PRELIMINARY

The Supply of Childcare in Britain: Do Mothers Queue for Childcare?

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Abstract:
This paper presents a model of partial observability applied to the childcare market in Britain. We simultaneously estimate the demand and use and calculate the excess demand for childcare. We find a large queue with nearly half of the mothers demanding childcare queuing for it. We also find that formal and informal care are not substitute, implying that policies increasing the supply of formal care lead to an increase in the use of care rather than solely a shift from informal to formal care. This has implication on the efficiency of policies aiming at increasing the labour supply of mothers.

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> We also want to ensure that families have access to good quality childcare. This matters to us all. To the many parents - especially mothers - who are unable to take up job, education or training opportunities because childcare isn't available. To businesses, who suffer when skilled and talented people are unable to take up work.
> [..] there are not enough childcare places, and ordinary working parents often cannot afford to take them up.
>
> Tony Blair (DfEE 1998)

1. Introduction

"British childcare is worst in Europe" states a headline in The Independent newspaper (2.9.2001). The claim is based on a study by the Daycare Trust that finds that the childcare provision in Britain comes close to the bottom among the 15 EU member states using measures such as publicly funded nurseries and parental leave. This finding is not good news for the current government that has been trying to get recognised for its family-friendly policies. The National Childcare Strategy, recently launched by the Secretary of State for Education and Employment, promises to raise the quality of childcare, making it more affordable, as well as increasing its provision.

The government promises should be welcome to the general public. A recent survey finds that 38% of parents think that there are not enough childcare places available and 43% say it is too expensive. According to the Daycare Trust, the typical cost of a nursery place for a two-year-old is £5,700 a year (£7,000 in London), which is more than the average household spends a year on either food or housing. Furthermore, the government estimates that there are only 830,000 registered childcare places for the 5.1 million under 8-year-old children in England. This potential shortage of childcare providers is likely to worsen with time as women are expected to fill 2/3 of all new job creations between 1998 and 2009 (Wilson, 2000).

It is well documented that the labour force participation of mother's of pre-school children is highly dependent on the price of childcare (see, for example, Blau (2001)

for a review, Powell (2002) for the US, and Duncan et al. (2001) or Viitanen (2001) for the UK). However, these studies typically assume that the supply of childcare is perfectly elastic. An exception is Kreyenfeld and Hank (2000) using the German Socio-Economic Panel supplemented by some regional information on the provision of childcare. They use multinomial logit regression to estimate the labour market decision of mothers of at least one child less than 12 years old. They find that childcare provision rate does not affect the labour force participation of German mothers but that prices do. However, their results may stem from country-specific effects and sample selection; while the literature has concentrated on pre-school children, Kreyerfeld and Hank include mothers of older children. Chevalier and Viitanen (2001) explore the causality between female participation and supply of childcare in Britain. Using aggregate data from the Labour Force Survey, they build a eight years time series and conclude that childcare Granger causes participation without feedback, which supports the claim that women could be constrained in their participation by the lack of childcare facilities. The absence of a feedback mechanism implies that the supply of childcare is inelastic and does not react to an increase in demand[1]. Equilibrium is therefore reached either by a price increase or by the formation of a queue, which is consistent with the stylised facts.

In this paper, we examine whether demand and supply of childcare are in a disequilibrium. We use a method, first proposed by Poirier (1980) and Abowd and Farber (1982), in which a binary outcome (using childcare or not) reflects the joint unobserved binary choices of two decision makers. In this case, a child is observed in childcare, conditional on the mother demanding it and childcare being available at her reservation price; this is referred to as a partial observability model. The childcare

[1] This is also of importance for simulations on the price of childcare on the mothers' labour supply, which typically assume the perfect elasticity of the supply of childcare.

market is a sequential decision model with partial observability, as in Abowd and Farber (1982). First, the mother applies for childcare and joins a queue of demanders. Then, childcare providers select individuals out of the queue and offer places to individuals satisfying a decision rule (ranking by characteristics, first come/first serve). Only children who have been accepted are observed using childcare. After estimating the probabilities of demanding and receiving childcare, the size of the queue can be calculated. While these models have been used to measure queues for union or federal jobs (see Heywood and Mohanty (1995) for example), we reckon that this paper provides the first application of partial observability estimation in the context of childcare. Determining the size of the queue and the childcare arrangement of queuing mothers allows conclusions to be made on the efficiency of an increase in childcare supply on the female labour supply.

We find that the queue for childcare is large. The demand for childcare exceeds supply by more than 50%. Since formal and informal childcare are not substitute, increasing the supply of childcare would reduce this bottleneck and likely lead to an increase in the labour force participation of mothers.

