

Working Paper Number 14

Families and Children Strategic Analysis Programme (FACSAP)

**Reviewing approaches to understanding the link
between childcare use and mothers' employment**

© Crown copyright 2004. Published with permission of the Department for Work and Pensions on behalf of the Controller of Her Majesty's Stationery Office.

The text in this report (excluding the Royal Arms and Departmental logos) may be reproduced free of charge in any format or medium provided that it is reproduced accurately and not used in a misleading context. The material must be acknowledged as Crown copyright and the title of the report specified. The DWP would appreciate receiving copies of any publication that includes material taken from this report.

Any queries relating to the content of this report and copies of publications that include material from this report should be sent to: Paul Noakes, Social Research Division, Room 4-26 Adelphi, 1-11 John Adam Street, London WC2N 6HT

For information about Crown copyright you should visit the Her Majesty's Stationery Office (HMSO) website at: www.hmso.gov.uk

First Published 2004

ISBN 1 84388 288 4

ISSN 1476 3583

Families and Children Strategic Analysis Programme (FACSAP)

**Reviewing approaches to understanding the link between childcare
use and mothers' employment**

Mike Brewer and Gillian Paull

Institute for Fiscal Studies

Acknowledgements

The authors are very grateful to Mike Bielby, Rebecca Endean, Alissa Goodman, Ganka Mueller and Jonathan Shaw and attendees at a DWP seminar for helpful comments on previous drafts, and especially to Stephen Morris at DWP who managed the project. All errors and omissions remain our own, however

This work was funded by the Department for Work and Pensions as part of the Families and Children Strategic Research Programme, although the views expressed are of the authors and do not necessarily reflect those of the DWP.

Executive Summary

This report discusses the appropriate theoretical model for thinking about childcare demand and labour supply. We conclude that:

- A sensible theoretical model of mothers' labour supply and childcare demand should recognise that mothers demand childcare both to free time for working or other child-free activities, and for the benefits that it may have for their children. Such a model has few theoretically unambiguous predictions, underlying the importance of empirical estimation.
- The standard approach in the literature is to assume that there is a well-defined market for formal childcare, with different parents facing common options at common prices. This is not a reasonable assumption for informal care: either the availability, price or quality of informal care may vary across parents.
- Many US studies assume that the price of formal childcare adjusts to ensure the childcare market is in equilibrium. Such a framework denies the possibility of excess demand for childcare, which is perceived to exist in the UK. Permanent excess demand for childcare can be rationalised through non-profit-maximizing childcare providers, or by childcare providers preferring stability in their users. Neither local monopolies in the formal childcare market nor constraints on expanding supply prevent prices from rising to remove excess demand.
- It is important to know whether there is excess demand in the childcare market, but discovering that parents would use more childcare if they could afford it does not tell us that the market for childcare operates inefficiently.

Our review of methods drawn from the programme evaluation literature concluded that:

- There are very few evaluations of interventions in the market for childcare which have been independent from other interventions. The single UK example had such a small sample size that the substantial magnitude of the estimated effects were insignificant in statistical terms.
- A well-designed experiment that used random assignment could tell us a lot about how mothers' employment decisions are related to the price of childcare. However, such an experiment would be difficult and expensive. In our view, it would only be worthwhile if it were used to evaluate interventions which were being considered for national implementation.
- Evaluations of two DfES policies – wrap-around care and Neighbourhood Nurseries – should tell us something about the impact of those particular interventions on mothers' employment, but the results are unlikely to be generalisable to other policies.
- An evaluation utilising natural variation could be based on the provision of free nursery places, which varies over time and between LEAs. A simple approach would use the difference in timing between England and Scotland, with a more

complicated approach could use variation between LEAs before the move to universal provision, but we are not convinced that existing data is adequate to support such analysis; the ideal data-set could probably only be put together by investigating each LEA's policy on free nursery places over the past few years. An alternative possibility would be to analyse variation in the age at which children are entitled to start full-time education

- Natural experiment techniques could be used to evaluate the impact of recent tax and benefit changes on childcare use. However, these should be viewed as evaluations of the specific changes, rather than as a means to learn more about the relationship between childcare use and mothers' employment.

Our review of evaluation methods derived from a structural model concluded that:

- The majority of studies that have investigated the link between mothers' employment and childcare use have attempted to estimate the elasticity of mothers' employment with respect to the price of childcare using a reduced-form approach. This is a very useful parameter for policy analysis. There are, though, several problems with this approach.
- Estimates of structural models, although more complicated and requiring more assumptions to be taken on trust, can overcome some of the problems faced by reduced-form participation equations, deal with the considerable number of non-linear relationships in a more satisfactory manner, and tell us about the inter-relationships between mothers' employment, childcare use and the price of childcare. Both structural and reduced-form models, though, tell us about the demand-side of the childcare market only, and not about how providers react to demand changes.
- The most challenging problem for both reduced-form and structural models is untangling the price-quality relationship so that researchers can show that there is variation in quality-constant prices, usually between areas. Data collected from providers, with explicit information on attributes that parents are likely to value, provides the best opportunity to achieve this.
- A best practice structural model would require simultaneous estimation of a labour supply function, the demand for quality or different types of childcare, mothers' wages, the quality-adjusted price of childcare, the relationship between weekly hours of childcare and the weekly cost of childcare, and variations in the quality or shadow price of informal care. Unsurprisingly, no single study has accomplished this because of the demands it would make on both data and numerical estimation; Blau and Hagy (1998) perhaps comes the closest.
- The type of data used by Blau and Hagy (1998) is not available in the UK, but it should be possible to estimate a simpler structural model of childcare demand and labour supply with UK data. This will partly depend, though, on the ingenuity of researchers in putting forward plausible exclusion restrictions. In addition, it may be possible to use the longitudinal element of FACS to help identify some of the unobservable heterogeneity.

1. Introduction

There have been a number of important policy initiatives in the UK in the area of childcare since 1997. Some have aimed to increase the supply of childcare by extending the availability of free nursery places or subsidising childcare providers, and others have aimed to increase parents' demand by subsidising expenditure or providing parents with better information (much more money has been spent on supply-side interventions than demand-side¹). Policies have been directed at the market for formal, registered childcare – childminders, nurseries, playgroups and out-of-school or holiday clubs; none has directly affected informal care. There have also been increases in employment since the mid 1990s which will have affected parents' demand for childcare independent of the childcare policy initiatives.

Little is known, though, about the impact of government policies on the childcare market or on parents' employment patterns. This is partly because evaluating the interventions would be difficult: for example, recent childcare policies have either not been piloted or have been piloted simultaneously in overlapping geographical areas, and this makes it difficult to determine the overall effect, and harder to separate out the effects of particular policies.

In addition, although the two are clearly related, little is known about how parents' (and particularly mothers') employment rates are linked to the supply of formal childcare, nor the link between childcare supply and price. Learning more requires knowledge of the following, inter-related, issues:

- what are the links between parents' childcare and employment choices, and how, for example, are each affected by childcare supply (and/or childcare price), and by labour demand (and/or wage);
- whether the market for childcare in the UK behaves like markets for other goods and services. For example, we need to know whether the price of childcare adjusts to balance supply and demand, or whether there is excess demand, rationing and queuing.
- to what extent formal and informal childcare are substitutes for each other (similarly for registered and unregistered childcare).

This paper reviews the most promising methodologies that could address these important policy questions, discussing the data requirements, and the feasibility of estimation. It distinguishes between quasi-experimental techniques derived from the evaluation literature, and estimates based on reduced-form or structural models. The emphasis will be on the links between childcare and parents' (particularly mothers') employment, and not on estimating the benefits or drawbacks to children from childcare, although we present a model which captures parents' demand for quality childcare.

¹ The Strategy Unit (2002) reports that, between 2001/2 and 2003/4, £5.9 billion was spent on free nursery places for three and four year-olds, £1.2 billion was spent on subsidising childcare providers, and £0.7 billion on the childcare tax credit. Much, but not all, of this money represents an increase on the previous government's policies.

The main advantage of quasi-experimental techniques is that, with reasonably few restrictions or assumptions, we can identify/estimate/learn something about the links between childcare use and parental employment. The main disadvantage is that we will usually only learn something about the impact of a particular change or policy reform, and it is not clear what the results would tell us about the impact of other changes, or the combined effect of several policies. By contrast, the advantage of a structural model of behaviour (ie a joint model of parents' demand for childcare and their labour supply) is that it can be used to predict the response to hypothetical changes in the childcare or labour market; the disadvantage is that, typically, many more untestable assumptions will have to be taken on trust in order for the model to be estimated.

The techniques discussed in this paper all aim to learn about only one side of the childcare market: they propose methods for learning about parents' demand for childcare, usually by examining exogenous variations in the price or supply of childcare. None of the methods described in this report tells us about the supply-side of the childcare market, so results from the sort of studies described above will not tell us about how childcare providers set their prices, how childcare providers react to an increase in the demand for childcare, such as what induces nurseries to set up or expand, or childminders to offer more hours of care. However, assumptions about these matters will often need to be made both when carrying out the sort of studies referred to in this paper, or when using the results of these studies to make predictions about the impact of policy changes.

The structure of paper is as follows: chapter 2 reviews the theoretical models of labour supply and the demand for childcare that have been used in the economics literature. Such theoretical models explicitly underpin all estimates based on reduced-form and structural models, but it is also important to think about the theoretical links between childcare and employment when considering results based on quasi-experimental techniques. Section 3 describes how solutions devised to solve the programme evaluation problem can be applied to childcare and mothers' labour supply. Section 4 describes the advantages and disadvantages of estimates based on structural models or reduced-form models of childcare demand and labour supply. ²

² A note on terminology: we use "formal childcare" to mean childcare provided by nurseries, crèches, play-groups, out-of-school clubs, childminders and nannies; full-time education never counts as childcare in this paper. Most formal childcare providers in England need to be registered if they provide care to children under 8, and these providers are referred to as "registered" or "eligible". Informal childcare has a less precise definition: in its widest definition, it refers to care provided by someone who is not a formal childcare provider and is not the child's main carer, but some people would also exclude care provided by someone in a child's immediate family. There is always a cost to formal childcare, but this may not be borne by parents directly; informal care is often, but not always, provided free of charge, and some papers mistakenly use "formal" and "informal" as synonyms for "paid" and "free to parents". These distinctions will be more important in Stage 2 of this research.

2. An economic model of parents' labour supply and the demand for childcare

The aim of this chapter is to describe the common theoretical background to the studies that are listed in Appendix A (and discussed more in chapter 4).³ Such theoretical models explicitly underpin all estimates based on reduced-form and structural models, but it is also important to think about the theoretical links between childcare and employment when considering results based on quasi-experimental techniques.

An important test of any theoretical model, though, is whether it can explain the observed patterns of childcare use. The second stage of this project will shed more light on this in the UK, but, for now, we take the key patterns to be that a majority of working mothers with pre-school children do not use formal childcare, and that a significant proportion who use formal childcare also use informal care.⁴ In addition, a small proportion of mothers who do not work pay for formal childcare.⁵

We separate our discussion into two areas:

- the nature of the demand for childcare: what justifications are given in the literature for why parents want to use childcare?
- whether it is sufficient, when considering the demand for childcare, to summarise the impact of the supply-side in the price.

2.1 The demand for childcare

In the economics literature, two main theoretical justifications are given as to why parents demand childcare:

- childcare is valued because it frees time for parents;
- childcare is valued because it can provide educational and development opportunities for children.

Some papers present models which incorporate only the first justification. Blau (2000) describes this approach as a “useful vehicle for beginning the analysis of work incentive effects of childcare subsidies”, but few of the papers mentioned in Appendix A pursue this approach, no doubt because it is an unsatisfactory explanation of why parents use childcare. An exception is Averett et al (1997), whose focus is on modelling the budget constraint accurately in the presence of complicated, non-linear childcare tax credits; studies that focus on labour supply behaviour, rather than on childcare demand, also

³ This section updates work in Blau (2000) and Anderson and Levine (1999); the latter stress that “most of these papers employ a similar methodology”.

⁴ For example, Paull and Taylor (2002) reports that, during the mid-late 1990s, two thirds of working mothers with pre-school children did not use formal care, and 7 per cent used formal and informal.

⁵ UK evidence relies on the GHS: see Duncan and Giles (1996), although some of this apparent use of childcare amongst non-working mothers may reflect “frictional” worklessness.

tend to model childcare costs in this way (see, for example, Blundell et al (2000) and Brewer et al (2003)).

