The Effect of Childcare Costs on Maternal Labour Force Participation in the United Kingdom

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This dissertation investigates the effect of childcare costs on maternal labour force participation in the UK. A bivariate probit model is used to estimate the joint decision of British mothers participating in the labour force and using a formal childcare provider, controlling for the effects of demographic, income and household composition characteristics. Selectivity-corrected estimates of wages and childcare costs are used to eliminate sample selection bias. The results are contrary to previous research, showing childcare costs no longer significantly, negatively affect maternal labour force participation. Childcare costs are found to be positively associated with formal childcare use and labour force participation, whilst wage is found to have no significant effect. Policy changes have been considerable since the majority of research has been published and could partly explain the differing outcomes of this model.

1. Introduction

Formal childcare can be considered as non-maternal or non-domestic care for which a cost is incurred to the child's guardians (Connelly, 1992, Kimmel, 1998). Conversely informal childcare is care given by relatives or friends for which no cost is incurred. Given that women tend to be the main carer for their children (Sigle-Rushton and Waldfogel, 2007, p.55), the cost of childcare is likely to affect maternal labour market participation decisions. Much research has been conducted regarding the link between paying for formal childcare and female labour market participation. There is a general consensus that the cost of childcare negatively impacts maternal employment, although the extent to which it does so is subject to considerable debate (Connelly, 1992; Kimmel, 1998; Cleveland *et al.*, 1996). The majority of existing research focuses on the US labour market, however, Viitanen (2005) conducted a study on the effects of childcare costs for female employment in the UK. This used data from 1997 to 2004 and found childcare costs significantly negatively affected UK maternal labour market participation.

Despite being the focus of government policy in terms of early years' education over recent decades, UK childcare costs are still relatively high, rising by 32.8% on average between 2010 and 2015 (Rutter, 2015). Additionally, maternal labour force participation in the UK is low and is cited as the main cause of the difference between the UK male and female rate of employment (Ben-Galim, 2014, p.18). The cost of childcare therefore has implications not just for labour market participation, but also gender pay inequality and pay inequality among females (Sigle-Rushton and Waldfogel, 2007). As women are the main care-givers, their male partners, despite having children, do not see the same impact on their respective earnings.

UK government policy has recognised the need for affordable childcare. This is reflected in the 1998 National Childcare Strategy, the 2004 Choice for Parents Strategy, the 2006 Childcare Act (Rutter, 2015, p.6), and the 2015 Childcare Bill (Department for Education (DfE), 2015a). Working Tax Credits (WTC) have also been used to make childcare more affordable. Redesigned in 2003, the Childcare Element of WTC, provides financial support for working parents using a formal childcare provider (HMRC, 2015, p.2).

The aim of this dissertation is to estimate the effect of childcare costs on maternal labour supply using more recent data than existing research does and allowing for government policy within the model. This is important as WTC focuses on the demand side of childcare costs; however, research shows that countries most successful at encouraging female labour market participation have focused on the supply-side (Ben-Galim, 2014).

This dissertation will achieve its aim by estimating labour force participation and childcare use given the predicted wage and predicted cost of childcare that would be incurred if the mother was working. Unlike other studies, the present one includes tax credits as a regressor to account for government policy, as well as the usual factors affecting the choice to enter the labour market and use formal childcare. The same method and data source used by Viitanen (2005) will be applied, but adding more recent data from 2011 and with tax credits taken into account. Section 2 provides contextual information on childcare costs and use, maternal employment rates in the UK and UK childcare policy. Section 3 reviews the current literature and Section 4 addresses the Theoretical Framework, justifying the chosen methodology. Section 5 covers the empirical analysis undertaken in this dissertation, explaining the data source used and the manipulation required, before explaining the methodology used and results yielded. These results are discussed at the end of the section with an evaluation on the strengths and weaknesses of the research.

2. Background

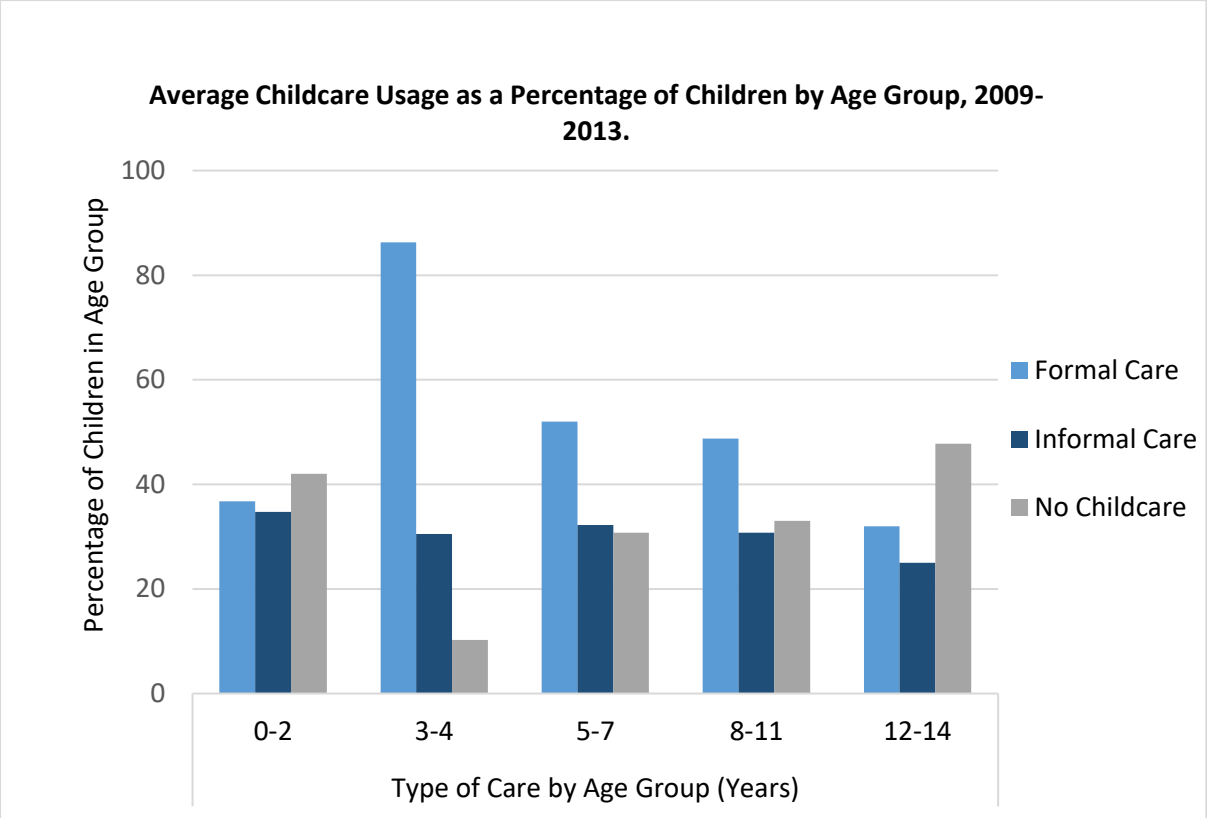
2.1. Childcare Usage and Costs

Pre-school aged children require the most formal care as they are not yet old enough to attend primary school and mothers are increasingly returning to work when their child is younger (Hibbett and Meager, 2003, p.506). This is reflected in the high demand for formal childcare for pre-school aged children compared with other age groups; 88 per cent of children aged 3-4 years were taken care of by a formal provider in 2012 (DfE, 2014a, p.41), significantly more than any other age group. This is reflected in Figure 1 which shows the average percentage of each age group using different forms of childcare between 2009 and 2013.

