Child Care Assistance: Are subsidies or tax credits better?

Xiaodong Gong and Robert Breunig*

Abstract

We evaluate price subsidies and tax credits for child care. We focus on partnered women's labor supply, household income and welfare, demand for child care and government expenditure. Using Australian data, we estimate a joint, discrete structural model of labor supply and child care demand. We introduce two methodological innovations: a more flexible quantity constraint that total formal and informal child care hours is at least as large as the mother's labor supply and child care explicitly included in the utility function as a proxy for child development. We find that tax credits are better than subsidies in terms of increasing average hours worked and household income. However, tax credits disproportionately benefit wealthier and more educated women. Price subsidies, while less efficient, have positive redistributional effects.
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*Xiaodong Gong (xiaodong.gong@natsem.canberra.edu.au) is associate professor at NATSEM, University of Canberra. Robert Breunig (robert.breunig@anu.edu.au) is Professor of Economics at the Crawford School of Public Policy, Australian National University. This paper has benefited from comments and suggestions provided by Patricia Apps, Richard Blundell, Anthony King and participants at the Econometric Society Australasia Meetings 2011 and the HILDA Conference 2011. We use unit record data from the Household, Income and Labour Dynamics in Australia (HILDA) Survey. The HILDA Project was initiated and is funded by the Australian Government Department of Families, Housing, Community Services and Indigenous Affairs (FaHCSIA) and is managed by the Melbourne Institute of Applied Economic and Social Research (Melbourne Institute). The findings and views reported in this paper, however, are those of the authors and should not be attributed to either FaHCSIA or the Melbourne Institute. All errors remain our own.

1 Introduction

Many governments subsidize child care. For example, in some European countries, child care services are provided through universal public programs (OECD (2007)). In the US, although most child care is provided by the private market, various programs exist which subsidize child care, particularly for low income families. In Australia, the Commonwealth Government pays over half of child care costs of most households through a combination of a means-tested price subsidy (Child Care Benefit, CCB) and a universal subsidy program, originally introduced as a tax rebate for expenditure on child care (Child Care Rebate, CCR). The most emphasized reason for public provision of child care is to encourage women with young children to enter the labor market. Improving child outcomes and distributional considerations related to equitable access to quality child care are two other oft-cited justifications.[1] Public provision comes with costs, including higher taxes, potential efficiency loss and crowding-out of private provision. Evaluating the economic effects of child care assistance is thus important for both governments and citizens.

Modeling the relationship between child care costs and labor supply presents a variety of challenges which we discuss in detail in the next section. For example, it can be difficult to determine the correct price of child care. Correctly estimating the labor supply response of women to changes in child care price requires modeling the tax and transfer system and other institutional features in their full complexity. The role of paid, formal child care and unpaid, informal child care both need to be considered. Families purchase child care so that they can go to work but they also purchase child care because they care about quality education for their children and models should allow for both aspects.

In this paper, we take on these challenges by estimating a joint, structural labor supply and child care demand model for partnered women (we include couples in de facto relationships and in formal marriages and refer generically to these two groups

[1] For example, the Henry Tax Review, Commonwealth of Australia (2009), p. 583, states "assistance to access high-quality and affordable child care is important to the workforce participation of parents, providing them with the means to support and provide opportunities for their children."

as ‘partnered’ or ‘married’). Our modeling recognizes the close relationship between decisions to work and child development. We use local area average prices to control, to some degree, for the household’s specific choice of child care quality. Our model incorporates the Australian tax and transfer system including all of the major welfare programs which affect married households’ labor supply and child care demand decisions. We improve on previous models of this type by incorporating a new, more flexible, hours constraint that the sum of formal and informal (which can include paternal) child care must be greater than or equal to the number of hours worked by the mother and by including maternal care explicitly in the utility function. We show that these modeling innovations make a substantive difference to the estimated elasticities.

Using our estimates, we provide a set of labor supply and child care demand elasticities for Australia. The advantage of our approach is that the structural model allows for welfare analysis and for the simulation of alternative policy experiments. As an example, we compare and contrast a child care price subsidy to a tax rebate for child care expenditure. We find that the tax rebate is more efficient and effective if the goal of policy is to increase women’s labor supply. However, child care price subsidies re-distribute the benefits towards those households with less education and less income whereas tax credits disproportionately benefit the already better off. Our modeling approach and results highlight the importance of accounting for the specific features of child care assistance, the tax system and welfare regimes in policy evaluation. As Australian institutions are a hybrid of U.S. and European ones, our results should be of interest to many. We believe that our overall conclusions about the trade-offs between tax rebates and price subsidies apply widely even if the estimates we present are specific to Australia.

In the next section, we provide some background and discuss, in more detail, the nature of the modeling challenges. In section 3 we briefly discuss child care arrangements in Australia before proceeding to discussion of our modeling approach and data (sections 4 and 5). We discuss parameter and elasticity estimates in section 6 and evaluate the relative performance of tax credits and price subsidies in section 7 before concluding.

2 Background

Assessing child care assistance programs depends upon correctly estimating the responses of women's labor supply and child care demand to child care costs. The literature over the last 15 years shows that female labor supply and child care demand respond negatively to child care prices, but the range of estimated elasticities is quite wide. Labor supply elasticity is estimated to be between 0 to -1.26 (see Blau (2003) or Breunig, Gong and King (2012)). Estimates of own price elasticities for child care vary equally widely, ranging from -0.07 in Blau and Hagy (1998) to -1.0 or more in, for example, Connelly and Kimmel (2003), Powell (2002), and Cleveland, Gunderson and Hyatt (1996).[2] Blau (2003) notes that the variation in estimates is likely a result of differences in specification and estimation. The complexity of the underlying economic problem and inadequate data both contribute to the specification and estimation issues.

Determining a correct price for child care may be difficult. Some problems are related to data availability. We may only observe total costs for child care, making it difficult to deal with the price heterogeneity for children of different age groups in households with more than one child. We may only observe hours worked by the mother, not hours in care. In a labor supply equation, a child care price that is constructed using working hours will be endogenous by construction as it induces spurious correlation between price and hours. Some studies deal with these problems by restricting the scope of analysis to full-time working mothers or families with only one child with the implicit assumption that hours worked are equal to formal child care hours, e.g. Connelly (1992). Breunig et al. (2012) illustrate with a simple linear labor supply model that a good measure of child care price is indeed crucial to the results and found that measurement error was, at least partly, responsible for previous authors' failure to find a relationship between child care price and women's labor supply in Australia.

Another complexity is that the observed price a family pays for child care reflects both a 'cost of working' aspect and a 'child care quality' aspect. Quality may be difficult or impossible to observe.[3] Another endogeneity problem arises because choice of child

[2]See Baker, Gruber and Milligan (2008) for additional references and discussion.

[3]Further discussion can be found in Anderson and Levine (2000), Blau (2003) and Baker et al. (2008).

care quality may be correlated with unobserved preferences relating to working hours. Child care price is not observed for those who do not use child care. Informal care, an important alternative to paid, formal care, is often unreported or when it is there is no price assigned to it.

