothers. Mental health inequalities potentially have increased post reforms.

JEL Classification: D13, I14, I38, J22

Keywords: welfare reform, employment, low-income, single mothers, mental health

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Introduction

In the UK, nearly a quarter of families with dependent children are led by single parents (ONS, 2021). A large proportion (43%) are in poverty (JRF, 2020) and at an increased health disadvantage, facing greater risks of depression (Targosz *et al.*, 2003), psychological distress, and long-term disability compared to their married counterparts (Gingerbread, 2018).

Since the late 1990s, the prevailing policy approaches towards tackling the social and health disadvantage of single parenthood have been focused on increasing the low employment rates among this group - less than half (46%) of single mothers were in employment in 1997, compared to an employment rate of approximately 70% for married mothers (Blundell and Hoynes, 2003). Such approaches have been based on a general political consensus that employment is not only a route out of poverty but also provides benefits for mental health (DWP, 2016). This line of reasoning is supported by well-established theories from psychology and sociology (e.g. Fryer (1986); Jahoda (1982)) as well as a large body of evidence base on social and psychological harms of unemployment, particularly for men (Paul and Moser, 2009).

However, there are a number of studies which suggest that single mothers may not reap the mental health benefits of employment compared to other groups. For example, a UK study by Baker *et al.* (1999) found that moving into employment provides little mental health benefits to single mothers compared to partnered mothers, suggesting that the movement from 'welfare to work' is unlikely to improve the health of single mothers. These findings are consistent with similar research that indicates transitions into work are associated with declines in psychological distress among married mothers while single mothers who entered employment received no mental health benefit (Ali and Avison, 1997). Evidence from recent systematic reviews on the effects of welfare-to-work programmes similarly shows that such programmes provide little benefit (Gibson *et al.*, 2018), or even have negative impacts, on the mental health of single mothers, attributing such effects to the increased role strain of being a worker and a mother, as well as to low-paid and precarious employment in this population (Campbell *et al.*, 2016).

Given the prevailing political consensus of the benefits of being in employment to mental health and as a route out of poverty, however, successive UK governments since 1997 have implemented a number of reforms aiming to incentivise employment for single parents. The first wave of such reforms was introduced by the New Labour government (1997-2010). The reforms consisted of welfare-to-work programmes as well as higher benefit rates for single parents in and out of work. Research evaluating these reforms suggests that, as intended, these policies led to increases in employment and improved mental well-being among lone mothers (Gregg *et al.*, 2009; Harkness, 2016), as well as to reductions in child poverty (Joyce and Sibieta, 2013).

Both the Coalition Government (2010-2015) and the subsequent Conservative Governments (2015-present) expanded upon New Labour's policies to prioritise employment as a key outcome of social security reform. However, the strategy to achieve this goal represented a marked departure from their predecessors. For example, there was an extension and intensification of mandatory work requirements, known as the Lone Parent Obligation (LPO), with the Welfare Reform Act 2012 (Lupton and Burchardt, 2016). Before 2012, the age of the youngest child with which single parents were eligible for unconditional Income Support was

7 years. By 2017, this age limit was lowered to 3 years (Millar, 2019). In April 2013, Universal Credit (UC) was introduced with the associated stricter conditionality measures for those in and out-of-work.

Evidence from a recent quasi-experimental study suggests that the conditionality measures associated with LPO led to increases in employment for single parents (Avram *et al.*, 2018). In line with this evidence, national figures also suggest that maternal employment rates have increased for single mothers rising from 57% in 2009 to 70% in 2019 (Barrett, 2010; ONS, 2019). This increase is at least in part been attributed to social security reforms (Bell and Gardiner, 2019). However, these increases in work requirements have also been associated with increased rates of disability benefits as well as declining mental health among single parents (Avram *et al.*, 2018; Katikireddi *et al.*, 2018). Similar findings are mirrored by the US welfare reform literature (Basu *et al.*, 2016; Narain *et al.*, 2017), indicating some the unintended consequences associated with such reforms.

From 2010, these increases in conditionality were accompanied by substantial cuts to working-age social security benefits. The programme of cuts began in 2011/2012 with the freezing of child benefit payments for three years in 2011. Additional cuts were introduced in April 2013 with a limit of a 1% benefit uprating of most working age benefits rather than having benefits rise with inflation, and cuts in support towards childcare costs. The Welfare Reform Act of 2016 introduced additional cuts to families. These included lowering of the housing allowance in 2016 – a reform that particularly affected single parent households (Women's Budget Group, 2017); a four-year benefits freeze applying to most working age benefits; a two-child limit imposed on receiving child benefit; and cuts in work allowance in UC (Child Poverty Action Group, 2017). For more detail on reforms affecting families see Hobson (2020).

The combined impact of the reductions in welfare benefits from 2010 has been estimated to account for a significant proportion for affected families. The poorest 10% of families who rely on benefits as their main source of income lost 20% of their income on average as a direct result of these reforms (Bourqin, 2019). Further evidence also suggests that benefit income fell more sharply among families with no earners (Cribb *et al.*, 2018) and, among those with children, single parent households were particularly affected (De Agostini *et al.*, 2018; Reed, 2020). Two parent families with at least one earner and single low-income women without children were likely to be less affected by these welfare reforms.

There is a growing body of public health research on the negative mental health impacts associated with different welfare reforms in the UK since 2010 (see, e.g., Reeves *et al.* (2020); Wickham *et al.* (2020)). To the best of our knowledge, there is currently a lack of evidence on how changes in employment - a key economic mechanism linking welfare reform and mental health - may have impacted on the mental health of single mothers during this period. The main aim of this paper is to investigate the role of employment in explaining changes in the mental health of single mothers during the period of social security reform (2009-2019). Our secondary aim is to explore if, following key UK social security reform implementation dates (April 2013 and April 2017 (APPG, 2021)), there was a significant change in mental of single mothers, relative to similar low-income women who were less likely to be affected by the reforms: low-income partnered mothers and low-income single mothers, and to therefore gain insights into whether the reforms have contributed to mental health inequalities.

Given the rising rates of employment among single parents, as well as the widespread claims of the potential benefits of employment in justifying the recent welfare reforms in the UK

(DWP, 2016), it is important to assess how changes in employment may have impacted on the mental health of single mothers - a group who is the most financially affected by the series of contractionary social security reforms implemented between 2010-2019. Understanding this relationship will help inform the design of future social security policies as well as public mental health strategies, potentially helping to reduce existing inequalities in mental health.

Theoretical framework

To understand how changes in welfare benefit payments may have influenced single mothers' decisions to participate in the labour market and hours worked, and how this relates to their mental health, we utilise a neoclassical model of time allocation (Becker, 1965; Gronau, 1977). In this model an individual aims to maximise their utility (which we proxy by mental health) by allocating their time between market work, non-market work and leisure to obtain an optimal bundle of goods.

Using this framework, maternal labour supply (and thus their utility or mental health) can be affected by exogenous changes in economic variables such as changes in non-labour or benefit income (e.g. those stemming from welfare reform). Given that single mothers are likely the sole providers in the household, they are likely to be more sensitive to any external influences (e.g. changes in benefit income) impacting on their time allocation compared to partnered or childless women.

Gronau's (1977) theory of maternal time allocation

In this section, we will describe a model, which is based on Gronau's (1977) extension of Becker's (1965) generalised model of time allocation and home production, where households are both consumers and producers. We will assume that every individual will maximise their household utility, which is summarised by a strictly concave utility function that consists of consumption of goods C and her own leisure time L.

(1) Utility function: $U(C, L, \tau)$

The preference parameter τ shows the trade-off between consumption of goods and leisure. The individual is constrained by the available time and the income they have, which is represented by a budget line. In this model, the purchased goods and the home produced goods are perfect substitutes, which means that the individual is indifferent to the combination of goods he or she consumes. For the sake of simplicity, we will assume that the price for each good at the market is equal to 1.

(2) $C = C_N + C_H$

C_N = goods purchased with monetary income at the market at a price P per unit of good;

C_H = goods produced at home, such as clothes made in a home workshop, home-cooked food or childcare, which is expressed by a household production function:

(3) $C_H = f(H)$

This function is represented by a production curve which is concave to the origin; this means that it has a decreasing marginal productivity, where $f' > 0$ and $f'' < 0$ (Gronau, 1977, p.

7). The shape and position of the production function (i.e. individual's productivity) depends on socio-demographic factors such as age, education, number of children, age of the youngest child, and benefit (non-earned) income (Gronau, 1980, p.104).

The budget constraint consists of the mother's earned income, which depends on her hourly offered wage rate (w) and working hours (N), and benefit
income (V). The total available time (T) will be allocated between leisure (L), work in the market (N) and household production (H).

The income constraint is represented by:

(4) $P \times C_N = w \times N + V$

The time constraint is represented by:

(5) $T = H + N + L$

By substituting N from (5) into (4), we can get the full budget constraint:

(6) $P \times C_N + w(H + L) = w \times T + V$

Rewriting the utility function by substituting (3) into (2) and then (2) into (1), we get:

(7) $U = U(C_N + f(H), L, \tau)$

The utility maximisation problem:

(8) $Max\ U = U(C_N + f(H), L, \tau)\ s.t.\ P \times C_N + w(H + L) = w \times T + V$

The optimal consumption point for the woman will be where her highest possible indifference curve is tangent to either the household production curve or the budget line. This is illustrated in Figure 1, where the individual chooses a point where the slope of the budget line is equal to the slope of the indifference curve which provides the highest possible utility. The marginal rate of substitution (MRS) between leisure and goods (ratio of marginal utilities) will be equal either to the marginal product of work at home or to their real wage rate (w). This can be seen in equation (9). For mothers not in employment, the marginal product of work at home is equal to their reservation wage (w^R) which is formally shown in equation (10).

The larger (smaller) the MRS, the steeper (flatter) the individual's indifference curve indicating a higher (lower) preference for leisure relative to consumption, therefore requiring a larger (smaller) compensation to give up an hour of leisure. Therefore, individuals with steeper ICs are less likely to work in the market whereas individuals with flatter ICs are more likely to work in the market, holding all else constant.

(9) $\frac{(\delta U/\delta L)}{(\partial U/\partial C)} = f'(H) = w$

(10) $\frac{(\delta U/\delta L)}{(\partial U/\partial C)} = f'(H) = w^R$

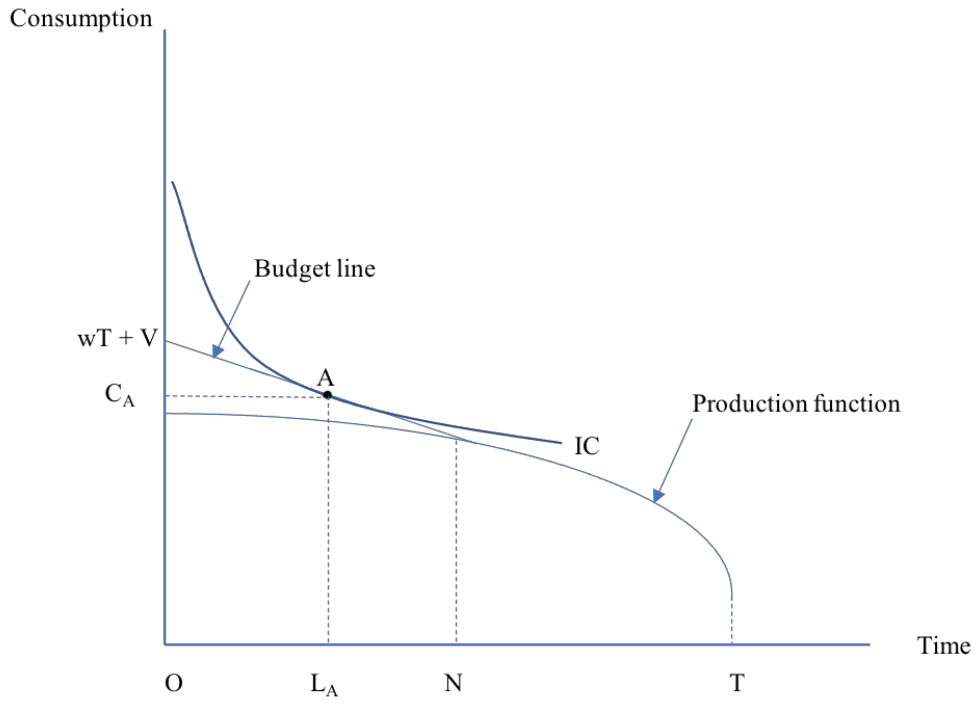

Figure 1 *Utility maximisation at point A*

At the optimal point A in Figure 1 the woman's indifference curve (IC), with the highest possible utility is tangent to her budget line. She chooses to have L_A hours of leisure, N - L_A working hours, T – N hours in household production and a consumption of C_A.

Effects of welfare reform

Based on the theoretical framework, a reduction in benefit income will move non-labour income (V) downwards. This causes a vertical shift downwards of the budget line resulting in a negative income effect, reducing the opportunities available in terms of both consumption and time allocation. Because of this shift, the mother will choose a different optimal consumption point. According to the theory of consumer choice, a negative income effect decreases demand for normal goods and increases demand for inferior goods (Snyder and Nicholson, 2012, p. 136). Therefore, if leisure is a normal good (as is commonly found in the empirical literature (Borjas, 2016)), the mother will unambiguously want to consume less leisure after the reform.

As illustrated in Figure 2, after the reduction in non-labour income (V), for those already in the workforce (i.e. for those who prefer 'goods-intensive' consumption technology (as indicated by relatively flat ICs) this will incentivise market work as there is a parallel downward shift in the budget constraint (from wT+V to wT+V*). A utility maximising individual reallocates her time so that both her leisure hours and consumption of goods decrease (from L_A to L_{A*} and from C_A to C_B respectively), while working hours increase (from N-L_A to N-L_B) and hours in household production (T-N) remain the same, resulting in the new lower utility maximisation at point B (and thus lower mental health).