Formal providers are considered by the DfE to include nursery schools, day nurseries, childminders, playgroups and holiday clubs (2014.a, p.31). Of the 3-4 year olds using formal care, the majority are cared for through a nursery class, day nursery or playgroup (DfE, 2014a, p.41).

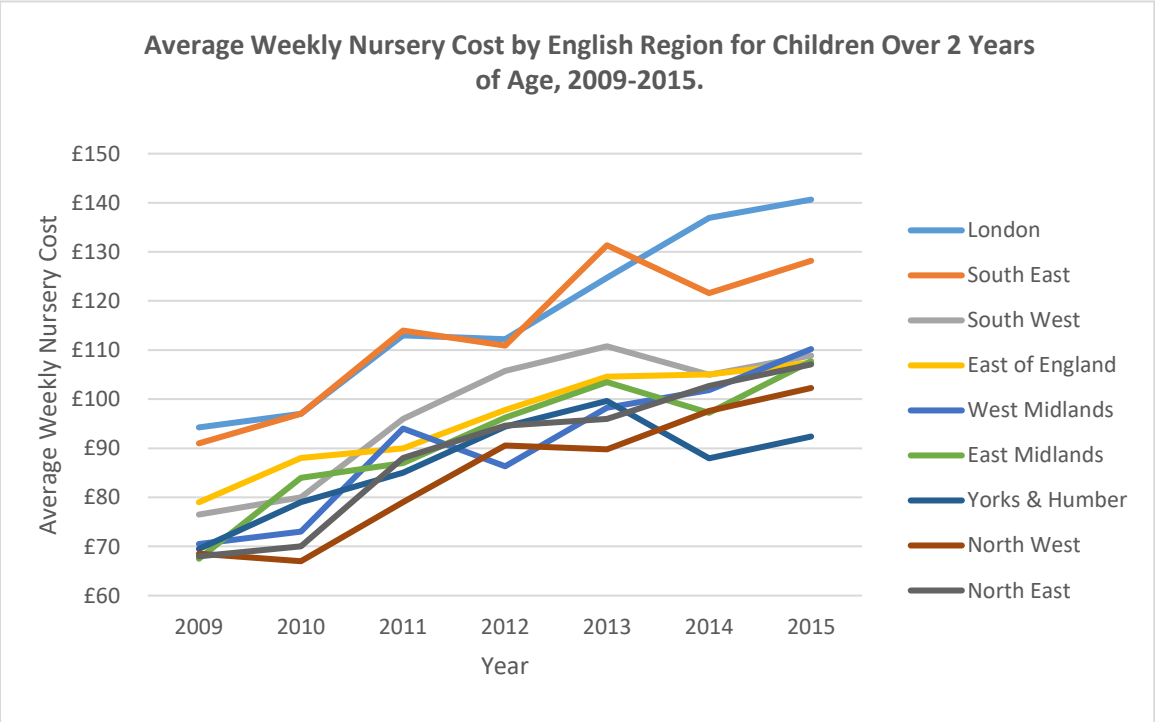
Even within postcode areas large differences can exist between prices, partly due to the supply mix of childcare. The UK childcare market consists of voluntary, private and maintained (generally local authority run) providers (DfE, 2014b). Pre-school aged children are more likely to require full-day care for which private providers are the most common, and most expensive (DfE, 2014b, p.50). This suggests pre-school aged children incur the largest childcare costs.

Figure 1: Average Childcare Usage as a Percentage of Children by Age Group, 2009-2013



Source(s): DfE, *Childcare and Early Years Survey of Parents, Main Tables: "Use of Childcare Providers, by Age of Child", 2010-2014.*

Figure 2: Avg. Weekly Nursery Cost by English Region for Children Over 2 Years of Age, 2009-2015



Source(s): Family and Childcare Trust, *Annual Childcare Costs Surveys: Average Weekly Childcare Costs by Region and Nation tables 2009-2015.*

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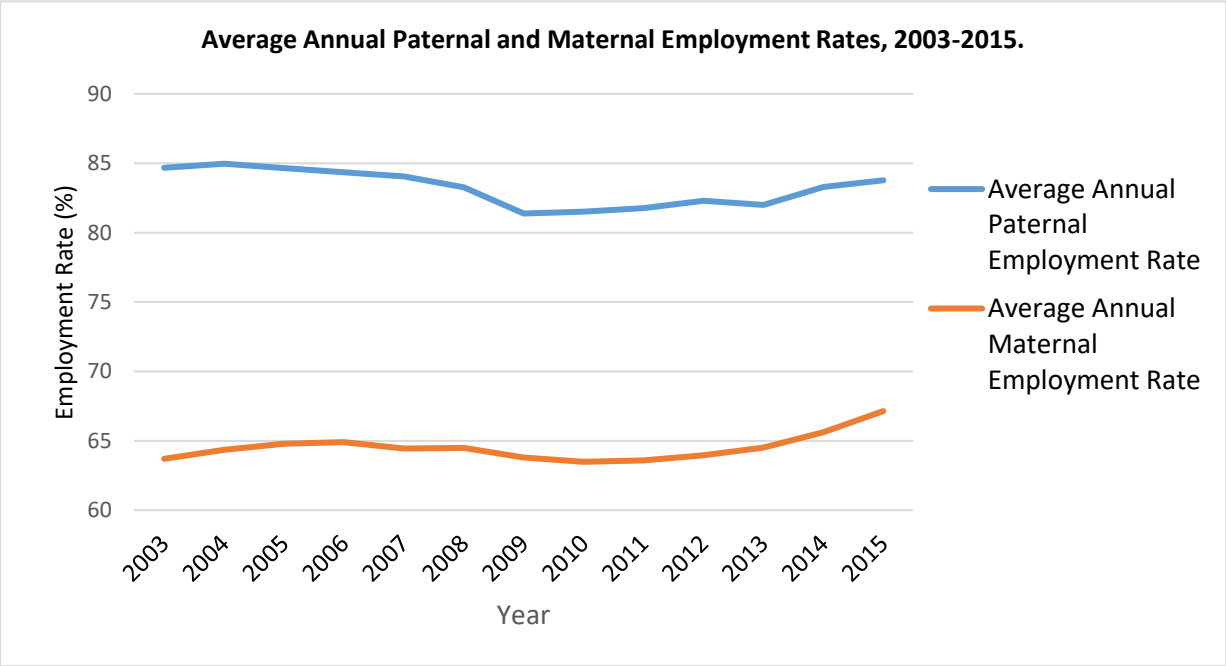
2.2. Maternal Employment Rates

The OECD states that, in the majority of countries, dependent children decrease the probability of maternal labour market participation (OECD, 2015, pp.2-3). On average in the UK, maternal employment rates have been 18% lower than paternal employment rates over the past decade; this gap is evident from Figure 3.