2. Economic model and econometric method

Models of the demand for childcare typically compare the utility derived by the mother while using formal childcare and other forms of care. However, comparing utilities only determines the demand for childcare (Abowd and Farber, 1982). In a partial observability model, the supply side of the market is also included; the assumption is that the decisions are taken by two agents but only the joint outcome is observed. Thus, the final outcome reflects the decision taken on the supply and the

demand side and can lead to some conclusions regarding the equilibrium state of the market. In the case of childcare, a child is observed in childcare if the mother wants to use childcare and a place is offered by a provider of care. A child is not observed in childcare if the mother wanted to take care of the child herself or if the application of the mother to childcare was rejected by the childcare provider. Formally, the probability of using childcare is given by the formula below:

$$\begin{aligned} \Pr(C_i = 1) &= \Pr(D_i = 1 \,\&\, O_i = 1) \\ \Pr(C_i = 0) &= \Pr(D_i = 0 or O_i = 0) \end{aligned} \tag{1}$$

where C is the observed outcome of the use of childcare by mother i; D and O are unobserved and reflects respectively the demand for childcare and the offer of a childcare place to child i. A childcare offer is always accepted by a mother demanding formal care. To simplify the notations, we now drop the i subscript.

The two non-observed decisions D and O follow latent models such as[2]:

$$\begin{aligned} D &= x_D \beta_D + \varepsilon_D \\ O &= x_O \beta_O + \varepsilon_O \end{aligned} \tag{2}$$

Where x_D and x_O are vectors of characteristics explaining the demand and the acceptance of childcare. These vectors typically will contain household, and local characteristics. The random error terms (ε_D and ε_O) both follow a univariate normal distribution. For the model to be identified at least one variable should be unique to x_D or x_O. To identify the model, we rely on local authority information on the price and the provision of childcare. The average price at the local authority level is a determinant of the demand for childcare only. Childcare being a normal good, we assume that higher mean price would have a negative effect on the individual demand

[2] The offer equation implicitly suggests that childcare providers use a ranking system based on the individual characteristics rather than operate a first come/first serve basis. This assumption is not formally imposed in the empirical specification where identification comes from variations in the local supply and prices of childcare.

for childcare. Additionally, childcare may be provided free of charge (usually to poorer working families, see Duncan and Giles (1996) for example). As free-fee carers were not included in the calculation of the average price, the proportion of children getting free care in the local authority is added. We also use identifying variables in the offer equation by including variables on the availability of childcare (expressed as a ratio for 100 children) for different types of providers. Children aged less than 4 may be accepted in pre-school classes. The provision of this alternative to childcare was, for the period of interest, non-compulsory and far from universal. Thus, as part of the supply of childcare, we include the proportion of 4 year old enrolled in education[3]. We assume that an offer is more likely to be made to individuals living in local authorities with a higher supply of care[4].

In a sequential-decision model with partial observability, the second equation in (2) is conditional on $D_i = 1$. Formally, the system of equation (2) is equivalent to:

$$\Pr(D = 1) = \Pr(x_D \beta_D > 0) \tag{3}$$

$$\Pr(O = 1 / D = 1) = \Pr(x_O \beta_O > 0 / x_D \beta_D > 0) \tag{4}$$

An offer for childcare is made only to mothers that were in the queue of women demanding childcare[5]. Thus, the distribution of ε_O only exists for $\varepsilon_D > -x_D \beta_D$ and conditional on being in the queue for childcare the error terms ε_D and ε_O are independent. The likelihood function to maximise has therefore the following form:

$$L = \prod_{D=1} [\Phi(\beta_D x_D)\Phi(\beta_O x_O)] * \prod_{D=0} [1 - \Phi(\beta_D x_D)\Phi(\beta_O x_O)] \tag{5}$$

[3] Since September 1998, each child aged 4 has a guaranteed access to a pre-school. This has recently been extended to children aged 3 as well.

[4] This model therefore implicitly implies that the total supply of childcare has no effect on the individual demand for the service. This assumption may be rejected if individuals faced with a low supply of childcare feel discouraged and do not apply.

[5] For a discussion on the differences between a simultaneous (as in Poirier) and sequential (as in Abowd and Farber) partial observability models, see Maddala (1983).

3. Data

The data comes from four waves of the Family Resources Survey (FRS) covering years 1994/5-1997/8[6]. The FRS is a continuous survey sponsored by the Department of Social Security for policy monitoring and the costing and modelling of changes to national insurance contributions and social security benefits in Great Britain. The FRS includes a detailed questionnaire relating to benefits and childcare take-up and expenditure. Unfortunately, the childcare section is routed and only families with at least one working adult have to complete it. We restrict our sample to mothers aged 18 to 59 with a least one child aged less than 5 (pre-school age), and drop families where no adult works. To limit the bias resulting from this selection rule, we drop lone mothers from the sample as only a small proportion of working lone mothers were observed. We define the use of childcare as using any type of formal providers of care; a detailed breakdown of the childcare providers is reported in Table 1. Childminders and nursery/playgroups are the main providers of formal childcare, but schools are also extensively used. Working mothers used more formal childcare, especially childminders and nurseries/playgroups, but also more informal care. Pre-schools may not be an ideal arrangement for working mothers since this is the provider for which the smallest difference between the use by working and non-working mothers is observed[7].