In a model where childcare is valued only because it frees time for parents, it affects parents' labour supply decisions in the same way as other work-related costs, such as transport costs. This is very restrictive, and such a model has relatively simple comparative statics: a reduction in the cost of childcare is identical to an increase in mothers' hourly wage. This means that it will increase the likelihood that mothers work, but will have ambiguous effects on hours of work conditional on employment because there are offsetting income and substitution effects. Such a model cannot rationalize many of the stylised facts (for example, that hours of childcare use sometimes exceed hours of mothers' employment (plus travelling time)). In addition, in such models, all childcare types are the same.

Allowing for both justifications for demanding childcare leads to a more sophisticated model where childcare becomes a consumption good that can contribute towards various child outcomes. In a further refinement, different types of childcare can have different "qualities", where "quality" is used as a shorthand for anything that is valued by mothers, such as convenience and proximity to home/work, as well as the notions of quality recognised by child psychologists or Ofsted inspectors.

This model, set out in full below, can rationalize why mothers who do not work are observed to use childcare. However, once we allow for parents to care about the quality of childcare – so that childcare becomes valued not just for its ability to free up parental time – then there are few useful theoretical predictions: the comparative statics become more complicated and ambiguously signed. For example, the impact of changes in the price of childcare on both childcare use and desired labour supply will depend not just on the relative size of the income and substitution effects that relate to labour supply, but also on the ability to substitute between different sorts of childcare, and the relative importance to the mother of her own leisure/working time and her child's outcomes.⁶ A model with different types of childcare also raises the possibility that changes in the price of one sort of childcare will affect demand for other types of childcare if, as is likely, they are substitutes for each other.

By way of example, a model which allows for all these factors is presented below (drawn from Ribar (1995)). It is a static, 1 period model, and assumes a single decision-maker, so is more applicable to lone parents than women with partners (although it may serve as a good approximation). Many recent studies of mothers' labour supply and childcare use present a model similar to the one below as their theoretical motivation. Mothers are assumed to derive utility from the quality of care received by the child (including maternal care) (Q), leisure (L) (defined as the time remaining after paid work) and consumption (C) (income after taxes, benefits and paying for childcare).

$$U = U(C, Q, L, F)$$

⁶ See, for example, Section 2 of Duncan, Paull and Taylor (2001a) or Blau (2000), Section IV.C.

The quality of care received by the child depends positively on how much time the mother spends not working (L) and on the family's total consumption, C , and on whether formal or informal childcare is used while the mother is working (F indicates the use of formal childcare):

$$Q = Q(L, F, C; \alpha_Q).^7$$

This flexible function does not tell us whether formal childcare is better than informal childcare. For example, the function Q may allow for the first hour of formal childcare a week to be good for a child, but the 60th hour in a week to be bad. The model assumes that mothers who work must use childcare, and restricts them to choose between formal and informal childcare. Formal childcare has cost P_F , where:

$$P_F = P_F(H; \alpha_Q).$$

and H is the number of hours the mother works, and allows for a non-linear relationship between weekly childcare cost and weekly hours worked. Letting W indicate the mother's wage, the budget constraint is as follows:

$$C = WH + N - P_F(H; \alpha_p)F = Y(H, F)$$

where N represents net transfers from the tax and benefit system and other non-earned income. If we substitute this back into the utility function, this says that a mother cares about disposable income, Y , which is gross earnings plus unearned income plus net transfers and taxes, less the cost of formal childcare. Informal care is assumed to have no financial cost, but can have non-financial costs.

If we substitute these terms into the previous expression for utility, and define total time to be K , so that $K = H + L$, then we can reduce the model to one where mothers choose how long they spend in paid work (H), whether or not they use formal childcare (F), and their disposable income after childcare costs (Y , itself a function of H and F), and these three choices determine their utility levels (we have omitted W , P_F and other exogenous variables for clarity):

$$U = U(C, Q, L, F) = U(Y(H, F), Q(K - H, F, Y(H, F); \alpha_Q), K - H, F).$$

The budget constraint, $Y(H, F)$, captures the fact that the potential financial return to work, as well as changes in the price and quality of childcare, will affect mothers' decisions about childcare use.⁸

Arriving at this relatively simple expression for mother's utility has required us to assume that the mother either works or cares for her child, and that there are only 2 types of childcare available (informal and formal). Breaking this link between hours of work and hours of care, and allowing for even more types of care, would make an explicit

⁷ In this and what follows, the alphas represent family characteristics.

⁸ See pp 566-567 in Ribar (1995) for the detailed comparative statics.

expression for utility much more complicated. Despite this, the value of the model is that it captures the inter-relations between the hours of work, childcare use and childcare quality. This means that examining variations in childcare use conditional on employment, or vice versa, is unlikely to be informative about mothers' preferences. In addition, if different types of childcare can vary in quality, then variations in the observed price of childcare will partly reflect variations in quality, and, as we discuss more in chapter 4, a failure to control for variations in the quality of childcare can lead to misleading inferences about the link between the price of childcare and parents' demand for childcare.

Of course, it is impossible to estimate any of the key relationships as the expression stands without a considerable number of simplifying assumptions. Where studies differ substantially is in making these assumptions, and how they econometrically estimate these models, and we discuss this more in chapter 4.

2.2 Can we summarise the impact on parents of the supply of childcare with the price of childcare?

A fully comprehensive treatment of childcare demand and labour supply could be obtained by modelling simultaneously the demand and supply side of both markets. In such a model, the price and wage would be determined simultaneously with equilibrium employment and childcare use. Such a model, though, would either be exceedingly complicated, or represent a much-simplified view of the world. In addition, the data requirements for estimation would be considerable. Presumably for these reasons, we are not aware of any examples in the literature.

By contrast, the model in 2.1 is usually made operational by assuming that mothers act to maximise their utility given their hourly wage and the price of childcare. In effect., only one side of each market is modelled, given the prevailing price in each market. Several papers have investigated whether it is reasonable to assume that, when trying to model the supply of labour, the impact of firms' labour demand can be summarised in the hourly wage; we do not discuss that issue further here, other than to note that it is a standard assumption in labour supply modelling. Below, though, we discuss whether it is reasonable to use the price of childcare as a sufficient statistic for the impact of supply on parents' demand for childcare. We separate our discussion into formal and informal childcare because there is a recognised market for formal childcare, and we think it reasonable to assume that all parents face the same options, at least within a given locality and for children of a given age. However, informal childcare very often involves a non-market transaction, and parents will have different informal care options depending on their individual circumstances.

2.2.1 Formal childcare

Most of the studies in Appendix A which have presented a model of childcare demand similar to that in 2.1 have taken, as a simplifying assumption, the textbook model of a large number of well-informed consumers making rational choices over childcare places offered by a large number of well-informed profit-maximising producers. They have also assumed that:

- all parents face the same choice of potential childcare providers, within a given area and for a given child’s age, and that there is a common quality-adjusted price for childcare.⁹
- the supply of childcare in an area should only affect parents’ decisions through its impact on the quality-adjusted price: in empirical work, this means that supply variables should have no impact on individual families’ demand for formal childcare having controlled for its price (this means that price is a “sufficient statistic” for the impact of supply).

We do not discuss the first of these any further. The second, though, is equivalent to saying that the formal childcare market is in equilibrium, where the quality-adjusted price adjusts to equalise demand and supply. In a market in equilibrium, parents would have an unrestricted choice of the level of quality of childcare (subject to minimum standards imposed by regulations), and an unrestricted choice of the amount of childcare they use given the market-clearing, quality-adjusted price of childcare. This result does not rely on the formal childcare market being competitive: even if childcare providers have some monopoly power, then theory suggests that the quality-adjusted price of formal childcare will alter to ensure that demand and supply are balanced in each locality, and that supply variables will have no predictive power over and above the price.

This market clearing assumption therefore allows the various studies listed in the Appendix to focus on the link between childcare *price* – rather than childcare *supply* or *availability* – on childcare use and mothers’ employment. However, many of the policy concerns in the UK seem to revolve around the links between the supply or availability of formal childcare and mothers’ employment (or around the impact of government-induced changes in the supply of formal childcare on mothers’ employment) without considering the role of price. There are two implications:

- this may simply reflect a difference in terminology, and it may be fully understood that the supply of formal childcare affects childcare use through its impact on the price. This would mean that concerns expressed about the lack of supply are really just concerns that the market-clearing price is too high – and that equilibrium use is too low – from the point of view of the government’s wider policy objectives.
- on the other hand, it may represent a perception that parents in the UK are quantity-constrained: this would mean that some parents would be willing to use formal childcare at the going price but cannot find a place, leading to rationing or queuing for childcare (or to an “excess demand” for childcare). In such a world, the supply of childcare would have a direct effect on an individual parent’s use of formal childcare, over and above the impact of childcare price because it would influence the size of the queue. We discuss the evidence for this proposition in Box 1.

⁹ By saying that there is a single quality-adjusted price for childcare, we are recognising that different types of childcare may have different equilibrium prices reflecting that the quality varies.

Box 1: is there excess demand for childcare in the UK?

An economist's notion of excess demand in the formal childcare market refers to a situation where parents would be happy to pay the going quality-adjusted rate for formal childcare, but they are unable to find a provider willing to offer them a place at this rate. Discovering that parents would use more childcare if they could afford it does not tell us that there is "excess demand", nor that the market operates inefficiently. Some examples of recent UK studies which give evidence of unmet or excess demand are listed in Appendix B. None of these studies, though, is entirely satisfactory.

- Callender (2000) seeks to learn about "unmet demand" by studying providers' waiting lists (section 4.4, the phrase is used in the original). The study finds that some providers do have waiting lists, but others have vacancies, and a third have both at the same time. This suggests that waiting lists and vacancies may reflect frictional demand and supply mismatches, because, for example, parents can move between childcare providers, and waiting lists are not always up to date. This is similar to the fact that job vacancies and the unemployed exist simultaneously, and may not be informative about whether there is excess demand or supply.
- In work in progress, Chevalier and Viitanen (2002a) use statistical exclusion restrictions to identify a group of mothers who are rationed in their use of formal care. They find that variables which record supply or availability are significant in explaining mothers' (particularly non-working mothers) use of childcare after controlling for the price of childcare. This closely matches the theoretical notion of what it means for a market to be out of equilibrium. However, their supply variables are based on Department of Health/DfEE data on the number of places in each LEA, and these may correspond more closely to childcare use rather than childcare supply, and this would weaken the finding (for example, it is possible that the variable used by Chevalier and Viitanen is partially reflecting the variation in childcare demand between LEAs, which would invalidate its use, and therefore their conclusions (see Box 2)). More importantly, perhaps, the data used (the FRS) is not a good data-set to use to investigate the childcare used by non-working mothers, and the study models childcare use conditional on employment status, disregarding the simultaneity in the labour supply and childcare decisions.
- Similarly, Chevalier and Viitanen (2002b) finds that changes in childcare supply lead to changes in mothers' employment, but that there is no evidence of feedback. The authors say this suggests that "the supply of childcare is not sensitive to participation in the labour market of mothers of young children." However, the authors also concede that their measure of childcare supply may not be perfect: it is proxied by the number of childcare workers, which, as above, might reflect equilibrium childcare use, rather than childcare supply.
- The two studies of the PDFC data-set investigate "unmet demand" (chapter 3 of La Valle et al (1999) and chapter 6.2 of Woodland et al (2002); the phrase is used

in both the originals). Here, unmet demand includes instances where childcare could not be used because the children were ill, instances where parents could not find childcare to cover social occasions, and instances where parents would have liked to use childcare but could not afford it. To economists, the last situation is not an example of excess demand: using the same principle, everyone would have an unmet demand for the majority of goods and services, making it an unhelpful notion.

Depending on the institutional setting carefully-designed questions in households surveys may elicit useful information about rationing or quantity constraints which could be used in estimation. We are not convinced, though, that existing surveys have yet achieved this (although they may not have intended to achieve this).

As mentioned above, the majority of studies listed in Appendix A have assumed that the market for formal childcare is in equilibrium and that parents are able to use as much childcare as they wish at the going quality-adjusted rate. This may reflect that the majority of studies referred to in Appendix A are from North America where the formal childcare market is dominated by private suppliers. One exception is Kornstad and Thoresen (2002), who use Norwegian data which includes information on whether a family has unsuccessfully applied for a place in a publicly-funded childcare centre (which they interpret as evidence of rationing of formal childcare places).

It is not necessary imperative to know whether the childcare market clears. For example, if policy-makers consider that too little childcare is being used given their wider policy objectives, then interventions that directly increase supply will increase overall use of childcare regardless of whether the market clears or not. But it is important to know whether there is excess demand in the childcare market when considering the possible impact of other interventions, and when estimating an empirical model of the link between childcare and mothers' employment.