Figure 3: Average Annual Paternal and Maternal Employment Rates, 2003-2015.



Source(s): UK Data Service*, 2016, Quarterly Labour Force Survey.*

2.3 Current Early Years Policy

Government policy suggests the need for affordable childcare has been recognised. All children aged 3 and 4 years old are eligible for 15 hours of free childcare per week; which has been the case for 3 and 4-year-olds since 2004 and 1998 respectively (DfE, 2015b). The government announced an extension of this policy in the 2015 Childcare Bill (DfE, 2015a) with more free hours for 3 and 4-year-olds and some 2-year-olds. Childcare costs to parents are also reduced with the Childcare Element in WTC, which can provide up to £210 per week to cover childcare costs (UK Government, 2016).

3. Literature Review

A wide breadth of literature exists on the relationship between childcare costs and female labour market participation. Much of the research uses North American data and was largely conducted prior to the millennium, with one of the first studies conducted being the one by Heckman in 1974. The majority of studies are similar in nature; estimating either labour force participation, or hours worked, with the joint decision to use formal childcare. Most papers consider married or cohabiting women only due to the different factors which explain the employment decision of lone parents (Jenkins and Symons, 2001, pp.132, 142). Whilst it is widely recognised that higher childcare costs negatively affect female labour force participation, debate exists around the size of the effect (Powell, 1997, p.578). Much of the research is alike in terms of the methodology and underlying theory. This section will therefore critically review the key papers focusing on the type of study used, the varying definitions of fundamental explanatory variables, and the role of government policy in estimations, which may account for the differing participation elasticities with respect to resulting childcare costs. The main studies covered by this review are Heckman (1974), Blau and Robins (1988), Connelly (1992), Ribar (1992), Cleveland *et al.* (1996), Averett *et al.* (1997), Powell (1997), and Viitanen (2005) who all provide estimations for married women; Jenkins and Symons (2001) who provide estimations for lone parents; and Kimmel (1998) who provides estimations for both.

Types of estimation will first be considered. It is helpful to know, at this point, the elasticities each study yielded to help compare the research. These are presented in Table 1 in order of decreasing magnitude. The elasticities are all consistent with the theory that an increase in the price of childcare negatively affects participation.

With regards to estimations, labour force participation is generally measured by the likelihood of the mother being employed given the price of childcare. Accordingly, the dependant variable is labour force participation. Some studies depart from this method. For example, Averett *et al.* (1997) consider participation in terms of number of hours worked, whilst Heckman (1974) evaluates the mother's marginal rate of substitution between leisure and work time. Most studies explicitly work from the theory that the mother maximizes her utility subject to time and budget constraints; with utility as a function of the quality of childcare, leisure, and income (Blau and Robins, 1988; Connelly, 1992; Ribar, 1992; Powell, 1997; Kimmel, 1998; Jenkins and Symons, 2001). It is assumed the remaining studies also take this approach as the rationale for labour force participation even without the specific explanation.

Table 1: Female labour force participation elasticities with respect to childcare costs from the key literature

Author	Labour Force Participation Elasticity with Respect to Childcare Costs
Kimmel (1998)	-0.92
Averett et. al. (1997)	-0.78
Ribar (1992)	-0.74
Cleveland et. al. (1996)	-0.388
Powell (1997)	-0.38
Blau and Robins (1988)	-0.38
Connelly (1992)	-0.2
Viitanen (2005)	-0.138
Jenkins and Symons (2001)	-0.09
Heckman (1974)	n/a

Source(s): As given.

In order to estimate participation, many of the later studies use probit models (Cleveland *et al.*, 1996; Connelly, 1992; Kimmel, 1998; Powell, 1997, Jenkins and Symons, 2001; Viitanen, 2005). Blau and Robins' (1988) study is significant in this respect as they use a multinomial logit. This allows for additional scenarios outside of just female labour force participation and formal childcare use to be estimated; Blau and Robins additionally estimate the effects on other members of the household working. This explicitly incorporates the availability of informal care into the estimation, rather than only including independent variables which make informal care more likely which is the approach taken by studies using the probit model. There is, however, some issue around Blau and Robins' definition of formal and informal care where some zero-cost care providers (generally considered 'informal') were categorised as formal providers (p.377).

One of the main variations between studies is in variable selection and definition. Not only are a range of different independent variables included in each paper, but the definitions of key variables, such as the price of childcare, also vary. The measurement of price is addressed in most studies. The first distinction is whether it is taken per child or per household. Averett *et al.* (1997), Connelly (1992), Jenkins and Symons (2001), Kimmel (1998) and Powell (1997) all use the total cost of childcare per household. This is logical because it captures the cost impacts of childcare for multiple children. Conversely, taking the price of childcare as the cost incurred from a randomly selected child in the family, the approach used by Cleveland *et al.* (1996), can be unreflective of how much a family is likely to pay. Prices vary by child age; infants require more attention and a higher staff to child ratio than older children (Ribar, 1992, pp.146-147), causing a higher price for their formal care[1]. Randomly selecting an older child would understate the price, and vice-versa. Taking the total cost paid by

[1] This is evidenced in the Family and Childcare Trust's Survey which shows higher nursery prices across all UK regions for children under 2 years compared to over 2 years (Rutter, 2016, p.5).

families therefore allows for the variation in price across the care of multiple children. It is important to acknowledge though that Cleveland *et al.* were limited by the data they used; the 1988 wave of the Canadian National Child Care Survey only records the main care received by one randomly selected child (Cleveland *et al.* 1996), therefore, the more reflective method of taking total family costs was unavailable to them.

The price of childcare also varies across studies in terms of whether it is measured per hour or per hour that the mother works. Averett *et al.* (1997), Connelly (1992), Jenkins and Symons (2001), Kimmel (1998) and Powell (1997) all calculate the price of childcare as the cost of childcare per hour the mother works. Conversely, Blau and Robins (1988), Cleveland *et al.* (1996) and Ribar (1992) use the hourly price of care, independent of hours worked. The latter approach is preferable as it allows for informal as well as formal care to be used. Measuring the cost of childcare per hour worked assumes all hours of employment require paid care. Averett *et al.* state "for each hour the mother is working, she is purchasing some form of child care" (1997, p.126). This could distort the price variable; if hours of employment are greater than paid hours of care due to the availability of informal alternatives, this may lead to a lower value than the true price. Using hourly price alone alleviates this problem. Although Kimmel attempts to acknowledge that hours of work are not necessarily equivalent to hours of formal childcare (1998, p.288), her definition of price conflicts with this.