[6] The definition of some local authorities was changed after 1998 hence breaking the series.
[7] On a similar note, Paull et al. (2002) note that the participation of mothers to the labour market does not jump when the youngest child reaches school age, thus undermining either that parental care prevented the mother from working or that schools are not a good alternative to childcare.

Table 1: Main providers of childcare

	All mothers	Working mothers	Non working mothers
Childminder	10.4%	17.0%	2.4%
Nursery/playgroup	9.8%	16.3%	1.9%
Creche	0.6%	1.1%	0.1%
School	6.4%	8.4%	4.2%
Informal provider	22.3%	37.1%	4.5%
Parental care	50.5%	20.1%	86.9%

The FRS is augmented with local authority statistics provided by the Department of Health, on the availability of various providers of childcare expressed as rates per 100 children within the local authority (109 local authorities (LA)). The childcare providers can be broken down in three categories: day nursery, playgroup, and childminder. In this administrative data, the detailed provision of childcare by type of providers was for some local authority badly reported and we drop those for which at least one type of provider was missing for each of the four years (9 LAs were dropped). We also impute the provision when some years were missing by using the rate reported the following year (or the previous year for 1997). The provision of care at the LA level ranges from 850 places per 10,000 children to more than 6,000 (City of London). City of London is a clear outlier since the second best LA only offers 3,800 places. To limit bias due to measurement error in this variable, we recode the supply distribution into quintiles.

We also compute the average price for the different providers of care at the local authority level. These calculations are based on the price paid by mothers using childcare in the FRS; therefore this implicitly assumes that all mothers within the same local authority are faced with the same price[8]. This calculation constrains us to group nurseries ,playgroups and crèche as the FRS does not distinguish between these

[8] Powell (2002) on the contrary impute childcare prices for all individuals based on their own personal characteristics.

categories of childcare providers. For each LA we calculate the average price for nursery and playgroup, and for childminder[9]. We also create variables on the proportion of children not paying for formal care and attending pre-school, to correct for the non-inclusion of children using free care in the calculation of the average price of childcare at the local authority level and the ratio of four years old in education.

The decomposition of the data to obtain our final sample is presented in Appendix A1 and the summary statistics on the variables of interest are presented in Table 2, separately for all mothers and then by working status. We have a sample of 5,825 married/cohabiting mothers with at least one child under school age. The average mother in our sample is aged 31 and left school at 17 and a half. Women are slightly younger. About 9% of women self-report themselves as being in bad health and 6% are non-white. Nearly three quarters of the families, have only one child less than 5 and only a marginal proportions have 3 or more children. The presence of other children will affect the use of childcare by the mothers. The effect of older children on the use of childcare is ambiguous and likely to depend on the age and gender of the older siblings. Thus, we report the number of children aged 5 to 12 in the families, who may increase the preference for the mother to stay home and the number of teenagers aged 13-17 split by gender. The father may also be able to provide some care. Younger more educated fathers as well as those working less hours may be able to provide more childcare. There are some variations in the provision of care at the local authority level. The average price per hour of childcare (deflated to 1997 prices) is slightly above £2 per hour for the two types of provider. These prices are consistent with those reported by the Daycare Trust (~£80 per week).

[9] Duncan and Giles (1996) report the hourly price of childcare for different types of providers. Even though the distributions are quite different, the hourly price of nursery and playgroup are comparable. In 1991, 90% of users of nursery and playgroup were paying less than a pound per hour, while the average price for childminder care was above £1.00.

Nearly 50% of mothers of young children are participating to the labour market, and a quarter of those are part-timers. It is important to notice the difference in the characteristics of working and non-working mothers. Working mothers are five times as likely to rely on formal childcare, they have less children and the youngest child is on average 6 months older than for non-working mothers. Their partners work two and half hour less in accordance with Becker's internal division of labour within the household.

Table 2: Summary statistics- correct the mistakes esp on price of care

	All		Mum not working		Mum working	
Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Use child care	0.2443	0.4297	0.0788	0.2695	0.3871	0.4872
1 child aged 0-4	0.7270	0.4455	0.6435	0.4790	0.7931	0.4051
2 children aged 0-4	0.2544	0.4356	0.3252	0.4685	0.1988	0.3992
3 children aged 0-4	0.0185	0.1349	0.0313	0.1742	0.0081	0.0896
Nbr Child aged 5-12	0.5845	0.7592	0.6035	0.8062	0.5683	0.7167
Nbr girls aged 13-17	0.0240	0.1629	0.0264	0.1695	0.0215	0.1544
Nbr boys aged 13-17	0.0247	0.1701	0.0275	0.1791	0.0229	0.1630
Child age 4 in FT edu.	0.0642	0.2493	0.0404	0.1988	0.0816	0.2789
Age of youngest child	1.7499	1.3752	1.4138	1.3499	2.0222	1.3327
Dad years in education	17.4702	2.5054	17.5624	2.6018	17.3902	2.4213
Dad hours worked	43.9409	14.0170	45.4070	12.1552	42.7590	15.1858
Dad age	33.9013	5.7030	33.7209	5.7942	34.0795	5.5944
Log household income	6.1909	0.5891	6.0802	0.6316	6.2809	0.5341
Mum education	17.5353	2.2687	17.4534	2.2680	17.5947	2.2493
Mum work full time	0.3535	0.4781			0.6390	0.4804
Mum work part time	0.1317	0.3382			0.2481	0.4320
Mum self-employed	0.0597	0.2370			0.1129	0.3166
Mum age	31.4999	4.8064	31.2290	4.9699	31.7287	4.6267
Mum non white	0.0591	0.2357	0.0754	0.2642	0.0426	0.2019
Mum bad health	0.0877	0.2829	0.0958	0.2944	0.0823	0.2749
Price nursery/playgroup	2.1675	0.3976	2.1707	0.4058	2.1794	0.3684
Price childminder	2.0651	0.3514	2.0743	0.3471	2.0714	0.3415
Nurseries/playgroups per 100	18.5579	5.9461	18.7642	5.9314	19.0664	5.4920
Childminders per 100	6.5959	3.3318	6.6360	3.2999	6.6352	3.3644
LA % age 4 in FT edu.	0.2355	0.0785	0.2341	0.0770	0.2286	0.0721
LA % free childcare	0.0173	0.0109	0.0172	0.0107	0.0194	0.0097
Observations	5,825		2,983		2,842	