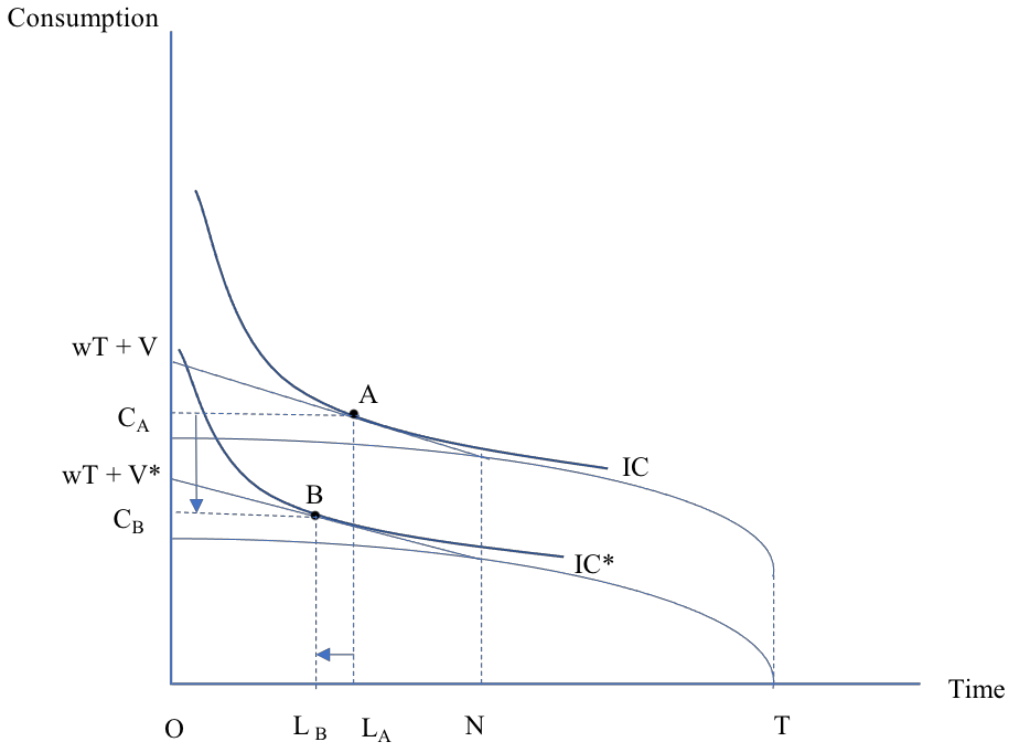

Figure 2 *Effects of benefit reduction on maternal utility for mothers in work*

For those outside of the labour force (i.e. those with 'leisure intensive' consumption technology and steeper ICs which means they do not initially work in the market and only allocate their time between working at home and leisure), the theory predicts that a fall in non-labour income (V) reduces their leisure time (from L_A to L_B in Figure 3a), however, given their preferences for 'leisure-intensive' consumption, rather than increasing their market work hours, these individuals choose to allocate more time to non-market work (increasing it from T-L_A to T-L_B). According to the neoclassical economic theory, they will only enter the labour market if their reservation wage (i.e. the minimum acceptable wage) falls below the offered market wage (Borjas, 2016). This will only happen if the reduction in benefit income is sufficiently large, given their preferences. This scenario is illustrated in Figure 3b, whereby following the reduction in benefits, single mothers will reduce their leisure from L_A to L_B, increase their non-market work from T-LA to N and will choose to work in the market for L_BN hours, compared to zero hours prior to the reform. Consumption decreases from C_A to C_B, leading to a new combination of consumption and leisure at point B on the lower indifference curve (IC*) and thus lower mental health, compared to pre-reform (point A), as illustrated in both Figures 3a and 3b.

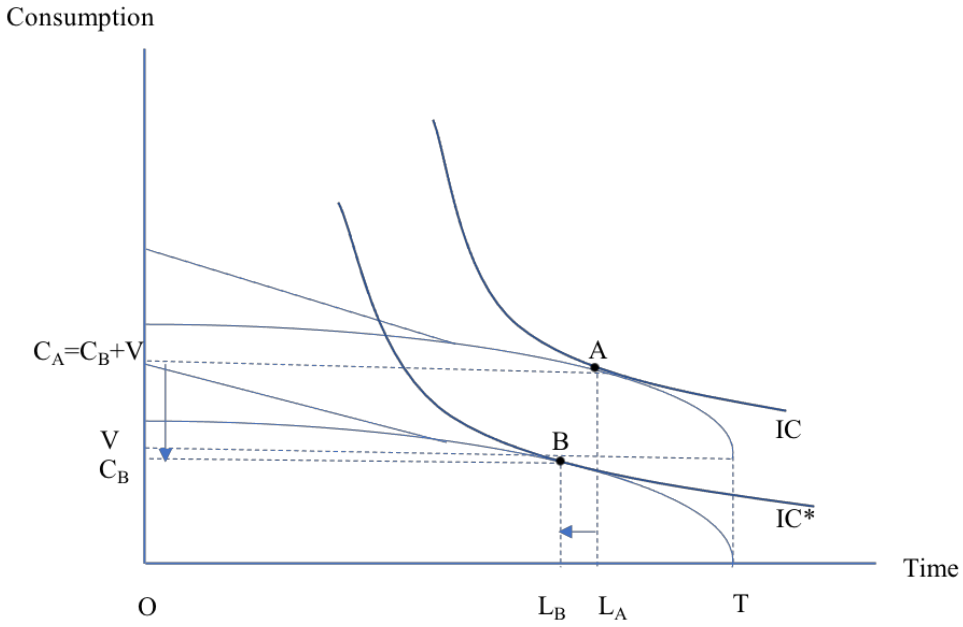

Figure 3a *Effects of benefit reduction on maternal utility for mothers who choose to remain outside of market work following the reform*

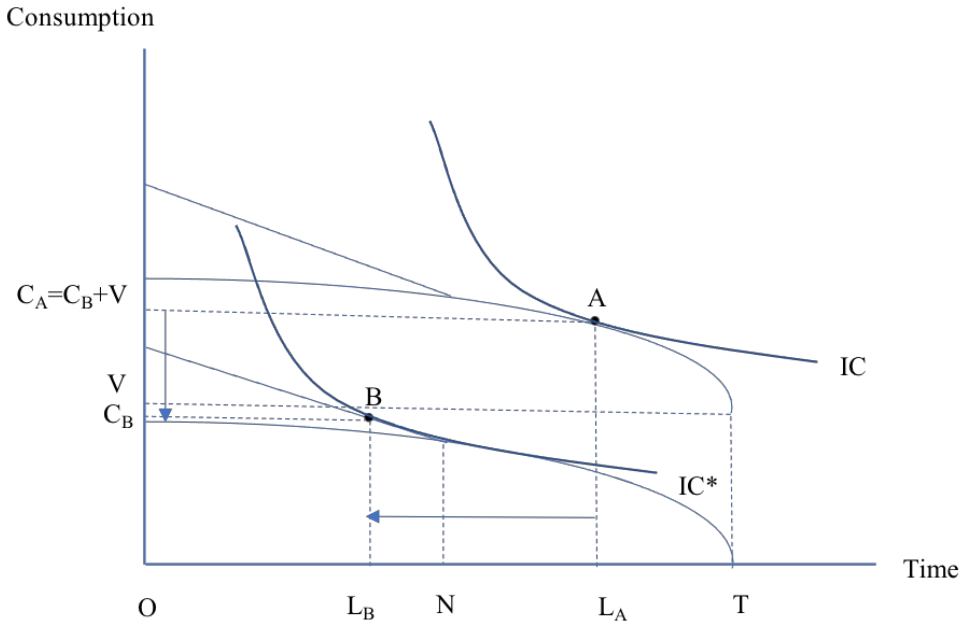

Figure 3b *Effects of benefit reduction on maternal utility for mothers who choose to enter market work following the reform*

Theoretical assumptions

It should be noted that, whilst the Gronau's (1977) theory of time allocation can provide important insights into individual behaviour regarding labour supply, it rests on a number of strong assumptions, including:

1. Labour market is well functioning (i.e. frictionless) – meaning that individuals are able to take up work or increase their work hours if they decide to;
2. Average wage rate equals the marginal wage (i.e. the same wage rate is earned irrespective of the number of hours worked);
3. There are no market costs associated with the supply of labour (e.g. transportation, childcare costs);
4. Market work and non-market work in themselves do not provide any direct utility or disutility;
5. Home produced goods are perfect substitutes for market produced goods.

The validity of these assumptions is important to consider when interpreting the empirical results and we will return to them in the Discussion.

Testable Hypotheses

1. Based on the theoretical framework, we hypothesise that increases in employment and hours worked during the period of contractionary welfare reform will be associated with lower mental health because of the reduction in benefit income forcing mothers to either reduce consumption or spend more time in paid employment. We expect this negative relationship to be stronger for single mothers than low income partnered or childless women who may have more slack in their budget constraint.

2. If we find evidence in support of Hypothesis 1, we suggest that this decrease in mental health may be contributing to increasing mental health inequalities between single mothers and partnered and low-income childless women. To operationalise how mental health between these groups may be changing over time, we utilise two time points for welfare reform which have had a greater impact on single mother's benefit income: 1) Welfare Reform Act 2012 and 2) Welfare Reform and Work Act 2016 (implemented from April 2013 and April 2017 respectively).

Methods

We use ten waves of data from the UK Understanding Society Survey (USS), covering the period between 2009-2019 (University of Essex, 2020). USS is a nationally representative, longitudinal panel survey based on a stratified clustered random sample of 40 000 households from the four UK countries. Sample selection for the survey is based upon postcode which are then grouped into geographical strata to ensure a nationally representative selection of households. The survey asks respondents a range of questions related to their health, labour market experience, finances, opinions, family life, and well-being. All household members aged 16 are interviewed annually using face-to-face interviews. For more information on study design, see Jackle *et al.* (2019).

Sample

Our analysis sample is limited to low-income women. We define low-income as living in relative poverty – i.e. below 60% of median equivalised household income, adjusted for housing costs. This is the primary poverty measure used in the UK and many other developed countries (Francis-Devine, 2021). Household income is defined as the equivalised net household income, that is, the total income of all household members net of taxes, adjusted for

household size and composition (i.e. accounting for the number of adults and children in the household). This adjustment or equivalisation is needed to make the household income of different households directly comparable (Longhi and Nandi, 2014). Household income is further adjusted for housing costs because it gives a more accurate measure of disposable income and thus living standards, compared to the 'before housing costs' poverty measure (CPAG, 2021).

The key sample of interest consists of a cohort of 1,110 working-age single mothers (18-64) who have at least one child (under 16) for the entire sample period and live in a low-income household and are single at baseline (wave 1), resulting in a total of 4,608 person-wave observations over the analysis period.

Our comparison groups consist of women with broadly similar socio-demographic characteristics (low-income and working-age) but who, based on distributional analyses such as those by Reed (2020) were less affected by the post-2010 welfare benefit reforms. The first comparison group contains women who were partnered at baseline, restricted to those with children at any given wave (n=1,424 at wave 1; N=6,465 across all waves); and the second group consists of single childless women – women who were single at baseline and had no children at any given wave (n=1,025; N=4,063). Neither of these groups is a perfect 'control' but, given that both of these groups were less likely to be affected by the welfare benefit reforms, including them should strengthen the validity of our findings, particularly for investigating the effects of welfare reform dates and changes in mental health inequalities (Gregg, 2009).

A key defining feature of our sample with children is that they had at least one child between the ages of 0-15 at the start of the study period. Thus, the fertility decision should be exogenous to the welfare reforms.

Outcome Variables

The outcome variables used in the analysis are employment status, which is a binary variable coded as 1 if an individual is in paid work or self-employed and 0 if unemployed or out of the labour force; job hours which is a continuous variable and is coded as zero for those not in work; and mental health. We explore two mental health related outcome variables available in the survey: mental distress and mental functioning. Together these variables capture a wide range of aspects of mental health, and they are less likely to suffer from the reporting biases that are present in simple overall evaluative measures such as subjective wellbeing (Bound, 1991; Bound *et al.*, 1999). Mental distress is measured with GHQ-12 (General Health Questionnaire) - a validated scale derived from 12 items to measure the levels of respondents' psychiatric illness. These items were converted to a single continuous scale ranging from 0 to 36 and reverse scored, with higher scores indicating better mental health. Mental functioning is measured using SF-12 (12-Item Short Form Health Survey), a widely used and validated instrument (Vilagut *et al.*, 2013) that measures respondents' general quality of life and focuses both on mental and physical health. We focused on the mental health component score (MCS) which ranges from 0 (the lowest mental functioning) to 100 (the highest mental functioning).

Key Explanatory Variables

To define our comparison groups, the original marital status variable (mastat_dv) is split into single (=1) vs partnered (reference category). The 'single' category includes those separated, divorced and widowed; 'partnered' includes those married or cohabiting.

Benefit income is a continuous variable 'fimnsben_dv' (defined as income component 7 – social benefit income). This measures total household benefit income, equivalised using the OECD before housing costs scale and adjusted for the prices of the reference month (January 2015) using Consumer Price Index (CPI) inflation indices, as provided by Office for National Statistics (2021a). The OECD equivalisation scales are routinely used in reports of national living standards to adjust income for household size both before and after housing costs (Department for Work and Pensions, 2017).

For regressions where mental health is the key outcome, further explanatory variables of interest include the reform implementation date dummies (post-April 2013 and pre-April 2017 (=1) and post-April 2017 (=2), with pre-April 2013 being the reference category (=0)).

Other covariates

Our models include a number of time-varying socio-demographic variables that are associated with labour force participation and mental health: age, age squared, education, number of children, age of the youngest child, and region (Jaumotte, 2004; Lund *et al.*, 2018). We include both age and age squared to account for the nonlinear relationship of age with mental health and employment. The education variable, originally containing six categories, is divided into three main categories: degree or higher (=1), GSCE, A-levels, or equivalent other qualification (=2); and no qualification (=3). For the difference-in-difference models, we additionally include housing tenure – an established determinant of mental health (Compton, 2015). The variable is split into three categories: home owned outright (reference category), rented in the social sector (=1) and rented in the private sector (=2).

Econometric framework

To estimate the association between changes in employment, work hours, and the mental health of single mothers we employ a Heckman selection model. This allows us to take into account the complex and bi-directional relationship between employment and mental health (Frijters *et al.*, 2014; Steele *et al.*, 2013). Individuals with better mental health may select themselves into employment which would bias the association between job hours and mental health.

In the first stage, we estimate the probability of being employed using a random effects Probit model. Formally this is specified as:

$$Y_{it} = \beta_1 X_{it} + \beta_2 MH_{it} + \varepsilon_{it} \quad (1)$$

$$\varepsilon_{it} = \alpha_i + u_{it}$$

where i = 1,2, … *n* and *t* = 1, …

In this equation, Y_{1it} is an individual's observed employment status which equals one if an individual (*i*) is employed in time (*t*) and is zero otherwise. *Xit* is a vector of individual characteristics such as age, education, benefit income, number of children, age of the youngest

child and *MHit* is a scalar for a mental health variable with associated coefficients β_1 and β_2 respectively. The error term ε_{it} is comprised of an individual-specific effect α_i and a random error component u_{it}.

A potential issue with the random effects (RE) estimation strategy is that it does not control for unobserved individual effects such as motivation, enthusiasm, and genetic characteristics which are likely to be correlated with some of the explanatory variables (Adams *et al.*, 2003). To overcome this issue, Mundlak (1978) proposed an alternative estimation method, also known as correlated random effects (CRE) (Wooldridge, 2019). This approach allows us to control for time-invariant unobserved heterogeneity by including means of time-varying independent variables in the regression equation, thus removing the potential bias associated with the correlation between unobserved heterogeneity and our explanatory variables. Both RE Probit and Mundlak Probit are then then estimated by a maximum likelihood function which is described in greater detail in Greene (2003).

Using the estimates from the Probit models we estimate an Inverse Mills Ratio (IMR) (Heckman, 1976) which is added as a regressor the second stage hours worked equation (described below) to reduce the potential bias associated with selection into the labour market. To calculate the inverse Mill's ratio, the theory of truncated normal distribution is used, whereby the conditional expectation $E([Y_{it}|Y_{it}$ is observed] = 1,$|X_{it}, MH_{it})$ is taken from the Probit Equation 1 when $Y_{1it} = 1$ to compute the unconditional expectation $E(Y_{1it}|X_{it},MH_{it})$. The IMR is then calculated as follows:

$$\lambda = (-X_{it}\beta_1 + MH_{it}\beta_2) = \frac{\varphi(X_{it}\beta_1+MH_{it}\beta_2)}{\Phi(X_{it}\beta_1+MH_{it}\beta_2)} \quad (2)$$

where for λ, $X_{it}\beta_1+MH_{it}\beta_2$ indicates the relationship between the explanatory variables and labour market participation. Parameters φ and Φ are the cumulative density function and probability distribution function, respectively, for a standard normal distribution (Wooldridge, 2010). Therefore, the inverse Mill's ratio is defined as the ratio between the standard normal probability distribution function and standard normal cumulative distribution function evaluated at $X_{it}\beta_1+MH_{it}\beta_2$ for Y_{it}.