Two papers which deviate from either of these methods are Blau and Robins (1988) and Heckman (1974). Heckman states that a price measure was not feasible (p.145), so considers variables that increase or decrease the potential care price. However, as only the marginal rate of substitution between work and leisure time, given the existence of children in general, rather than their specific care price is the focus of the paper, proxies for care expenditure are sufficient. Blau and Robins however, use geographical average childcare prices rather than a predicted price. This reduces the credibility of their results. Connelly (1992) highlights that formal childcare costs vary by family (p.84), due to the various types of providers and effects of government policy. Therefore, using only 20 geographical regions to infer the childcare costs experienced by all families per area, as Blau and Robins have done, is unlikely to indicate the cost accurately.

The income variable is also used in a variety of ways across existing research. This variable takes account of the finances outside of the mother's wage influencing labour force participation and childcare use. All studies include a variable for non-labour income, but the way this is constructed varies. Averett *et al.* (1997), Connelly (1992) and Kimmel (1998) take non-labour income as the entire family income minus the mother's earnings. Blau and Robins (1988) and Cleveland *et al.* (1996) provide a more comprehensive analysis on this however. Whilst both include variables for the mother's non-

labour income and partner's labour income, Blau and Robins additionally include wages from other household members and Cleveland *et al.* include the partner's non-labour income and working hours. This allows the influence of the partner's income and hours on childcare use and labour market participation to be observed. In theory, higher partner income allows more childcare use but also potentially reduces the need for the mother to work. Cleveland *et al.* (1996) find the father's labour and non-labour income to have small, but significant effects on the probability of maternal labour force participation and no significant effect on care use.

The difference in variable definition and inclusion could explain the varying elasticities across different studies. Kimmel's (1998) paper is significant as it extends the analysis further to investigate whether "equation specification" (p.293) is the main reason for these variations. She reconstructs her own estimation using Connelly's specification and still finds different elasticities. Connelly provides an elasticity of -0.2 and Kimmel's replication yields -0.42 (Kimmel, 1998, p.293). This is important as it demonstrates the complexity of calculating the effects of childcare costs on labour force participation. In this case it is likely to be the data source which accounts for differences; Kimmel states that the 1987 SIPP panel has greater detail on childcare expenditure than the 1984 panel that Connelly used (p.288).

Viitanen's (2005) study is useful as it covers the UK childcare and labour market and uses relatively recent data. However, Viitanen uses data over the period 1997 to 2004. Whilst this leads to large sample size, it neglects to account for the impact of policy changes. Viitanen acknowledges that tax credits were reformed to help with the cost of childcare during the period of her study, but fails to control for this in the estimation. Averett *et al*. (1997) conduct one of the few studies which do include policy effects in the estimation. They account for the changes that the US Child Care Tax Credit (CCTC) and Income Tax impose on the budget constraint (p.127). They find that CCTCs are positively related to maternal labour supply and a relatively high resulting labour force participation elasticity with respect to childcare costs of -0.78. Despite being published in 1997 however, the data used is from 1986 and only includes mothers aged 21-29 (p.128) which provides a much smaller sample than other studies. This dissertation aims to build specifically on the significant research of Viitanen (2005) and Averett *et al.* (1997) by focusing on the UK and controlling for tax credits.

4. Theoretical Framework

For a mother to participate in the labour market, non-maternal care for her children is required. A mother is assumed to participate if it maximises her utility; which can be taken as a function of consumption, leisure and childcare quality (Blau and Robins, 1988; Connelly, 1992; Ribar, 1992). In

choosing to enter the labour market, if informal care is unavailable or unsatisfactory, formal care may be used (Blau and Robins, 1988). In this case the mother's wage minus the cost of care must exceed her reservation wage. The wage and cost of childcare therefore jointly determine labour market participation (Blau and Robins, 1988; Cleveland, *et al.*, 1996; Viitanen, 2005).

Given that estimating labour force participation requires cost and wage variables to be used, the issue of "self-selection bias" (Heckman, 1979, p.153) must be corrected for. Wages are recorded only for women who have chosen to participate in the labour force and childcare costs only for women who have chosen to buy formal care. These women may be experiencing unusually high wages or unusually low childcare prices. Therefore, the wage and childcare cost must be estimated for those who have not chosen these options (Blau and Robins, 1991; Cleveland, *et al.* 1996; Connelly, 1992, Ribar, 1992; Viitanen, 2005). This is addressed in Section 5.2.

While both the cost of care and the wage rate affects formal childcare use and labour force participation, other factors also contribute. These factors include demographic, income and family composition variables. Within family composition for example, a child's age affects the cost of their care, or their ability to provide informal care for a sibling. Exogenous factors such as regional effects also have an impact. The influences of these determinants are captured in the estimation conducted in Section 5.

A bivariate probit model is appropriate, given the simultaneous probabilities being estimated are whether the mother participates or does not participate in the labour force (LFP), and whether she purchases or does not purchase formal care (CCUSE). This estimation is based on the two equations featured in Viitanen (2005, p.152) and Cleveland *et al.* (1996, p.140):

Equation 1:

Bivariate Probit Estimation Equation.

$$LFP = X_{LFP}b_{LFP} + a_{LFP}WAGEHAT + c_{LFP}PRICEHAT + u_{LFP} \quad (1)$$

$$CCUSE = X_{CCUSE}b_{CCUSE} + a_{CCUSE}WAGEHAT + c_{CCUSE}PRICEHAT + u_{CCUSE} \quad (2)$$

Source: Viitanen, 2005, p.152 and Cleveland *et al*., 1996, p.140.

The first terms in both equations respectively represent vectors of determinants for labour force participation and childcare use. $WAGEHAT$ and $PRICEHAT$ represent the predicted wage and childcare price respectively which are derived from the selectivity-corrected estimations obtained in

Sections 5.2.1 and 5.2.2, whilst u_{LFP} and u_{CCUSE} represent the error terms which are normally distributed (Cleveland, *et al.*, 1996; Viitanen, 2005).

5. Empirical Analysis

As stated, this analysis uses the same data source and follows the same methodology as Viitanen (2005), using the Family Resources Survey (FRS), but introduces an additional tax credits regressor and uses more recent data. This analysis required considerable data manipulation initially so this section begins with a description of the data source and editing required. It then explains the methodology, a discussion of the results, and an evaluation.

5.1 Explanation of the Data

This analysis uses data from the 2011-2012 band of the FRS - an annual survey of UK households since 1992, used to inform and evaluate government policy (UK Data Service, 2013). The survey provides information on household income and expenditure with sections on, but not limited to, household composition, individual earnings, employment, benefits and since 2005, childcare use and associated costs.