Labor supply and child care decisions are closely related, but households use child care for purposes beyond freeing up time for paid work. These include child development, socialization and education, and freeing up time for leisure or home production activities of the parents. This relationship needs to be accounted for in modeling. For example, Duncan, Paul and Taylor (2001) found that failure to take into account the 'quantity constraint' on child care (young children need to be taken care of at all times) may lead to overestimation of labor supply elasticities. This restriction has been ignored in most studies. In a few studies where it is included, the restriction is imposed in a strong way that violates the observed data. For example, Duncan et al. (2001) constrained the number of paid (or formal) child care hours to be greater than the number of hours worked by the mother, ruling out the possibility that informal care is used during mother's working hours. Kornstad and Thoresen (2006, 2007) are similar in assuming that mother's work hours must be exactly equal to paid child care hours. In our data, for example, one-third of households report amounts of formal child care and mother's work hours violating these restrictions, see Figure 1.

Another problem is that the details of institutional features of child care assistance, the welfare system and the tax system are often difficult to model and hence are 'abstracted away' in economic analysis.[4] Yet, some institutional features may be too important to ignore and child care subsidies are often intertwined with other aspects of the welfare system. As Atkinson (1999) (page 89) points out, incorporating or ignoring such institutional features may lead to very different results.[5] Child care subsidy programs may be complicated and nonlinear as they are often designed to achieve multiple policy objectives such as labor force participation and redistribution and often reflect political compromises rather than first-best policy. In our case, Child Care Benefit (see section

[4]Child care price effects on labor supply estimated in the literature are generally assumed to be linear while most subsidies are non-linear, Blau (2003).

[5]See also Atkinson and Micklewright (1999) and Atkinson (1992).

3 below) is means-tested, depends upon the number of children and number of hours in care, and the labor market and training status of the parents.

Our approach will be to estimate a joint, discrete structural model of child care demand and women's labor supply. This type of discrete model, first proposed by Van Soest (1995), allows us to restrict working and child care hours to those points commonly observed in the data and to incorporate the tax and transfer system as well as institutional features of child care assistance. This approach also allows us to calculate net as well as gross price elasticities.

Specifying and directly estimating the utility function has been done by others, for example, Blau and Robins (1988); Ribar (1992, 1995); Blau and Hagy (1998); Duncan et al. (2001); and Kornstad and Thoresen (2006, 2007). Only the last two papers allow for a non-linear budget constraint as we do. We also introduce two novel features. The first is that we assume that families directly derive utility from the use of formal child care. Child care enters the utility function because it contributes to child development. Kornstad and Thoresen (2006, 2007) allow the choice set to depend upon the mode of child care but restrict utility to depend only upon leisure and consumption. The second novel feature we introduce is that we impose a more flexible 'quantity constraint' that the number of total child care hours (*formal* plus *informal*) is at least as large as the labor supply of the mother. This matches the data better than previous hours constraints and is intuitively more appealing as we know that families meet their child care needs through a variety of arrangements. We estimate informal care hours by assuming that the amount of informal care satisfies the adding up constraint that children must be taken care of at all times. This adding up constraint is important in modeling the close relationship between demand for formal child care and mother's labor supply. Our paper is the first, to our knowledge, to include both an hours constraint and explicitly allow flexibility in care arrangements. Both are important, as we show in section 6.3.

The impact of child care subsidies and tax credits on child care demand and female labor supply has been investigated previously, for example, Apps, Kabátek, Rees and van Soest (2012), Averett, Peters and Waldman (1997), Doiron and Kalb (2005), Michalopoulos, Robins and Garfinkel (1992), Viitanen (2005), and Wrohlich (2011).

Apps et al. (2012) adopts a similar approach to this paper in estimating a joint structural model, but without our improvements to the hours constraint. They emphasize the consequences of household heterogeneity in estimating the model, but specify and estimate a household welfare function rather than a utility function.

Finally, we are careful in our treatment of the child care price. Using detailed household-level data we construct a child care price for each child who uses child care. We use the median of the constructed individual prices at the local area in the labor supply equation. This overcomes the endogeneity problems discussed above and allows us to 'impute' a price for those who do not use child care. This approach incorporates an assumption that people use local average prices in making their decisions about labor supply and the quantity of child care purchased. Preferences about quality determine the difference between the average price and the price the household actually pays.

Next, we describe Australia's child care subsidy schemes.

3 Australia's Child Care Subsidies

Like many other countries, Australia only subsidizes formal child care.[6] The primary subsidy is Child Care Benefit (CCB), a means-tested program, indexed to the Consumer Price Index (CPI), which reduces the hourly cost of formal child care. CCB decreases with family income but is available to all households at every income level. In 2005, the standard subsidy was \$2.88 per hour (up to 50 hours per week) for a single child. The minimum hourly rate in 2005 was \$0.483 for households with combined income over \$95,683 per annum.[7] CCB depends upon the number of children in care and the number of paid child care hours–the hourly rate is higher if more children are in care or if less than 38 hours of care are used. In addition, CCB has loosely-enforced work and training requirements–in households where at least one of the parents is not working or participating in training/education, the maximum subsidized number of hours is limited

[6] Formal child care in Australia takes three main forms: Long Day Care centres; Family Day Care; and In-Home Care. An accreditation system operates for all three types and families of children in accredited centers are eligible to receive child care assistance. See Department of Education, Employment and Workplace Relations (2008). We do not impose any assumption about relative quality across these three types of care.

[7] All dollar amounts in Australian dollars. Current exchange rates with the U.S. are near parity.

to 20 (rather than 50). Thus, CCB has a complicated structure, which we incorporate into our model, that depends on a variety of household characteristics. Because CCB is primarily paid directly to providers, take-up rates are nearly 100 per cent.

Child Care Tax Rebate (CCTR), which is not means-tested, provided a tax rebate which could be claimed by families with children in accredited care. It was announced by the Howard Government during the election campaign in late 2004. The essence of CCTR was that families were able to claim 30 per cent of their out-of-pocket costs (that is, costs in excess of CCB payments received) for approved child care up to a maximum of $4000 per child per annum. This cap was indexed to CPI. Households were able to claim CCTR for the 2004-2005 Financial Year, but could only do so after filing their 2005-06 Financial Year tax return.[8]

These subsidies are part of a larger, quite complicated system of progressive tax and transfer payments. For our population, the important payments include: Family Tax Benefit Part A, a tax credit for households with children which is means-tested and capped; Family Tax Benefit Part B, an additional tax credit for families when one partner does not work; Parenting payments for low-income families with children; Newstart Allowance, an unemployment benefit which is essentially a minimum income payment that does not depend upon any insurance scheme and which is paid indefinitely. There is also a low-income tax offset similar to the earned income tax credit in the U.S.[9]

4 Model and Estimation

4.1 The discrete choice model of labor supply and child care

Our empirical model is based on the discrete neo-classic labor supply model developed by Van Soest (1995). We extend the model to include maternal child care as an explicit argument of the household utility function and to define the budget constraint over

[8] CCTR has undergone a number of changes since its inception. Since the 2006-2007 Financial Year (The financial year in Australia is 1 July to 30 June.) CCTR has been changed into a transfer payment which households can receive even if they incur no tax liability. Since the 2008-2009 Financial Year, CCTR was increased to cover 50 per cent of the out-of-pocket child care costs after CCB and paid quarterly. Only a year later, indexation was removed from the per-child cap which now stands at $7,500 per year.