The identifying variable of this first stage equation is education (i.e. the variable is not included in the second stage). The reason for this exclusion is that the IMR is a non-linear function of the explanatory variables in the Probit equation, thus the second stage equation (jobs hours) is identified because of this non-linearity (Billari and Borgoni, 2005). However, the non-linearity of the IMR is based upon the normality assumptions of the Probit equations which is not normally tested or justified. To make the source of identification clear, it is advisable to have an explanatory variable in the Probit equation which is not included in the job hours equation (Greene, 2003). The justification for excluding education is that while education is a well-established determinant of labour market participation (Jaumotte, 2004), it is likely have less of an influence on job hours which tend to be set by the employer or dependent on the type of contract.

The IMR is added as a variable to the second stage job hours equation which takes the following form:

$$JH_{it} = \beta_1 X_{it} + \beta_2 MH_{it} + \beta_3 \lambda_{it} + \varepsilon_{it} \quad (3)$$

where $i = 1, 2, \ldots n$, $T = 1, \ldots$

In this equation, JH_{it} is the number of job hours per week for an individual i in period t. Vector Xit represents individual characteristics as per equation (1) with the exception of education and scalar MH_{it} are defined as in Equation 1; λ_{1it} is the inverse Mill's ratio calculated for labour market participation with the associated parameter, β_3. The error term ε_i is comprised of unobservable individual effects α_i and a random error term, u_{it}. The model is estimated by generalised least squares controlling for random effects.

To control for potential omitted variable bias caused by the error term ε_{it}, being correlated with the explanatory variables, a fixed effects model is also estimated. The standard errors in the random effects and fixed effects job hours equation are bootstrapped to correct the bias in the standard errors caused by the two-stage estimation procedure.

To determine our preferred choice of estimation method between random effects and fixed effects (or Mundlak in the case of Probit models), we conduct the Mundlak test (1978) – a test of joint significance of the estimated means of the time-varying variables augmented in the random effects regression. Unlike the commonly used Hausman test, the Mundlak test can include cluster-robust standard errors to allow for heteroscedasticity and serial correlation (Wooldridge, 2021). Significant result suggest that unobserved heterogeneity biases the results and therefore that fixed effects or proxy fixed effects (Mundlak) would be the preferred estimation method.

Difference-in-Difference Model

To determine if changes in welfare benefits have increased mental health inequalities between low-income single mothers and partnered and childless mothers, we estimate two sets of difference-in-difference models.

Difference-in-difference is used to estimate the effects of a policy change on the group most likely to be affected by the change by comparing the effects of the treatment group to those of similar characteristics but who were less likely to be affected by the policy change. The key assumption for the validity of the difference-in-difference models is the parallel trends assumption. It requires that in the absence of treatment, the difference between the 'treatment' and 'control' group is constant over time. We investigate this assumption by looking at mental health trends across the three groups for each interview year before the major reforms took place - between 2009-2013 or the pre-reform period.

In the model we interact the time dummies for the two reform implementation dates (April 2013 and April 2017) and the treatment group dummy (e.g. single mothers vs partnered mothers and single mothers vs single childless women).

The equation for the difference-in-difference is as follows:

$$MH_{it} = \alpha_i + \beta_1 X_{it} + \beta_2 Comparison\ group + \beta_3 Reform + + \beta_4 Year + \beta_5 Comparison\ group * Reform + \varepsilon_{it} \quad (4)$$

where $i = 1, 2, \ldots n$, $T = 1, \ldots$

Where MH_{it} is mental health of an individual i at period t; α_i is a fixed effect; X_{it} is a vector of individual characteristics associated with mental health, including: age, age squared, education, job hours, number of children age of the youngest child, housing tenure, and region. For

regressions where partnered mothers were the comparison group, the dummy was coded as 1 if single mother (i.e. 'treatment group'; 0 if partnered, or missing if neither of the two. For regressions where single childless women were the comparison group, the dummy was coded as 1 for single mothers as before, but in this case 0 was assigned to single childless women and missing otherwise. (It should be noted that in models where single childless women were the comparison group variables relating to child characteristics were omitted). Variable *Year* represents a set of interview year dummies included to control for factors that vary over time (e.g. national economic trends) but are stable across individuals. *Reform* refers to welfare reform act implementation dates (0=before 2013; 1=after 2013 and before 2017; 2=after 2017). The interaction term between comparison group and reform is the difference-in-difference estimator and its coefficient β_5 is our main parameter of interest, and ε_{it} is the idiosyncratic error term. The models are estimated using fixed effects (Wooldridge, 2010).

Robustness checks

A key identifying assumption of the difference-in-difference models is the parallel trends assumption. Prior to the first reform period, the difference between the 'treatment' and 'control' group is constant over time (Angrist *et al.*, 2008). To test this assumption, we performed an event study analysis by including leads and lags of the first set of reforms in our model (e.g. Autor (2003); He and Wang (2017)). We disaggregated our three analysis periods into individual interview years and augmented the specification in equation (4) to include leading and lagging indicators of the first round of reforms implemented in 2013. The leading indicators included years 2009, 2010 and 2011, with year 2012, a year prior to reform implementation, set as the baseline year and thus omitted from the model. If the coefficients of the leads are not statistically different from zero, the pre-intervention parallel trends are not violated. This suggests that a difference-in-difference model is an appropriate estimation technique. Including the lagging indicators of the first round of reforms (i.e. years 2013-2019) also allowed us to explore the dynamic effect of reform implementation on mental health over time.

As a further test of validity of our difference-in-difference estimates, we also explored if our results are sensitive to alternative reform date specifications, using as alternatives the welfare reform act legislation dates (March 2012 and March 2016 for WRA 2012 and WRWA 2016 respectively).

Attrition

Attrition is a common issue when using long-term panel datasets such as USS. In our sample, attrition is high: for single mothers, the net attrition rate between waves 1 and 2 is equal to 32%, though it becomes smaller between the subsequent waves (ranging between 10% to 25%). Taken together this means that, by wave 10, we have only 130 single mothers with non-missing data on all key variables compared to 812 at wave 1, when GHQ-12 is used as the mental health outcome. Similar trends hold when SF-12 is used as the outcome of interest. More detail on attrition rates is provided in Appendix A.

To test for health-related attrition bias, we applied the Verbeek and Nijman (1992). The test variables were (1) an indicator of whether a respondent responds in the next wave, (2) an indicator of whether an individual responds in all waves (3) the number of waves an individual responds to the survey. All three of these variables were added to the base specification of our mental health regression model, and estimated with the unbalanced sample for both of the mental health outcomes (GHQ-12 and SF-12). The statistical significance of the added

variables provides a test for attrition. The null hypothesis is that the three variables are not significant. However, we find that in all of our models (for single mothers only as well as for the full sample) the null hypothesis of random non-response cannot be rejected, thus we do not expect that attrition will bias our results (see Appendix B).

Results

Descriptive Statistics

Table 1 shows the baseline characteristics of our sample, split by comparison group. At baseline, there are 1,110 single mothers (31%), 1,424 partnered mothers (40%), and 1,025 single childless women (29%). Looking at our mental health measures (GHQ-12 and SF-12), we can see that single mothers have a lower GHQ score compared to for partnered mothers but higher than childless women (22.6 vs 24.0 vs 21.7 respectively). A similar pattern can be seen with SF-12 - with a mean score of 44.7 for single mothers, 48.2 for partnered mothers, and 44.4 for childless women.

Mean working hours across the whole baseline sample is 4 hours per week for single mothers, 5 hours for partnered mothers and just under ten hours for single childless women. At baseline, >70% of mothers are outside of work (mostly engaging in family care) and thus have zero working hours. Among those employed, the average working hours are also relatively low: 22.2 hours per week for single mothers, 22.8 and 28.0 hours for partnered mothers and single childless women respectively.

Benefit income is a much greater share of total household income (BHC) for single mothers compared to either comparison group (85% vs around 50%), which makes them more vulnerable to any benefit-related reforms. Single mothers are also, on average, less educated than either of the comparison groups: only 16% of them have a higher education degree, compared to the rates of 25% and 26% for partnered mothers and single childless women respectively. Similarly, single mothers in our sample are also less likely to own their accommodation compared with either partnered mothers or single childless women (10% vs 36% and 22%) and are more likely to rent their accommodation in the social housing sector (58% vs 36% and 43%).

The proportions of non-White individuals are relatively high compared to the UK population of 13% (ONS, 2021b). It is 33% for single mothers, 48% for partnered mothers and 30% for childless women. This reflects the fact that, in the UK, ethnic minority groups tend to be highly over-represented among those in poverty compared to individuals of White ethnic backgrounds (SMC, 2020).

On average, single mothers have fewer children than partnered mothers in our sample (1.76 vs 2.15 respectively) which is consistent with overall national statistics (ONS, 2021). The average age of the youngest child in the household is slightly higher among single mothers than partnered mothers (around 6 and 5 years respectively).

Approximately 18% of single childless women report a limiting long-term condition as their employment status compared to 4% of single mothers and 3% of partnered mothers which may impact on the benefits women are entitled to.

Table 1 Baseline characteristics

	Single mothers (SM)*	**Partnered mothers (PM)**	**Single childless women (SC)**	**N (SM)**	**N (PM)**	**N (SC)**
Age	34.1 (8.82)	34.8 (7.85)	39.8 (14.0)	1110	1424	1025
Mental health						
-GHQ-12	22.6 (6.74)	24.0 (5.95)	21.7 (7.63)	856	1000	806
-SF-12	44.7 (12.4)	48.2 (10.5)	44.4 (13.4)	1092	1364	997
Job hours (all)	4.28 (9.66)	5.27 (10.9)	9.09 (14.2)	1076	1361	964
Job hours (employed)	22.18 (9.27)	22.81 (10.45)	27.95 (10.87)	199	291	292
HH benefit income	961.5 (440.5)	560.5 (419.1)	457.1 (506.5)	1110	1424	1025
HH income (BHC)	1120.9 (395.0)	1051.4 (424.2)	946.41 (528.6)	1110	1424	1025
Employment status						
-Employed	0.21	0.25	0.34	1109	1424	1024
-Unemployed	0.24	0.08	0.20	1109	1424	1024
-Family care	0.43	0.58	0.07	1109	1424	1024
-Full time student	0.05	0.03	0.19	1109	1424	1024
-Long-term illness/disability	0.04	0.03	0.18	1109	1424	1024
Education						
-Degree or higher	0.16	0.25	0.26	1108	1421	1023
-GCSE A-levels or equivalent	0.63	0.53	0.53	1108	1421	1023
-Below GCSE or other	0.21	0.22	0.21	1108	1421	1023
Ethnicity						
-Non-white	0.33	0.48	0.30	1109	1424	1024
Number of children						
-One child	0.48	0.33	-	1110	1424	-
-Two children	0.35	0.35	-	1110	1424	-
-Three or more	0.16	0.32	-	1110	1424	-
Age of youngest child	6.11 (4.76)	5.03 (4.56)	-	1110	1424	-
Housing tenure						
-Owned	0.10	0.36	0.22	1110	1424	1021
-Rented social	0.58	0.36	0.43	1110	1424	1021
-Rented private & other	0.32	0.28	0.35	1110	1424	1021
Region						

-London	0.26	0.27	0.24	1110	1424	1025
-North East and West	0.14	0.13	0.15	1110	1424	1025
-Midlands	0.25	0.27	0.24	1110	1424	1025
-East	0.08	0.08	0.07	1110	1424	1025
-South	0.13	0.15	0.15	1110	1424	1025
-Wales	0.05	0.04	0.05	1110	1424	1025
-Scotland	0.07	0.04	0.07	1110	1424	1025
-Northern Ireland	0.03	0.03	0.04	1110	1424	1025

*Mean (standard deviation) or proportion

Trends over time

Mental health

Figures 4 and 5 below illustrate mental health trends for all three comparison groups across the three time periods of interest: before April 2013 (implementation of Welfare Reform Act 2012 – first round of reforms), between April 2013 and April 2017 (implementation of Welfare Reform and Work Act 2016 – second round of reforms). Both of our mental health measures (GHQ-12 and SF-12) reflect similar trends: decreasing mental health of single mothers after April 2017 and relatively stable mental health for the two comparison groups. Specifically, single mothers' average GHQ-12 scores fell from 22.8 (before implementation of the first round of reforms) to 22.7 (after implementation of the first round of reforms) and 21.9 (after the implementation of the second round of reforms). SF-12 scores fell from 44.8 to 44.3 to 42.0 over this period, reflecting an overall downward trend. The statistical significance and magnitude of these changes is investigated in regression analyses in the subsequent section.