This band, which covers April 2011 to March 2012, has been selected due to the high level of tax credits entitlement at this time (HMRC, 2015). Furthermore, by 2011 tax credits had existed in their contemporary form for eight years. As such public awareness of the benefit was high but uptake yet to be affected by Government policy revisions in 2013. Therefore, the 2011-2012 band of the FRS is a sensible period to select in terms of being able to capture the influence of tax credits on childcare costs and female labour market participation. The survey has a large sample size of 20,759 households.

The survey is split into three levels; the household, benefit unit and individuals. Each individual belongs to a benefit unit within a household. The benefit unit is effectively a family and a household is effectively the address. The results from the FRS are provided at the individual level with separate tables on various topics, for example, *Job,* which contains all employment information for an individual including hours of employment and wages.

This dissertation therefore considers the childcare costs and employment decision of mothers based on the benefit unit. The dataset was sorted by selecting all females either married or cohabiting. This is necessary as the *Childcare* table only provides information on those households where at a minimum, one parent is working (Viitanen, 2005, p.154). Therefore, if single mothers were included, it would not be possible to properly estimate their childcare use and costs. Married or cohabiting females were joined to the *Child* table wherever a child under the age of 5 was present; children 5

years and over are of school age and therefore do not typically require full-time formal care. Relationship identifiers from the *Adult* table were used in this process to ensure all matches between females and children were mother-child relationships. The same identifiers were then used to match fathers into the benefit unit. The *Job* and *Adult* tables were used to obtain wage, working hours and non-labour income information for each parent in the benefit unit. Hours and wages are taken from the main job only. In the majority of cases this was also the highest paid job.

The *Childcare* table provides each type of childcare, both formal and informal, used for each child with the number of hours and cost if it exists. Costs and hours used were aggregated for each child and summed across all children within the family to provide the total childcare cost. This forms the *Price* variable.

Other variables were either taken from various tables or generated to take account of factors affecting the participation and childcare use decision. New variables generated include multiple dummy variables representing the number of children within various age groups and a variable to identify any other adults present in the benefit unit. The presence of multiple younger children reduces the mother's likelihood of participating in the labour market since the cost of childcare increases more significantly with each younger child, increasing the mother's reservation wage. However, the presence of older children, provides another opportunity for informal care, as does the presence of other adults.

Following the data manipulation and removal of families without the required characteristics, the sample size reduced to 918 families. Of this figure, 485 parents used at least one formal childcare provider and 384 of these mothers participated in the labour market. Of the 433 families not using a formal provider, 257 mothers were in work.

Confidentiality protections mean that some information, although recorded in the survey, is not publicly available; for example, adult age. Age is important to include, given wages increase with experience; meaning older mothers incur a greater opportunity cost in choosing not to participate in the labour market. To solve this problem dummy variables for each age category have been generated, thereby limiting the information loss associated with only using 5-year age bands.

Table 2 shows the variables that have ultimately been included in the analysis. Where possible, equivalent variables to Viitanen's (2005) study have been used for comparative purposes. The Appendix provides an explanation of how new variables have been generated. Table 3 shows summary statistics of the variables comparable to Viitanen's, which are used in the estimations and used to derive predicted values.

Table 2: Variables included in Empirical Analysis

Variable Category	Variable Name	Description
Key Variables	LFP	Labour force participation, 1 if working and 0 otherwise.
	CCUSE	Formal childcare use, 1 if childcare incurs a cost and 0 otherwise.
	Price	Price of formal childcare per hour.
	Wage	Hourly wage of the mother.
	Pricehat	Predicted price of formal childcare per hour.
	Wagehat	Predicted hourly wage of the mother.
Demographic Variables	Under 24 Age 25-29 Age 30-34 Age 35-39 Age 40-44 Over 45	Dummy variables for the mother's age category. 1 if age fits the category and 0 otherwise.
	No degree	Mother's education level. 1 if no higher education and 0 otherwise.
	Ethnic minority	Mother's ethnic group. 1 if minority ethnic group and 0 otherwise.
Income Variables	Mother's non-labour income	Female non-labour income. Includes benefits, excludes tax credits.
	Father's non-labour income	Male non-labour income. Includes benefits, excludes tax credits.
	Father's working hours	Male total hours worked per week.
	Tax credit amount	Total amount received in tax credits, includes child and working tax credits.
Family Composition	Multiple pre-school children	Multiple pre-school aged children. 1 if at least 2 children aged under 5 and 0 otherwise.
	Primary school child	Primary school aged children. 1 if at least 1 child aged 5-12 and 0 otherwise.
	Secondary school child	Secondary school aged children. 1 if at least 1 child aged 12-16 and 0 otherwise.
	Other adults	Dummy variable to represent the presence of other adults. 1 if other adults, 0 otherwise.
	Under 1 year Age 1 Age 2 Age 3 Age 4	Dummy variables to represent the presence of a child in each age category. 1 if a least 1 child in age category and 0 otherwise.
Regional Variables	North East and South East Midlands London Wales South West Scotland	Dummy variables to account for regions. 1 if family lives in region and 0 otherwise.

Source(s): UK Data Service*, 2013, Family Resources Survey 2011-2012.*

Table 3: Summary Statistics

Variable Category	Variable Name	Whole Sample		Using Formal Childcare	
		Mean	Std. Dev.	Mean	Std. Dev.
Key Variables	LFP	0.70	0.46	0.79	0.41
	CCUSE	0.53	0.50	1.00	0.00
	Price	15.00	9.96	16.65	10.56
	Wage	4.51	2.74	4.51	2.74
Demographic Variables	Under 24	0.19	0.39	0.14	0.34
	Age 25-29	0.31	0.46	0.32	0.47
	Age 30-34	0.30	0.46	0.35	0.48
	Age 35-39	0.12	0.33	0.14	0.35
	Age 40-44	0.02	0.15	0.02	0.14
	Over 45	0.22	0.15	0.02	0.14
	No degree	0.48	0.50	0.39	0.49
	Ethnic minority	0.17	0.37	0.12	0.32
Income Variables	Mother's non-labour income	4.30	5.14	4.32	5.66
	Father's non-labour income	8.55	28.80	9.09	26.46
	Father's working hours	40.99	10.82	41.66	10.57
	Tax credit amount	24.45	51.31	18.13	41.98
Family Composition	Multiple pre-school children	0.26	0.44	0.25	0.44
	Primary school child	0.38	0.48	0.34	0.47
	Secondary school child	0.05	0.22	0.04	0.19
	Other Adults	0.25	0.51	0.22	0.45
	Under 1 year	0.15	0.36	0.11	0.31
	Age 1	0.28	0.45	0.31	0.46
	Age 2	0.27	0.45	0.34	0.47
	Age 3	0.27	0.44	0.26	0.44
	Age 4	0.31	0.46	0.24	0.43
Regional Variables	North	0.24	0.43	0.24	0.43
	East and South East	0.23	0.42	0.24	0.43
	Midlands	0.14	0.34	0.13	0.34
	London	0.11	0.32	0.12	0.32
	Wales	0.05	0.21	0.04	0.19
	South West	0.08	0.26	0.08	0.27
	Scotland	0.16	0.37	0.15	0.36