Clearly, excess demand for any product may exist in the short-run while suppliers are adjusting their prices to an increase in demand, and it may be that prices in the market for childcare are relative sticky for various cultural or institutional reasons. But the existence of excess demand over long periods of time requires the price of childcare to remain too low to clear the market. A price ceiling would certainly achieve this outcome, but there are no statutory price ceilings in the UK childcare market. But there are some other reasons why childcare providers might be unwilling to raise their prices in response to excess demand for their places, leading to an implicit price ceiling:

- Childcare providers may not have the sole goal of maximizing profits. This might well be suspected where childcare is provided by a non-profit-making body, but it may also be true for childminders (who are self-employed), and even for some for-profit providers. If childcare providers have other goals than maximizing

profits, then they may decide not to increase their prices in order to remove excess demand.¹⁰

- Several theories can rationalise why childcare providers, even when acting as rational profit maximisers, end up charging a lower amount than that required for market clearing, leading to excess demand. One idea is analogous to (but operating in the opposite direction to) “efficiency wage” models, in which firms rationally choose to pay a wage above the market-clearing rate either to encourage productivity or reduce quits. For example, if providers prefer to have a stable set of users, perhaps because they are risk averse about future profits, or they face high costs each time they take on a new child, or for some other reason, then the provider’s optimum price could be lower than the market-clearing rate. In essence, a provider’s current users will have more influence on providers than potential users if providers prefer stability in their users. On the other hand, if parents cannot observe quality before using childcare, then this would suggest that parents would also act as if they faced a large cost to changing providers, and this would give providers some market power to raise prices above the market-clearing rate.
- Childcare providers may prefer to face a situation of excess demand because it enables them to choose between the children who are waiting in the “queue”. This could only be the case if the cost of providing childcare varied across children (and could not be passed on in full to parents), and that the provider was able to predict which children would be more costly, and discriminate against these children, when offering places.

It is also noting some arguments which cannot alone rationalise the persistence of excess demand for formal childcare, but which might distinguish the childcare market from an economist’s textbook model of a perfectly-competitive product market:

- It is often argued that the supply of formal childcare is limited because of planning restrictions, high start-up costs, the need to meet minimum regulatory standards, and the difficulty in recruiting childcare workers.¹¹ If true, these factors would lead to childcare having a very low price elasticity of supply. In a market with very inelastic supply, an increase in the demand for formal childcare would change the amount of childcare used by very little: instead, the price of childcare would rise substantially to remove the excess demand. A low elasticity of supply alone does not explain why the price of childcare would not rise to choke off excess demand.

¹⁰ Table 6.1 in Callender (2000) reports that 68% of non-childminders and 83% of childminders agreed that the belief that childcare should be cheap was an obstacle to the economics of provision, and around 40% of day nurseries and 60% of childminders identified it as the main obstacle (ranking it above, for example, how much parents can afford to pay for childcare). It is not clear what weight to place on these subjective questions, but, at face value, they could be taken as evidence that not all childcare providers are profit maximising. On the other hand, this survey question may merely reflect providers’ desire not to drive their customers away with high prices, which is entirely consistent with profit-maximizing behaviour.

¹¹ See, for example, sections 4-7 of Callender (2000).

- Parents may not have full information about childcare quality because some aspects of quality are very hard to assess without using the childcare (and it is the child, rather than the parent, who actually receives the childcare).
- Childcare may be a bulky good, in that it is not possible to buy a single hour of childcare without committing to paying for more. This would introduce a friction into the childcare market, and might mean that parents could find themselves at sub-optimal positions. But it is hard to see how this could lead to permanent excess demand.
- Some parents may face a narrow choice of actual or potential providers, and some providers may have only a few customers, or may act as if there are only a few potential customers. Any of these conditions would lead to the price of formal childcare deviating from its marginal cost (being higher in the first case, and lower in the others), but these are not symptoms of a non-functioning market, and will not prevent market-clearing.

2.2.2 *Informal care*

Existing models of childcare use have usually focused on the market for formal childcare because the main US policy concern has been the link between childcare subsidies and employment, and the subsidies only cover formal care. In contrast with formal care, the models used in the literature have different approaches to whether they allow for informal childcare, and the assumed availability of informal care. As argued in Blau (2000), it is unconvincing for models to ignore the use of informal childcare when so many working mothers use it as their only form of non-maternal care. Blau goes on to note that:

“specifying an employment model under the assumption that paid care is always the relevant non-maternal child care option is ... a potentially serious error, leading to inconsistent parameter estimates. This was noted by Heckman (1974) in one of the earliest economic studies of child care, but has been ignored in most recent analyses.”¹²

In fact, some of the studies in Appendix A present theoretical models which recognise informal care, but then assume it does not exist (or ignore it) when they go on to estimate the model (discussed more in chapter 4). We agree with the views in Blau (2000): given that so many working mothers in the UK use informal care, a sensible model of employment and childcare use must recognise the option of informal care, and allow for the use of informal care to be determined simultaneously with the use of formal care.

The key difference between informal and formal care is that informal childcare very often involves a non-market transaction. It is also highly likely that parents will have different informal care options depending on their individual circumstances, whereas it would be

¹² Section IV.C. of Blau (2000).

more reasonable to assume that parents in a same area face similar formal childcare options. In theoretical terms, this means that a model of childcare demand should allow for informal care as an option, and allow for the availability, (shadow) price or quality of informal care to vary across families. Those studies in Appendix A that have recognised the option of informal care have followed this approach: we give more details on these in chapter 4.

2.3 Conclusions

This chapter has made the following points:

- A sensible model of mothers' labour supply and childcare demand would recognise that mothers demand childcare both to free time for working or other child-free activities and for the benefits that it may have for their children. It must also recognise that there are different types of childcare available, with different financial or psychological costs, and varying in quality.
- There are few unambiguous predictions from such a model: the impact of changes in the price of childcare on the use of childcare, the quality of childcare used and on labour supply is theoretically ambiguous.
- The recognition that different types of childcare have varying costs and qualities means that a change in the price of childcare may cause shifts between different types of childcare as well as changes in a mother's labour market behaviour.
- The standard approach in the literature is to assume that all parents in a given market face the same quality-adjusted price for formal childcare and the same options. We support this: formal childcare does not conform to all the standard assumptions made in economists' classical analysis of a product market, but this does not invalidate its use as a simplifying assumption. This is not a reasonable assumption, though, for informal care: a well-specified model should allow for either the availability, price or quality of informal care to vary across individuals.
- Much of the US-based literature assumes that the market for formal childcare functions normally, and that the quality-adjusted price will rise or fall to ensure that the market clears. Such a model denies the possibility of excess demand and queuing for childcare, which are, however, perceived to exist in the UK. Permanent excess demand for formal childcare market can be rationalised through non-profit-maximizing childcare providers. Alternatively, it could be caused by childcare providers preferring stability in their users, which would grant existing users market power over potential users. Local monopolies in the formal childcare market would lead to an inefficient market outcome, but do not prevent the price of childcare from adjusting to clear the market. Similarly, constraints on expanding supply would mean that childcare use varied little as demand varied, but do not prevent prices from rising to remove excess demand.

- It is important to know whether there is excess demand and rationing in the childcare market. Discovering that parents would use more childcare if they could afford it does not tell us that the market for childcare operates inefficiently.

3. Methods drawn from the programme evaluation literature

This chapter discusses experimental and quasi-experimental approaches to learning more about the links between childcare use and parental employment.¹³ The main advantage of these approaches are that, with reasonably few restrictions or assumptions, we can learn something about the links between childcare use and parental employment. The main disadvantage is that we will usually only learn something about the impact of a particular change or policy reform, and the results, in general, will not be generalisable. By contrast, a structural model of behaviour (ie a joint model of parents' demand for childcare and their labour supply, discussed in the next chapter) can be used to predict the response to hypothetical changes in the childcare or labour market; but requires many more untestable assumptions to be taken on trust for the model to be estimated.

Three sorts of experimental and quasi-experimental techniques (hereafter shortened to "experimental techniques") have been used to learn more about the links between childcare demand and mothers' employment:

- a) randomised social experiments;
- b) non-randomised social experiments;
- c) natural experiments, or difference-in-differences.

In this chapter, we review the existing studies that have used experimental methodologies, and then discuss what might be feasible in the UK in future.

3.1 Randomised social experiments

A randomised experiment is in many ways the most convincing evaluation method, although there are many drawbacks: they can be expensive and difficult to implement, do not help in an *ex ante* appraisal of a policy reform, and may not be generalisable beyond the precise policy intervention.¹⁴

What sort of studies have already been undertaken?

Randomised experiments (or demonstrations) have been especially common in the US. Blau (2000) and Anderson and Levine (1999) review what the very large number of welfare reform demonstration projects in the US over the past two decades have told us about the links between employment and childcare use. In fact, they find that there have been very few demonstration projects that affected only the cost (or supply) of childcare:

¹³ US studies are surveyed in Blau (2000) and Anderson and Levine (1999). Blundell and Costa Dias (2000) discusses various sorts of non-experimental evaluation techniques in general.

¹⁴ For more discussion of random assignment as an evaluation method, see, for example, Blow et al (2003).

most projects have provided assistance with childcare together with other services. Together, they cite 2 studies, both of which showed no significant impact of the (different) particular programme on childcare expenditure, although in one the sample was small, and in the other, take-up of the programme was very low.¹⁵ The vast majority of welfare reform demonstration projects provided an explicit or implicit childcare subsidy as only one of several services, making it impossible to isolate the impact of the childcare subsidy alone: as the discussion of the theoretical model in chapter 2 made clear, anything which affects labour supply behaviour or net incomes will affect childcare use, as well as the more direct impact of changes in the price of childcare. We therefore do not discuss these findings further.

We are aware of one example from the UK, reported in Toroyan et al (2003). The study investigated the impact of being allocated a place at an Early Years centre in Hackney. It was able to use random assignment because demand for places at the centre exceeded availability: children on the application list (all aged under 42 months) were assigned a place at random. The study investigated the impact on various outcomes for the mother (eg employment, psychological health) and child (mental development and general health). The study found that the children offered a place had mothers who were more likely to work, worked longer hours, and had higher earnings. The children had slightly better mental development but slightly worse health outcomes (specifically, an increased incidence of ear infections). However, as the authors stress in their conclusion, the small sample size meant that “the effect estimates were imprecise and the results are compatible with chance”: none of the effect estimates was significantly different from zero.

It should be noted that this study did not estimate the impact of formal childcare on children, because the children in the control group were free to use formal childcare at other centres (and 63 per cent were doing so at the end of the follow-up period). This means that the study probably underestimates the impact of formal childcare.

What would be feasible in the UK, and what could we learn?

We do not attempt here to produce a full feasibility study of a random assignment demonstration involving childcare interventions. In principle, a well-designed UK demonstration project that implemented policies that changed the cost or availability of childcare, and that used random assignment to assist in the evaluation, could potentially tell us a great deal about the links between childcare use, childcare price and mothers employment. It would be attractive because, as the previous and subsequent chapter discuss, modelling the impact of the price or availability of childcare on the demand for childcare is so difficult. But this information would come with a large price tag, and it would not be available for many years.

It should be stressed, though, that there are limits on what can be learnt from a random assignment social experiment. A starting point is that such an evaluation could tell us about the impact of the specific policy intervention: for example, the Toroyan evaluation

¹⁵ See Bowen and Neenan (1993) and Behrens (1978).

tells us about the impact of providing a place at an Early Years centre compared to not providing a place. But the extent to which the results can be generalised will depend upon the environment faced by the control group, and this is why it is highly unlikely that a random assignment project will be able to tell us about the impact of a child attending formal childcare compared to a child not attending formal childcare. This means that a random assignment demonstration would be particularly attractive if it evaluated reforms that could conceivably be implemented nationally, rather than if it were being considered merely as a way to learn more about the links between childcare and mothers' employment.

There is one major random-assignment demonstration project ongoing in the UK: the Employment, Retention and Advancement demonstration project (hereafter ERA). One of the three target groups for ERA is lone parents currently working part-time and receiving the Working Tax Credit, and they will be provided with personal adviser support and financial incentives to encourage retention and advancement. The services offered by the personal adviser will not include childcare subsidies, but may include advice on childcare options.¹⁶ Depending on the design of the survey, it should be possible to evaluate the impact of the ERA programme on childcare use using the control group. However, as with the US demonstrations, it will not be possible to estimate the individual impacts of the various services provided by the ERA programme, such as the retention bonuses, on childcare use: all we will be able to obtain is an unbiased estimate of the impact of ERA as a whole on childcare use.