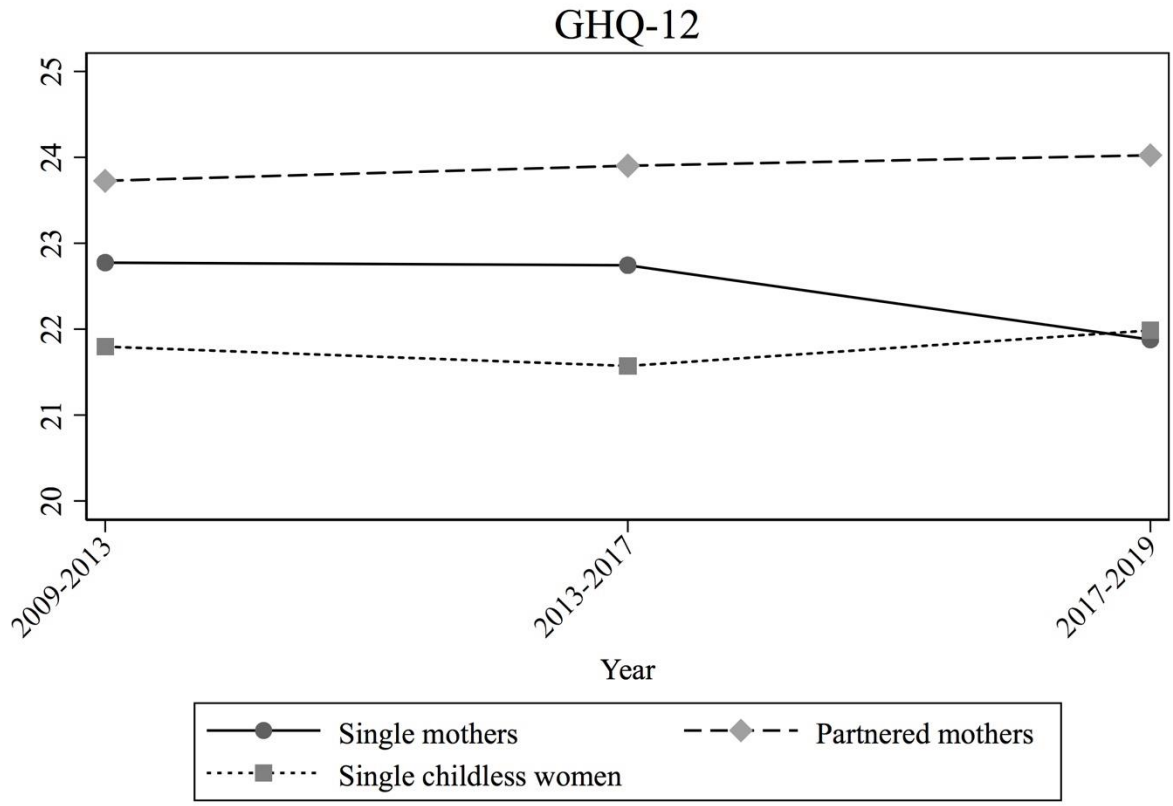

Figure 4 GHQ-12 trends

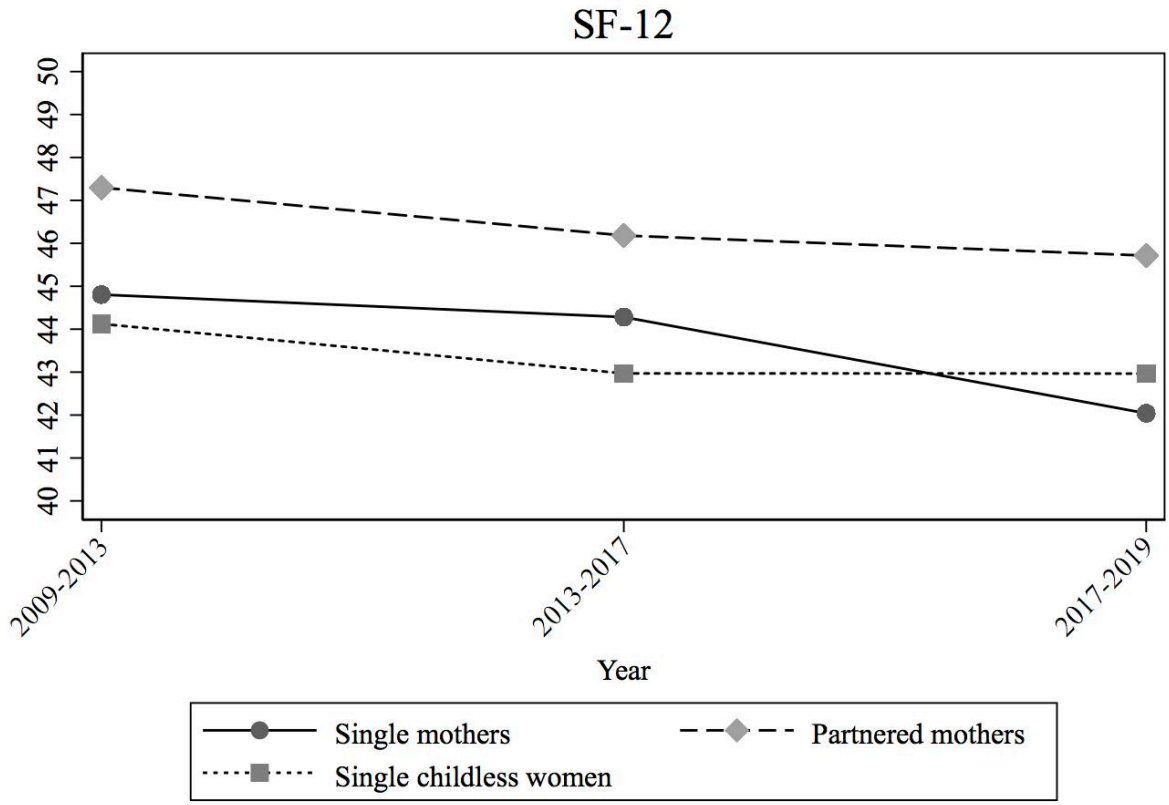

Figure 5 SF-12 trends

Income

Figure 6 below illustrates that, consistent with national distributional analyses (e.g. Reed (2020)), benefit income of single mothers has decreased over the period of the study (from £1,032 to £883) and remained relatively stable for partnered mothers (at around £650). For single childless women, benefit income increased from £564 to £738.

Total monthly household income (AHC), in contrast, was on an overall upward trend throughout the period of our study (Figure 7). It increased the most for single childless women (from £803 to £1,403), whereas for single and partnered mother's household income increased from around £871 to £1,337, suggesting that women in our sample became more reliant on labour income.

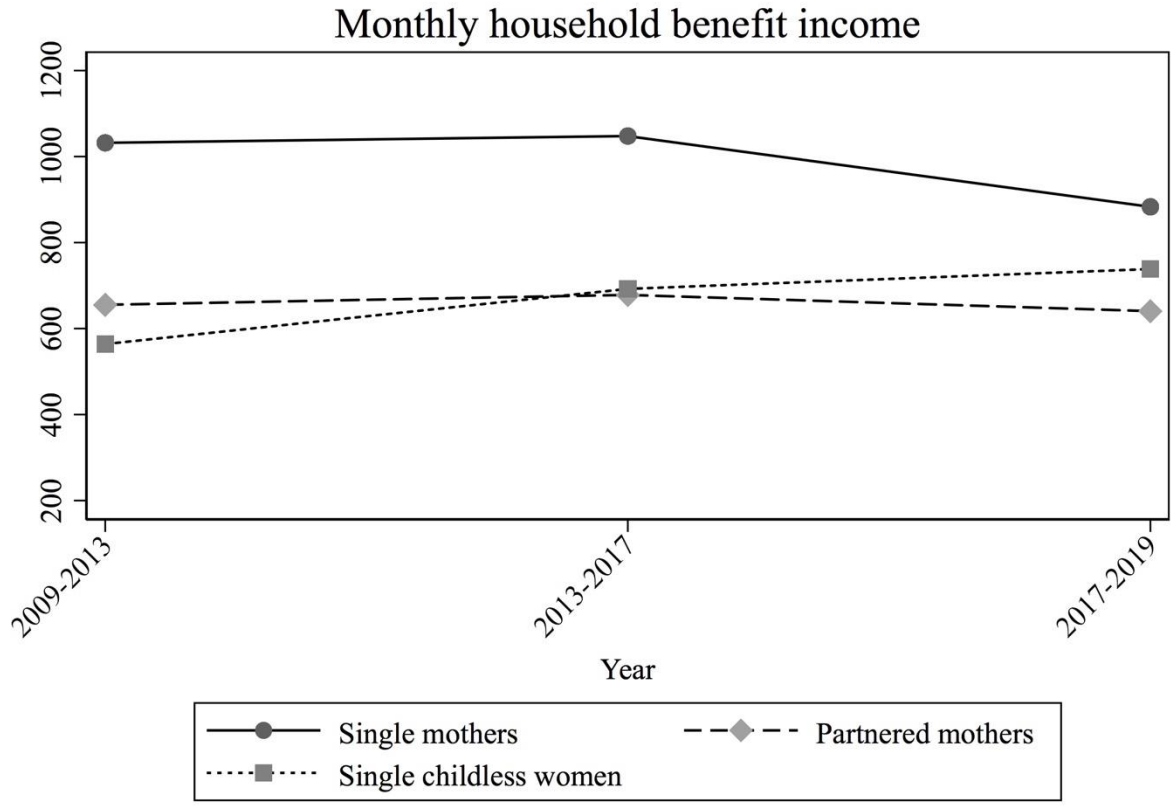

Figure 6 Trends in benefit income

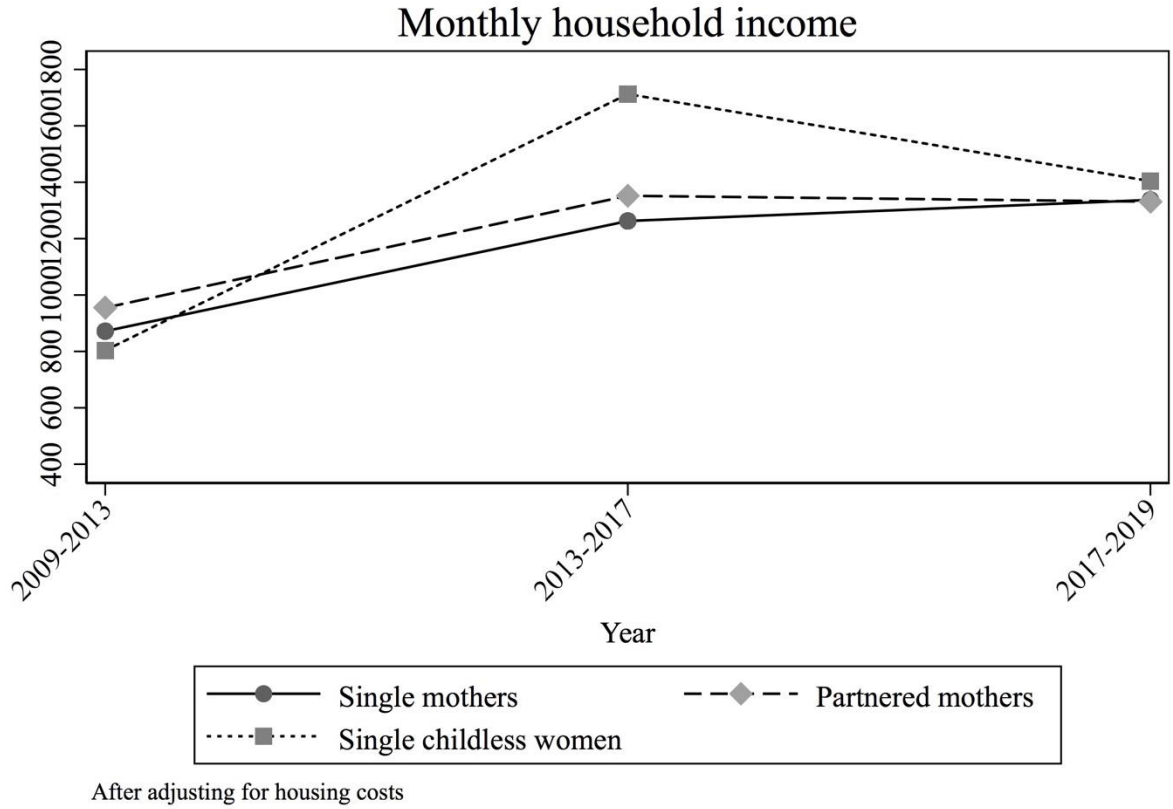

Figure 7 Trends in household income (AHC)

Employment

In line with national data suggesting increasing employment rates for women between 2010 and 2018 (Bell and Gardiner, 2019), Figure 8 below shows increasing employment rates across all three comparison groups: employment increased from 28% to 56% for single mothers, from 29% to 42% for partnered mothers, and from 41% to 54% for single childless women.

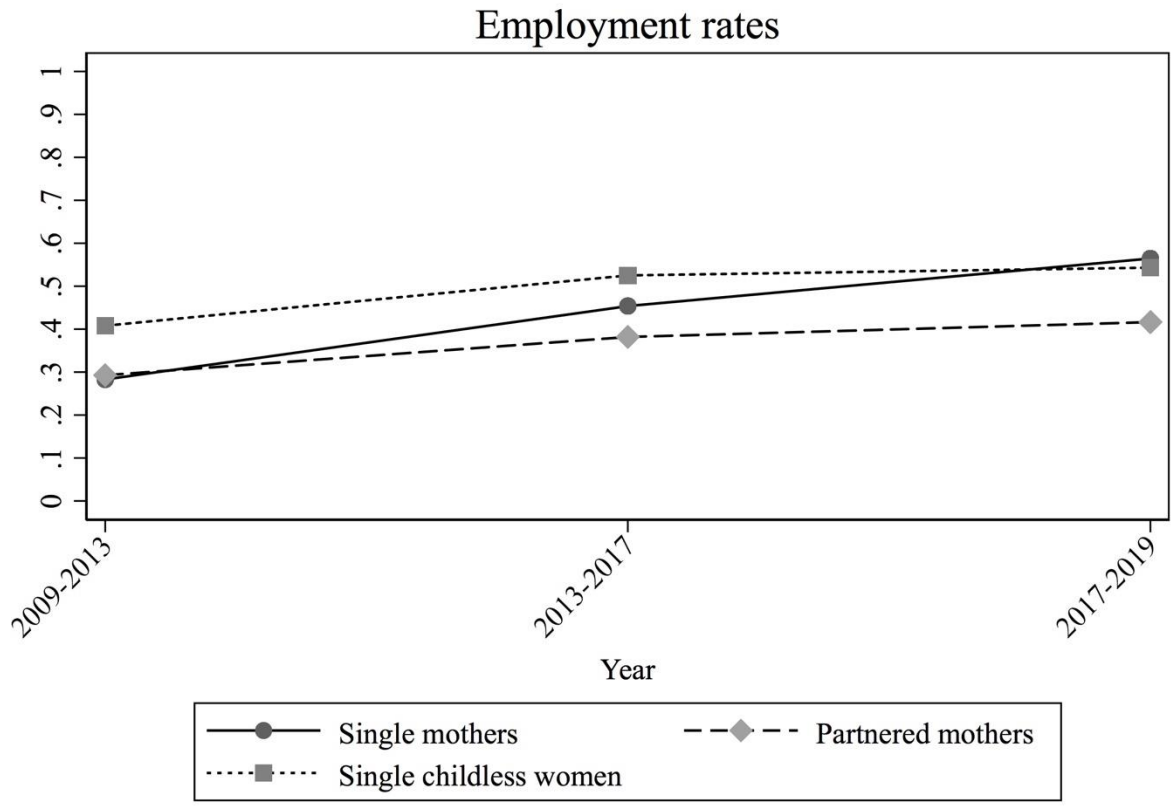

Figure 8 Employment rates

Among those in work, average weekly job hours increased for single and partnered mothers (from 22.0 to 23.9 and from 22.5 to 25.7 respectively), as shown in Figure 9. For single childless women, however, the increase was lower with hours rising from 29.0 before the first round of reforms to 29.7 after the second round of reforms.

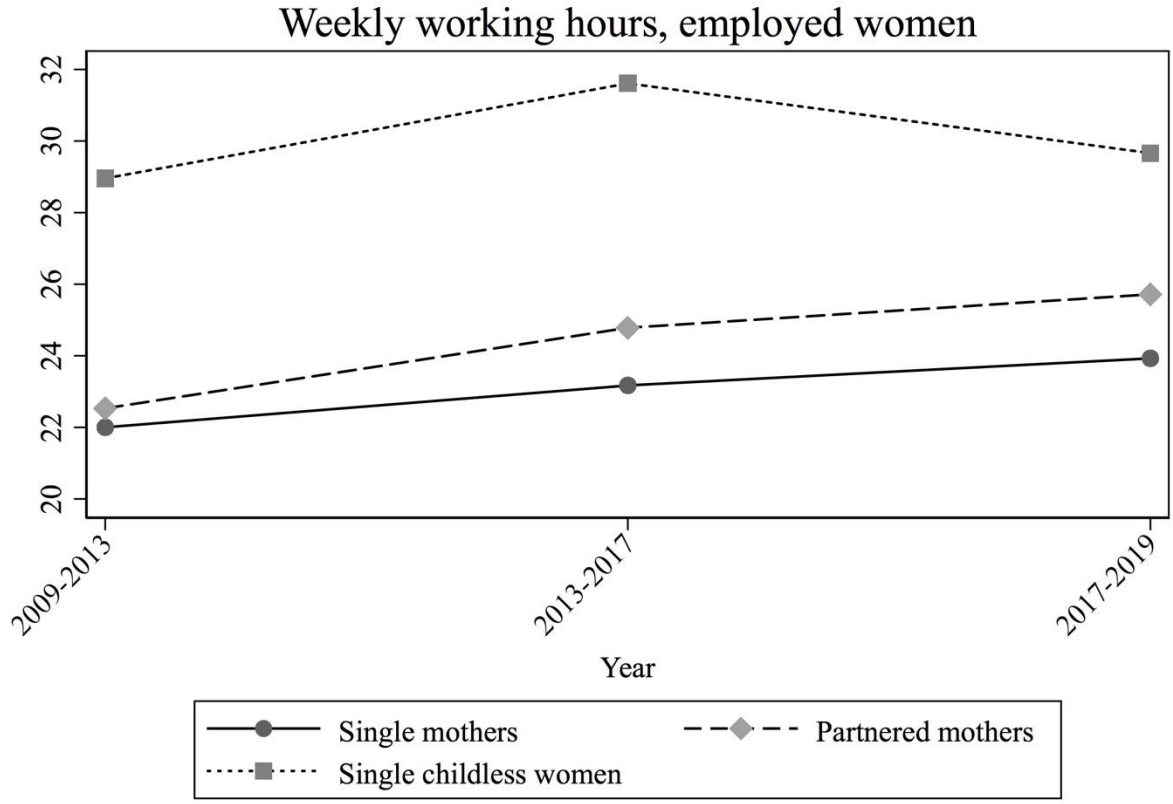

Figure 9 Weekly work hours

Statistical analyses

Selection model

We report two sets of results for our selection models: one for random effects models, and one for fixed effects Mundlak (in the case of Probit). The results from the Mundlak test are presented in Appendix C suggest that the Mundlak method (or the fixed effects method) is the preferred estimation method. Separate models are presented for each of the three comparison groups as well as for the two mental health outcomes.