Source(s): UK Data Service*, 2013, Family Resources Survey 2011-2012.*

5.2 Methodology

To estimate the effect of childcare costs on female labour market participation a bivariate probit is used with predicted wage (*Wagehat*) and childcare cost (*Pricehat)* variables. These are generated in the initial probit estimations. As explained in Section 4, it is necessary to correct for sample selection bias given that not all observations in the sample contain a record for *Wage* and *Price*. Selectivity-corrected estimates of these variables are therefore produced using the two-step Heckman method in the initial probit estimations (Longhi and Nandi (no date)). This removes sample selection bias by

censoring observations for which the variable of interest (*wage* or *price*) cannot be observed (Heckman, 1974; 1979), thus adjusting for the probability of labour force participation and care use. Predicted values for all mothers are generated from these estimations, showing the wage a mother would receive or the price of childcare she would pay regardless of whether she participates or uses care. These values are then used in the bivariate probit referred to in Section 5.2.3. The probability of labour force participation with a selectivity-corrected wage estimation is produced first, followed by the probability of formal childcare use with a selectivity corrected price estimation (Viitanen, 2005, pp.157, 159). These are covered in 5.2.1 and 5.2.2 respectively.

5.2.1 Labour Force Participation and Wage Estimation

The labour force participation probit with the selectivity-corrected wage estimation yields the results shown in Section 5.2.2. *Under 24* and *Age 4* have been used as reference categories and thus are omitted from this estimation (the case is the same for the next estimation).

The results from this stage of the estimation are as expected. Characteristics relating to the mother have the expected effects on both labour force participation and wage rate. Age has a positive impact which is consistent with economic theory; the older the age of the mother, the more labour market experience she is likely to have and thus receives a higher wage. A lack of higher education has the expected opposite effect on the wage rate, with no significant impact on labour force participation. Belonging to an ethnic minority also has the significant negative effect on both labour force participation and wage, with a large impact on wage.

In terms of household characteristics, tax credits also have a significant negative effect on labour force participation; this is because this is the total amount including child tax credit which is means tested. lower labour force participation will therefore be associated with a higher tax credit income, particularly given that this sample only includes households with children.

As anticipated, mothers with multiple pre-school aged children are less likely to work, but having a child of primary school age also reduces the likelihood that a mother works whereas having a pre-school aged child does not. This is perhaps due to the fact that childcare policy has been focused only at pre-school aged children, but having a job that is able to fit around school hours, including getting children to and from school, may be difficult for a lot of mothers. Consequently, we observe the *Primary school child* category having the strongest negative effect on maternal labour market participation.

Table 4: Results for the labour force participation probit with two-step Heckman method for wage estimation

Variable Category	Variable Name	Labour Force Participation		Wage	
		Coefficient	Std. Dev.	Coefficient	Std. Dev.
Demographic Variables	Under 24	*Reference category*			
	Age 25-29	0.379*	0.228	-0.289	1.921
	Age 30-34	0.763***	0.231	3.980**	1.897
	Age 35-39	0.613***	0.233	5.299***	1.877
	Age 40-44	0.547**	0.258	7.786***	2.022
	Over 45	0.584	0.396	8.060***	2.945
	No degree	0.040	0.104	-5.674***	0.724
	Ethnic minority	-0.744***	0.130	-3.798***	1.313
Income Variables	Mother's non-labour income	-0.013	0.009		
	Father's non-labour income	-0.005***	0.002		
	Father's working hours	-0.002	0.004		
	Tax credit amount	-0.006***	0.001		
Family Composition	Multiple pre-school children	-0.456***	0.141		
	Primary school child	-0.537***	0.107		
	Secondary school child	0.048	0.233		
	Other adults	0.044	0.123		
	Under 1 year	-0.134	0.165		
	Age 1	-0.043	0.145		
	Age 2	0.089	0.141		
	Age 3	-0.074	0.126		
	Age 4	*Reference category*			
Regional Variables	North	-0.030	0.160	2.187**	1.078
	East and South East	-0.322**	0.156	4.225***	1.145
	Midlands	-0.059	0.179	0.660	1.250
	London	-0.262	0.192	8.318***	1.414
	Wales	0.071	0.278	-0.440	1.717
	South West	-0.059	0.212	0.198	1.482
	Scotland	*Reference category*			
Statistical values	_cons	0.900***	0.339	12.277***	2.174
	Mills lambda	-1.310	1.700		

* p<0.1, ** p<0.05, *** p<0.01

Regional variables generally have the expected effect, with the highest positive impact on wage coming from the London variable. Interestingly, the Mills lambda value is not significant, suggesting that self-selection is not an issue here. This means that women who are currently participating in the labour market are not selecting into this due to receiving different wages to what non-participating mothers would receive had they entered the labour market. The method used here is repeated for the childcare use and childcare price estimation below.

5.2.2 Childcare Use and Price Estimation

As with the labour force and wage estimation, selectivity-corrected estimates must also be used for the price of care. The price of care is predicted by adjusting for the probability of using care in the same way wages are predicted. The effects of independent variables have limited effects on the price of childcare. As can be seen in Table 5, there are only three variables that have a significant effect on price.

Table 5 Results for the childcare use probit with two-step Heckman method for price estimation

Variable Category	**Variable Name**	**Childcare Use**		**Price**	
		Coefficient	**Std. Dev.**	**Coefficient**	**Std. Dev.**
Demographic Variables	Under 24	*Reference category*			
	Age 25-29	0.151	0.225	-0.070	0.773
	Age 30-34	0.525**	0.227	0.827	1.033
	Age 35-39	0.805***	0.230	1.752	1.354
	Age 40-44	0.911***	0.252	1.230	1.519
	Over 45	0.551	0.375	0.451	1.404
	No degree	-0.436***	0.096	-0.729	0.676
	Ethnic minority	-0.604***	0.130	-0.971	0.974
Income Variables	Mother's non-labour income	0.002	0.001	0.037	0.024
	Father's non-labour income	0.001	0.009	0.001	0.005
	Father's working hours	0.003	0.001	0.017	0.013
	Tax credit amount	-0.001	0.004	-0.005	0.003
Family Composition	Multiple pre-school children	-0.413***	0.135	0.476	0.717
	Primary school child	-0.266***	0.101	-0.868*	0.497
	Secondary school child	-0.285	0.213		
	Other adults	0.051	0.114		
	Under 1 year	-0.018	0.158	-0.254	0.497
	Age 1	0.532***	0.136	1.490*	0.885
	Age 2	0.862***	0.133	1.459	1.282
	Age 3	0.365***	0.120	0.237	0.646
	Age 4	*Reference category*			
Regional Variables	North	0.144	0.143	0.129	0.470
	East and South East	0.212	0.144	0.711	0.526
	Midlands	0.212	0.163	-0.077	0.565
	London	0.249	0.182	1.649***	0.620
	Wales	-0.097	0.233	-0.094	0.713
	South West	0.184	0.193	0.483	0.619
	Scotland	*Reference category*			
Statistical Values	_cons	-0.731**	0.324	0.558	3.269
	Mills lambda	1.973	2.499		

* p<0.1, ** p<0.05, *** p<0.01

Primary school child would be expected to reduce the price of childcare, as seen in the estimation, as children of primary school age require less attention and a lower staff to child ratio than pre-school aged children. Following this, it is reasonable to assume that the costs of care for the youngest children are highest and this is indeed supported by results (see Age 1). The regional disparities in childcare prices across the UK, as mentioned in Section 2.1, are evident here with the London region exerting a significant positive effect on the price of care.