4. Results

Since the use of childcare is mostly confined to working mothers, the results will be presented first for all mothers and then specifically for working mothers. As the decision to work and to use childcare are not independent, the results are biased, providing a lower band on the size of the queue for childcare.

The model includes the variables presented in the summary statistics as well as regional and year dummies. The provision of nursery/playgroup and childminder places at the local authorities are recoded into quintiles to reduce the bias due to measurement error.

The composition of the household is clearly an important determinant of the use of childcare. Families relying on parental care can expect economies of scale when taking care of more than one young child. Those economies are not likely to be redistributed to the parents using childcare, thus we expect that more young children will reduce the use of formal childcare. The presence of young school age children may also increase the preference for the mother to stay home and take care of her youngest child, some possible economies of scale for the mother are also possible; thus the presence of older siblings may reduce the use of childcare. Teenagers (aged 13-17), in a household may provide informal childcare and reduce the demand for formal care. This provision of care by teenagers may be dependent on their gender, with females providing more care than male teenagers. The age of the child affects the probability of relying on formal childcare in a positive way. First, mothers are guaranteed some maternal leave (see Waldfogel, 1998 for details) and the preference for taking care of one's own child may be higher, the younger the child is.

Additionally, the provision of childcare for very young children is limited, reducing the possibility of using childcare for babies.

As the role of women in the society has changed in the past three decades, we expect some cohort effects in the use of childcare, with younger more educated couples more likely to use childcare. Parental labour force participation should also be associated with a greater use of childcare. For both parents, and especially the mother, labour force participation and childcare use are endogenous since the two decisions are taken simultaneously. As we do not have valid instruments in the data to identify the decision to work independently of the use of childcare, we only stress that the estimates on labour force participation could be biased.

The mother's health may have ambiguous effects on the use of childcare. On one hand, if the health conditions reduce the probability of working then it may reduce the need for childcare. On the other hand, serious health problems may prevent the mother from providing care herself and thus increase the demand for formal childcare. This estimate is likely to be affected by measurement error. The ethnicity of the mothers may also affect her choice of childcare, but the direction of the effect is likely to be specific to unobserved characteristics (mother's integration, proportion on non-white in the neighbourhood).

Finally, we expect childcare to be a normal good and higher local prices should lead to a reduction in the use of childcare. Similarly, the proportion of free providers in the local authority should be associated with an increased use of childcare. Since the data was collected before it was made compulsory for schools to offer places for below school-age children, there is quite a large variation between local authorities.

Table 3: Probit: Estimates of demand for childcare (All mothers)