Tables 2 and 3 below illustrate the results of the employment equations for GHQ and SF-12 respectively. Across all models and comparison groups, our results suggest that benefit income is negatively associated with the probability of being employed whereas mental health, as measured by either GHQ-12 or SF-12, is positively associated with being employed. Full results are presented in Appendix D.

Table 2 Heckman selection model, stage 1 (GHQ-12 measure)

	Single Mothers*		**Partnered Mothers**		**Single childless**	
	Probit RE dy/dx	**Probit Mundlak dy/dx**	**Probit RE dy/dx**	**Probit Mundlak dy/dx**	**Probit RE dy/dx**	**Probit Mundlak dy/dx**
Log benefit income	-0.115***	-0.0733***	-0.0613***	-0.0328***	-0.158***	-0.109***
	(0.0137)	(0.0133)	(0.00872)	(0.00884)	(0.0117)	(0.0129)
GHQ-12	0.00846***	0.00785***	0.00493***	0.00379***	0.00975***	0.00596***
	(0.00114)	(0.00130)	(0.000992)	(0.00109)	(0.00136)	(0.00151)
Observations	3884	3884	4928	4928	2256	2256

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
*Controlling for education, age, age squared, region, number of children, age of the youngest child

Table 3 Heckman selection model, stage 1 (SF-12 measure)

	Single Mothers*		**Partnered Mothers**		**Single childless**	
	Probit RE dy/dx	**Probit Mundlak dy/dx**	**Probit RE dy/dx**	**Probit Mundlak dy/dx**	**Probit RE dy/dx**	**Probit Mundlak dy/dx**
Log benefit income	-0.115***	-0.0731***	-0.0610***	-0.0348***	-0.154***	-0.107***
	(0.0133)	(0.0129)	(0.00827)	(0.00838)	(0.0115)	(0.0123)
SF-12	0.00325***	0.00291***	0.00202***	0.00138**	0.00525***	0.00377***
	(0.000588)	(0.000699)	(0.000538)	(0.000600)	(0.000708)	(0.000848)
Observations	4041	4041	5176	5176	2327	2327

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
*Controlling for education, age, age squared, region, number of children, age of the youngest child

The results of job hours regression controlling for selection are illustrated in Tables 4 and 5 for GHQ and SF-12 respectively. The statistically significant IMR suggests that selection into employment matters. The negative coefficient of the IMR implies that the hours offered are lower than those observed, i.e. below average job hour offers tend to be accepted and become observed hours, but above average hours are not, suggesting that not controlling for selection would cause a downward bias on our results.

We can see a negative relationship between benefit income and job hours across all three groups. In the fixed effects specification, there is no significant association between mental health and job hours for either the GHQ-12 or SF-12 measure for single mothers. For the two comparison groups, however, the results are slightly more mixed. For partnered mothers, there is a negative association between job hours and mental health for the GHQ-12 measure, however, not for SF-12. For single childless women, the mental health coefficients are also negative but slightly greater than for the other two groups, however, the association is not significant for the SF-12 measure.

Overall, the selection model results suggest that, while there is a positive association between the probability of employment and mental health, controlling for selection and individual fixed effects, there is a negative association between higher job hours and mental health (but not statistically significant for single mothers). The lack of variation of job hours within individuals (i.e. job hours remained the same for 73% of person year observations for single mothers), may partially explain the non-significant results for this group. These findings are fairly consistent with the theoretical predictions.

Table 4 Association between job hours and GHQ-12, controlling for selection

	Single mothers*		Partnered mothers		Single childless	
	RE	**FE**	**RE**	**FE**	**RE**	**FE**
Log benefit income	-3.176***	-3.681***	-0.633**	-1.265***	-1.183***	-1.373**
	(0.476)	(0.458)	(0.258)	(0.298)	(0.400)	(0.680)
GHQ-12	-0.0699***	-0.0176	-0.0922***	-0.0768**	-0.185***	-0.0705*
	(0.0195)	(0.0358)	(0.0202)	(0.0304)	(0.0340)	(0.0379)
IMR	-6.622***	-5.780***	-6.723***	-6.735***	-6.099***	-5.242***
	(0.234)	(0.314)	(0.219)	(0.514)	(0.387)	(0.536)
Observations	3681	3681	4632	4632	2158	2158

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
*****Controlling for age, age squared, region, number of children, age of the youngest child

Table 5 Association between job hours and SF-12, controlling for selection

	Single mothers*		Partnered mothers		Single childless	
	RE	**FE**	**RE**	**FE**	**RE**	**FE**
Log benefit income	-3.124***	-3.620***	-0.584*	-1.105***	-1.138***	-1.404***
	(0.440)	(0.497)	(0.305)	(0.324)	(0.431)	(0.427)
SF-12	-0.0343**	-0.00843	-0.0336***	-0.0237	-0.0978***	-0.0405
	(0.0138)	(0.0215)	(0.0119)	(0.0153)	(0.0242)	(0.0278)
IMR	-6.799***	-6.057***	-6.312***	-6.540***	-6.093***	-4.992***
Observations	3833	3833	4873	4873	2227	2227

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
*****Controlling for education, age, age squared, region, number of children, age of the youngest child

Difference-in-difference models

Tables 6 and 7 below illustrate the results from our difference-in-difference regression models. Full results are presented in Appendix E; an exploration of the validity of the parallel trends assumption is presented in Appendix F. The non-significant interactions between pre-reform years and comparison group dummies for both GHQ-12 and SF-12 suggest that parallel trends assumption is likely to hold. However, the results should still be interpreted with caution.

As we can see in Table 6, relative to partnered mothers, there has been a significant decrease in the mental health of single mothers following both of the reform implementation dates (post April 2013 and post April 2017) for GHQ-12 but not for the SF-12 measure. The effect was larger following the second round of reforms with a decrease of 1.96 (95% CI [-2.96, -0.95]) in GHQ-12 scores compared to a decrease of 0.94 [-1.57, -0.30] following the first round of reforms, corresponding to approximately -0.28 and -0.14 standard deviations (s.d.) where a 'small' meaningful effect is considered to be at least -0.2 (Cohen, 1988).

Table 6 Difference-in-difference results, comparison group: partnered mothers

	GHQ-12	SF-12
After April 2013 and before 2017 X Single mother	-0.939***	-0.158
	(0.324)	(0.502)
After April 2017 X Single mother	-1.955***	-0.982
	(0.515)	(0.778)
Observations	8273	8666

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7 shows the difference-in-difference results where the comparison group is single childless women. Relative to this comparison group, the coefficient associated with the first round of reforms is not statistically significant. The coefficient for the second round of reforms, on the other hand, is greater (-1.79 [-3.34, -0.23]) – corresponding to -0.26 s.d. - and significant at 5% level suggesting that mental health of single mothers has declined following the second reform period.

Overall, the results suggest that mental health measured by GHQ-12 of single mothers relative to each of the two comparison groups has declined. However, these results do not hold for SF-12.

Table 7 Difference in difference results, comparison: single childless women

	GHQ-12	SF-12
Single mother X After April 2013 and before 2017	-0.438	0.352
	(0.483)	(0.715)
Single mother X After April 2017	-1.788**	-1.519
	(0.792)	(1.177)
Observations	5809	6028

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

As a robustness check on our findings, we re-estimated the results with alternative reform dates. This analysis is shown Appendix G. We found some significant results for an alternative date of March 2016 providing further support that the difference-in-difference results should be interpreted with caution.

Discussion

Over the past decade the UK social security system has undergone a series of contractionary social security reforms. These reforms have particularly affected low-income single mothers. We explore how these reforms have impacted on the labour supply and subsequently mental health of single mothers compared to low income partnered mothers and low-income childless women. Next, we investigate how these welfare changes have impacted on mental health inequalities between these three groups. Our results provide mixed support for the time allocation theoretical framework (Becker 1965; Gronau, 1977). After a decrease in the budget constraint, women substitute their time from non-market work and leisure to paid employment. Being employed is associated with better health which goes against our theoretical predictions. This may stem from the increases in minimum wage over the period (LPC, 2019), or factors such as childcare costs, changing the financial benefits of work which are not considered in our simple model. However, an increase in work hours is associated with worsening mental health when health is measured by GHQ, though the fixed effects results are not significant for single mothers. These findings provide some support for our theoretical predictions and are consistent with the small evidence base suggesting that employment, or working longer hours, may deliver few mental health benefits for single mothers (Ali and Avison, 1997; Baker *et al.*, 1999).

There are a few explanations for the non-significant finding for hours worked for single women. Only 27% of single mothers in our sample changed their hours worked. There might have not been enough variation in hours worked within individuals to detect a significant association with mental health. To add further support to this, approximately 44% of single mothers still did not participate in the labour market by the end of the study period. This is consistent with research that has shown that because of increases in benefit conditionality, single mothers and others with high barriers to entering the labour market switched to disability benefits rather than increased their employment. (Avram et al., 2018; Basu et al., 2016).

We found some evidence to suggest that the period of welfare reform is associated with worsening mental health of low-income single mothers compared to low income partnered mothers and low-income childless women. This is in line with previous public health research evaluating specific welfare policy changes which has found the reforms have led to significant decreases in mental health of those affected (Katikireddi *et al.*, 2018; Reeves *et al.*, 2020; Wickham *et al.*, 2020).

Our findings help to put some of the public health research on welfare reform into context. The mental health decreases may have stemmed from a changing budget constraint from reduced benefit income changing the cost of paid employment. Although increases in the minimum wage from 2010 may have further incentivised paid work (LPC, 2019), there are still significant barriers to work particularly affecting single mothers which may have led to decreases in mental health. For example, childcare costs in the UK are the third highest among OECD countries (OECD, 2021) and childcare costs and availability are major contributing factors to maternal employment decisions. A Centre for Public Policy report has found that employment rates are 11 percentage points higher in parts of the UK where local childcare options are more readily available (Franklin and Hochlaf, 2021). Childcare availability is also a likely factor impacting on the relationship between employment and mental health, as was shown by a study by Harkness and Skipp (2013). They found that an extension of formal childcare following legislation in 1999 reduced the risk of depression of single mothers working full time.

Reductions in childcare support following the 2013 changes to working tax credits may have contributed to the relatively low working hours among single mothers and therefore potentially impacted on their mental health.

In conclusion, our research suggests that to improve the health and economic well-being of single mothers by incentivising employment, additional measures should be in place to facilitate this move to employment and working a higher number of hours. One option could be universal free childcare for all children aged 3 and 4.

References

Adams, P., Hurd, M.D., McFadden, D., Merrill, A. and Ribeiro, T. (2003) 'Healthy, wealthy, and wise? Tests for direct causal paths between health and socioeconomic status', *Journal of Econometrics*, 112(1), pp. 3-56.

Ali, J. and Avison, W.R. (1997) 'Employment transitions and psychological distress: The contrasting experiences of single and married mothers', *Journal of Health and Social Behavior*, pp. 345-362.

Angrist, J.D., Angrist, J.D. and Jörn-Steffen, P. (2008) *Mostly harmless econometrics: An empiricist's companion*. New Jersey: New Jersey: Princeton University Press.

APPG (2021) 'Five years on: the health effects of the 2016 Welfare Reform and Work Act on Children and Disabled People'. Available at: https://debbieabrahams.org.uk/wp-content/uploads/2021/02/210221_HIAP-A4-Report-Debbie-Abrahams.pdf (Accessed: 01/09/2021).

Autor, D.H. (2003) 'Outsourcing at will: The contribution of unjust dismissal doctrine to the growth of employment outsourcing', *Journal of labor economics*, 21(1), pp. 1-42.

Avram, S., Brewer, M. and Salvatori, A. (2018) 'Can't work or won't work: Quasi-experimental evidence on work search requirements for single parents', *Labour Economics*, 51, pp. 63-85.

Baker, D., North, K. and Team, A.S. (1999) 'Does employment improve the health of lone mothers?', *Social Science & Medicine*, 49(1), pp. 121-131.

Barrett, R. (2010) 'Disadvantaged groups in the labour market', *Economic & Labour Market Review*, 4(6), pp. 18-24.

Basu, S., Rehkopf, D.H., Siddiqi, A., Glymour, M.M. and Kawachi, I. (2016) 'Health Behaviors, Mental Health, and Health Care Utilization Among Single Mothers After Welfare Reforms in the 1990s', *American Journal of Epidemiology*, 183(6), pp. 531-538.

Becker, G.S. (1965) 'A Theory of the Allocation of Time', *The economic journal*, pp. 493-517.

Bell, T. and Gardiner, L. (2019) *Feel Poor, Work More* Resolution Foundation.

Billari, F.C. and Borgoni, R. (2005) 'Assessing the use of sample selection models in the estimation of fertility postponement effects', *Statistical Methods and Applications*, 14(3), pp. 389-402.

Blundell, R. and Hoynes, H. (2003) 'Has "In-Work" Benefit Reform Helped the Labour Market? '. Available at: https://www.ucl.ac.uk/~uctp39a/blundell-hoynes2-3-03.pdf (Accessed: 24/10/2021).

Bound, J. (1991) 'Self-Reported Versus Objective Measures of Health in Retirement Models', *The Journal of Human Resources*, 26(1), pp. 106-138.

Bound, J., Schoenbaum, M., Stinebrickner, T.R. and Waidmann, T. (1999) 'The dynamic effects of health on the labor force transitions of older workers', *Labour Economics*, 6(2), pp. 179-202.

Bourqin, P., Keiller, AN., Waters, T. (2019) *The distributional impact of personal tax and benefit reforms, 2010 to 2019*. Available at: https://www.ifs.org.uk/election/2019/article/the-distributional-impact-of-personal-tax-and-benefit-reforms-2010-to-2019.

Campbell, M., Thomson, H., Fenton, C. and Gibson, M. (2016) 'Lone parents, health, wellbeing and welfare to work: a systematic review of qualitative studies', *BMC Public Health*, 16, p. 188.

Cohen, J. (1988) *Statistical power analysis for the behavioral sciences*. 2nd ed.. edn. Hillsdale, N.J.: Hillsdale, N.J. : L. Erlbaum Associates.

CPAG (2021) *Measuring Poverty Based on Income*.

Cribb, J., Keiller, A. and Waters, T. (2018) 'Living standards, poverty and inequality in the UK: 2018'. IFS. Available at: https://ifs.org.uk/uploads/R145%20for%20web.pdf (Accessed: 01/09/2021).