Childcare use can be better explained by the independent variables. Having multiple children under the age of 5 reduces the likelihood of using childcare, as does having children of primary school age or a lower level of education or belonging to an ethnic minority. Increasing age is positively related to childcare use. This could potentially be due to women experiencing a higher wage at these ages, although according to the price estimation, this does not cause them to pay a higher price for childcare which might be expected from higher earners. Tax credits fail to show any effect on the use of childcare. This may be due to the fact that the *Tax Credit Amount* variable, as previously mentioned, is the total tax credit amount, so this does not account for just the childcare element alone. As with the wage estimation, the Mills lambda value is not significant showing that women paying for childcare in this sample do not pay a significantly different amount to what other mothers would if they were to participate in the childcare market.

5.2.3 Labour Force Participation and Childcare Use Bivariate Probit

As stated above, the bivariate probit model can now be used to estimate the joint effect of childcare costs and wages on the probability of labour force participation and childcare use. The predicted wage and price values yielded from 5.2.1 and 5.2.2 are included here, the results from which are shown in Table 6. In this estimation, *Primary school child* is taken as the reference category instead of *Age 4* in order to avoid problems with collinearity. *South West* and *Other adults* are also omitted due to collinearity.

The model provides a better prediction with regard to labour force participation than for childcare use. Having pre-school aged children has a significant negative effect on labour force participation. The mostly significant negative effects of the same age categories on both dependent variables supports the theory that labour force participation and childcare use are a joint decision. Surprisingly, having multiple children under the age of 5 does not exert a significant effect on childcare use; in theory this would be expected to reduce the likelihood of childcare use due to the relatively high costs involved. Multiple pre-school children do, however, exert a significant positive effect on labour force participation; given the simultaneous lack of influence of this variable on childcare use, mothers could potentially be using informal care opportunities here. Due to collinearity however, the *Other adults*

variable has been omitted from this estimation, so the potential effects of informal care opportunities cannot be observed here. Tax credits have an extremely small negative association with labour force participation, but again this is likely due to the construction of this variable.

Table 6: Results for 'labour force participation' and 'childcare use' bivariate probit

Variable Category	Variable Name	Labour Force Participation		Childcare Use	
		Coefficient	**Std. Dev.**	**Coefficient**	**Std. Dev.**
Predicted Variables	Wagehat	-1.800	1.112	0.227	1.011
	Pricehat	0.619***	0.124	0.307***	0.116
Demographic Variables	Under 24	*Reference category*			
	Age 25-29	-0.110	0.383	0.212	0.362
	Age 30-34	7.406*	4.417	-0.656	4.013
	Age 35-39	9.114	5.856	-0.927	5.319
	Age 40-44	13.846	8.639	-1.225	7.852
	Over 45	14.858*	8.967	-1.407	8.152
	No degree	-9.709	6.291	1.085	5.720
	Ethnic minority	-6.968*	4.193	0.562	3.811
Income Variables	Mother's non-labour income	-0.036***	0.010	-0.010	0.010
	Father's non-labour income	-0.005***	0.002	0.001	0.001
	Father's working hours	-0.012**	0.005	-0.005	0.005
	Tax credit amount	-0.003*	0.001	0.001	0.001
Family Composition	Multiple pre-school children	1.102*	0.645	0.578	0.441
	Primary school child	*Reference category*			
	Secondary school child	0.018	0.231	-0.307	0.211
	Other adults	*Omitted due to collinearity*			
	Under 1 year	-1.705***	0.619	-0.971**	0.415
	Age 1	-2.753***	0.662	-1.007**	0.457
	Age 2	-2.609***	0.654	-0.658	0.448
	Age 3	-2.033***	0.631	-0.793*	0.417
	Age 4	-1.858***	0.623	-1.121***	0.409
Regional Variables	North	3.816	2.361	-0.391	2.151
	East and South East	6.833	4.609	-0.958	4.200
	Midlands	1.141*	0.687	0.083	0.629
	London	13.650	9.129	-2.156	8.305
	Wales	-0.663	0.618	0.064	0.551
	South West	*Omitted due to collinearity*			
	Scotland	*Reference category*			
Statistical Values	_cons	24.465*	13.734	-2.602	12.469
	athrho _cons	0.281***	0.064		

* p<0.1, ** p<0.05, *** p<0.01

The lack of significant effects on childcare use from observable variables suggests that other, non-observable factors influence this decision. The most unusual effect here is that the price of childcare, *Pricehat*, exerts a significant positive effect on childcare use. This is contrary to what existing research

suggests. However, the significant positive effect that price also has on labour force participation suggests that those who are using childcare can afford to, and due to this are paying a higher price. This could represent a higher quality of care, for example higher staff to child ratios and additional activities. The presence of a younger child, generally regardless of age, exerts a significant negative effect on childcare use. The simultaneous negative impact of these variables on labour force participation suggests that mothers prefer to care for their children themselves.

The influence of the *Wagehat* variable is also different to what would be expected. Theoretically, wages would be positively associated with labour force participation. This model finds no significant effect on either dependent variable, but with a negative coefficient related to labour force participation. This could be due to the influence of policy changes; greater support is now available for using paid childcare, thus the mother will have a lower reservation wage than previously as the amount of income that needs to be earned in order to cover childcare costs is reduced. This should at least reduce the size of the coefficient on *Wagehat*. Secondly, other variables could be more important in the decision to participate in the labour market. For example, the significant negative effects of young children (shown by the *Age* variables) could suggest that mothers value time with their children at this age more than they value consumption, leading *Wagehat* to have no significant effect on labour force participation.