3.2 Non-randomised policy evaluations

It is also possible to learn from policy reforms that have been evaluated in the absence of random assignment.

What sort of studies have already been undertaken?

In the US, both Blau (2000) and Anderson and Levine (1999) refer to just two US studies that have evaluated the impact of various child-care subsidies: because the results are so reliant on the particular subsidy programmes, we do not discuss them further here. In the UK, the previous Conservative Government piloted nursery vouchers in four areas before introducing them in April 1997. Government press releases of the time refer to "evaluations", but we have not yet found anything published which looks at the impact on employment.¹⁷

What would be feasible in the UK, and what could we learn?

In our view, the most promising on-going and future evaluations for learning about the link between childcare and mothers' employment are the wrap-around care pilots and the Neighbourhood Nurseries Initiative. Clearly, if new policies are developed that affect

¹⁶ See Greenberg and Morris (2003) for further details.

¹⁷ House of Commons Education and Employment Committee (1997) reviews some of the evidence from the 4 pilot areas, but does not look at the impact on employment.

employment of lone parents or their childcare use, then it may be possible to use those evaluations to provide relevant evidence.

As with evaluations that take advantage of random assignment, what we learn depends on the policy being evaluated. The on-going evaluations of the wrap-around care pilots and the NNI will tell us about how extra childcare provision (of a particular type) affects, amongst other things, childcare use and mothers' employment.

3.3 Natural experiments

Evaluations based on natural experiments in this areas would seek to link variations in mothers' employment to exogenous variations in the price of childcare.¹⁸ To produce accurate results, the variations in childcare supply would need to be caused by underlying factors that were unconnected with parents' decision to work or not. The usual approach is to argue that policy reforms, or differences between local areas, generate different environments which are exogenous to parents' choices about childcare use and labour supply. A estimator based on a matching approach or difference-in-differences will often be appropriate when there are natural experiments.

What sort of studies have already been undertaken?

The main example cited by Blau (2000) and Anderson and Levine (1999) is a study of the impact of starting full-time education: see Gelbach (2002).¹⁹ In the US, children can start full-time education in January of the calendar year in which they have their fifth birthday. This means that a child born in December will be able to start kindergarten shortly after its 4th birthday, and a child born in January will start kindergarten shortly before its 5th birthday. So whether a child is at kindergarten on its 5th birthday, for example, depends on its month of birth. Gelbach found significant variation in the employment rate, hours of work, weeks worked, earned income and welfare receipt of lone mothers whose youngest child was aged five depending on the month of the child's birthday: having a child attend full-time education at an earlier age helped lone mothers work, and work more.

Month of birth is a good instrument, and Gelbach used a large sample, so the results should be reliable.²⁰ As with all policy evaluations, though, it is not clear to what extent the results can be generalised. Certainly the results only apply to lone mothers whose youngest child is aged between 4 and 5 (the study found no significant variation in employment rates for lone mothers who had a child aged 4 to 5 and younger children). If

¹⁸ Alternatively, looking at the relationship in reverse, we could link exogenous variations in parents' employment (or wages) to variations in childcare use; this might be informative about the impact of mothers' employment and childcare use, but not on the impact of childcare price on mothers' employment. For example, the proposed "in work credit" does not directly affect the price of childcare, but its future evaluation may tell us about the links between childcare use and employment of lone parents returning to the labour market.

¹⁹ A version of Gelbach (2002) existed as a working paper in 1999.

²⁰ A good instrument needs to be uncorrelated with the outcome of interest – whether a mother works – but highly correlated with the potentially endogenous variable – availability of "free" childcare. In this case, the instrument is the month of the child's birth (Gelbach actually used quarter-of-birth) which we can treat as random.

the value of full-time kindergarten could be estimated, then Gelbach's results could be used to estimate the elasticity of employment to the price of childcare. However, full-time education provides childcare for a fixed number of hours a week, at fixed times, and only during term-time. Even if it could be valued, and a thought experiment considered where parents of five year olds were given a voucher equal to the subsidy value, it is possible that they would buy childcare provided at different times to full-time education, and that this might have a greater impact on employment; equally, they might buy less childcare but of a higher quality, and that this might have a smaller impact on employment.

A recent study has examined the impact of state variation in child care subsidy programmes in the US on lone parent employment rates (Bainbridge et al (2003)). It found that childcare subsidies have a similar "cost per job" as changes to EITC and other taxes, but it is difficult to see how the results could be made useful for UK policy discussions. Similarly, Jaumotte (2003) reports the results of explaining cross-country variation in mothers' employment rates through cross-country institutional and policy variation, including help with childcare: it finds that countries that have relatively high public spending on childcare tend to have relatively high maternal employment rates, particularly full-time. However, it is not clear which direction the causation runs: it may be that countries where mothers have a underlying tendency to work will have to spend more on childcare services.

What would be feasible in the UK, and what could we learn?

The need to have some variation in policy environments is the main reason why evaluation techniques based on natural experiments cannot be used to evaluate the main policies introduced since 1997: many of these were national in scope, affected all parents with children of particular ages, and were introduced at overlapping times, thus ruling out estimates based on area variation, variation by age of child, or time variation.²¹

However, there are some recent policy developments which may generate sufficient exogenous variation in environments to support a "natural experiment" estimate. These include:

- a. following Gelbach (2002), variation in the age that children start full-time education or become entitled to free, part-time, nursery places;
- b. changes to the tax, benefit and welfare system that lead to exogenous variations in employment or incomes.

The challenges for any natural experiment evaluation are in identifying variations in parents' environment that are genuinely exogenous to parents' work and childcare decisions, or identifying a "control" group for whom the vital assumption of "common time trends" is plausible. We discuss the suggestions more below.

²¹ It should be noted that the considerable variation between local authorities in the use of childcare and in mothers' employment does not tell us whether high mothers' employment leads to high demand for childcare use, nor whether a low supply of childcare constrains mothers' employment: all we observe is the joint outcome of the interaction between supply and demand in both the childcare market and the labour market: see Paull and Taylor (2002).

(a) The statutory school age, free nursery places and mothers' employment

The study by Gelbach (2002) made use of variation in the age of children when they began full-time education in the US (which is any time between their 4th and 5th birthday). A identical estimation strategy in the UK is unlikely to be as successful, because the statutory school age only varies by 5 months.²² In addition, the age of children when they actually start full-time education may be less than 5, depending on the policy of the particular school. In theory, though, if it were possible to document the admissions policies that parents faced over time and across schools, then it would be possible to compare this with mothers' employment rates, and their use of childcare, in the same way as Gelbach's study. As with policy on nursery places (discussed below), we think that only by asking each individual LEA about their admissions' policies could we learn about this, and there may be a limit to how far back in time their knowledge would extend.

A related idea is to make use of variation in the provision of free nursery places for the under 5s. Recent policies have increased the proportion of three and four year-olds who are able to benefit from free nursery places. For example, since September 1998, all 4 year olds in England have had access to 3 terms of free part-time nursery education, and this right will be extended to all three year olds by April 2004.²³ Three year olds in Scotland, however, became entitled to free part-time nursery places two years' earlier than in England. This suggests that a simple difference-in-difference estimator could identify the impact of universal free part-time nursery places for three year olds by comparing otherwise-identical three year old children in England and Scotland observed between April 2002 and April 2004, providing there were no other relevant differences between the two nations at the time. Such a study may need to wait a few months for up-to-date data to exist, would be further improved when data becomes available on mothers' employment rates after three year olds in England become entitled to their free place from April 2004 because we could test both whether employment rates changed in Scotland in 2002, and then whether rates in England changed in a similar way in 2004.

Such an estimator would tell us whether part-time nursery places affected employment, but it would not lead to an enormously useful parameter for policy-making. For example, it would not be able to quantify by how much a percentage change in provision led to a percentage change in employment. We would learn more if we could take advantage of the variation across LEAs in the level of provision for 3 and 4 year olds before the current government's policies to implement universal provision, rather than merely exploiting variation in the timing of policy changes.²⁴ This would potentially provide exogenous variation in the effective price of childcare of three and four year-olds over time and across areas, and we could examine how they are related to variations in mothers' employment.

With both of these approaches (differences in timing in implementing universal free nursery places across nations, and variation in provision of nursery places across LEAs) ,

²² Children are between 5 years and 5 years and 5 months when they reach the statutory school age.

²³ Children are allowed to start nursery in the term that commences after their 4th birthday.

²⁴ See, for example, DfES, *Pupils Under Five Years of Age in Schools in England*, various editions.

we could investigate both how mothers' employment changed and how use of other forms of childcare varied across areas with different levels of nursery provision, telling us something about the substitutability of nursery places and other forms of childcare.

There are several issues to be considered, however:

- How did the nations in the UK move from partial to universal provision of free part-time nursery places for 3 and 4 year-olds? If all the nations simultaneously increased their provision, but managed to attain universal provision at different times, then the difference-in-difference estimator may not capture the true effect of the policies.²⁵
- Is the policy variation between LEAs genuinely exogenous? If LEAs introduced free nursery places particularly quickly (or accepted children into full-time education earlier than the statutory school age) where there was a high demand for childcare places, or high unsatisfied demand for childcare places, or particularly high levels of female employment, then the variation on policy would not be exogenous to parents' decisions. To investigate this further, it would be necessary to understand how LEAs decided how their policy on nursery places, information that only LEAs can know.
- Do we have adequate data? Estimates of mothers' employment rates by LEA (or equivalent in Scotland) can potentially be calculated across Britain from a number of household surveys (see Appendix C), although sample sizes will be small when we condition on having pre-school children. But there is no existing data source that adequately records the availability of nursery places for the under 5s, or schools' admissions policies. The existing data for England – *Pupils Under Five Years of Age in Schools in England* and *Provision for children under five years of age in England* – records the number of nursery places taken up by the under 5s. This is not the same as availability: it is the minimum of availability (supply) and demand (similar data is available in Scotland with the same comments; see Appendix D for more information). We think that only by asking each individual LEA about their availability of nursery places and/or admissions' policies could more accurate information be produced, and there may be a limit to how far back in time their knowledge would extend.

Box 2: estimates of the availability of childcare places in England

Many UK studies make use of estimates of the number of childcare places offered by providers to children. These estimates, covering children under 8 in England, used to be collected by DH/DfEE based on returns from local authorities, and are now collected and by Ofsted (similar data exists for Scotland). These estimates are usually used as an indicator of the supply of childcare in each LEA.

The data does capture the availability of childcare places in each local authority in the

²⁵ In other words, for research purposes, we would ideally have liked Scotland to have implemented universal provision of free part-time nursery places overnight, while England was not increasing its provision at all!

short-run. However, the number of total childcare places might be little different to the number of filled places, because most childcare providers would not operate for very long with a large number of unfilled places. This series might, then, actually just record “use” of childcare, rather than “availability” or “supply”, and this would mean that it is not a valid instrument for the supply of childcare.

Just as with Gelbach’s study, it should be emphasised that such a study can only tell us about the impact of free nursery places on various outcomes. It would be possible to generalise the results only if we believed that nursery places were a good substitute for other forms of childcare, and/or if we could value the provision of nursery places.

(b) Tax and benefit changes and childcare use

It is often argued that changes to the tax, benefit and welfare system provide variation in parents’ circumstances. A possible evaluation strategy could be to compare changes in the childcare and employment patterns of parents affected by some tax or benefit reform to those of parents unaffected by the reform, giving a difference-in-difference estimate. For example, we could compare the behaviour of parents who are “newly entitled” to WFTC with the behaviour of a similar group in earlier years, and compare this to the change in the behaviour of a group entitled to both WFTC and FC, or a group entitled to neither FC nor WFTC. Any household survey recording employment, incomes and childcare expenditure – FRS BHPS or FACS – could be used for such an analysis.

This work could certainly tell us how moving from FC to WFTC affected childcare use and employment (under the usual conditions for difference-in-difference estimators to be valid), but such an evaluation would not lead to a useful, single, parameter:

- the income changes caused by the move to WFTC are partly endogenous because they depend upon labour supply decisions, and the decision to claim FC/WFTC, and this weakens the reliability of the results;
- the change from FC to WFTC changed both incomes and employment patterns, both of which are likely to affect childcare demand (as argued in chapter 2);
- we could not separate the impact on childcare use of the changing financial return to work implied by moving from FC to WFTC from the introduction of the new childcare tax credit.

Similarly, the introduction of the new tax credits may provide some possibilities, but this is a less promising reform, partly because moving to the new tax credits affected almost all families with children, and so there are no contemporaneous “control groups”, and partly because the income changes were smaller.