De Agostini, P., Hills, J. and Sutherland, H. (2018) 'Were We Really All in it Together? The Distributional Effects of the 2010–15 UK Coalition Government's Tax-benefit Policy Changes', *Social Policy & Administration*, 52(5), pp. 929-949.

Department for Work and Pensions (2017) *Households Below Average Income (HBAI) Quality and Methodology Information Report*

DWP (2016) *Improving Lives: The Work, Health and Disability Green Paper* London: DWP.

Francis-Devine, B. (2021) *Poverty in the UK: statistics*.

Franklin, B. and Hochlaf, D. (2021) 'Women in the labour market'. Centre for Progressive Policy. Available at: https://www.progressive-policy.net/publications/women-in-the-labour-market-2 (Accessed: 17/11/2021).

Frijters, P., Johnston, D.W. and Shields, M.A. (2014) 'THE EFFECT OF MENTAL HEALTH ON EMPLOYMENT: EVIDENCE FROM AUSTRALIAN PANEL DATA', *Health Economics*, 23(9), pp. 1058-1071.

Fryer, D. (1986) 'Employment deprivation and personal agency during unemployment: A critical discussion of Jahoda's explanation of the psychological effects of unemployment', *Social Behaviour*, 1(1), pp. 3-23.

Gibson, M., Thomson, H., Banas, K., Lutje, V., McKee, M.J., Martin, S.P., Fenton, C., Bambra, C. and Bond, L. (2018) 'Welfare-to-work interventions and their effects on the mental and physical health of lone parents and their children', *Cochrane Database of Systematic Reviews*, 2018(2).

Gingerbread (2018) 'One in four: a profile of single parents in the UK'. Available at: https://www.gingerbread.org.uk/wp-content/uploads/2018/02/One-in-four-a-profile-of-single-parents-in-the-UK.compressed.pdf (Accessed: 22/10/2021).

Greene, W.H. (2003) *Econometric analysis*. Pearson Education India.

Gregg, P., Harkness, S. and Smith, S. (2009) 'Welfare Reform and Lone Parents in the UK', *Economic Journal*, 119(535), pp. F38-F65.

Gronau, R. (1977) 'Leisure, home production, and work--the theory of the allocation of time revisited', *Journal of political economy*, 85(6), pp. 1099-1123.

Gronau, R. (1980) 'Home production--a forgotten industry', *The Review of Economics and Statistics*, pp. 408-416.

Harkness, S. and Skipp, A. (2013) 'Lone mothers, work and depression'. Nuffield Foundation London. Available at: https://www.nuffieldfoundation.org/wp-content/uploads/2013/12/Lone-mothers-work-and-depression.pdf (Accessed: 17/11/2021).

Harkness, S. (2016) 'The Effect of Employment on the Mental Health of Lone Mothers in the UK Before and After New Labour's Welfare Reforms', *Social Indicators Research*, 128(2), pp. 763-791.

He, G. and Wang, S. (2017) 'Do college graduates serving as village officials help rural China?', *American Economic Journal: Applied Economics*, 9(4), pp. 186-215.

Hobson, F. (2020) 'The aims of ten years of welfare reform (2010-2020)' *Briefing paper No. 9090*. House of Commons Library. Available at: https://researchbriefings.files.parliament.uk/documents/CBP-9090/CBP-9090.pdf (Accessed: 01/09/2021).

Jackle, A., Al Baghal, T., Burton, J., Kaminska, O. and Lynn, P. (2019) *Understanding Society: The UK Household Longitudinal Study Innovation Panel, Waves 1-11, User Manual* University of Essex: Institute for Social and Economic Research

Jahoda, M. (1982) *Employment and unemployment : a social-psychological analysis*. Cambridge: Cambridge : Cambridge University Press.

Jaumotte, F. (2004) 'Labour force participation of women: Empirical evidence on the role of policy and other determinants in OECD countries', *OECD Economic studies*, 2003(2), pp. 51-108.

Joyce, R. and Sibieta, L. (2013) 'An assessment of Labour's record on income inequality and poverty', *Oxford Review of Economic Policy*, 29(1), pp. 178-202.

JRF (2020) 'Women should not be held back because of the vital care they provide'. Available at: https://www.jrf.org.uk/blog/women-should-not-be-held-back-because-vital-care-they-provide (Accessed: 24/10/2021).

Katikireddi, S.V., Molaodi, O.R., Gibson, M., Dundas, R. and Craig, P. (2018) 'Effects of restrictions to Income Support on health of lone mothers in the UK: a natural experiment study', *The Lancet Public Health*, 3(7), pp. e333-e340.

Longhi, S. and Nandi, A. (2014) *A practical guide to using panel data*. Sage.

LPC (2019) '20 years of the National Minimum Wage: A history of the UK minimum wage and its effects'. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/790910/20_years_of_the_National_Minimum_Wage__a_history_of_the_UK_minimum_wage_and_its_effects.pdf (Accessed: 29/11/2021).

Lund, C., Brooke-Sumner, C., Baingana, F., Baron, E.C., Breuer, E., Chandra, P., Haushofer, J., Herrman, H., Jordans, M., Kieling, C., Medina-Mora, M.E., Morgan, E., Omigbodun, O., Tol, W., Patel, V. and Saxena, S. (2018) 'Social determinants of mental disorders and the Sustainable Development Goals: a systematic review of reviews', *The Lancet Psychiatry*, 5(4), pp. 357-369.

Lupton, R. and Burchardt, T. (2016) *Social policy in a cold climate: Policies and their consequences since the crisis*. Policy Press.

Millar, J. (2019) 'Self-Responsibility and Activation for Lone Mothers in the United Kingdom', *American Behavioral Scientist*, 63(1), pp. 85-99.

Narain, K., Bitler, M., Ponce, N., Kominski, G. and Ettner, S. (2017) 'The impact of welfare reform on the health insurance coverage, utilization and health of low education single mothers', *Social Science & Medicine*, 180, pp. 28-35.

OECD (2021) 'Net childcare costs'. Available at: https://data.oecd.org/benwage/net-childcare-costs.htm (Accessed: 17/11/2021).

ONS (2019) 'Families and the labour market, UK: 2019'. Available at: https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/articles/familiesandthelabourmarketengland/2019 (Accessed: 30/11/2021).

ONS (2021a) 'Inflation and price indices'. Available at: https://www.ons.gov.uk/economy/inflationandpriceindices (Accessed: 17 December 2021).

ONS (2021b) 'Families and households in the UK: 2020'. Available at: https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/families/bulletins/familiesandhouseholds/2020 (Accessed: 12/11/2021).

Paul, K.I. and Moser, K. (2009) 'Unemployment impairs mental health: Meta-analyses', *Journal of Vocational Behavior*, 74(3), pp. 264-282.

Reed, H. (2020) 'The Distributional Impact of Tax and Social Security Reforms in the UK from 2010 to 2017', *Social Policy and Society*, 19(3), pp. 470-486.

Reeves, A., Fransham, M., Stewart, K. and Patrick, R. (2020) *Did the introduction of the benefit cap in Britain harm mental health? A natural experiment approach*. Centre for Analysis of Social Exclusion.

SMC (2020) 'Measuring poverty'. 15//11/2021. Available at: https://socialmetricscommission.org.uk/wp-content/uploads/2020/06/Measuring-Poverty-2020-Web.pdf.

Snyder, C. and Nicholson, W. (2012) *Microeconomic theory : basic principles and extensions*. 11th edn. Australia: Australia
United Kingdom : South-Western Cengage Learning.

Steele, F., French, R. and Bartley, M. (2013) 'Adjusting for selection bias in longitudinal analyses using simultaneous equations modeling: the relationship between employment transitions and mental health', *Epidemiology*, pp. 703-711.

Targosz, S., Bebbington, P., Lewis, G., Brugha, T., Jenkins, R., Farrell, M. and Meltzer, H. (2003) 'Lone mothers, social exclusion and depression', *Psychological medicine*, 33(4), pp. 715-722.

University of Essex (2020) ' Understanding Society: Waves 1-10, 2009-2019 and Harmonised BHPS: Waves 1-18, 1991-2009. ' UK Data Service. Kantar Public: UK Data Service.

Verbeek, M. and Nijman, T. (1992) 'Testing for selectivity bias in panel data models', *International Economic Review*, pp. 681-703.

Vilagut, G., Forero, C.G., Pinto-Meza, A., Haro, J.M., De Graaf, R., Bruffaerts, R., Kovess, V., De Girolamo, G., Matschinger, H. and Ferrer, M. (2013) 'The mental component of the short-form 12 health survey (SF-12) as a measure of depressive disorders in the general population: results with three alternative scoring methods', *Value in Health*, 16(4), pp. 564-573.

Wickham, S., Bentley, L., Rose, T., Whitehead, M., Taylor-Robinson, D. and Barr, B. (2020) 'Effects on mental health of a UK welfare reform, Universal Credit: a longitudinal controlled study', *The Lancet Public Health*, 5(3), pp. e157-e164.

Women's Budget Group (2017) 'Austerity is reducing social security for women'. Available at: https://wbg.org.uk/wp-content/uploads/2017/11/soc-security-pre-budget-nov-2017-final.pdf (Accessed: 21/10/2021).

Wooldridge, J. (2021) 'Two-Way Fixed Effects, the Two-Way Mundlak Regression, and Difference-in-Differences Estimators', *Available at SSRN 3906345*.

Wooldridge, J.M. (2010) *Econometric analysis of cross section and panel data*. MIT press.

Appendix A: Sample Attrition

Table A1 *Single mothers, mental health outcome: GHQ-12*

Wave	No. Individuals	Drop-outs	Re-joiners	Survival rate	Raw attrition	Net attrition
1	812					
2	553	339	80	68%	42%	32%
3	473	180	100	58%	33%	14%
4	412	114	53	51%	24%	13%
5	338	100	26	42%	24%	18%
6	288	90	40	35%	27%	15%
7	259	57	28	32%	20%	10%
8	225	48	14	28%	19%	13%
9	168	65	8	21%	29%	25%
10	130	46	8	16%	27%	23%

Table A2 *Single mothers, mental health outcome: SF-12*

Wave	No. Individuals	Drop-outs	Re-joiners	Survival rate	Raw attrition	Net attrition
1	812					
2	553	339	80	68%	42%	53%
3	473	180	100	58%	33%	0.03%
4	412	114	53	51%	24%	12%
5	338	100	26	42%	24%	18%
6	288	90	40	35%	27%	15%
7	259	57	28	32%	20%	10%
8	225	48	14	28%	19%	13%
9	168	65	8	21%	29%	25%
10	130	46	8	16%	27%	27%

Item non-response to questions related to socio-demographic characteristics, employment and mental health (GHQ-12/SF-12) questions are controlled for in the table.

Appendix B: Testing for attrition

Single mothers

Table B1 *Verbeek Nijman test for attrition, single mothers*

		GHQ-12		**SF-12**	
Wald test for attrition		Random Effects	Mundlak	Random Effects	Mundlak
Number of waves individual is present	Chi2(1)	0.70	0.01	0.62	0.00
	P>Chi2>	0.4044	0.9212	0.4325	0.9767
If individual is present in all waves	Chi2(1)	0.22	0.05	0.11	0.47
	P>Chi2>	0.6418	0.8253	0.7435	0.4926
If individual is present in next wave	Chi2(1)	1.46	1.17	1.67	1.34
	P>Chi2>	0.2272	0.2793	0.1962	0.2463

Controlling for age, age sq, job hours, log benefit income, ethnicity, education, region, tenure, number of children, age of the youngest child, interview year.

The null hypothesis of no attrition cannot be rejected – evidence of no attrition bias under either RE or Mundlak estimation methods.

Partnered mothers

Table B2 *Verbeek Nijman test for attrition , partnered mothers*

		GHQ-12		**SF-12**	
Wald test for attrition		Random Effects	Mundlak	Random Effects	Mundlak
Number of waves individual is present	Chi2(1)	2.84	2.84	0.22	0.33
	P>Chi2>	0.0919	0.0920	0.6424	0.5646
If individual is present in all waves	Chi2(1)	0.68	0.59	0.03	0.02
	P>Chi2>	0.4085	0.4420	0.8615	0.8993

If individual is present in next wave	Chi2(1)	0.92	0.83	0.44	0.42
	P>Chi2>	0.3384	0.3624	0.5051	0.5184

Controlling for age, age sq, job hours, log benefit income, ethnicity, education, region, tenure, number of children, age of the youngest child, interview year.

The null hypothesis of no attrition cannot be rejected – evidence of no attrition bias under either RE or Mundlak estimation methods.

Single childless women

Table B3 *Verbeek Nijman test for attrition single childless women*

		GHQ-12		**SF-12**	
Wald test for attrition		Random Effects	Mundlak	Random Effects	Mundlak
Number of waves individual is present	Chi2(1)	1.17	0.77	0.50	0.26
	P>Chi2>	0.2798	0.3796	0.4799	0.6106
If individual is present in all waves	Chi2(1)	0.83	0.37	0.08	0.00
	P>Chi2>	0.3613	0.5456	0.7754	0.9741
If individual is present in next wave	Chi2(1)	2.10	1.57	0.35	0.15
	P>Chi2>	0.1475	0.2095	0.5518	0.7026

Controlling for age, age sq, job hours, log benefit income, ethnicity, education, region, tenure, interview year.

The null hypothesis of no attrition cannot be rejected – evidence of no attrition bias under either RE or Mundlak estimation methods.

Appendix C: Mundlak test results

The test assesses whether the panel-level means generated in stage 1 selection model Mundlak method are jointly zero. We cannot reject the null hypothesis, suggesting that the Mundlak method is preferred over the Random effects method. It is assumed the same holds for stage 2.