5.3 Results

The results from the bivariate probit estimation of the effects of childcare use on maternal labour force participation depart from the consensus reached by previous research. Whilst some factors on the labour force and childcare use decision are expected, such as the presence of multiple younger children, the price of childcare has the opposite effect on both labour force participation and childcare use to what would be expected. When the marginal effects at average values are computed, it is observed that a ten per cent increase in the price of childcare would actually simultaneously increase labour force participation and childcare use by 1.6 per cent. However, the coefficients and this result are likely due to evolving government policy which makes the childcare use decision more complex and is no longer just a question of price. As highlighted in the literature review, most research does not cover the UK; studies that do, do not consider tax credits or free hours of childcare. The *Pricehat* variable used in this study includes the free hours of childcare for 3 and 4-year olds which reduces the cost considerably; this is likely to explain at least partly why the results yielded here differ so much from previous research. There are other variables that this study does not explicitly take account of, such as availability and quality of childcare. These unobserved factors may also account for some of the differences.

5.4 Evaluation

There are a number of ways this analysis has added to the existing knowledge in this area. This estimation uses more recent data than other studies and takes account of government policy (through tax credits) which has changed considerably since previous studies had been completed. The *Price* variable is also calculated in a more refined way compared with prior studies. Instead of using *price per hour worked*, the *price per hour of childcare used* is calculated, which better reflects the true cost of care. However, there are also limitations within this study. Available data do not allow for all factors, which would ideally be included in the estimation, to be used; for example, the 15 free hours of childcare cannot be controlled for, it is simply included in *Price*. Data may also be unreflective of the cost of childcare. It is not clear what price parents are actually reporting. For example, some parents include the childcare element of WTC in the amount they report paying, while some exclude it and a small minority of parents are unsure of the impact the benefit makes to their expenditure (DfE, 2013b, p.156). This means that tax credits may have been double counted in this study, since the childcare element could be included in both the *Tax credit amount* and *Price* variables. Improvements could be made here with the use of more focused survey questions. Explicitly asking parents for the amount they pay on childcare, excluding the help they receive from tax credits, would permit a deeper understanding of the exact cost of childcare.

A further limitation with tax credits is the simplification used in the *Tax credit amount* variable. WTC present the same self-selection bias as prices and wages. A separate WTC variable would therefore require the use of further selectivity correction; thus, the total amount of tax credits has been used instead. This prevents the effects of government policy being fully observed.

There are a number of ways the model could be improved by drawing upon past research. Blau and Robins (1988) for example, include the employment status of other adults in the household. This generates a better understanding of whether informal care is available. Blau and Robins use a more complex model, though; extending the estimation in the way they have would be beyond the scope of this model. Changes that would be possible within this model include modifying the income variables. As highlighted in Section 3, previous research considers income in a variety of ways. Averett *et al.* (1997), Connelly (1992) and Kimmel (1998) use the total household income excluding the mother's wage. This could be preferable to the method used here as it also allows for the partner's labour income and the income of other family members to be accounted for. These could both influence the price paid for childcare and the mother's labour force decision.

Additional variables that influenced the mother's earning potential, such as years of full-time and part-time work, and highest qualification level were considered. However, this required a large number of

additional dummy variables to be included and made no significant difference to the results yielded from the existing model.

6. Conclusion

This dissertation has addressed the effect of childcare costs on maternal labour force participation in the UK, by modelling the joint decision British women face in choosing to use a formal childcare provider and enter the labour market. Section 2 highlighted changes to childcare policy and the increasing cost of UK childcare which has changed the conditions under which mothers are making their decisions. This provided the scope for up-dated research, conducted through this dissertation. It has specifically built upon the work of Viitanen (2005) and Averett *et al.* (1997) by covering the UK childcare and labour market and has attempted to include the influence of recent government policy in the form of tax credits. Using a bivariate probit model with selectivity-corrected estimates for the mother's wage and price of childcare, this dissertation finds childcare costs to have a significant positive effect on maternal labour force participation, with no significant influence of the wage rate. This is contrary to existing research and economic theory. Further research could be done to explain why this is; explicit measures for the availability and quality of childcare could be included, along with a selectivity-corrected WTC variable. This would better account for policy reform and potentially explain why the childcare use decision and thus the labour force participation decision has become more complex. Ultimately, the available data to inform such analysis is a significant limitation on extending the scope of this research.

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Appendix

Table 7: Derivation of variables from the Family Resources Survey, 2011-2012.

Variable Category	Variable Name	Description
Key Variables	LFP	Uses the employment status variable *(EMPSTATI)* from the *Adult* table. 1 if *EMPSTATI*=1, 2, 3 or 4 and 0 otherwise.
	CCUSE	Uses the cost of childcare variable *(CHAMT)* from the *Childcare* table to determine whether formal, paid childcare is used. 1 if CHAMT>0 and 0 otherwise.
	Price	Calculated by dividing the cost of childcare *(CHAMT)* by the number of hours used *(CHHR),* from the *Childcare* table. Summed across all children in the benefit unit to determine the total childcare price incurred.
	Wage	Calculated by dividing gross weekly pay *(UGRSPAY)* by total job hours *(JOBHOURS).* Both variables taken from the *Job* table and use the main job only.
Demographic Variables	Under 24 Age 25-29 Age 30-34 Age 35-39 Age 40-44 Over 45	Dummy variables generated for each 5 year age band using the age band variable *(IAGEGR4)* from the *Adult* table. 1 if mother fits the age band category and 0 otherwise.
	No degree	Uses highest level of qualification variable (*HI2QUAL)* from the *Adult* table with a dummy variable generated for degree level education. 1 if no degree and 0 otherwise.
	Ethnic minority	Uses the ethnic group variable *(ETNGRP),* from the *Adult* table. 1 if ethnic minority and 0 otherwise.
Income Variables	Mother's non-labour income	Calculated by subtracting the sum of earned income *(INEARNS)* and tax credit income *(INTXCRED)* from total income *(INDINC).* All variables taken from the *Adult* table.
	Father's non-labour income	See Mother's non-labour income.
	Father's working hours	Uses total hours worked variable *(TOTHOURS)* from the *Adult* table.
	Tax credit amount	Uses the tax credit income variable *(INTXCRED)*.
Family Composition	Multiple pre-school children	Uses *Age* from the *Child* table and then combines all children by household and benefit unit. Dummy variables generated for each child age. Multiple pre-school children variable also generated with the number of children summed across the benefit unit by age category; 1 if at least 2 children aged under 5 and 0 otherwise.

	Primary school child	See Multiple pre-school children. Dummy variable uses 1 if at least 1 child aged 5-12 and 0 otherwise.
	Secondary school child	See Multiple pre-school children. Dummy variable uses 1 if at least 1 child aged 12-16 and 0 otherwise.
	Other adults	Uses the total number of adults in the household variable *(DVADULTH)* from the *Household* table, with the parents subtracted. 1 if other adults are present and 0 otherwise.
	Under 1 year Age 1 Age 2 Age 3 Age 4	See Multiple pre-school children. 1 if any children appear in the category and 0 otherwise.
Regional Variables	North East and South East Midlands London Wales South West Scotland	Uses household region variable *(GVTREGN)* from the *Household* table with dummy variables generated. 1 if household in region and 0 otherwise.

Source(s): UK Data Service, 2013