It is for these reasons that tax and benefit reforms are often best evaluated using structural models, and ideally with those that simultaneously model childcare demand, labour supply and the decision to claim tax credits.²⁶

3.4 Conclusions

This chapter has made the following points:

- As is the case in many areas, a randomised social experiment is the most convincing evaluation method, and a well-designed experiment could tell us a lot about how mothers' employment decisions are related to the price of childcare. However, such an experiment would be difficult and expensive to set up. In our view, it would only be worthwhile if it were used to evaluate interventions which were being considered for national implementation.
- We are aware of very few international examples of randomised experiments that have evaluated interventions in the market for childcare separate from other interventions. The sole UK example had such a small sample size that the substantial magnitude of the effect estimates were insignificant in statistical terms.
- Two DfES policies – wrap-around care and Neighbourhood Nurseries – are currently being evaluated, and these evaluations should tell us something about the impact of those particular interventions on mothers' employment and childcare use. However, the results are unlikely to be generalisable.
- An evaluation utilising natural variation in the price of childcare could be based on the provision of free nursery places, which varies over time and between LEAs, or on schools' policies on when children start full-time education. A simple approach would use the difference in timing in attaining universal provision of places for three year-olds between England and Scotland. A more complicated approach could use the variation between LEAs that existed before 1998, but we are not convinced that existing data is adequate to support such analysis; the ideal data-set could probably only be put together by investigating each LEA's policy on free nursery places over the past few years.
- Natural experiment techniques could be used to evaluate the impact of recent tax and benefit changes on childcare use. However, the complicated nature of these changes means that this should be viewed as evaluations of the specific changes, rather than as a means to learn more about the relationship between childcare use and mothers' employment. Structural models of childcare use and mothers' employment, though, could both evaluate the impact of tax and benefit changes and provide results relating to the link between childcare use and mothers' employment which could be generalised.

²⁶ This is discussed more in chapter 4. *Ex ante* evaluations of WFTC based on structural or semi-structural models can be found in Blundell et al (2000) and Duncan et al (2001b); Brewer et al (2003) reports an *ex post* evaluation. Only Duncan et al (2001b) has attempted to model how WFTC might affect the demand for childcare and labour supply simultaneously.

4. Structural and reduced-form models

This chapter discusses techniques for learning about the links between childcare use and parental employment that are based on specifying and estimating a behavioural model. These models attempt to describe the relationship between parents' childcare use and employment through describing individuals' underlying preferences for working and using childcare. They make use of variation in the price of childcare.

An evaluation based on a structural or reduced-form model differs from a natural experiment approach because it places more structure (equivalently, more restrictions) on the data, but has the advantage that, if the structural model is correct, it is then possible to predict the response to hypothetical changes in the supply of childcare or any other variable in the model because the model is aiming to describe parents' behaviour directly.

27

In this report, we shall use the phrase a “structural model” to refer to a model expressed in terms of mothers' utility functions and a childcare quality production function,²⁸ and when we talk about “estimates of a structural model”, we mean estimates of either the key parameters in the utility function and childcare quality production function, or a behavioural relationship which is derived directly from a utility function.²⁹ Studies that present reduced-form estimates often start with a structural model describing individuals' preferences with a utility function, but they do not attempt to estimate directly the parameters of the utility (or production) function. Reduced-form estimates only describe the relationships between observed economic variables; a structural model, in contrast, attempts to describe the unobserved preferences of individuals that led to the observed economic variables. This means that a structural model can potentially be used to predict the response to a wide range of changes in individuals' economic environment.

Section 4.1 compares the approach taken by structural and reduced-form studies, and what the existing studies can tell us. Understanding the merits of a particular structural model requires some discussion of the econometric approach, and so Section 4.2 discusses the solutions to the common set of econometric problems adopted by the literature. The most important of these is untangling the impact of quality on price, which has been most successfully achieved by data collected from childcare providers. Section 4.3 discusses what more could be done with UK data.

²⁷ Another way of viewing this is that it is possible to use structural models to estimate a childcare demand curve, and a labour supply curve, and the interactions between the two.

²⁸ The terminology varies in the literature. Other people describe studies that relate labour supply and childcare use only to exogenous variables (such as unchanging individual characteristics) as “reduced form”, and those that relate labour supply and childcare use to wages and childcare costs as “structural”.

²⁹ For example, a utility functions necessarily implies a particular labour supply function, and for some utility functions, the labour supply function has an explicit closed-form solution. Some papers estimated these utility-maximising-consistent labour supply functions, and we refer to those estimates as “estimates of a structural model” as well.

4.1 Differences between structural and reduced-form models

Appendix A details many papers that have estimated structural and reduced-form models of mothers' employment and childcare use. The papers can be usefully grouped into a two main categories:

- Reduced-form estimates of mothers' employment probabilities conditional on wages and childcare price; Connelly (1992) is one of the earliest, and Jenkins and Symons (2001) is the only study of this sort that uses UK data). These can be extended to estimate simultaneous reduced-form models of employment and childcare use, conditional on wages and childcare price: for example, Ribar (1992) and Duncan et al (2001b). In all of these, the parameter of interest has usually been the elasticity of mothers' employment with respect to the price of formal childcare.
- Estimates of structural models of labour supply and childcare use: Michalopoulos et al (1992) is an early example, with Blau and Hagy (1998) and Tekin (2004) some more up-to date examples; no estimate of a structural model has used UK data.

Below, we show how the two are related.

Structural models

The common feature of papers that estimate a structural model is that they start from a particular form of the general utility function outlined in chapter 2. For example, Michalopoulos et al (1992) assume a particular form of the utility function:³⁰

$$U(C, Q, L, F) = \beta_1 \log(C - C_0) + \beta_2 \log(L - L_0) + \beta_3 \log(Q - Q_0)$$

where, following chapter 2, C is net income or consumption, Q is quality of childcare, L is the mother's time spent not in paid work, and F is an indicator for the use of formal childcare (the subscripted characters are constants representing minimum thresholds) and an equation for childcare quality:

$$Q = (T - L) \{ (1 - F) Q_I + F Q_F \} + L Q_h$$

where Q_h is the quality of maternal care, Q_F is quality of informal care and Q_I is quality of formal care, F is 1 if the family chooses formal care, and $T-L$ is time spent in paid employment. The simplifying assumptions are that non-working mothers care for their children exclusively, and one of formal or informal care must be chosen if the mother works.

These assumptions – plus a lot of algebra – provide explicit expressions for optimal hours of work, earnings and spending on formal childcare given the parameters³¹, and

³⁰ We have re-written equation (1) of Michalopoulos et al (1992) to be consistent with the notation in chapter 2.

³¹ See equation (5) in Michalopoulos et al (1992).

these parameters can be estimated given data on women's labour supply choices, family circumstances and childcare use. The estimated parameters are very closely related to the theoretical model presented in chapter 2.

Other econometric approaches have been used, though:

- some studies have estimated a utility function over mother's labour supply and net income, with additional utility or disutility terms if formal or informal childcare is used. This recognises that mothers care about the quality of childcare, and that the quality of childcare varies between types of childcare, but it does not attempt to model preferences for childcare quality directly. Examples include Heckman (1974), Ribar (1995), Kornstad and Thoresen (2002) and Andren (2003);
- some studies have estimated linear approximations to the indirect utility function. Although the estimated parameters have little meaning, like all structural models, the parameters can be used to predict how employment would change in response to changes in wages or childcare prices. Examples include Tekin (2004) and Blau and Hagy (1998); the latter paper also explicitly estimates mothers' demand for childcare across different types of childcare, and so the model can predict how changes in childcare prices affect both childcare use and mothers employment.

In addition to these differences in the econometric approach, there are more important differences in the what they assume about families' childcare options, as discussed in chapter 2. The papers also vary in how accurately they model net incomes and participation in welfare programmes, issues which are more important when modelling the choices made by lone mothers than mothers in couples: we do not discuss this more here.

Reduced-form models

The majority of papers with reduced-form models estimate the probability that a mother works as a function of exogenous explanatory variables, wages and childcare price.

The probability that a mother works is the probability that the utility from working is greater than the utility from not working, given the optimal choices of childcare use and quality and net incomes in and out of work. Referring back to the notation in chapter 2, this is equivalent to saying that:

$$\Pr(P=1) = \Pr \left(\begin{array}{l} U(C^*(P=1), Q^*(P=1), P=1, F^*(P=1)) > \\ U(C^*(P=0), Q^*(P=0), P=0, F^*(P=0)) \end{array} \right)$$

where P is an indicator for participation, and $C^*(.)$ gives the optimum choice of consumption given a value for P (similarly Q^* , F^*). If we substitute the values of C and Q given in chapter 2, then this expression becomes a complicated function of the wage, childcare price, the various childcare qualities and other explanatory variables, which we

do not show here. Most studies then estimate a linear approximation to the equation above, or:

$$\Pr(P = 1) = \Pr(X'\beta + \chi W + \delta P_F + \varepsilon > 0),$$

where X is a vector of household characteristics that might affect the likelihood of working, or preferences for using paid childcare, or preferences for quality of childcare, and, as in chapter 2, W is the maternal wage, and P_F is the price of formal childcare.

What can we learn from these studies?

Most of the studies that have implemented the reduced-form technique described here have sought to estimate the (uncompensated) elasticity of mothers' employment with respect to the price of childcare: this is a function of δ in the equation above.

For many policy questions, this is the most interesting parameter. Knowing this parameter, we can estimate how mothers' employment might change in response to the change in the price of childcare. Such a price change might be caused by a direct subsidy to parents. However, because most studies estimate linear approximations to the true net utility function (in other words, childcare price and wage enter linearly), they can only give approximate predictions of the impact of non-linear childcare subsidies, such as the childcare tax credit, or of any but the simplest change to the tax and benefit system. Price changes might also be caused by a change in the supply of childcare.

On top of these limitations, it should also be stressed that the simplest implementation of these models – which estimate only a equation of mothers' participation in the labour market – can tell us nothing about how the use of childcare responds to changes in the price of childcare; some papers have, though, estimated simultaneous reduced-form models for mothers' labour supply and childcare use, conditional on wages and price.

Estimates of structural models, though, can potentially tell us much more. Because such models attempt to describe preferences directly, it is possible to use these models to estimate how parents' behaviour will change in response to any sort of change in the price of childcare or the tax and benefit system, be it linear or non-linear (or in any other variable in the model). It is worth remembering, though, that their additional usefulness comes with the price of increased complexity, and the need to have made many more assumptions on how parents behave.

Both reduced-form and structural models, though, only tell us about one side of the market – the demand for childcare and how it depends on the price. Translating the impact of an direct increase in childcare supply to a change in mothers' employment would also require knowledge of the elasticity of childcare supply.

What do the existing studies tell us?

Many of the US studies listed in Appendix A are compared in Table 5 of Anderson and Levine (1999) and Table 7 in Blau (2000). Appendix A also reports the estimated elasticities of mothers' employment to the price of childcare. There is a wide range of estimates; Blau (2000) concludes that neither sample composition nor data sources can

explain the variation, implying that “specification and estimation issues most likely play an important role in producing variation in the estimates”, and we discuss some of these later in this chapter.

Anderson and Levine (1999) report that “these studies do uniformly find a negative relationship between childcare costs and mothers’ employment”. On the other hand, reviewing much the same studies, Blau (2000) concludes that:

“it is risky to generalize from only two studies, but the fact that the two studies that accounted for informal care in ways consistent with economic theory [Ribar (1995) and Blau and Hagy (1998)] produced small elasticities [of mothers’ employment with respect to the price of childcare] suggests that the true elasticity may be small”.

It should be remembered that there are many differences in the time period and samples, and the majority are based on US data in the 1980s and 1990s, and it is not clear what that would tell us about the behaviour of parents in the UK in 2003. It is also of note that those studies that have estimated such elasticities of childcare use find that the use of and type of childcare seem more responsive to the price of childcare than is mothers’ employment.³²

4.2 Econometric and data problems common to reduced-form and structural models

The vast majority of the papers in Appendix A attempt to estimate the impact of the price of formal care on mothers’ employment behaviour by making use of variation in the childcare price, often aiming to predict how childcare subsidies might affect employment decisions. Identifying this price impact, though, is not always simple. Some of the more important problems faced by these studies is that:

- Childcare expenditure, and its hourly price, is endogenous if mothers chose the quality of care, and if the price of childcare reflects its quality.³³
- Wages are only observed for workers, and childcare prices are only observed for childcare users, and sometimes only for workers who use childcare. This means that we do not know what wage would be earned by non-workers, nor what childcare prices would be faced by a non-childcare user.
- Data on the price of an hour childcare is usually not observed. Instead, household surveys often record weekly expenditure on childcare, and sometimes weekly hours of childcare.
- Generally, much less is known about informal or unpaid care than formal, paid care.