Table C1 *Mundlak test results*

	Wald test	**GHQ-12**	**SF-12**
Single mothers	Chi2(30)	130.44	134.28
	P>Chi2>	0.0000	0.0000
Partnered mothers	Chi2(30)	109.17	112.60
	P>Chi2>	0.0000	0.0000
Single childless	Chi2(25)	50.51	47.04
	P>Chi2>	0.0000	0.0000

Appendix D: Selection model, full results

Table D1 *Selection equation, GHQ-12 measure*

	Single mothers		Partnered mothers		Single childless	
	RE Probit	**Mundlak Probit**	**RE Probit**	**Mundlak Probit**	**RE Probit**	**Mundlak Probit**
Log benefit income	-0.115***	-0.0733***	-0.0613***	-0.0328***	-0.158***	-0.109***
	(0.0137)	(0.0133)	(0.00872)	(0.00884)	(0.0117)	(0.0129)
GHQ-12	0.00846***	0.00785***	0.00493***	0.00379***	0.00975***	0.00596***
	(0.00114)	(0.00130)	(0.000992)	(0.00109)	(0.00136)	(0.00151)
Age	0.0451***	0.0662***	0.0478***	0.0778***	0.0192***	0.0518***
	(0.00957)	(0.0175)	(0.00929)	(0.0142)	(0.00591)	(0.0200)
Age squared	-0.000507***	-0.000417*	-0.000620***	-0.000830***	-0.000162**	-0.000445**
	(0.000128)	(0.000240)	(0.000121)	(0.000191)	(0.0000716)	(0.000198)
Age of youngest child in HH	0.0253***	0.0224***	0.0210***	0.0143***	-	-
	(0.00286)	(0.00386)	(0.00242)	(0.00299)	-	-
One	0	0	0	0	-	-
	(.)	(.)	(.)	(.)	-	-
Two	-0.0192	-0.0453*	-0.00673	-0.0320	-	-
	(0.0186)	(0.0248)	(0.0188)	(0.0217)	-	-
Three or more	-0.0443	-0.0980**	-0.0455*	-0.0704**	-	-
	(0.0283)	(0.0408)	(0.0240)	(0.0305)	-	-
London	0	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)	(.)
North east and west	0.0342	0.00186	0.0527	0.0371	-0.0307	-0.0308
	(0.0372)	(0.0342)	(0.0345)	(0.0328)	(0.0428)	(0.0386)
Midlands	0.0686**	0.0266	0.00676	-0.00601	-0.0650	-0.0642*
	(0.0304)	(0.0300)	(0.0284)	(0.0275)	(0.0409)	(0.0352)
East	0.102**	0.0569	0.0552	0.0308	-0.0264	-0.0331
	(0.0459)	(0.0411)	(0.0376)	(0.0352)	(0.0526)	(0.0498)
South	0.0695**	0.0457	0.0460	0.0165	-0.0368	-0.0455
	(0.0348)	(0.0350)	(0.0328)	(0.0313)	(0.0418)	(0.0382)
Wales	0.0265	-0.0176	0.0816	0.0673	-0.0522	-0.0491
	(0.0593)	(0.0546)	(0.0640)	(0.0624)	(0.0571)	(0.0507)
Scotland	-0.0214	-0.0375	-0.0258	-0.0426	-0.00493	-0.0130
	(0.0407)	(0.0417)	(0.0558)	(0.0509)	(0.0499)	(0.0453)
NI	0.0646	0.0120	0.113**	0.0890	-0.0877	-0.0895*
	(0.0687)	(0.0649)	(0.0574)	(0.0574)	(0.0561)	(0.0496)
Degree or higher	0	0	0	0	0	0

	(.)	(.)	(.)	(.)	(.)	(.)
GCSE, A-levels or equivalent	-0.0988***	-0.132	-0.127***	-0.165**	-0.0943**	-0.469***
	(0.0282)	(0.0833)	(0.0242)	(0.0659)	(0.0389)	(0.101)
Below GCSE or other	-0.248***	-0.0556	-0.336***	-0.207**	-0.257***	-0.586***
	(0.0348)	(0.115)	(0.0277)	(0.0873)	(0.0416)	(0.103)
mean_log_benefit_inc		-0.172***		-0.120***		-0.0879***
		(0.0282)		(0.0156)		(0.0194)
mean_ghq		0.00322		0.00545**		0.00607***
		(0.00225)		(0.00233)		(0.00235)
mean_two_children		0.0707*		0.0462		-
		(0.0374)		(0.0382)		-
mean_three_children		0.0148		0.0201		-
		(0.0588)		(0.0465)		-
mean_agechy		-0.00584		0.00631		-
		(0.00524)		(0.00474)		-
mean_a_levels		0.261***		0.198***		0.00511
		(0.0836)		(0.0719)		(0.0547)
mean_degree		0.181		0.106		-0.412***
		(0.114)		(0.0930)		(0.134)
mean_age		-0.0353*		-0.0606***		-0.0343
		(0.0209)		(0.0181)		(0.0217)
mean_age_sq		0.0000236		0.000518**		0.000300
		(0.000286)		(0.000240)		(0.000220)
Observations	3884	3884	4928	4928	2256	2256

Table D2 *Selection equation, SF-12 measure*

	Single mothers		**Partnered mothers**		**Single childless**	
	RE Probit	**Mundlak Probit**	**RE Probit**	**Mundlak Probit**	**RE Probit**	**Mundlak Probit**
Log benefit income	-0.115***	-0.0731***	-0.0610***	-0.0348***	-0.154***	-0.107***
	(0.0133)	(0.0129)	(0.00827)	(0.00838)	(0.0115)	(0.0123)
SF-12	0.00325***	0.00291***	0.00202***	0.00138**	0.00525***	0.00377***
	(0.000588)	(0.000699)	(0.000538)	(0.000600)	(0.000708)	(0.000848)
Age	0.0410***	0.0616***	0.0442***	0.0688***	0.0202***	0.0576***
	(0.00923)	(0.0172)	(0.00886)	(0.0133)	(0.00576)	(0.0185)
Age squared	-	-0.000354	-	-	-0.000171**	-
	0.000467***		0.000574***	0.000724***		0.000492***
	(0.000124)	(0.000237)	(0.000116)	(0.000178)	(0.0000703)	(0.000185)
Age of youngest child in HH	0.0254***	0.0222***	0.0209***	0.0149***	-	-
	(0.00277)	(0.00387)	(0.00227)	(0.00278)	-	-

One	0 (.)	0 (.)	0 (.)	0 (.)	- -	- -
Two	-0.0166 (0.0181)	-0.0388 (0.0253)	-0.00129 (0.0179)	-0.0236 (0.0205)	- -	- -
Three or more	-0.0355 (0.0271)	-0.0814** (0.0414)	-0.0406* (0.0226)	-0.0540* (0.0282)	- -	-
London	0 (.)	0 (.)	0 (.)	0 (.)	0 (.)	0 (.)
North east and west	0.0416 (0.0356)	0.0133 (0.0327)	0.0662** (0.0333)	0.0543* (0.0320)	-0.0128 (0.0420)	-0.0207 (0.0375)
Midlands	0.0655** (0.0291)	0.0302 (0.0284)	0.0165 (0.0263)	0.00304 (0.0257)	-0.0476 (0.0380)	-0.0508 (0.0325)
East	0.104** (0.0448)	0.0619 (0.0397)	0.0792** (0.0352)	0.0505 (0.0332)	-0.00377 (0.0493)	-0.0118 (0.0462)
South	0.0617* (0.0343)	0.0431 (0.0339)	0.0593* (0.0307)	0.0277 (0.0295)	-0.0220 (0.0400)	-0.0350 (0.0367)
Wales	0.0201 (0.0562)	-0.0190 (0.0523)	0.0874 (0.0613)	0.0707 (0.0599)	-0.0673 (0.0528)	-0.0741 (0.0468)
Scotland	-0.0223 (0.0401)	-0.0380 (0.0396)	0.00561 (0.0544)	-0.0114 (0.0496)	0.00364 (0.0458)	-0.00558 (0.0407)
NI	0.0485 (0.0666)	0.00127 (0.0617)	0.0944* (0.0531)	0.0735 (0.0523)	-0.0581 (0.0568)	-0.0646 (0.0510)
Degree or higher	0 (.)	0 (.)	0 (.)	0 (.)	0 (.)	0 (.)
GCSE, A-levels or equivalent	-0.105*** (0.0282)	-0.158* (0.0930)	-0.131*** (0.0230)	-0.169*** (0.0595)	-0.109*** (0.0408)	-0.478*** (0.0884)
Below GCSE or other	-0.260*** (0.0334)	-0.0921 (0.124)	-0.339*** (0.0254)	-0.237*** (0.0770)	-0.276*** (0.0426)	-0.596*** (0.0907)
mean_log_benefit_inc		-0.165*** (0.0265)		-0.108*** (0.0148)		-0.0902*** (0.0185)
mean_sf		0.00202 (0.00123)		0.00329*** (0.00124)		0.00267** (0.00129)
mean_two_children		0.0467 (0.0376)		0.0421 (0.0359)		
mean_three_children		-0.00869 (0.0583)		0.000722 (0.0437)		
mean_agechy		-0.00711 (0.00513)		0.00474 (0.00443)		
mean_a_levels		0.250***		0.164**		0.0121

		(0.0843)		(0.0650)		(0.0512)
mean_degree		0.148		0.0749		-0.407***
		(0.121)		(0.0838)		(0.119)
mean_age		-0.0321		-0.0476***		-0.0406**
		(0.0203)		(0.0167)		(0.0200)
mean_age_sq		-0.0000332		0.000365*		0.000352*
		(0.000279)		(0.000220)		(0.000203)
Observations	4041	4041	5176	5176	2327	2327

Table D3 *Job hours equation, GHQ-12 measure*

	Single mothers		Partnered mothers		Single childless	
	RE	**FE**	**RE**	**FE**	**RE**	**FE**
Log benefit income	-3.176***	-3.681***	-0.633**	-1.265***	-1.183***	-1.373**
	(0.476)	(0.458)	(0.258)	(0.298)	(0.400)	(0.680)
GHQ-12	-0.0699***	-0.0176	-0.0922***	-0.0768**	-0.185***	-0.0705*
	(0.0195)	(0.0358)	(0.0202)	(0.0304)	(0.0340)	(0.0379)
Age	-1.473***	-1.075**	-0.696***	-0.836*	-0.0873	-0.467
	(0.238)	(0.498)	(0.245)	(0.497)	(0.180)	(0.562)
Age squared	0.0179***	0.0137**	0.00896***	0.0100	0.00115	0.00509
	(0.00345)	(0.00634)	(0.00314)	(0.00614)	(0.00215)	(0.00560)
Age of youngest child in HH	-0.142**	-0.0430	-0.138**	-0.0584	-	-
	(0.0669)	(0.0896)	(0.0673)	(0.139)	-	-
One	0	0	0	0	-	-
	(0)	(0)	(0)	(0)	-	-
Two	-0.269	-0.00922	-0.111	0.569	-	-
	(0.483)	(0.691)	(0.454)	(0.604)	-	-
Three or more	0.786	0.649	1.933***	2.625***	-	-
	(0.631)	(1.164)	(0.522)	(0.801)	-	-
London	0	0	0	0	0	0
	(0)	(0)	(0)	(0)	(0)	(0)
North east and west	-1.039	4.109	-0.542	2.352	0.161	-0.291
	(0.955)	(10.28)	(0.917)	(9.596)	(1.125)	(14.96)
Midlands	-1.111*	1.345	0.920	7.519	-1.509	-21.95
	(0.656)	(7.455)	(0.723)	(12.54)	(1.396)	(15.05)
East	-2.468**	-3.977	-0.775	4.259	0.0371	2.026
	(1.068)	(4.690)	(1.201)	(5.014)	(1.771)	(11.01)
South	-1.901**	1.458	-0.283	6.093	0.285	8.280
	(0.784)	(4.585)	(1.039)	(6.841)	(1.272)	(13.13)
Wales	-0.216	0	-1.339	14.41*	-2.686	-28.85*
	(1.321)	(0)	(1.349)	(7.682)	(1.793)	(15.42)
Scotland	-0.0505	5.145	0.312	7.739	-1.007	0
	(0.737)	(10.25)	(1.568)	(12.52)	(1.489)	(0)
NI	-3.971***	0	-2.656*	0	1.485	0
	(1.031)	(0)	(1.412)	(0)	(1.258)	(0)
imr1	-6.622***	-5.780***	-6.723***	-6.735***	-6.099***	-5.242***
	(0.234)	(0.314)	(0.219)	(0.514)	(0.387)	(0.536)

Constant	70.30***	60.33***	36.88***	39.21***	31.73***	43.74***
	(4.935)	(11.35)	(4.485)	(11.00)	(4.160)	(16.48)
Observations	3681	3681	4632	4632	2158	2158

Table D4 *Job hours equation, SF-12 measure*

	Single mothers		**Partnered mothers**		**Single childless**	
	RE	**FE**	**RE**	**FE**	**RE**	**FE**
Log benefit income	-3.124***	-3.620***	-0.584*	-1.105***	-1.138***	-1.404***
	(0.440)	(0.497)	(0.305)	(0.324)	(0.431)	(0.427)
SF-12	-0.0343**	-0.00843	-0.0336***	-0.0237	-0.0978***	-0.0405
	(0.0138)	(0.0215)	(0.0119)	(0.0153)	(0.0242)	(0.0278)
Age	-1.476***	-1.127*	-0.584**	-0.603	-0.175	-0.386
	(0.238)	(0.603)	(0.248)	(0.392)	(0.158)	(0.433)
Age squared	0.0181***	0.0130	0.00733**	0.00709	0.00208	0.00420
	(0.00324)	(0.00802)	(0.00341)	(0.00500)	(0.00195)	(0.00414)
Age of youngest child in HH	-0.201***	-0.0878	-0.141*	-0.101	-	-
	(0.0689)	(0.0946)	(0.0720)	(0.0790)	-	-
One	0	0	0	0	-	-
	(0)	(0)	(0)	(0)	-	-
Two	-0.206	-0.0308	-0.421	0.222	-	-
	(0.519)	(0.779)	(0.394)	(0.473)	-	-
Three or more	0.805	0.604	1.519***	1.914***	-	-
	(0.710)	(1.025)	(0.574)	(0.561)	-	-
London	0	0	0	0	0	0
	(0)	(0)	(0)	(0)	(0)	(0)
North east and west	-1.355	3.237	-1.280	2.591	0.168	2.797
	(0.863)	(10.21)	(1.009)	(11.35)	(1.349)	(14.43)
Midlands	-1.379*	0.335	0.388	4.964	-1.124	-17.97
	(0.705)	(9.662)	(0.716)	(8.934)	(1.568)	(14.28)
East	-2.778**	-5.392	-1.408	3.382	0.263	-1.226
	(1.098)	(7.906)	(1.096)	(10.10)	(1.329)	(13.54)
South	-2.064**	0.103	-0.740	6.966	0.986	0.984
	(0.817)	(7.650)	(1.152)	(10.61)	(1.656)	(18.24)
Wales	-0.468	0	-1.976	13.86	-1.641	-19.57
	(1.139)	(0)	(1.774)	(11.53)	(1.330)	(14.17)
Scotland	-0.447	4.080	-1.102	7.146	-0.524	0
	(0.880)	(9.446)	(1.333)	(13.15)	(1.235)	(0)
NI	-3.893***	0	-3.121**	0	1.216	0
	(1.264)	(0)	(1.569)	(0)	(1.654)	(0)
imr1	-6.799***	-6.057***	-6.312***	-6.540***	-6.093***	-4.992***

	(0.248)	(0.339)	(0.220)	(0.352)	(0.360)	(0.579)
Constant	70.64***	64.16***	34.63***	34.37***	33.29***	41.77***
	(4.997)	(12.85)	(4.733)	(9.644)	(3.665)	(14.25)
Observations	3833	3833	4873	4873	2227	2227

Appendix E: Difference-in-difference, full results

Table E1 *Comparison group: partnered mothers*

	GHQ-12	SF-12
Before April 2013	0	0
	(.)	(.)
After April 2013 and before 2017	0.438	0.775
	(0.442)	(0.760)
After April 2017	1.091	1.055
	(0.741)	(1.220)
Single mother X After April 2013 and before 2017	-0.939***	-0.158
	(0.324)	(0.502)
Single mother X After April 2017	-1.955***	-0.982
	(0.515)	(0.778)
Job hours	0.0572***	0.0689***
	(0.00982)	(0.0148)
Log benefit income	-0.367***	-0.495**
	(0.123)	(0.201)
One	0	0
	(.)	(.)
Two	0.348	0.225
	(0.280)	(0.428)
Three or more	0.701*	0.724
	(0.415)	(0.649)
Age of youngest child in HH	-0.0816*	-0.107
	(0.0432)	(0.0681)
Age	-0.249	-0.684
	(0.284)	(0.510)
Age squared	0.00411*	0.00769**
	(0.00230)	(0.00364)
Degree or higher	0	0
	(.)	(.)
GCSE, A-levels or equivalent	1.901**	3.475***
	(0.838)	(0.933)
Below GCSE or other	0.188	1.357
	(1.099)	(1.591)
London	0	0