[9] Centrelink (2011) lists 35 separate payments which currently comprise the Australian welfare system. Most of these are quite small or do not apply to our population. See also footnote 16.

discrete pairs of working hours and formal child care hours. Households are assumed to maximize utility over consumption, leisure of the mother, and child development[10], by choosing mother's hours of work and hours of formal child care.[11]

We incorporate into the model, via a series of hours constraints, the following assumptions on the relationship between mother's hours worked and child care hours:

- Total (formal plus informal) child care hours are at least as large as the mothers hours of work. During waking hours, children are cared for in one of three possible ways: by the mother, in formal child care or in informal child care (including paternal care).

- Child care serves a child development purpose and the family may explicitly use child care for this reason. Thus, the household may choose to use formal child care regardless of whether the mother is at work or not. We allow formal care hours to exceed mother's working hours.

- Informal care (including paternal care[12]) is modeled as the difference between mother's working hours and hours in formal child care. If formal child care hours equal or exceed mother's working hours, informal child care is zero; otherwise, informal child care equals mother's hours worked less hours in formal child care. Informal care can not be modeled as an independent choice because of the adding up constraint which requires that children be cared for at all times, thus we do not use the reported hours of informal child care which are available in the data. Our approach solves the problems of missing data in reported informal hours and the failure of some combinations of reported hours to satisfy the adding up constraint. Below, we discuss that our estimated hours match the reported hours in the data

[10] We will also use the term 'child quality' as synonymous with child development. Unfortunately, we do not observe measures of child development. In our model, maternal hours spent caring for children, along with formal child care, are the key inputs we use as proxies for child development. Admittedly, this is a strong assumption on the production function of child development.

[11] Early work on child care, while done in a framework of utility maximization, abstracted from the non-linearity of the tax and transfer system by specifying a linear labor supply model, for example Connelly (1992), or estimated a reduced form model (e.g. Ribar (1995) and Blau and Hagy (1998)).

[12] We assume that informal care could be provided by the father, but we do not explicitly model this. The model does not rule out substitution between informal child care (including paternal care) and mother's hours of leisure or work.

fairly well. One could model informal care rather than labor supply or formal child care, but this would require a 'price' of informal care, which would need to be modeled or imputed.

- We assume that the father's work hours are fixed–i.e. there is no labor supply response of fathers to changing child care subsidies or changing work hours of the mother. This is assumed for tractability of the model but also corresponds to evidence that mothers still bear a disproportionate share of time in taking care of children–Sayer (2005); Kalenkoski, Ribar and Stratton (2005).[13]

These assumptions reflect the inter-linkage between labor supply and child care and the dual purpose of child care as an input into child development and a cost of working. They also provide sufficient restrictions to allow for model estimation. Our approach recognizes the important role of informal care but we implicitly (because families are only allowed in our approach to choose informal care for working time not for leisure time) treat informal care as inferior to formal care.[14] This assumption implies that mothers put their child's welfare above their own leisure. Of course, the relative quality of informal care is likely to vary across households. Different families will face different costs and benefits of informal care depending upon the presence of potential care-takers at home and nearby family and friends. We account for this by including appropriate variables in the model. As discussed above, our set-up is an improvement over previous research because we simultaneously include an hours constraint and allow for full flexibility of care arrangements.

One final simplifying assumption is that we do not model child care usage of school-aged children. In our sample, 42 of 422 households with both pre-school and school-aged children used formal care for school-aged children, on average 7 hours per week. This simplification, while somewhat unrealistic, makes the model easier to estimate. However,

[13]Kalenkoski et al. (2005) also confirm a common finding that while women's market work responds to the presence of children, men's market work does not. Kimmel and Connelly (2007) model women's time spent in a variety of activities including home production and childcare and similarly treat father's behavior as fixed.

[14]Findings suggest that informal care is generally inferior to formal care, for example Bernal and Keane (2011). Quality of informal care is likely to vary across households and informal care in couple-headed households may be better than that available to the single-mother households studied by Bernal and Keane (2011).

we test this assumption by estimating two alternative models and we find that our results are robust.[15]

4.2 Model specification

The household is assumed to maximize utility by choosing mother's working hours h and formal child care hours c_f of her young children (the average hours if more than one child) from a set of discrete options:

$$\max_{h,c_f} U(v) = v'Av + b'v, \quad v \equiv (\log y, \log l_m, \log c_m) \tag{1}$$

$$s.t. \;\; y \leq \tau(y_0 + wh, X) - N_k\psi(p_f c_f, y_0 + wh, X) - N_s\psi(p_s c_s, y_0 + wh, X) \tag{2}$$

y is general consumption net of child care costs which is determined through the budget constraint (2) by asset income and father's income (both captured in y_0), the mother's wage (w) and working hours, and the tax/welfare system which is captured by the function τ and which depends upon household characteristics, X.[16] c_s is the formal child care hours of her school aged children, which is assumed to be fixed at the observed hours. N_k and N_s are the number of pre-school and school-aged children and p_f and p_s are prices of formal child care for pre-school and school-aged children, respectively. The function ψ captures child care subsidies which depend upon child care costs (price multiplied by usage) and household characteristics.

For p_f and p_s we use local average prices, constructed as described in subsection 5.2 below. Using a local average price is important to overcome endogeneity issues associated with using a household-level price measure. Households simultaneously choose work hours, amount of child care, and the quality of child care. Chosen hours of work and child care may depend upon quality, which we don't observe, but which will be correlated

[15] First, we model demand for before- and after-school care for school-aged children as being determined by child care demand for the pre-school child. For example, if formal hours of child care for the pre-school child are 40 and the school-aged child spends 30 hours in school per week, then the school-aged child is in care for 10 hours per week. Secondly, we estimate the model using households with pre-school children only. These estimates, and the simulated elasticities, are available from the authors. In neither case do the substantive results presented below change. Our preferred results are the ones we present below as the sample of households with pre-school children only is about forty per cent smaller.

[16] In τ, we include Newstart Allowance (NSA), Parenting Payment Partnered (PPP), Family Tax Benefits A and B, together with income tax, Medicare Levy, Pharmaceutical Payment and Low Income Tax Rebate (LITO).

with price. This creates an omitted variable problem since omitted quality is correlated with included price. The quality of child care which is chosen may also be correlated with unobserved preferences which affect working hours. By using local area averages, we are essentially using a quality-adjusted price. Our modeling assumption is that households use the average price level as the signal in deciding the amount of child care to purchase. This is akin to assuming that shifts in median prices affect all quality levels.

Mother's leisure, l_m, is specified as the difference between her time endowment ($T_m = 70$) and time spent working or caring for children

$$l_m = T_m - h - c_m \tag{3}$$

c_m, time spent on maternal care, is specified as

$$c_m = \min\{T_c - h, T_c - c_f\} \tag{4}$$

where $T_c = 60$ is the time during which children need to be cared for either by the mother, through the formal market or informally. Informal care, assumed to be financially costless, is used when the mother's work hours are greater than purchased hours of formal child care. Importantly, and a novel feature of our modeling of the hours constraint, households can choose less formal child care than the mother's working hours.