³² See Blau and Hagy (1998).

³³ This point is made in Heckman (1974), and stressed in Blau (2000) and Duncan et al (2001a).

We discuss these in turn below.

Price and quality of childcare

It is very likely that observed expenditure on childcare will reflect quality differences. If mothers chose the quality of care, then observed expenditure on childcare becomes endogenous to the decision to use childcare and work. This means that variations in the price of childcare are not exogenous, and relating patterns of employment and childcare use to observed childcare prices will lead to biased and inconsistent coefficient estimates.

This has led many studies to include predicted childcare price in their models, rather than observed childcare price. If it is possible to find variables that can predict childcare price but that are exogenous to a mother's decisions to work and use childcare, then estimates of the link between employment and the predicted childcare price will be unbiased; this is known as the instrumental variables approach. The majority of studies have argued that some geographical variation in the quality-adjusted childcare price can be treated as exogenous. But not all geographical variation need be exogenous: if one area contained a lot of mothers who liked using private nurseries, and another contained mothers who liked using childminders, then the average price of childcare is likely to be higher in the first area than the second, but this is perhaps only because the average quality (in a general sense) is higher in that area. The geographical variation in price in this case is therefore of no use: mothers in the first area do not face higher childcare prices; instead, they are choosing, on average, higher quality childcare.

There are differences in the precise approach used to predict childcare prices so that they reflect only exogenous variations, but all aim to remove the variation in prices that can be attributed to variations in quality. The most convincing approach estimates the quality-price relationship for childcare using data from a survey of childcare providers.³⁴ If the data includes enough direct measures of the quality of childcare, or factors that are related to quality, then any unexplained variation in childcare prices between areas can be treated as exogenous. This method requires two surveys in the same areas at the same time: one of parents, and one of childcare providers. However, the method does not require that the providers who are surveyed be the actual providers used by the parents in the parental survey, merely that the providers and parents can be argued as being in the same areas or market so that the results from one can be mapped to the other.

Data from providers is relatively uncommon, and so the majority of studies have had to use household survey data to estimate childcare price. Such surveys might record what sort of childcare is being used, but will rarely have any other measures of childcare quality or provider-specific factors that influence the quality. The aim remains to strip out the variation in prices that is due to variation in quality, but only using household characteristics: these are correlated with quality because the characteristics affect parents' preferences for quality (for example, Duncan et al (2001a) find that being a non-white mother and having school-age siblings are both associated with cheaper childcare for pre-school children: this is presumably because these mothers prefer to use relatively cheap

³⁴ See Blau and Hagy (1998), Fronstin and Wissoker (1995).

childcare given their income, rather than because providers give a discount to mothers from ethnic minorities or to children with an older sibling).

This can only ever be an approximation to the first method outlined above: rather than using provider-based direct measures of quality, it removes the variation in quality that can be predicted using observed characteristics of the parents. One of the most sophisticated approaches is shown in Duncan et al (2001a), who predict the price of childcare using household characteristics and local area dummies, and then use the local area dummies as an estimate of the exogenously-varying, quality-adjusted price. As with data from providers, this relies on controlling for enough characteristics so that any residual variation between areas can be argued to be exogenous.

Other, less sophisticated, methods that have been used include:

- using the average price of childcare in the mothers' locality³⁵; this does not, though, account for the fact that mothers in different areas may have different characteristics, on average, and that these differences may lead to variation in the average quality of childcare between areas
- predicting childcare price using household characteristics and variables measuring local regulations on childcare providers and the wages of actual or potential childcare workers.³⁶ This approach exploits supply-side variation between areas in the price of childcare. However, it is likely that any variations in provider regulations will also lead to variations in quality, and so the variation in predicted price would be partly caused by variation in quality, making it endogenous.

However, all of the approaches that use data from only parents suffer from the observability problem discussed below: the price of childcare is only observed for those parents that use childcare, and these parents may not be representative of all parents; in particular, they will tend to have below-average preferences for childcare quality.

The observability problem: what would non-workers earn and what price would non-childcare-users pay?

As with the great majority of labour supply studies, studies of mothers' employment and childcare use have to deal with the problems that wages are only observed for workers, and childcare expenditure is only observed for mothers using childcare; indeed, because of survey design, childcare expenditure is often only observed for working mothers using childcare.

The standard approach to deal with the problem of "missing" wages has been to use the predicted values from wage equations. However, because the decision to work is based on the wage, then the sample of mothers in work will not be a random sample of mothers, and inferences based on them will therefore not necessarily be applicable to those mothers who are not working. In practice, this means that simple OLS regressions of wages will lead to biased coefficient estimates. The common response to this has been

³⁵ See Blau and Robins (1988), Chevalier and Viitanen (2002a).

³⁶ See, eg, Connelly (1992).

to estimate a “selection-corrected” wage equation.³⁷ Such equations rely on there being variables that affect the probability of working, but not the wage: these variables help identify and estimate the “selection effects” (another phrase used is that these approaches rely on finding *exclusion restrictions*, because they rely on some variables being included in an equation that predicts whether a woman works, but being excluded from a prediction of her wage). For parents, the level of welfare benefits is often used as such a variable. Having done this, a “selection-corrected” wage equation can be used to predict correctly potential wages for non-workers.

A similar argument applies to childcare expenditure. A prediction of the price of childcare faced by a non-childcare user based on mothers who are employed and pay for childcare will be inaccurate if the unobserved factors that affect the price of childcare are correlated with unobserved factors that affect employment or preferences for childcare quality; there is no reason to think that this will not be true. As with wages, most researchers therefore estimate a “double-selection-corrected” childcare price equation, which attempts to control for the fact that childcare expenditures are often only observed for mothers who work and use childcare, and that this is not a random sample of mothers. This equation can then be used to predict the childcare price faced by a non-childcare user. As with the wage, such an approach relies on finding a variable that affects the probability of using childcare, but not the price of childcare.

However, a substantial criticism put forward by Blau (2000) is that, if the price of childcare reflects its quality, then there are no theoretically-justified variables. This is because the quality of childcare is chosen by the mother simultaneously with her labour supply, and so it is potentially affected by all relevant variables in the model. It is simply not possible to think of a variable that affects the likelihood that a mother uses childcare but not the price, because the mother’s choice of childcare quality would have been affected by this variable, and therefore the suggested variable will directly affect the childcare price.³⁸ As the model in chapter 2 makes clear, mothers’ decisions on how much to work, whether to use childcare, and what sort of childcare to use are made simultaneously.

Given this – perhaps rather obscure– critique, what can be done? . The ideal solution for wages is to model the mother’s wage simultaneously with her labour supply and childcare use equations so that the selection-correction-adjustments are made in a logically- and econometrically-consistent manner; this usually adds a great deal to the complexity of estimation. There is clearly nothing that can be done to remove the general observability problem for childcare price other than using data from providers, as described above (although it would also help if more household surveys asked non-working families, as well as working families, about their use of childcare). Most studies ignore Blau’s point about childcare prices, and impose their own exclusion restrictions in order to estimate a childcare price equation. A slightly better alternative is shown in Tekin (2002), who estimates a price equation simultaneously with equations determining employment and

³⁷ Heckman (1979) developed the model for a single selection-correction.

³⁸ In Appendix A, we write “Accounts for selection bias” if the study estimates a selectivity-corrected childcare equation even if it is subject to this critique.

childcare use, allowing for the unobservable factors to be correlated, but she has to assume that a parent's location (in her case, state in the US) affects outcomes only by affecting the price of childcare.³⁹

Estimating the price of an hour of childcare

Data on the price of an hour of childcare is usually not observed in household surveys. Instead, household surveys often record weekly expenditure on childcare, and sometimes weekly hours of childcare.

As is clear from Appendix A, there have been a number of approaches to estimating the cost of an hour of childcare:

- Divide total weekly childcare expenditure by weekly hours of childcare use, to derive the average cost of an hour of childcare;
- Divide total weekly childcare expenditure by weekly hours of mothers' employment, to derive the average childcare cost of an hour of mothers' employment;
- Model total weekly childcare expenditure as a non-linear function of hours of childcare use.

Clearly, the first two approaches will not capture either the marginal cost of an hour of a childcare nor an hour of mothers' employment. Kimmel (1998) finds that whether the price of childcare is measured by the expenditure per hour of childcare or the expenditure per hour of mothers' employment makes a considerable difference to the estimated price elasticity. This is unsurprising because we would expect a non-linear relationship between hours of work and hours of childcare because, for example, school aged children do not require childcare during school hours.

The third approach – examples include Michalopoulos et al (1992), Ribar (1995), Duncan et al (2001b) – is therefore preferable, although estimating the relationship between the cost of childcare and hours of childcare used increases the complexity of estimation because it ideally requires simultaneous estimation of the price equation, and an equation for hours of childcare.

Informal care

As discussed in chapter 2, Blau (2000) has argued that:

“specifying an employment model under the assumption that paid care is always the relevant non-maternal child care option is ... a potentially serious error, leading to inconsistent parameter estimates.”⁴⁰

³⁹ There is a related but less serious problem with the wage equation: the “selection correction” used to predict wages has to be based on a reduced-form participation equation that includes all exogenous variables in the model: this means that the impact of wages on participation in the eventual participation equation is identified either by inconsistent exclusion restrictions or on functional form alone. But this problem is common to (and ignored by) many papers that estimate labour supply models.

As is clear from Appendix A, there are a few approaches to dealing with informal care:

- The most common approach has to been present a theoretical model which allows for informal, unpaid care, but then to ignore this when estimating parameters. This can lead to incorrect inferences. For example, when the price of formal childcare is relatively high, some mothers will prefer not to work than to work and use formal childcare, and so the more important choice for them is between not working, and working and using informal childcare
- A few papers have explicitly recognised informal care.⁴¹ The more recent of these have used a discrete choice approach to modelling employment and childcare use, where mothers are assumed to choose a work/childcare combination from a small choice set. In this context, it is reasonably straightforward to allow some of the choices to include informal care. All of these studies have modelled the choice of the most important childcare type, which effectively means that mothers choose one of formal care, informal care and no care: no study has explicitly modelled the combination of formal and informal care.

As discussed in chapter 2, one key difference between formal and informal care is that it is highly likely that the availability, quality and cost of informal care vary across parents. Including informal care within a model requires both good data on the use of informal care, but also further assumptions to identify the shadow price or quality of informal care. This will clearly increase the complexity of estimation. For example:

- the model in Ribar (1995) allows parents' relative preferences for informal care over formal care to vary with observable and unobservable characteristics. This approach does not say whether this variation is due to variation in the price of informal care or the quality. In addition, the model assumes that parents have to choose between either formal or informal care, and that informal care is available to all parents, although perhaps at a very low quality.
- Blau and Hagy (1998) similarly assume that informal care is available to all, but allow both preferences for informal care and the price of informal care to vary with observable and unobservable characteristics. The model assumes that parents have to choose between either formal or informal care.

It is unlikely that anything more could be achieved with the limited data that is typically available in household surveys. In particular, identifying heterogeneity in the availability of informal care separately from heterogeneity in quality and price may be impossible: in other words, we may never know whether families who do not use informal care don't have access to it, or have strong preferences for using other forms of care.⁴²

⁴⁰ Section IV.C. of Blau (2000).

⁴¹ Heckman (1974), Ribar (1995), Blau and Hagy (1998) and Tekin (2004).

⁴² This point is valid for many discrete choice models, not just those applying to childcare demand.

Does this subtlety matter? If the models in Ribar and Blau and Hagy were estimated having incorrectly assumed informal care is available to all, then their estimated heterogeneity in preferences for informal care could be capturing heterogeneity in availability. As Blau and Hagy (1998) note, “if some families have access to free arrangements ... but others do not...then our results are still useful as a description of joint distributions, but not as evidence of consumer behaviour”. It may be the case, though, that the estimates of the interesting parameters from the point of view of policy makers are relatively unaffected by this potential bias; given that data on availability is very hard to collect, we will never know whether this is the case or not.

Best practice models should, therefore, allow mothers to choose to use informal as well as formal care. This is difficult, as we usually know little about the availability and quality of informal care. It does suggest, though, that studies of childcare demand should ideally use data that record any factors which might be correlated with the availability or quality of informal care including, for example, the presence of teenage girls or other adults in the household, distance from close relatives, and so on.