	(.)	(.)
North east and west	-0.557	-9.427**
	(1.714)	(4.076)
Midlands	-7.105***	-10.37***
	(2.206)	(3.877)
East	-0.233	-3.483*
	(1.773)	(1.905)
South	-2.161	-6.486***
	(1.385)	(2.084)
Wales	-1.128	-13.35***
	(1.933)	(5.058)
Scotland	-3.371***	-8.680**
	(1.294)	(3.501)
NI	0	0
	(.)	(.)
Owned	0	0
	(.)	(.)
Rented social	-0.374	-1.289
	(0.650)	(0.978)
Rented private & other	0.112	-0.516
	(0.606)	(0.918)
Interview year 2009	0	0
	(.)	(.)
Interview year 2010	-0.0627	0.0575
	(0.337)	(0.627)
Interview year 2011	-0.192	-0.411
	(0.533)	(1.000)
Interview year 2012	-0.270	-0.853
	(0.751)	(1.414)
Interview year 2013	-0.526	-1.480
	(0.999)	(1.871)
Interview year 2014	-0.551	-1.657
	(1.228)	(2.299)
Interview year 2015	-0.321	-1.049
	(1.451)	(2.721)
Interview year 2016	-0.788	-1.643
	(1.670)	(3.135)
Interview year 2017	-1.381	-2.534
	(1.880)	(3.539)
Interview year 2018	-1.584	-1.864

	(2.152)	(4.005)
Interview year 2019	-1.860	-3.465
	(2.342)	(4.379)
Constant	30.69***	68.31***
	(8.320)	(15.16)
Observations	8273	8666

Table E2 *Comparison group: single childless women*

	GHQ-12	SF-12
Before April 2013	0	0
	(.)	(.)
After April 2013 and before 2017	-0.454	-0.416
	(0.591)	(0.944)
After April 2017	1.072	1.523
	(1.025)	(1.518)
Single mother X After April 2013 and before 2017	-0.438	0.352
	(0.483)	(0.715)
Single mother X After April 2017	-1.788**	-1.519
	(0.792)	(1.177)
Job hours	0.0904***	0.104***
	(0.0127)	(0.0199)
Log benefit income	-0.0722	-0.0940
	(0.156)	(0.249)
Age	0.0317	-0.597
	(0.315)	(0.605)
Age squared	0.00294	0.00796**
	(0.00221)	(0.00370)
Degree or higher	0	0
	(.)	(.)
GCSE, A-levels or equivalent	0.643	3.002***
	(0.918)	(1.069)
Below GCSE or other	-0.795	1.279
	(1.335)	(2.145)
London	0	0
	(.)	(.)
North east and west	0.549	-8.635*
	(2.128)	(5.218)
Midlands	-6.653***	-8.378**
	(2.085)	(3.723)
East	-0.247	-0.550
	(1.616)	(5.158)
South	-2.373	-2.173
	(1.450)	(3.235)
Wales	3.771*	-16.08***
	(2.178)	(3.801)

Scotland	-2.033	-6.237
	(2.016)	(4.749)
NI	0	0
	(.)	(.)
Owned	0	0
	(.)	(.)
Rented social	0.309	-1.401
	(1.002)	(1.253)
Rented private & other	0.559	-0.492
	(0.879)	(1.152)
Interview year 2009	0	0
	(.)	(.)
Interview year 2010	0.00267	0.148
	(0.414)	(0.783)
Interview year 2011	-0.261	0.205
	(0.614)	(1.182)
Interview year 2012	-0.954	-1.222
	(0.859)	(1.662)
Interview year 2013	-0.657	-1.197
	(1.162)	(2.180)
Interview year 2014	-1.238	-1.363
	(1.417)	(2.687)
Interview year 2015	-1.354	-1.163
	(1.650)	(3.154)
Interview year 2016	-2.342	-2.035
	(1.875)	(3.633)
Interview year 2017	-3.359	-2.872
	(2.170)	(4.183)
Interview year 2018	-3.969	-3.535
	(2.439)	(4.704)
Interview year 2019	-4.365	-5.082
	(2.690)	(5.165)
Constant	17.75*	57.81***
	(10.36)	(19.72)
Observations	5809	6028

Appendix F: Investigating the parallel trends assumption

The underlying assumption of an unbiased difference-in-difference estimate is that the trends in the outcomes for both control and treatment groups prior to the implementation of the first round of welfare reforms are parallel. We examine the parallel pre-reform trends assumption for the two mental health outcome variables using an event study approach, commonly used in the difference-in-difference literature. As for our main analysis, separate models are estimated relative to each of the two comparison groups: partnered mothers and single childless women.

Following Pischke (2003), we estimate an equation of the following form:

$$MH_{it} = \alpha_i + \delta_t + \gamma X_{it} + \sum_{j=-m}^{q} \beta_j D_{it}(t = k + j) + u_{it}$$

Instead of a single treatment effect, we have now also included m leads and q lags of the treatment effect with parameter coefficients β_j, associated with the variables D_{it} denoting interactions between comparison group variable and time dummies (i.e. the 'treatment dummy' for individual i at time t), where m ranges from -4 (i.e. year 2009, four years pre-reform) to -2 (i.e. year 2011, two years pre-reform) and q ranges from 0 (reform implementation, year 2013, also represented by k) to 6 (6 years post implementation, year 2019). The year 2012 (where j = -1), one year pre-reform, is set as the baseline year and is omitted from the model so that the post-reform effects are relative to the period immediately prior to the start of the reform. MH_{it} represents outcomes of mental health for individual i at time t, standardised relative to baseline year. The parameters $\alpha_i$and δ_t indicate individual and year fixed effects respectively, and X_{it} is a vector of individual socio-demographic characteristics included in our main regression models, with the associated coefficients represented by γ.

Our null hypothesis for the parallel trends assumption states that β_j=0 for all values of m – i.e. the coefficients on all leads of the reform implementation are not statistically different from zero at 5% level of significance.

The results of the above described regression models are summarised in table F1. The graphical representation of the standardised mental health coefficients over time is represented in Figures F1-F4.

Table F1 shows the coefficients of the comparison group and time dummy interactions. Looking at coefficients relating to years between 2009-2011, we cannot reject the null hypothesis of no statistically significant difference in pre-reform trends in three out of the four models, suggesting that in most cases (with an exception of comparison with single childless women, GHQ-12 outcome) the parallel trends assumption is likely to hold, lending support to our difference-in-difference estimates.

***Table F1**: Parallel Trends Models*

	Partnered mothers		Single childless	
	GHQ-12[+]	SF-12	GHQ-12	SF-12
Ref. Single mother X 2012				
Single mother X 2009	-0.113	-0.0825	-0.0134	-0.0343
	(0.0861)	(0.0859)	(0.123)	(0.111)
Single mother X 2010	-0.00649	-0.0127	-0.0556	-0.0163
	(0.0701)	(0.0700)	(0.0975)	(0.0864)
Single mother X 2011	0.0203	0.0861	-0.0919	-0.0551
	(0.0653)	(0.0642)	(0.0835)	(0.0789)
Single mother X 2013	0.0139	0.0480	-0.0728	0.0376
	(0.0720)	(0.0687)	(0.0863)	(0.0798)
Single mother X 2014	-0.145*	0.0306	-0.136	-0.00174
	(0.0783)	(0.0711)	(0.0957)	(0.0839)
Single mother X 2015	-0.109	0.0158	-0.0440	0.0359
	(0.0791)	(0.0793)	(0.103)	(0.0977)
Single mother X 2016	-0.303***	-0.0961	-0.223*	-0.107
	(0.0859)	(0.0805)	(0.114)	(0.106)
Single mother X 2017	-0.296***	-0.0562	-0.276**	-0.233**
	(0.0976)	(0.0889)	(0.132)	(0.115)
Single mother X 2018	-0.301***	-0.0724	-0.274*	-0.0686
	(0.108)	(0.0938)	(0.141)	(0.124)
Single mother X 2019	-0.364***	-0.166	-0.412**	-0.240
	(0.129)	(0.114)	(0.169)	(0.149)
Observations	8273	8666	5809	6028

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

+The models control for age, age squared, education level, housing tenure, region, number of children and age of the youngest child (the latter two variables are not included in the comparison with single childless women)

These results are also illustrated graphically in Figures F1-F4 which show the evolution of the standardised mental health outcomes over time with accompanying 95% Confidence Intervals. We can see that, relative to pre-reform year, 2012 (baseline), most of the pre-reform coefficients cross the line of zero, indicating no statistically significant difference in the pre-reform period (except in Figure 2, which illustrates the comparison between single mothers and single childless women for the GHQ-12 outcome). In terms of dynamic treatment effects, we can see there is a downward trend in mental health of single mothers relative to either of the two comparison groups, suggesting that mental health deteriorates over time, though in the

case of comparison to partnered mothers (SF-12 outcome), the changes are not statistically significant.

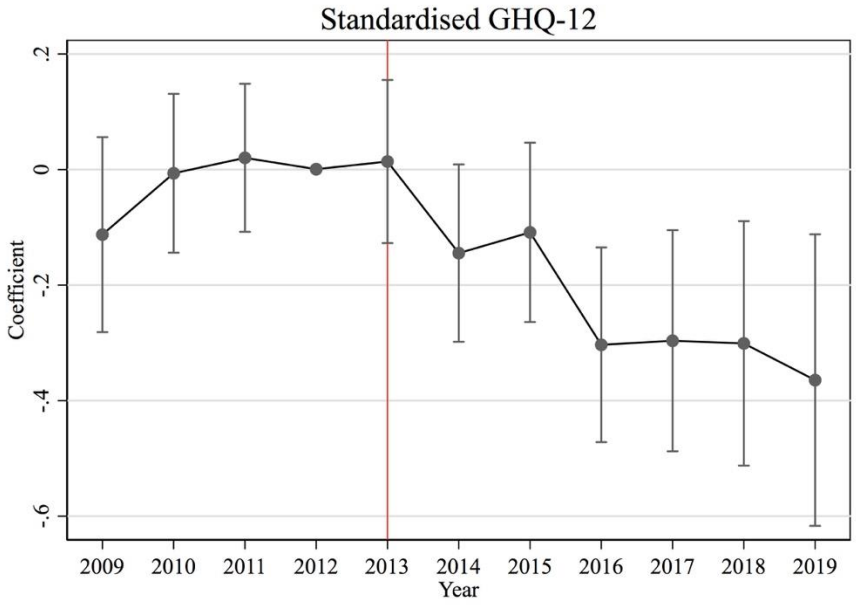

Figure F1 *Comparison group: Partnered mothers*

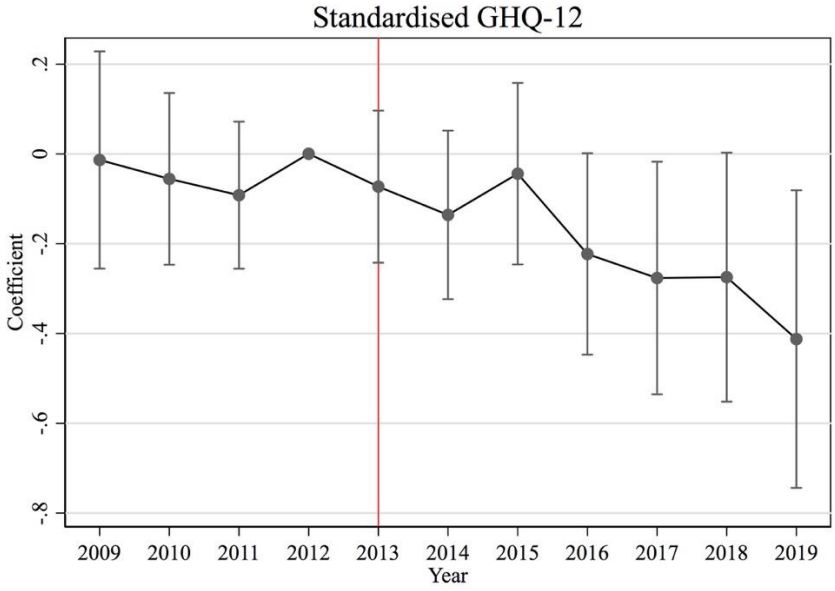

Figure F2 *Comparison group: Single childless women*

Figure F3 *Comparison group: Partnered mothers*

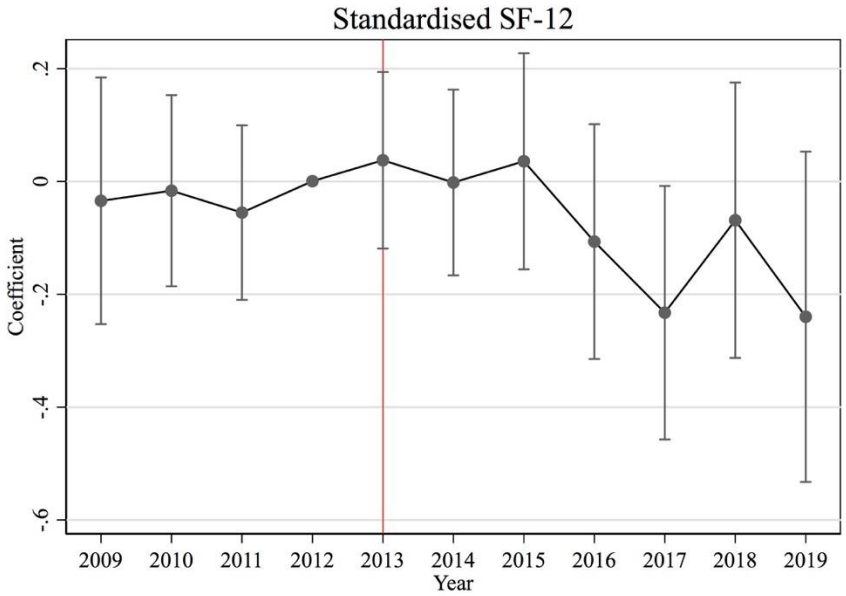

Figure F4 *Comparison group: Single childless women*

Reference

Pischke, J.-S. (2005) 'Empirical methods in applied economics: Lecture notes'. p. 2015. Available at: https://econ.lse.ac.uk/staff/spischke/ec524/evaluation3.pdf (Accessed: 17 December 2021).

Appendix G: Investigating alternative reform dates

Table G1 below illustrates the results from the sensitivity analyses including alternative reform specification dates. When compared to partnered mothers, single mothers experience worse mental health as measured by GHQ-12 following March 2016 welfare reform legislation. The association is not statistically significant when using the SF-12 measure. These results are reflective of those from the main specification, providing confidence in our estimates.

Table G1 *Difference in difference results, comparison: partnered mothers*

	GHQ-12	**SF-12**
Single mother X After March 2012 and before 2016	-0.302	0.291
	(0.316)	(0.515)
Single mother X After March 2016	-1.749***	-0.899
	(0.457)	(0.711)
Observations	8273	8666

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table G2 illustrates the results using a comparison group of single childless women. The results reflect some slight deviations from our main results. For example, the direction of the coefficients of the first round of reforms (post March 2012) is consistent with the main specification, however, in this case, the coefficient in relation to SF-12 is statistically significant. The direction of the coefficients for the second round of reforms (after March 2016) is also consistent with the main specification, however, the coefficient for post-2016 GHQ-12 is not statistically significant (unlike in the main specification).

Table G2 *Difference in difference results, comparison: single childless women*

	GHQ-12	SF-12
Single mother X After March 2012 and before 2016	0.0414	0.740
	(0.498)	(0.719)
Single mother X After March 2016	-1.352 (0.773)	-1.354
		(1.158)
Observations	5809	6028

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$