	No queue		Demand		Offer	
	Coefficient	Standard Error	Coefficient	Standard Error	Coefficient	Standard Error
Mum age	0.1482 **	0.0511	0.2561 **	0.1118	-0.0340	0.1382
(Mum age ^{2})/10	-0.1893 **	0.0762	-0.3677 **	0.1682	0.0783	0.1990
Mum education	0.0633 **	0.0113	0.1659 **	0.0328	-0.0392	0.0322
Mum bad health	0.0198	0.0729	0.2003	0.1621	-0.1965	0.1564
Mum non white	-0.3421 **	0.1073	-0.1885	0.3194	-0.4684 *	0.2706
Mum full time work	1.1859 **	0.0508	-0.1924	0.3806	2.0057 **	0.1608
Mum part time work	0.5901 **	0.0667	-0.5454 *	0.3306	1.2913 **	0.2177
Mum self-employed	0.6712 **	0.0850	-0.2486	0.3290	1.1030 **	0.1929
2 kids aged <4	-0.0831	0.0558	-0.3320 **	0.1227	0.2374 *	0.1404
3 kids aged <4	-0.2180	0.2094	-0.5373 **	0.7781	0.1459	0.6850
Nbr kids aged 5-12	-0.2588 **	0.0327	-0.1852 **	0.0669	-0.2574 **	0.0706
Nbr girls aged 13-17	-0.3894 **	0.1454	-0.4276 *	0.2446	-0.1427	0.4014
Nbr boys aged 13-17	0.1693	0.1174	0.3514	0.3205	-0.0773	0.2814
Age youngest child	0.2636 **	0.0179	0.1892 **	0.0431	0.2758 **	0.0402
Ln income	0.2636 **	0.0438	0.6579 **	0.1067	-0.1276	0.1133
Dad age	0.0311	0.0358	-0.2045 **	0.1022	0.2051	0.0906
(Dad age^2)/10	-0.0402	0.0472	0.3081 **	0.1437	-0.2906	0.1162
Dad education	0.0409 **	0.0103	0.0667 **	0.0249	0.0190	0.0221
Dad hours worked	-0.0001	0.0015	0.0035	0.0026	-0.0058	0.0035
LA price nursery/playgroup	0.0411	0.0612	-0.0153	0.0916		
LA price childminder	-0.0091	0.0785	-0.1278	0.1200		
LA % free provider	6.0075 **	2.0394	8.7453 **	3.1855		
LA supply nursery quint 1					-0.1526	0.1585
LA supply nursery quint 2					-0.2134 *	0.1297
LA supply nursery quint 3					-0.0775	0.1285
LA supply nursery quint 4					-0.3031 **	0.1160
LA supply childminder q 1					-0.1325	0.1304
LA supply childminder q 2					0.0984	0.1165
LA supply childminder q 3					0.0685	0.1192
LA supply childminder q 4					-0.1913 *	0.1150
LA % kids 4 in school					1.3250 **	0.5752
Constant	-8.7556	0.8130	-9.1041	1.8753	-3.4775	2.5443
Observations	5825		5825			
Log Likelihood	-2450.9 (Chi^2(33)=1575)		-2385.4 (Chi^2(73)=1706)			

Note: Dummies for the 10 administrative regions and 4 years were also included. ** and * refers to significance at the 10% and 5% level.

Some promoted the inclusion of children in school at the youngest age either because it is thought to be beneficial for the child (see Duncan and Giles (1996) for some evidence) or as a cheaper alternative to the provision of childcare while others did not offer the option at all.

We first estimate the constrained version of the model where there is no queue. This is equivalent to assuming that the supply of childcare is perfectly elastic and that a childcare place is always provided to a mother demanding childcare. This is a special case of the queue model, which is formally equivalent to imposing $\forall \mathrm{i}, \Pr(\mathrm{O_i} = 1 / D_i = 1) = \Pr(D_i = 1) = \Pr(C_i = 1)$. This model can be estimated as a univariate probit for the use of childcare (Table 3, columns 1 and 2).

With the no queue model specification, we can reject that the explanatory variables have no power; the log likelihood is -2450.9, which gives a likelihood ratio test of 1575 significantly higher than the critical value for a Chi-square with 33 degrees of freedom. Most of the expected relations hold. Younger more educated parents, working mothers and wealthier white households are more likely to use childcare. The presence of other children aged 5 to 12 increases the preference for the mother to take care of her children herself. Female teenagers appear to provide some care for their younger siblings but not teenage boys. Surprisingly, the number of children aged less than four has no significant effect on the demand for childcare. The proportion of free providers is associated with a greater probability of use but surprisingly the local prices of childcare are not significant determinants of the use of childcare. The price of playgroup/nursery is even positive, which could reflect a quality issue, where parents unable to appreciate the quality of the provider of care, rely on the price as an indicator. If parents have a preference for quality but are not

able to observe it, they use price as an indicator of quality[10]. The unpredicted effect of the price of playgroup/nursery on the use of childcare may also be a consequence of the grouping of providers.

The no queue model has a significant amount of explanatory power: the use of childcare is correctly estimated for 80% of the observations, but to answer the question of interest we now shift our attention to the queue model. Columns 3 to 4 in Table 3 reports the estimates for the demand of childcare and columns 5 to 6 those for the acceptance into care. The maximum log likelihood value is –2385, which compares favourably with the -2451 in the no queue model. The likelihood ratio test reaches 130.94 while the critical value for a Chi-square with 39 degrees of freedom is 54.29 at the 5% confidence level, hence the no-queue model is rejected.

The estimates of the demand for childcare are similar to those obtained for the use of childcare. The main differences are that the number of children under five in the family negatively affects the demand for childcare, as was expected in a model of economies of scale in the production of childcare by the mother. The prices of the two types of providers have a negative effect on the demand for childcare, through both are insignificant. It can be noted that the demand for childcare is about 10 times more sensitive to the price of childminder than the price of nursery/playgroup. Powell (2002) similarly finds that the mother's employment-childcare choice relationship was more sensitive to changes in the price of sitter than in the price of centre. More surprisingly, the mother's participation to the labour market is now associated with a reduction in the demand for childcare compared to non-working mothers. We do not have a good explanation for these results that are likely to be due to the endogeneity of the participation and demand for childcare decisions.