4.3 What would be possible in the UK?

There are no published examples of structural models of childcare demand and labour supply using UK data: existing studies of childcare demand are all reduced-form estimates, and existing studies of labour supply do not attempt to model the demand for childcare fully.

The main data available in the UK is similar in structure to that available to researchers in the US, where most studies have used the SIPP data-set: an important exception is Blau and Hagy (1998), which combined information from separate surveys of parents and childcare providers. This means that it should be possible to estimate one of the relatively simple examples of a structural model using UK data. As the discussion in 4.2 makes clear, structural models require various untestable identification or exclusion restrictions to make them operational; whether UK data supports a structural model will therefore depend partly on the ingenuity of researchers in putting forward plausible exclusion restrictions.

The main household surveys are listed in Appendix C, with the usual advantages and disadvantages of each. None of the US-based studies uses panel data, and it may be possible to advance the literature if researchers can suggest ways to use the panel element in FACS or BHPS to provide more information on the unobserved heterogeneity.⁴³

4.4 Conclusions

This chapter has shown the following:

- The majority of studies that have investigated the link between mothers’ employment and childcare use have attempted to estimate the elasticity of

⁴³ Changes in the sample composition and the childcare questions mean that an analysis using FACS would have to be limited to lone mothers from wave 2 onwards, or all mothers from wave 3 onwards.

mothers' employment with respect to the price of childcare using a reduced-form approach. This is a very useful parameter for policy analysis. There are, though, several problems with this approach.

- Estimates of structural models, although more complicated and requiring more assumptions to be taken on trust, can overcome some of the problems faced by reduced-form participation equations, deal with the considerable number of non-linear relationships in a more satisfactory manner, and tell us about the inter-relationships between mothers' employment, childcare use and the price of childcare. Both structural and reduced-form models, though, tell us about the demand-side of the childcare market only, and not about how providers react to demand changes.
- The most challenging problem is untangling the price-quality relationship so that researchers can show that there is variation in quality-constant prices, usually between areas. Data collected from providers, with explicit information on attributes that parents are likely to value, provides the best opportunity to achieve this.
- A best practice structural model would require simultaneous estimation of a labour supply function, the demand for quality or different types of childcare, mothers' wages, the quality-adjusted price of childcare, the relationship between weekly hours of childcare and the weekly cost of childcare, and variations in the quality or shadow price of informal care. Unsurprisingly, no single study has accomplished this because of the demands it would make on both data and numerical estimation; Blau and Hagy (1998) perhaps comes the closest.
- The type of data used by Blau and Hagy (1998) is not available in the UK, but it should be possible to estimate a simpler structural model of childcare demand and labour supply with UK data. This will partly depend, though, on the ingenuity of researchers in putting forward plausible exclusion restrictions. In addition, it may be possible to use the longitudinal element of FACS to help identify some of the unobservable heterogeneity.

References

- Anderson, P. A. & Levine, P.B. (1999), "Child Care and Mothers' Employment Decisions", NBER Working Paper 7058
- Andren, T. (2003), "The Choice of Paid Childcare, Welfare and Labour Supply of Single Mothers", *Labour Economics*, 10, pp133-147.
- Averett, S. Peters, E. & Waldman, D., (1997), "Tax Credits, Labor Supply, and Child Care", *Review of Economics and Statistics*, 79, February, 125-35
- Bainbridge, J., Meyers, M. and Waldfoegel, J. (2003), "Child Care Policy Reform and the Employment of Single Mothers", *Social Science Quarterly* 84(4), 771-791.
- Behrens, J. (1978), *The Demand for the Gary Childcare Subsidy Program*, Princeton: Mathematica Policy Research.
- Berger, M. & Black, D. (1992), "Child Care Subsidies, Quality of Care, and the Labour Supply of Low-Income Single Mothers", *Review of Economics and Statistics*, 74(4), 635-42
- Blau D. and Hagy, A. (1998), "The Demand for Quality in Child Care", *Journal of Political Economy*, vol. 106 no. 1
- Blau, D. (2000), "Child Care Subsidy Programmes", NBER Working Paper 7806. A version also appears in Robert A. Moffitt (ed) (2003), *Means-Tested Transfer Programs in the United States*, Chicago: The University of Chicago Press.
- Blau, D. and Robins, P. (1988) "Child-Care Costs and Family Labour Supply", *Review of Economics and Statistics*, 70(3), 374-381
- Blow, L., Goodman, A., Kaplan, G., Walker, I. and Windmeijer, F. (2003), "How Important is Income in Determining Children's Outcomes? A Review of Econometric Approaches", unpublished mimeo, IFS.
- Blundell, R. and Costa Dias, M. (2000), "Evaluation methods for non-experimental data", *Fiscal Studies*, 21(4).
- Blundell, R, Duncan, A, McCrae, J and Meghir, C. (2000), "The Labour Market Impact of the Working Families' Tax Credit", *Fiscal Studies* 21(1).
- Bowen, G. and Neenan, P. (1993). "Does subsidized child-care availability promote welfare independence of mothers on AFDC: An experimental analysis". *Research on Social Work Practice*, 3(4), pp. 363-384.
- Brewer, M., Duncan, A., Shephard, A. Suárez, M.-J. (2003), "Did WFTC work? Analysing the impact of in-work support on labour supply and programme participation", Inland Revenue Working Paper, download from www.inlandrevenue.gov.uk/research/index.htm .
- Cabinet Office (2002), *Delivering for Children and Families: Inter-Departmental Childcare Review, November 2002*.
- Callender, C. (2000) *The Barriers to Childcare Provision*, Department for Education and Employment, Research Report RR231, October 2000

- Chevalier, A. and Viitanen, T. (2002a), "The Supply of Childcare in Britain: Do Mothers Queue for Childcare?", mimeo, ISSC, University College, Dublin.
- Chevalier, A. and Viitanen, T. (2002b), "The causality between female labour force participation and the availability of childcare", *Applied Economics Letters*, 9(14), 915-918.
- Connelly, R. (1992) "The Effects of Childcare Costs on Married Women's Labour Force Participation", *Review of Economics and Statistics*, 74(1), 83-90
- Duncan, A. Giles C. (1996) "Should We Subsidise Pre-School Childcare, and, If So, How?", *Fiscal Studies*, vol. 17 no. 3,
- Duncan, A., G. Paull & J. Taylor (2001a) "Price and Quality in the UK Childcare Market", IFS Working Paper W01/14, abridged as chapter 7 of Paull, G. & J. Taylor with A. Duncan (2002) *Mothers' Employment and Childcare Use in the UK*, London: Institute for Fiscal Studies.
- Duncan, A., G. Paull & J. Taylor (2001b) "Mothers' Employment and the Use of Childcare in the UK", IFS Working Paper W01/23, abridged as chapter 8 of Paull, G. & J. Taylor with A. Duncan (2002) *Mothers' Employment and Childcare Use in the UK*, London: Institute for Fiscal Studies.
- Education and Employment Committee (1997), "The Operation of the Nursery Education Voucher System", London: The Stationery Office.
- Gelbach, J. (2002), "Public Schooling for Young Children and Maternal Labour Supply", *American Economic Review*, 92(1), 307-323.
- Greenberg, D., and Morris, S. (2003), *Large Scale Social Experimentation in Britain: What Can and Cannot be Learnt from the Employment Retention and Advancement Demonstration?* Government Chief Social Researcher's Office, Occasional Papers Series No. 3, download from policyhub.cmps.gov.uk/servlet/DocViewer/doc=1465/lse.pdf
- Heckman, J. (1974), "Effects of Child-Care Programs on Women's Work Effort", *Journal of Political Economy*. 82, March/April, S153-S161.
- Heckman, J. (1979), "Sample Selection Bias as a Specification Error", *Econometrica*, 47(1), 153-161.
- La Valle, I., Finch, S., Nove, A. and Lewin, C. (1999) *Parents' Demand for Childcare*, DfEE Research Report RR176,
- Jaumotte, F. (2003), "Female Labour Force Participation: Past Trends and Main Determinants in OECD Countries", ECO/WKP(2003)30, download from www.oecd.org/eco.
- Jenkins, S. & Symons, E. (2001), "Child Care Costs and Lone Mothers' Employment Rates: UK Evidence", *The Manchester School*, Volume 69, Issue 2.
- Kimmel, J. (1998), "Child Care Costs as a Barrier to Employment for Single and Married Mothers", *Review of Economics and Statistics*.
- Kornstad, T. and Thoresen, T. (2002), "A Discrete Choice Model for Labor Supply and Childcare", Discussion Papers No. 315, Statistics Norway, Research Department.

- Michalopoulos, C., Robins, P. & Garfinkel, I. (1992) "A Structural Model of Labor Supply and Child Care Demand", *Journal of Human Resources*, 27(1), 166-203
- OFSTED (2003), "Registered childcare providers and places in England, 30 June 2003", download from www.ofsted.gov.uk/publications/docs/3310.pdf (checked 23.1.04).
- Paull, G. and Taylor, J. with Duncan, A., (2002) *Mothers' Employment and Childcare Use in the UK*, London: Institute for Fiscal Studies.
- Powell, L. (1997), "The Impact of Child Care Costs on the Labour Supply of Married Women", *Canadian Journal of Economics* 30, August, 577-594
- Ribar, D. (1992) "Child Care and the Labor Supply of Married Women: Reduced Form Evidence", *Journal of Human Resources*, 27, 134-65
- Ribar, D. (1995) "A Structural Model of Child Care and the Labor Supply of Married Women", *Journal of Labor Economics*, vol. 13 no. 3.
- The Strategy Unit (2002), *Delivering for children and families, Inter-departmental Childcare Review – November 2002*, download from www.number-10.gov.uk/su/childcare/downloads/su-children.pdf (checked 4.2.04).
- Tekin, E. (2004), "Childcare Subsidy Receipt, Employment and Childcare Choices of Single Mothers", NBER WP 1049, www.nber.org/papers/w10459 (checked 21.5.04).
- Toroyan, T., Roberts, I., Oakley, A., Laing, G., Mugford, M., Frost, C. (2003), "Effectiveness of out-of-home day care for disadvantaged families: randomised controlled trial", *British Medical Journal*, 327, 906-911.
- Woodland, S., Miller, M. and Tipping, S. (2002, revised 2004), *Repeat Study of Parents' Demand for Childcare*, DfES Research Report 348.

Appendix A. Empirical studies of mothers' employment and childcare use

Study and data-set	Demand assumptions	Supply assumptions for formal care	Supply assumptions for informal care	Allowed to use more than 1 childcare type?	Quality assumptions	How is childcare price calculated or predicted?	What is estimated?	Elasticity of employment relative to childcare price
Heckman (1974), using the 1966 National Longitudinal Survey (NLS)	Childcare an input into child quality.	Competitive market for formal care.	Available to all at varying shadow price.	Allowed to use formal and informal childcare, but no further disaggregation. Childcare use not explicitly modelled.	Quality of informal care assumed fixed. Free choice of quality of formal care (unobserved).	Formal and informal childcare care spend not observed	Utility-maximising-consistent labour supply function	N/a
Blau and Robins (1988), using Baseline EOPP survey (1980).	Childcare needed when mothers work and an input into child quality. Mothers choose between childcare and work.	Competitive market for formal care.	Available to all at varying quality.	Yes	Formal childcare varies in quality; ; quality choice not modelled. Quality of informal care given.	Average spend per hour of work within areas, without accounting for selection bias.	Multiple choice model over participation and use of formal and informal childcare.	-.34

Study and data-set	Demand assumptions	Supply assumptions for formal care	Supply assumptions for informal care	Allowed to use more than 1 childcare type?	Quality assumptions	How is childcare price calculated or predicted?	What is estimated?	Elasticity of employment relative to childcare price
Connelly (1992), using SIPP wave 5 (1984-85).	Childcare an input into child quality. Mothers choose between leisure, childcare and work.	Competitive market for formal care.	Informal care available to all, but at varying quality.	Parents allowed to use formal or informal childcare, but not explicitly modelled.	Formal and informal childcare vary in quality; quality choice not modelled.	Cost per hour of work. Accounts for double selection bias.	Probit for participation conditional on wage and childcare costs	-.20
Michalopolous et al (1992) using SIPP wave 5 (1984-85).	Childcare an input into child quality. Mothers choose between childcare and work. Non-working mothers do not use childcare.	Competitive market for formal care.	Informal care available to all, but at varying quality.	No: working parents assumed to use formal or informal childcare.	Formal and informal childcare vary in quality. Assumes quality of childcare proportional to cost.	They model weekly childcare expenditure for working mothers using childcare, accounting for double selection bias.	Utility-maximising-consistent labour supply, childcare use and childcare quality functions for mothers working and using childcare.	0.00 [sic]
Ribar (1992) using SIPP wave 5 (1984-85).	Childcare an input into child quality. Mothers choose between childcare and work.	Competitive market for formal care.	Informal care available to all at varying (shadow) price.	Parents allowed to use formal and informal childcare, but no further disaggregation.	Formal and informal childcare vary in quality; quality choice not modelled.	Predicted cost per hour of childcare. Accounts for double selection bias.	Probits for participation, Tobits for formal and informal childcare use	-.74