The parameters of the utility function are summarized in A, a symmetric 3×3 parameter matrix with entries A_{ij} , and a vector $b = (b_1, b_2, b_3)'$. b_1 is a constant, but b_2 and b_3 are specified to allow both observed and unobserved individual and household characteristics to affect utility:

$$b_k = \sum_{t=1}^{T_k} \beta_{kt} x_t^k + \epsilon^{p_k}, \quad (k = 2, 3), \tag{5}$$

where $x^k = (x_1^k, \ldots, x_{T_k}^k)'$ are vectors of exogenous characteristics including age of the mother and the children, number of children in each age group, immigrant status and other characteristics that describe the family composition such as the presence of extra female adults in the household. Immigrant status and the presence of extra female adults are used as proxies for the presence of other potential care-takers at home (or nearby) which may capture differences in costs and benefits of informal care. In the case of multiple children, maternal child care is measured as the average number of maternal care hours for all preschool children in the household and the impact of the number of children on utility is through b_3. That is, the number of children affects the marginal utility of maternal care by shifting b_3. We include a dummy variable which shifts the utility of maternal care when the household chooses an alternative that requires using informal care. We control for child care quality by adding state-level variables from administrative data which capture the average number of qualified staff per child in formal day care centers. Local-level information on quality would be preferable, but is not available. The terms ϵ^{p_k} may be interpreted as random preferences due to unobserved characteristics.

The choice set for working hours and formal child care hours are defined as

$$h \in 0, s, 2s, \ldots, (m-1)s, \tag{6}$$

and

$$c_f \in 0, r, 2r, \ldots, (g-1)r, \tag{7}$$

where s and m describe all possible alternatives of working hours, and r and g describe all possible alternatives of formal child care hours. In this paper s is set to 8 hours, m is set to 8, r is set to 10 hours for young children to reflect the typical length of child care sessions in this age group, and g is set to 6. Thus, the household chooses from a choice set with $m \times g = 48$ working/formal child care hour combinations, allowing a wide range of part-time and half-day possibilities for both work and formal care.

To the utility of each alternative in the choice set, we add random disturbances μ_j (as in Van Soest (1995), as in the multinomial logit model (Maddala (1983)) which can be interpreted as alternative-specific unobserved utility:

$$U_j = U_j(y_j, l_{mj}, c_{mj}) + \mu_j, \quad (j = 0, \ldots, m \cdot g), \tag{8}$$

where $\mu_j' s$ are independently and identically distributed with a type I extreme value distribution, and are independent of all X and the other unobservable terms in the model. This multinomial approach is somewhat restrictive in not allowing correlation across choices but these assumptions are commonly employed.

The mother chooses alternative j if U_j is the largest among all the alternatives. Conditional upon ϵ^{p_k}, X, and w, the probability that alternative j is chosen is

$$Pr[U_j \geq U_i, \text{ for all } i] = \frac{exp(U(y_j, l_{mj}, c_{mj}))}{\sum_{i=1}^{m \cdot g} exp(U(y_i, l_{mi}, c_{mi}))}. \tag{9}$$

To predict wage rates for non-workers and workers whose wages are missing in the data and to allow for correlation between wage rates and unobserved utility preferences (ϵ^{p_k}), a standard wage equation is simultaneously estimated with (1) and specified as:

$$\log w = \pi' z + \epsilon^w \tag{10}$$

where z is a vector of the mother's characteristics which determine labor productivity including education and potential experience (see Table 2B). We also include a variable equal to one if the mother lived with both of her parents when she was 14 (to capture stability while growing up) and current area of residence measured by capital city and state variables which are omitted from the utility function and serve the role of exclusion restrictions. π is a vector of parameters to be estimated. ϵ^w is an unobserved term, assumed to be normally distributed with mean zero, independent of z, but is allowed to be correlated with ϵ^{p_k}.

Following Gong and Van Soest (2002) fixed benefit of not working (FB) is added to income at zero hours of work. Thus the utility of all alternatives at zero hours of work are replaced by $U(y_0 + FB, l_{m0}, c_m)$ where l_{m0} is the mother's leisure at zero work hours. FB is specified as

$$FB = \delta' t \tag{11}$$

where t is a vector of exogenous variables and δ is a vector of parameters. Positive fixed benefits can be interpreted equally as fixed costs associated with working.

4.3 Identification

Identification of the model is achieved in several ways. Given the specification of the utility function, the child care price provides a shadow value of mother's utility from maternal child care, hence our detailed attention to the construction of this variable. Mother's wage provides a shadow value for the utility of maternal leisure. These two variables are sufficient to identify the parameters in the utility function. The wage equation is identified through exclusion restrictions and through the assumption of normality of the unobservables. Education, mother's family background at age 14 and regional dummies are included in the wage equation and excluded from the two utility equations. All of these variables might affect mother's wage and employment possibilities but we believe that they should not systematically affect utility from leisure or provision of maternal child care.

As an additional source of identification, but one that is not strictly necessary, we also impose several exclusion restrictions on the model equations. Variables which capture whether the couple is educated or born in Australia as opposed to outside of Australia, presence of older children in the household, the average age of pre-school children, state-level controls for child care quality and a dummy variable equal to one if mother's working hours exceed the hours of formal child care for children are all included in the equation which determines the utility of maternal child care and excluded from the equation that determines the utility of maternal leisure. Note that age of youngest child is assumed to affect both equations. These exclusion restrictions help to identify the utility of maternal leisure and that of maternal child care.

Since we assume that children need to be taken care of at all times, maternal care, informal care and formal child care must sum up to children's total time endowment. Informal care is identified, as described above, as the difference between mother's work hours of formal child care. This is an adding up constraint imposed by the model rather than a condition of identification for the utility equations.

4.4 Estimation

If all wages were observed and without random preferences, the model could be estimated by maximum likelihood with the likelihood contribution given by equation (9). With unobserved wages, the wage equation (10) also needs to be estimated. With the presence of unobserved preferences in leisure and maternal child care, maximum likelihood estimation would require evaluation of the three-dimensional integral defined over the distribution of the error terms ϵ^{w}, ϵ^{p_2}, and ϵ^{p_3}. Numerical integration in more than two dimensions can be difficult to solve. In this paper, we use Simulated Maximum Likelihood (SML) to avoid this multi-dimensional numerical integration. Denoting the probability of working hours h_j and using c_{fj} hours of formal child care conditional on ϵ^{p_2}, ϵ^{p_3}, and wage rate[17] by

$$Pr[h = h_j, c_f = c_{fj}|w, \epsilon^{p_2}, \epsilon^{p_3}] \ (j = 1, \ldots, m \cdot g), \tag{12}$$

The exact likelihood contribution for someone observed to work h_0 and use c_{f0} hours of formal child care with observed gross wage rate w_0 is then given by

$$L = \int\int Pr[h = h_0, c_f = c_{f0}|w_0, \epsilon^{p_2}, \epsilon^{p_3}] f_1(\epsilon^{p_2}|w_0) f_2(\epsilon^{p_3}|w_0) \mathrm{d}\epsilon^{p_2} \mathrm{d}\epsilon^{p_3} f(w_0), \tag{13}$$