[10] Mocan (2001) reveals moral hazard issues, with providers investing in the quality of easily to observe (bythe parents) items rather than items directly related to the quality of the care provided. Blau (2001) also shows that parents are not good at assessing the quality of the childcare providers.

The childcare offer estimates are presented in the last two columns of Table 3. This equation is identified by the exclusion of the local authority price of childcare variables and the inclusion of dummies for the supply of childcare in the local authorities. The supply is separated between playgroup/nursery and childminder, and reported in quintiles (the omitted quintile represents the highest supply for 100 children). The last identifying variable measures the proportion of children aged 4 registered in school within the local authority of residence. The supply of childcare has roughly the expected effect on the probability of being offered a childcare place. Mothers living in better endowed local authorities are more likely to be accepted than others. However, despite the large variation in the provision of childcare, this effect is not really strong and does not appear to be linear. For childminders, only one quintile is associated with a significant effect and a couple of quintiles have effects with the wrong sign. The provision of education for children aged 4 is, on the other hand, strongly associated with an increase in the probability of using childcare.

The other variables affecting the likelihood of an offer being made are mostly due to the labour force participation of the mother. Working mothers are more likely than non-participating mothers to be offered a place for their child. The effects are ordered with full time employed mothers having the greatest chance of an offer and self-employed mothers the lowest. This could indicate that self-employed mothers are expected to be more flexible in their working patterns in order to accommodate work and parental care. This pattern may also reflect a process by which providers rational the queue; offering places to mothers that are thought to be more needing. Having more than one child under the age of five increases the chances of an offer being made. Older children are more likely to be accepted than babies, which could be related to regulations (Children Act 1988) increasing the number of staff for children

under the age of 2. Since childcare is a labour intensive activity, providers may have an incentive to focus on older children in order to maximise their profits.

Providers of care appear to discriminate in favour of white mothers but not against the poor. This could be a selection effect since poorer families are less likely to demand childcare in the first place. Surprisingly, mothers with bad health are not more likely to be offered a place with their children, which is likely to be due to the definition of bad health (self-reported) in the data. It is not clear how providers allocate childcare. If personal characteristics had no effect on the probability of receiving an offer, this would indicate the use of a first come/first serve allocation model, but we only find a few significant personal variables thus not fully supporting a ranking model.

As the demand for childcare is strongly affected by the working characteristics of the mother, and since the labour force participation of the mother is endogenous, we also conduct the analysis on a sub-sample of working mothers. Not accounting for the selection effects, these results will provide a lower band on the demand and queue for childcare for working mothers. The results for this sub-sample are presented in Table 4.

Most of the results of the no-queue model are similar to those presented for the full sample. We reject the hypothesis that the specification used has no explanatory power (Chi^2 (32)=600). To summarize briefly; younger, wealthier, more educated white parents with only one child of pre-school age are more likely to use childcare. Other children in the household reduce the probability of using childcare. Mothers working part-time or being self-employed are less likely to use childcare than full-time employed mothers.

Table 4: Probit: Estimates of demand for childcare (working mothers)

	No queue		Demand		Offer	
	Coefficient	Standard Error	Coefficient	Standard Error	Coefficient	Standard Error
Mum age	0.1667**	0.0662	0.1864**	0.0846	-0.2604	0.2796
(Mum age ^{2})/10	-0.2135**	0.0997	-0.2441*	0.1299	0.3757	0.3834
Mum education	0.0769**	0.0148	0.0942**	0.0196	0.0067	0.0434
Mum bad health	0.0126	0.0937	-0.1286	0.1039	1.4302	1.0602
Mum non white	-0.3963**	0.1443	-0.3644	0.2284	-0.4984	0.5041
Mum part time work	-0.5492**	0.0672	-0.6725**	0.0836	0.4341	0.3501
Mum self-employed	-0.4855**	0.0868	-0.4899**	0.1155	-0.1632	0.2643
2 kids aged <4	-0.2446**	0.0723	-0.2089**	0.0942	-0.2010	0.2722
3 kids aged <4	-0.4146	0.3169	-0.6929**	0.3475	6.1920	0.1669
Nbr kids aged 5-12	-0.3352**	0.0425	-0.2626**	0.0569	-0.4645**	0.1453
Nbr girls aged 13-17	-0.3819**	0.1771	0.3794	0.4304	-1.6022**	0.3891
Nbr boys aged 13-17	0.2336	0.1586	0.2128	0.2217	0.1191	0.4456
Age youngest child	0.2022**	0.0229	0.2204**	0.0290	0.0623	0.0921
Ln income	0.3935**	0.0688	0.7239**	0.0862	-0.6770**	0.2355
Dad age	0.0445	0.0428	-0.1292*	0.0720	0.3212*	0.1691
(Dad age^2)/10	-0.0570	0.0560	0.2102**	0.1022	-0.4870**	0.2089
Dad education	0.0494**	0.0136	0.0612**	0.0187	0.0050	0.0421
Dad hours worked	-0.0010	0.0018	0.0027	0.0024	-0.0219**	0.0071
LA price nursery/playgroup	-0.0083	0.0850	-0.0551	0.0990		
LA price childminder	-0.0472	0.1013	-0.1141	0.1149		
LA % free provider	7.8973**	3.0268	9.4128**	3.4819		
LA supply nursery quint 1					-1.0756**	0.4868
LA supply nursery quint 2					-1.1250***	0.4096
LA supply nursery quint 3					-0.7321**	0.3653
LA supply nursery quint 4					-0.7510**	0.3213
LA supply childminder q 1					0.3869	0.3168
LA supply childminder q 2					0.3997	0.3110
LA supply childminder q 3					0.5359	0.3261
LA supply childminder q 4					-0.1478	0.2493
LA % kids 4 in school					0.6542	1.3221
Constant	-8.9481	1.0652	-8.9281	1.3696	6.3270	5.1487
Observations	2,842				2,842	
Log Likelihood	-1596.8 (Chi^2(32)=600)				-1547.1 (Chi^2(71)=699)	