Study and data-set	Demand assumptions	Supply assumptions for formal care	Supply assumptions for informal care	Allowed to use more than 1 childcare type?	Quality assumptions	How is childcare price calculated or predicted?	What is estimated?	Elasticity of employment relative to childcare price
Ribar (1995), using SIPP wave 5 (1984-85).	Childcare an input into child quality. Mothers choose between childcare and work.. Non-working mothers do not use childcare.	Competitive market for formal care.	Informal care available to all at varying quality.	No: working parents assumed to use formal or informal childcare.	Formal and informal childcare differ in quality; quality choice not modelled.	Models weekly expenditure as non-linear function of hours of work. Accounts for double selection bias.	Utility function for labour supply with (dis)utility of childcare use, estimated jointly with childcare expenditure	-.09
Averett et al (1997), using 1986 wave of NLSY (women aged 21-29).	Mothers choose between childcare and work. Pre-school children require continuous care; childcare only demanded when mother works so childcare costs reduce mothers wage.	Competitive market for formal care.	Available to all. Assumes price of formal care = shadow price of informal care (but does not introduce a full-income budget constraint).	Parents allowed to use formal or informal childcare, but not explicitly modelled..	Formal and informal childcare vary in quality; quality choice not modelled.	Predicted cost per hour of work. Accounts for double selection bias.	Labour supply function under piece-wise linear budget set.. Childcare use assumed equal to maternal hours of work.	-.78
Powell (1997) using Canadian National Child Care Survey and LMAS (1988).	Childcare an input into child quality. Mothers choose between leisure, childcare and work.	Competitive market for formal care.	Ignored.	Not applicable (childcare use not explicitly modelled).	Formal childcare varies in quality; quality choice not modelled.	Predicted cost per hour of work. Accounts for double selection bias.	Probit for participation, conditional on wage and childcare costs	-0.38

Study and data-set	Demand assumptions	Supply assumptions for formal care	Supply assumptions for informal care	Allowed to use more than 1 childcare type?	Quality assumptions	How is childcare price calculated or predicted?	What is estimated?	Elasticity of employment relative to childcare price
Blau and Hagy (1998) using US National Child Care Survey and the Profile of Child Care Settings (1989-1990)	Childcare an input into child quality. Mothers choose between leisure, childcare and work. Non-workers allowed to use childcare.	Competitive market for formal care: all types of childcare offer all possible quality combinations	Competitive market for informal care: all types of childcare offer all possible quality combinations	No: parents allowed to use formal or informal childcare.	Models demand for quality explicitly	Predicted cost per hour of childcare estimated from survey of providers.	Joint model of labour supply, type and hours of childcare & demand for quality, all via indirect utility function.	-.20
Kimmel (1998) using SIPP wave 6 (1987).	Childcare an input into child quality. Mothers choose between childcare and work.	Competitive market for formal care.	Ignored.	Not applicable (childcare use not explicitly modelled).	Formal and informal childcare vary in quality; quality choice not modelled.	Predicted cost per hour of work. Accounts for double selection bias.	Probit for participation, conditional on wage and childcare costs	Married: -.92 Single: -.22
Anderson and Levine (1999) using SIPP 1990 – 1993.	Childcare an input into child quality. Mothers choose between childcare and work.	Competitive market for formal care	Not explicit.	Not applicable (childcare use not explicitly modelled).	Formal and informal childcare vary in quality; quality choice not modelled.	Predicted cost per hour of work. Accounts for double selection bias.	Probit for participation, conditional on wage and childcare costs	Married, <13: -.30 Single, <13: -.47 Married, <6: -.46 Single, <6: -.58

Study and data-set	Demand assumptions	Supply assumptions for formal care	Supply assumptions for informal care	Allowed to use more than 1 childcare type?	Quality assumptions	How is childcare price calculated or predicted?	What is estimated?	Elasticity of employment relative to childcare price
Jenkins and Symons (2001) using UK LPS (1990).	Not stated	Competitive market for formal care.	Informal care ignored.	No (childcare use not explicitly modelled).	Formal childcare varies in quality; quality choice not modelled.	Predicted cost per hour of work. Accounts for double selection bias.	Probit for participation, conditional on wage and childcare costs	
Duncan et al (2001b) using FRS (various years).	Childcare an input into child quality and required when mothers work. Mothers choose between childcare and work.	Competitive market for formal care.	Informal care ignored.	No	Formal childcare varies in quality; quality choice not modelled.	Models quality-adjusted weekly expenditure as non-linear function of hours of work. Accounts for double selection bias.	Tobits for hours of work and hours of childcare use, conditional on wage and childcare cost.	
Andren (2002) using Swedish Household Income Survey (1997, 1998)	Childcare an input into child quality (not stated explicitly, but use of paid childcare enters utility function directly).	Competitive market for formal care.	Informal care ignored.	No	Formal childcare varies in quality; quality choice not modelled.	Predicted cost per hour of childcare. Does not account for selection bias.	Utility function over labour supply with (dis)utility of formal childcare.	

Study and data-set	Demand assumptions	Supply assumptions for formal care	Supply assumptions for informal care	Allowed to use more than 1 childcare type?	Quality assumptions	How is childcare price calculated or predicted?	What is estimated?	Elasticity of employment relative to childcare price
Chevalier and Viitanen (2002a), using FRS (various years) and DH/DfEE data on availability.	Not stated.	Formal childcare is rationed.	Informal care ignored.	Childcare use not explicitly modelled, but price estimated separately for each type..	Informal care ignored.	Cost per hour of childcare, averaged over areas and childcare type. Does not account for selection bias.	Probit for formal childcare use, conditional on employment (coefficients are biased). Rationing is not observed.	
Kornstad and Thoresen (2002), using Norwegian Home Care Allowance Survey (1998).	Mothers need childcare to cover time working.	Formal childcare is rationed.	Informal care ignored.	Mothers assumed to chose only 1 of centre-based care, non-centre formal care, and own care.	Quality of care varies by type but fixed.	Weekly expenditure is predicted, varying over childcare type. Does not account for selection bias.	Utility function over labour supply with (dis) utility of childcare use, allowing for rationing. Rationing is observed.	

Study and data-set	Demand assumptions	Supply assumptions for formal care	Supply assumptions for informal care	Allowed to use more than 1 childcare type?	Quality assumptions	How is childcare price calculated or predicted?	What is estimated?	Elasticity of employment relative to childcare price
Tekin (2002), using National Survey of America's Families (1997).	Childcare an input into child quality. Mothers choose between childcare and work. Only working mothers use childcare.	Competitive market for formal care.	Available to all at varying quality or shadow price	No	Formal childcare varies in quality; quality choice not modelled.	Predicted cost per hour of childcare. Fully accounts for selection bias. Predicted childcare price is area-intercept in reduced-form equation.	Joint model of labour supply and use of formal childcare, conditional on wages and childcare prices, via indirect utility function.	-.15

Notes: "participation" means labour market participation. SIPP is Survey of Income and Program Participation. Similar tables appear in Blau (2000) (Table 7) and Anderson and Levine (1999), Table 5.

Appendix B. Evidence on excess/unmet demand for childcare in the UK

Study and data-set	Sample	Conclusions	Identification/question
Callender (2000) using Survey of Childcare Providers	Childcare providers in 1999	Finds evidence of both excess supply and demand, and of considerable heterogeneity across providers. One third of providers had both vacancies and waiting lists.	Providers asked about vacancies and waiting lists
La Valle et al (2000)	Parents of children aged 14 or under in 1999	31% of childcare users had times in past year when would have liked to use more (referred to as “unmet demand”)	“Parents who had used childcare in the last year were asked whether there were any occasions when they had wanted/needed childcare, but had been unable to get it”.
Woodland et al (2002)	Parents of children aged 14 or under in 2001	24% of parents had times in past year when would have liked to use more (referred to as “unmet demand”)	“Parents who had used childcare in the last year were asked whether there were any occasions when they had wanted/needed childcare, but had been unable to get it”.
Chevalier and Viitanen (2002a)	FRS (various years) and DoH/DfEE data on availability.	Excess demand for childcare amongst non-working mothers is similar size as number of non-working mothers actually using childcare; formal and informal childcare are poor substitutes.	Uses exclusion restrictions to identify mothers queuing for childcare, and finds that they are not particularly likely to use informal care. Other paper (Chevalier and Viitanen (2002b)) found 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.”

Appendix C. Main UK/GB datasets with information on mothers' employment and/or childcare use

Data-set	Time and geographical coverage	Sample of mothers	Mothers' employment	Childcare use	LEA indicator	Comments
Surveys						
FACS	From 1999. Timing has changed from summer to September-January. Two-stage cluster design so takes random sample of parents from random sample of postal areas in GB.	Circa 6,000 in waves 3 onwards; fewer in waves 1-2	Yes	Hours and cost at child-type level (from wave 2)	Could be supplied (?)	Not nationally representative so limited variation between LEAs
FRS	Continuous survey since April 1994 in GB	Circa 7,000 in each financial year	Yes	Type, hours and cost at child level	Could be supplied (?)	Used in Paull and Taylor, Chevalier and Viitanen (2002)
LFS	Continuous survey since 1992 in UK	Around 30,000 in each quarter, with each individual appearing in up to 5 waves; income/earnings data available for 40% of the sample.	Yes	Type at child level (not over whole period)	Could be supplied (?)	Could be used to investigate impact on employment, but not childcare use
FES	Continuous survey since 1961 in UK	Around 2,200 in each financial year.	Yes	Cost at family level	Could be supplied (?)	Sample too small to allow for LEA individual-effects.
PRILIF	Irregular longitudinal survey since 1991. Two-stage cluster design so takes random sample of parents from random sample of postal areas in GB.	Around 900 lone mothers.	Yes	Type & cost at family level	Could be supplied (?)	Not nationally representative, so limited variation between LEAs. Small sample.

Data-set	Time and geographical coverage	Sample of mothers	Mothers' employment	Childcare use	LEA indicator	Comments
BHPS	Annual panel survey since 1991 across GB (UK in later years)	Around 1,500 mothers in each wave.	Yes	Type & cost at family level	Could be supplied (?)	Always survey in autumn. Sample too small to allow for LEA individual-effects.
Administrative data-sets						
DWP benefit records	GB	100% sample of claimants	Receipt of IS/JSA (so measures worklessness in families)	No	Yes	Only available for recent years.

Appendix D. Data sets/sources with information on childcare places/use/availability

Data	Collected /held by	Time period	Comments
“Registered childcare providers and places in England”.	Ofsted	Quarterly from 31 March 2003	<p>Records places available to children under 8 in England at registered childcare providers Based on Ofsted regulated childcare, ie childminders, day care, out of school clubs and crèches for children in England aged under 8.</p> <p>Estimates are based on last inspection/registration with Ofsted; all numbers will be an upper bound on actual number of places.</p>
“Children’s Day Care Facilities”	Department of Health (until 1998) and then DfEE/DfES	March 1990 – March 2001. 2002 data was not released.	<p>Based on returns from English Local Authorities on “places” in day nurseries, playgroups, childminders, out-of-school clubs and holiday schemes for children under 8.</p> <p>Similar data is available for Wales, but I am not sure about the time-span.</p> <p>Have not yet found Scottish data.</p>
“Pupils Under Five Years of Age in Schools in England”	DfEE and predecessors	January 1996 – January 1999	<p>“Since 1996, the Annual Schools Census has collected data on 3 and 4 year olds in schools.</p> <p>Records children in nursery schools, not number of places available. Not sure how far back Scottish and Welsh data is available.</p>
“Provision for children under five years of age in England”	DfEE/DfES	January 2000 – January 2003	<p>“ Since 1999, the Early Years Census has collected data on 4 year olds attending private and voluntary providers and independent schools that are registered with Early Years Development and Childcare Partnerships. Since 2000, EYC has collected data on 3 year olds from private and voluntary providers and independent schools that are registered with EYDCPs.”</p> <p>Children of compulsory school age or over, i.e. those who turn five before the end of December of the previous calendar year, are excluded.</p> <p>Similar data exists for Scotland and (I think) Wales in recent years, but I am not sure about the time-span.</p>