Or, if the wage rate is not observed, the exact likelihood contribution is

$$L = \int\int\int Pr[h = h_0, c_f = c_{f0}|w, \epsilon^{p_2}, \epsilon^{p_3}] f_1(\epsilon^{p_2}|w) f_2(\epsilon^{p_3}|w) f(w) \mathrm{d}\epsilon^{p_2} \mathrm{d}\epsilon^{p_3} \mathrm{d}w, \tag{14}$$

where $f_k(\cdot|w)$, $(k = 1, 2)$ are the conditional density functions of ϵ^{p_k} given w, and $f(w)$ is the density of the wage rate (or of ϵ^w). The three error terms ϵ^w, ϵ^{p_2}, and ϵ^{p_3} are specified to follow a joint normal distribution of which the parameters are to be estimated:

$$\begin{pmatrix} \epsilon^w \\ \epsilon^{p_2} \\ \epsilon^{p_3} \end{pmatrix} \sim N(0, \Sigma), \text{ where } \Sigma = \begin{pmatrix} \sigma_w^2 & & \\ \sigma_{wp_2} & \sigma_{p_2}^2 & \\ \sigma_{wp_3} & 0 & \sigma_{p_3}^2 \end{pmatrix} \tag{15}$$

The numerical multi-dimensional integral is approximated by a simulated mean: for each individual, we take R draws from the distribution of the error terms (ϵ^w, ϵ^{p_2}, and ϵ^{p_3}) and compute the average of the R likelihood values conditional on these draws. The integral equation (13) is thus approximated by

$$L = \frac{1}{R} \sum_{r=1}^{R} Pr[h = h_0, c_f = c_{f0}|w_0, \epsilon_r^{p_2}, \epsilon_r^{p_3}] f(w_0), \tag{16}$$

and equation (14) is replaced by

$$L = \frac{1}{R} \sum_{r=1}^{R} Pr[h = h_0, c_f = c_{f0}|w_r, \epsilon_r^{p_2}, \epsilon_r^{p_3}], \tag{17}$$

[17] Throughout, we condition on 'other household income' (earnings of the husband and household non-labor income), child care price, and other exogenous explanatory variables x, z, and t. These are suppressed in our notation.

where $\log w_r = \pi' z + \epsilon_r^w$ and $(\epsilon_r^w, \epsilon_r^{p_2}, \epsilon_r^{p_4})$ are based upon draws from the distribution of $(\epsilon^w, \epsilon^{p_2}, \epsilon^{p_4})$. The draws are taken from Halton sequences using the procedure described in Train (2003). The estimator resulting from random independent draws is inconsistent for fixed R, but will be consistent as R tends to infinity with the number of observations of the sample.[18] Many studies (see e.g., Caflisch (1995), Sloan and Woźniakowski (1998), Bhat (2001), Train (2003), Sándor and Train (2004)) show that using 'quasi-random' draws which are designed to provide better coverage than independent draws, simulation can be more efficient in terms of reduced simulation errors for a given number of draws. In particular, Bhat (2001), Train (2003), and Sándor and Train (2004) all tested Halton sequences for mixed logit models and found their use to be vastly superior to random, independent draws.

4.5 Calculation of elasticities and policy effects

Labor supply and child care demand behavior of households may be described by their corresponding elasticities. Due to the complexity of the model, simulation is required to derive elasticities and to estimate policy effects. When calculating elasticities, hours of work and child care are calculated as 'expected hours', computed as a probability weighted sum of hours over all possible values. Wage, gross child care price, and income elasticities for each observation are derived by increasing each quantity by one per cent and calculating the percentage change in average hours or the employment rate. The net child care price elasticity is calculated as the ratio between the percentage change of hours or employment rate and the percentage change in the net child care price. The net price change we use in the calculation corresponds to a one per cent change in the gross child care price. From these, we calculate average elasticities for the whole sample and for selected sub-samples. The standard errors of the estimated elasticities and policy effects are obtained using Monte Carlo methods with 100 repetitions.[19] Further discussion of calculating these quantities may be found in Gong and Van Soest (2002).

[18] If $\sqrt{n}/R \rightarrow 0$ and with independent drawings across observations, the method is asymptotically equivalent to maximum likelihood (see Lee (1992), or Gourieroux and Monfort (1993) for references).

[19] We ignore the clustering in the data. The amount of clustering is very small given that we are only pooling over two years of data and many individuals only appear once in those two years. Furthermore, in previous work (see Breunig et al. (2012)), where we similarly pool across three waves of data, we find that the correction for clustering changes the standard errors by very little.

5 Data

5.1 Data source and sample

Data for the main analysis are drawn from waves five and six of the 'in-confidence' version of the Household, Income and Labour Dynamics in Australia Survey (HILDA) which cover the period 2005 - 2006. We also include the seventh wave when we construct the child care price. The HILDA Survey is an annual panel survey of Australian households which was begun in 2001.[20] There are approximately 7,000 households and 13,000 individuals who respond in each wave. Our choice of data is based upon the following three considerations. First, and most importantly, the HILDA data from wave five onwards collected child care usage data separately by child and separately for employment and non-employment related reasons. Secondly, we choose to pool across three waves of data to achieve a sufficiently large sample size for the construction of our local average child care price. Details are described in Section 5.2 below. We use median child care prices within Labour Force Survey Regions (LFSR) as defined by the Australian Bureau of Statistics (ABS).[21] In order to construct this local average price we need a reasonable number of observations in each LFSR. Pooling across these three waves achieves sufficient sample size to estimate a median for each LFSR. Lastly, we use data from the fifth and sixth waves for estimation because child care policies in Australia were roughly constant over these two years.[22] In particular, there were no major changes to the Child Care Benefit scheme during this period. The Child Care Tax Rebate (CCTR), now called Child Care Rebate, was announced before the beginning of the sample period. However, the way in which the rebate was originally structured through the tax system meant that families did not receive the rebate, in the form of a lump sum payment, until the end of the sample period (about two years after making the expense). Given this time lag and the lump-sum nature of the payment, we assume that this program did not affect people's decisions during our sample period. A final consideration which favours

[20] See Watson and Wooden (2002) for more details.

[21] Labour Force Survey Regions are described in ABS (2005). Australia's six states and two main territories are divided into 77 labour force regions with populations ranging from around 100,000 up to about 500,000.

[22] We also estimate the model over three waves of data, five to seven, and found similar elasticity estimates.

this choice of sample period is that ABS created a child care price index, which we use to make the price comparable across waves. This index is only available from 2005.

We focus on the labor supply of partnered mothers of working age (younger than 65) with at least one young child (0 and 5 year old who are not yet at school) and the demand for formal child care in these households. In waves 5 through 7 of the HILDA survey there are 20,342 total observations on 7,741 women. Once we remove women from the sample who are neither married nor in defacto relationships, there are 12,109 observations on 4,754 women. Excluding those families with no young children further reduces the sample to 2,601 observations on 1,198 women. We exclude a further 131 observations on 92 women who live in multiple-family households and 219 observations on 156 women who are studying full-time. This leaves us with a sample of 2,251 observations on 1,069 women across the three waves which we use for the construction of the child care price. After further excluding observations from wave seven and those who are beyond working age or self-employed and discarding observations with missing values for any variables used in our model (excepting wage), the sample for the main analysis consists of 1,015 observations on partnered mothers with at least one young child.