Note: Dummies for the 10 administrative regions and 4 years were also included.

The local price of childcare has the expected effect on the use of childcare; working mothers are less likely to use childcare in areas where childcare is more expensive and more likely to use it in areas where a larger proportion of childcare is provided free of charge to the parents.

Shifting our attention to the queue model, a likelihood ratio rejects the no queue model at any level of significance ($Chi^2(39)=99$). The demand estimates are similar to those obtained for all mothers, but on this sub-sample, the working patterns of the mother have the expected effect on the demand for childcare. Employed mothers working full time are likely to be the least flexible with their time, while part-time workers and self-employed may be able to provide most of the childcare themselves and rely on their partners or informal care for the rest of the time. The offer estimates are rather different from those obtained on the full sample. Women working part-time or being self-employed are as likely, conditional on having demanded, to receive childcare than women working full time, while in the full sample, we had a clear ranking. We no longer observe discrimination against non-white in the provision of care, but this may be due to the small number of working non-white mothers. Similarly, the coefficients on the number of children under the age of 5 may be affected by the small number of observations. The age of the child does not appear to affect the probability of having an offer made as there is less variation in the age of the children for working mothers. The reduced variation stems from the endogeneity between the decision to go back to work by the mother and the age of the child. As can be seen in the summary table, working mothers have children that are older than non-working mothers. Mothers in local authorities where more playgroups and nurseries are available are more likely to be offered a place in childcare. This effect is almost ranked and appears to be fairly large even for the fourth quintile. On the other

hand, neither the supply of childminders nor the availability of pre-school classes have a significant effect on the probability of having a demand for childcare accepted.

The demand (3) and offer (4) equations allow us to calculate the proportion of mothers asking for childcare and the size of the queue for childcare[11]. These decompositions of the population of mothers are reported in Table 5 for all mothers and for working mothers only.

Table 5: Predicted probabilities in the use of childcare

	Full sample	Working mother
Pr (D=1)	0.503	0.433
Pr (O=1/D=1)	0.473	0.974
Pr (O=0/D=1) * Pr(D=1)	0.265	0.011

Looking at the full sample, 50.3% of mothers of pre-school children would like to use formal childcare, however only 47.3% of these demands are accepted. This implies that 26.5% of mothers do not get the care provision that they would like (row three). The shortage of childcare in the UK is extremely important. It is interesting to compare these figures with the use of childcare by providers as reported in Table 1. The model does a good job at predicting the use of childcare, more importantly it appears that the size of the queue is nearly similar to the proportion of mothers using informal childcare. In the next section, we will explore this issue of whether the informal sector accommodates for the unsatisfied demand for formal childcare. If this is the case a policy increasing the supply of formal care would only shift users from

[11] The probabilities are estimated for each individual. The mean probability for the population is thereafter calculated.

informal to formal childcare and thus be unlikely to have large effects on the labour supply of mothers[12].

For the sub-sample of working mothers, the results appear contra-intuitive. Only 43% of them would like to use childcare and for those who do 97% are accepted, which indicates that there is no queuing for childcare for working mothers. However, these results may be due to rational expectations and reverse causality. Mothers who would like to work but realise that they are unlikely to be granted a formal care place may decide not to work. By excluding this type of women, our sub-sample reduces the real demand for childcare. Also working mothers who do not rely on childcare may have some good reasons not to, hence they do not demand formal care.