We present sample statistics in the second column of Table 1. In the third column of Table 1, we present the sample statistics for a sub-sample of 593 mothers of young children in households in which there are no school-aged children present. This sub-sample is used for the sensitivity analysis described in footnote 15. From the second column of Table 1, about 43 per cent of households with young children use formal child care. Hours spent in child care for the young children are about 18 hours per week. About 57 per cent of the mothers were employed and the average working mother works 25 hours per week at an hourly wage of $24 (at the June 2005 price level). The characteristics of the mothers in the sub-sample are broadly similar to that of the whole sample except they are younger and slightly better educated.

5.2 Child care price

In the HILDA survey, we have the number of hours c^f_{kht} spent in child care for each child (k) in the household (h) for each of three types of formal child care (t)–long day care, family day care, and other formal paid care. These reports reflect hours spent at the child care center, not necessarily hours paid for. Thus, we calculate hours paid by rounding up to multiples of five hours for young children and multiples of three hours for school-aged children to reflect typical lengths of paid sessions. Long day care centers and family day care centers typically operate 50 hours per week, and typical part-time arrangements are at least in units of half-days. For school-aged children, typical after-school care sessions are 3 hours. Net cost of child care Q^s_{ht} is not provided for each child but is provided for each type of care and is split by school-aged ($s = 1$) and young ($s = 0$) children. For families who have one young child, we know the cost of child care for each type of care for that child. For families that have more than one young child, we only know the total amount spent on that group of children for each type of care. Since we know the hours that each child is in care for each type of care, we split the cost in proportion to the hours spent in that type of care. We assume that families are spending the same amount per hour on each child within the same age range for each type of care. We calculate the net child care cost per child as

$$\tilde{q}_{sht} = Q^s_{ht} \frac{c^f_{kht}}{\sum_{m=1}^{M} c^f_{mht}} \tag{18}$$

With the information we have on child care usage by each child, gross family income, child and family characteristics, and CCB eligibility rules, we are able to construct the gross cost of child care for each child for each type of care. We combine this with the hours of child care information to calculate a gross per-child price for each type of care.

We take all of these individual child prices and calculate two median prices for each Labour Force Survey Region (LFSR): one for children who are not yet in school and one for school-aged children. We impute this median price to each household in the LFSR. For pre-school children, we have sixteen observations per LFSR on average. There is substantial variation across LFSRs. Breunig et al. (2012) construct child care prices in the same way and show that this method of constructing prices does well in matching state-level average prices from administrative data.[23]

[23] Administrative data is *only* available at state level which does not provide sufficient variation for identification.

6 Results

6.1 Parameter Estimates

Our Simulated Maximum Likelihood (SML) results are based upon 30 draws per household. We present parameter estimates for the utility function in Table 2A. The parameters A_{ij} and b_i determine the shape of the utility function but their interpretation is non-trivial. The signs of the parameters in b determine the direction in which characteristics affect preferences. A positive b_2 (b_3) for a variable implies a positive effect of that variable on the marginal utility of leisure (maternal care). Unlike in a standard labor supply model where a positive effect on leisure could be interpreted equally as a negative effect on labor supply, a positive effect on leisure must be interpreted as a *combined* negative effect on labor supply and maternal care. It is consistent with the model that one of these effects could be positive and one negative with the combined effect being negative. Number of children, mother's age, and father's education all have significant effects on preferences. The indicator variable for mothers working hours being greater than hours of formal care is positively significant. Those families that use informal care seem to value maternal care more. This would be consistent with families who prefer care at home to formal child care preferring all kinds of care at home–both maternal care and informal care such as paternal care. This could also be interpreted as being consistent with Bernal and Keane (2011) that informal care could be better relative to formal care for some two-parent households. In general, the direction and magnitude of the impacts of the variables on labor supply or formal care can not be ascertained directly from the parameter values, but rather need to be calculated through simulation.

The parameters in the fixed benefit equation (Table 2B) can be linked more directly to the mother's labor force participation–a positive parameter indicates that the corresponding variable has a positive effect on the benefits of not working and thus a negative impact on participation. For example, the older the youngest child, the more likely she is to participate in the labor force. The number of school-aged children also plays a significant role–more young children (including school-aged) leads to lower participation. Unobserved preferences for maternal care play a significant role as well and they are positively correlated with unobserved heterogeneity in the wage equation. The variance of the unobserved preference for leisure is imprecisely estimated, though.

The parameter estimates of the wage equation are presented in the last column of Table 2B. These results are consistent with a standard Mincer equation for Australia.[24] Higher education brings a wage premium of about 45 per cent for mothers of preschool children, relative to their counterparts who only finished Year 12 and women who speak a language other than English earn less than those who do not.

6.2 Simulation Results

6.2.1 Fit of the model

With simulation, we check the model's goodness of fit. First of all, although we did not impose the restriction that the derivative of utility with respect to income be positive, it is required for the model to be coherent with the utility maximization framework. We check this, ex post, by calculating derivatives of the utility function with respect to income. They are indeed positive for all observations.

Secondly, in Table 3 we check model performance by comparing simulated labor supply, child care demand, and net child care costs with the observed data. From the table we can see that the simulation results resemble nicely the observed data. It is important to point out that the average of the estimated net child care costs, which are calculated based upon the median price in the local areas, is extremely close to that of the observed net costs in the data. This may suggest that price of the local area is a reasonable measure upon which households make their decisions. Also, although informal care is treated as the residual between hours of work and formal care in the model in order to satisfy adding-up constraints, the average of simulated hours of informal care is reasonably close to reported hours of informal care from the data. It may imply that our assumption about the role of informal care may not be as strong as it first appears. These two findings give us confidence in the performance of the model.

[24] See Breusch and Gray (2004); Leigh (2008); and Breunig, Cobb-Clark and Gong (2008).

6.2.2 Elasticities

Table 4 presents average elasticities of labor supply and child care demand with respect to wage, income, gross child care price and net child care price calculated for each household and average across the full sample. In Table 5, we present elasticity estimates for selected sub-samples of interest. While we prefer the net elasticities for our main purpose of evaluating policy alternatives, we report gross elasticities for comparability with previous studies and because gross price changes are often easier to observe.

First of all, it is worth noting that the estimates of wage and income elasticities of labor supply in Table 4 are comparable to previous Australian estimates, e.g. Breunig et al. (2008). For mothers with preschool children, the average wage elasticities of hours worked and employment are 0.48 and 0.30 and the income elasticities of hours worked and employment are -0.13 and -0.09, respectively. They are all significant at the 5 per cent level and consistent with reasonable model performance.

Secondly, the average labor supply elasticities of both gross and net child care price are statistically significant and negative. The average gross child care price elasticities of hours of work and employment for the mothers are -0.14 and -0.09, respectively. The net price elasticities of hours of work and employment of the mothers with preschool children are -0.10 and -0.06, respectively. As expected, they are slightly smaller than the gross price elasticities due to means-testing of CCB.

Thirdly, as expected, child care demand is negatively impacted by its own price. The results in Table 4 also show that both child care demand and labor supply elasticities with respect to wage are positive and with respect to child care price they are both negative. The two cross-price elasticities have the same sign as the own price elasticities (wage elasticity of labor supply and child care price elasticity of child care) which implies that labor supply and child care are complements.