5. Simulations and policy recommendations

From the full sample, we noticed that the size of the number of women in the queue for childcare and the number of women relying on informal childcare were similar. If informal care only captures mothers who have been rejected from formal childcare then policies aiming at increasing the use of formal childcare (usually in order to increase female labour supply) would mostly shift children from one type of care to another and hence are likely to have no substantial effect on the female labour supply. If on the other hand, the queue is mostly composed of women who are taking care of their children themselves, then a policy of increasing the supply of formal care, would free these mothers from part of their parental care duties and may allow them to participate in the labour force. In Table 6, we report the actual and predicted

[12] A policy of shifting from informal to formal sector may be desirable, even if no effect on the labour supply of mother is expected, if the quality of the care provided is higher in the formal sector. The relative quality of the two sectors is difficult to judge. Relatives may be full of good intentions but does that make them good carer, on the other hand, formal care may be less good than the one provided by the experienced neighbour.

use of care[13]. The predictions of the model are reasonably accurate, nearly 60% of formal care users are assigned to the correct category. The bulk of the queue is represented by mothers using parental care; while 55% of mothers are relying on parental care in the population, their proportion in the queue reaches 78%. It thus appears that formal and informal childcare are not substitutes. The majority of mothers who do not get access to formal childcare take care of their children themselves rather than rely on informal care. This behaviour may be due to concerns about the quality of the care provided in the informal sector. Thus, the lack of formal childcare is a bottleneck that forces mothers of young children to provide parental care rather than possibly participate in the labour force. Policies reducing this constraint may therefore be efficient at increasing the proportion of young mothers working.

Table 6: Origin of mothers queuing for childcare

		Predicted	
Observed	Not demanding	Queuing	Using care
Parental care	1945	1076	218
Informal care	705	95	368
Formal care	402	198	818

The traditional complaints about childcare in the UK concern the scarcity of the supply and the high costs. We simulate the effects of changing these characteristics on the demand and the queue for childcare. Since we have used variations in prices and supply to identify respectively the demand equation and the offer equation, simulated policies have to affect both prices and supply in order to affect both

[13] Individuals with a predicted probability greater than 0.5 were coded as 1. Thus, these results slightly differ from those presented in Table 5 where the actual probabilities were used.

equations. We simulate four policies whose effects on the demand and the queue for childcare are reported in Table 7.

Table 7: Effects on demand and queue for childcare (Full sample)

	Currently	Pol 1	Pol 2	Pol 3	Pol 4
Pr(D=1)	0.503	0.512	0.507	0.512	0.516
Pr(O=1/D=1)	0.473	0.481	0.481	0.500	0.507
Pr(O=0/D=1) *Pr(D=1)	0.265	0.266	0.263	0.256	0.254

Policy 1: Mean price at LA reduced by 10%, Provision of school in Education increased by 10%
Policy2: Proportion of free providers at LA increased by 10%, Provision of school in Education increased by 10%
Policy 3: Mean price at LA reduced by 10%, supply shifted by one quintile
Policy 4: All of the above simultaneously

The policies have the expected effects. Reducing the price of childcare or increasing the supply of free-care increases the demand by about a percentage point [how does that compare with other UK stuff…Duncan? Ian and Gauthier??] while increasing the supply increases the probability of an offer for childcare being made. We cannot comment on the relative efficiency of one policy versus another one, since the interventions simulated here are not in the same metrics. Current childcare policies such as Working Families Tax Credit may only lead to an increase in the queue if the supply of childcare does is inelastic.

6. Conclusion

We have examined the determinants of childcare demand in the UK for mothers of pre-school age children. For the first time in this type of analysis, we account for partial observability; a woman uses childcare if she demands it and if her offer is accepted. We found an excess demand for childcare in the UK. The size of the queue for childcare is substantial: while a bit more than 50% of mothers would like to use childcare, only 47% are provided with a place for their child. Furthermore, the queue

is underestimated since we have imposed the exogeneity of the mother's labour force decision.

Finally, informal and formal childcare are not perfect substitutes and a majority of women queuing for childcare take care of their children themselves rather than relying on informal care. This means that policies increasing the supply of childcare, would free these women from childcare duties and thus may have some positive impact on their participation to the labour force.

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Appendix A1: Data.

FRS 94/95 to 97/98

All mothers with child less than 4:	10,738
Married/cohabiting mothers:	-2,409
At least one working adult in HH:	-1,169
Unclear family relations:	-531
Missing LA:	-490
Other missing variables:	-314

APPENDIX: The childcare providers in the UK

Registered childminders are self-employed child-carers who look after the children in their own home. They must be registered with the local authority (LA) and inspected once a year. Childminders can care for up to six children aged under eight of whom no more than three must be aged under five, at any one time. They are limited to one or two babies at one time. The childminders set the charges themselves and there is no national rate, however, most charge between £60 and £120 per child per week for full-time care. The average price at the national level reported by the Daycare Trust is £88.87.

Preschool playgroups usually provide play and education sessions lasting about 2½ to three hours. They are also registered and inspected by LA. Some provide free early education and are inspected by Office for Standard in Education (OFSTED). At least half the staff must be trained to work with children. It is recommended that there is one member of staff for every eight children aged three to five and one adult for every four children aged two to three, also, often parents help out. Preschools cost between £2 to £5 per session.

Nurseries look after and educate children aged 0-5. They are registered and inspected by the LA. There are different types of nurseries: private, local authority, community (non-profit), and workplace. At least half the staff must be trained. Staffing levels are: one for every child between three to five years old, one for every four children aged two to three and one staff for every three children aged under two. Most nurseries provide between 26 and 40 places. The expected price per child per week is between £80 and £180 and the average price for full-time care for a two-year old is £110.49 (Daycare Trust).