In Table 5, elasticities for a few sub-samples are presented. The sample is partitioned according to education level and 'other household income' of the mothers, and the number of children in the household. 'Other household income' is defined as the sum of spouse's labor income (held constant in our modeling) and total household non-labor income. Labor supply and child care demand responses differ by demographic group. Labor supply of women with higher education (and hence higher wages) or in households with higher income levels is slightly less responsive to the gross child care price than those with lower education or from households with lower income. For example, the average labor supply elasticity of gross child care price for women with higher education is -0.12 while for those without higher eduction, it is -0.15.[25] Comparing women above and below median 'other household income', produces similar results. Similar to the results for labor supply elasticities, gross child care price elasticity of employment is also smaller for women with higher education or with higher 'other household income' than those with lower education or with lower 'other household income'.

However, it seems that the differences are due mainly to the means-testing of the CCB program—the differences become negligible in terms of net child care price elasticities. The elasticity is -0.097 for women with tertiary education and -0.102 for women without tertiary education. Means testing implies that for women with higher education (hence higher wages) and income, a change in the gross child care costs corresponds to a smaller change in the net child care costs for these women relative to the poorer and less educated women who see a higher change in net costs due to the subsidy regime.

Child care price elasticities also differ by family type. In households with multiple children, elasticities of child care price are larger than those in single child households. In multiple children households, child care costs form a larger part of the budget and the effect of the same child care price change in magnitude is therefore larger. We plotted curves of labor supply, child care demand and costs against wage and child care price and found few surprises. Labor supply curves are backwards bending after wages reach high enough levels. The relationships between labor supply and child care demand with child care price are downward sloping and roughly linear.[26]

[25] We can reject that these differences are zero at the 5 per cent level using bootstrapped confidence intervals.

[26] These plots are available from the authors upon request.

6.3 Impact of hours constraint

Above, we have emphasized the importance of the more flexible hours constraint that our model allows. To see the effect of this more flexible constraint in our estimates, we estimate two alternative model specifications. First, we restrict formal child care hours to be greater than or equal to mothers' hours of work ($h \leq c_f$) as in Duncan et al. (2001). In this specification, observed formal child care hours are replaced by mothers' hours of work if they are less than mothers' labour supply. Second, we restrict formal child care hours to equal mothers' labour supply ($h = c_f$), as in Kornstad and Thoresen (2006, 2007). Consequently, in this specification, the utility function only depends upon leisure and income and maternal care does *not* enter the utility function.

Elasticities for these two alternative specifications are presented in Table 6. As before, model estimates are used to simulate labour supply elasticities. Comparing the estimates in Table 6 with those of Table 4, we can see that the elasticity estimates with respect to child care price are much larger in these specifications than in our preferred model. For example, the estimate of mothers' labour supply elasticity with respect to the net child care price, assuming formal child care hours are at least as large as mothers' hours of work, is -0.187, nearly double the benchmark model. These results provide evidence that ignoring the role of informal child care may lead to overestimating the labour supply elasticity with respect to child care price.

7 The Effects of Child Care Assistance Programs

Using our estimates from section 6, we can contrast the effects of a child care price subsidy and a tax rebate for expenditure on child care on mother's employment and working hours, child care demand and out-of-pocket costs, household disposable income and welfare and net government revenue.

In order to compare a price subsidy to a tax rebate we need to choose settings for both policies. We compare a benchmark case of no child care assistance first to a scenario with a price subsidy (without any tax rebate) and then, secondly, to a scenario with a tax rebate (without any price subsidy). For policy settings we use the CCB and CCTR programs as they appeared in Australia in 2005 (see section 3):

- Child Care Benefit (CCB)

  Maximum child care benefit is \$2.88 per hour which tapers to a minimum rate of \$0.483 per hour following the rules of the 2005 CCB.

- Child Care Tax Rebate (CCTR)

  A rebate that can be applied to tax liability for 30% of 'out-of-pocket' child care costs (after CCB) capped at \$4,000 per child.

In Table 7 we present the simulated average effects of each of these two child care assistance programs, considered separately. Net government revenue takes into account both the assistance paid and changes in tax revenue. Program (CCB or CCTR) effects are calculated and presented in columns 3 and 4 as the difference in the quantity of interest between a scenario with the child care assistance program and a scenario with no government child care assistance (column 2). In the last column, the difference between the two child care assistance programs is presented. We present the effects as the amount per dollar of child care assistance for comparability across the two programs.

From Table 7, we see that both CCB and CCTR significantly increase the labor supply of mothers, demand for formal child care, and household disposable income. On average, every dollar of CCB increases hours worked by the mother of 0.02, hours of formal child care by 0.04 and household disposable income by \$0.96. It also reduces net child care costs by 76 cents. The two programs are quite similar in their effect on increased rates of employment and and child care usage. As a result of increased labor supply, which brings extra tax revenue and reduces welfare payments, the cost to the government is less than the subsidy paid (the cost is 68 cents per dollar for CCTR and 81 cents per dollar for CCB).

There are four important, and statistically significant, differences in the effects of CCB and CCTR:

1. Despite having similar employment effects, CCTR's effect on hours worked is 50% larger.

2. Hours of informal care decrease significantly under CCB but not under CCTR. This is evidence of a crowding-out effect of the price subsidy.

3. Household budgets improve by an additional 11 cents (about 11 per cent) under the tax credit relative to the price subsidy.

4. As a consequence of the first and third effects enumerated here, the net cost to taxpayers per dollar of subsidy is 13 cents lower under CCTR relative to CCB.

These results would appear to provide strong support for a tax credit relative to a price subsidy from an efficiency point of view. If the primary goal of the government is to increase female labor supply, CCTR is the more effective and cost efficient program. Additionally, there is no significant crowding out of informal care under the tax credit. Under CCTR, higher educated women face a larger net price change than under CCB. This occurs because of means testing of CCB and also because higher educated/income women benefit disproportionately from the tax rebate. This results in a larger labour supply effect for more highly educated women under CCTR than under CCB.

A more nuanced picture emerges if we consider distributional effects. In Table 8, we evaluate the effects of the programs as in Table 7, but we split the sample (in the top panel of the table) into women with and without tertiary education. In the bottom panel, we split the sample into two based upon whether 'other household income' is above or below the median. This shows that the price subsidy scheme redistributes towards lower income households.

For example, under CCB, women with tertiary education (who are generally higher wage earners) receive \$16.10 of subsidy on average, less than the \$17.65 received by women without a tertiary education. Under CCTR, more educated women receive over 20% more (\$24.45 compared to \$19.03). The difference of the two schemes over the income distribution is more clearly illustrated in the last panel of Table 8. The results show that the higher income families receive more than \$14 dollars more government subsidy under CCTR than under CCB, while the lower income families receive a slightly smaller amount of subsidy under CCTR (the difference is not statistically significant). Yet, even for women with low education or below median other household income, the effects on labor supply and household disposable income are larger under CCTR than CCB. The costs to government are also lower under CCTR. For example, for the women from lower income households, each dollar of CCTR only costs the government 58 cents, compared with 76 cents for CCB. Again, there are similar 'crowding-out' effect for all groups with CCB.

We ignore, in our analysis, administrative costs associated with the programs. One might expect that such costs are higher for the more complex CCB. As discussed by Drèze and Malinvaud (1994), welfare programs increase the size of government at a risk of inefficiency; their funding enhances the amount of revenue to be raised and thus the magnitude of tax distortions. It is conceivable that it is likely to be more so, the more complicated the program. This provides an additional argument in favor of tax credits relative to the price subsidy we model which includes varying rates, complex rules and means testing.

It is also important to compare household welfare across the two programs. The comparisons here are partial equilibrium–we do not impose revenue neutrality nor do we consider feedback from the demand side of the economy. The way in which the government raises the required additional revenue, particularly how the additional tax burden is shared across households with and without children, will have welfare implications which we do not include in these comparisons.

We summarize our welfare comparison in Figures 3, 4 and 5. The welfare gain is calculated as the increase in utility relative to the benchmark scenario for each household from an increase in CCB or CCTR. Figure 3 presents a non-parametric estimate of the welfare gain from CCB graphed against 'other household income'.[27] Figure 4 presents the same for CCTR and Figure 5 presents the difference between the two. Interestingly, welfare gains are higher for both programs for lower income families (above some threshold) and then decrease in 'other household income'. Those in the very lowest part of the income distribution do not benefit from CCB because entitlements are restricted due to labor supply requirements; nor do they benefit from CCTR because they do not

[27] This is just a simple kernel regression of the welfare gain against 'other household income' for our sample of households.

have sufficient tax liability to benefit from the tax credit. The redistributive effects of CCB can be seen clearly in Figure 7: those in the lower part of the income distribution benefit more from CCB than CCTR. Those in the upper part of the income distribution benefit roughly equally from the two programs.

8 Conclusions

In this paper, we construct and estimate a model of labor supply and child care demand for partnered women with young children. The model is an extension of the standard discrete structural labor supply model which explicitly includes child care as a separate argument of the utility function. This model enables us to analyze labor supply and child care demand simultaneously. This approach corresponds more closely to how households actually make decisions about work and child care. Unobserved heterogeneity in time allocation preferences is included and is allowed to be correlated with unobservable factors which influence wages. We introduce two important methodological innovations: we explicitly incorporate maternal care into the utility function as a proxy for child development and we impose a more flexible quantity constraint that the number of total child care hours (formal and informal) is at least as large as the number of hours worked by the mother. We show that both of our modelling innovations matter substantively for the results. It appears that failing to account for informal care may lead to over-estimating the labour supply elasticity with respect to child care price.

The model estimates are used to simulate estimates of the gross and net child care price elasticities for partnered women with children. We find that the net child care price elasticities of hours of work and employment are -0.10 and -0.06, both are statistically significant. Labor supply and child care demand responses to gross child care price changes are highest amongst women with lower wages, lower household income, and lower education. The differences seem to be due to means testing of the CCB. In other words, responses to net cost changes are not very different across income levels. Another interesting result is that labor supply and child care are complements.

In terms of child care assistance, we compare a means-tested subsidy to a tax rebate. Both programs increase labor supply of mothers, demand for formal care, and disposable income of the household. Secondly, for each dollar of child care subsidy, the much simpler flat rate CCTR is more effective in increasing women's labor supply and households' disposable income, with less 'crowding-out' of informal care and is much cheaper for tax payers. This superior economic efficiency holds even in the absence of accounting for administrative costs which are undoubtedly higher for the subsidy than for the tax rebate. Third, the means-tested CCB redistributes more towards lower income households and results in relatively more welfare gains for economically disadvantaged households. Our results illustrate the importance of accounting for specific aspects of how child care assistance is implemented and the institutional features of the tax and transfer system in assessing costs and policy impacts. They also illustrate the delicate trade off between economic efficiency and redistribution in making social economic policies.

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Figures

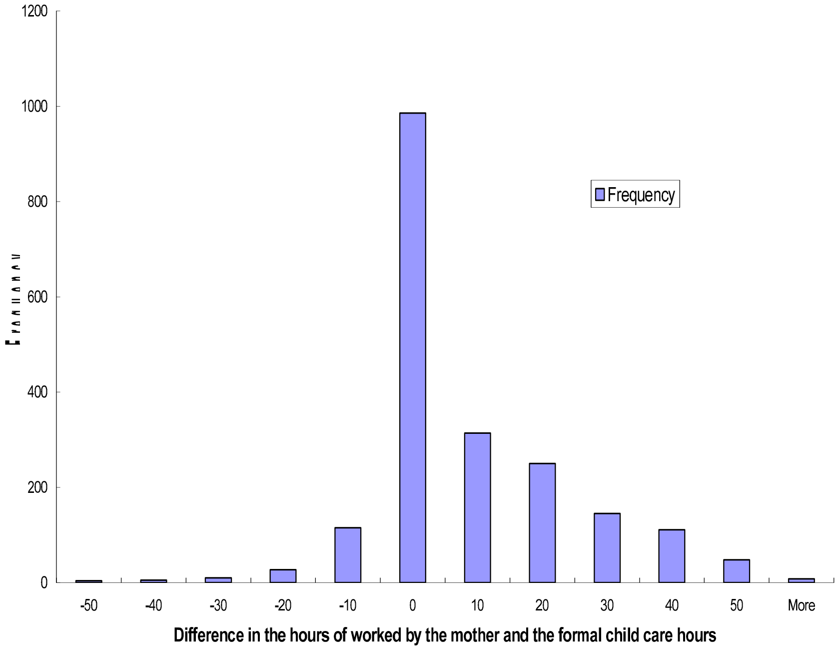

Figure 1. Differences between mothers' hours of work and formal child care

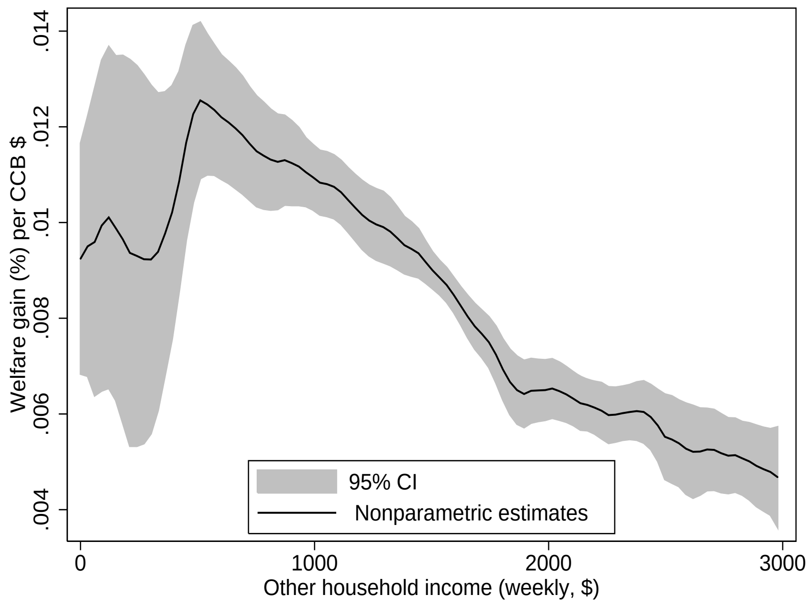

Figure 2. Nonparametric regression of welfare gain per CCB dollar against non-labor income

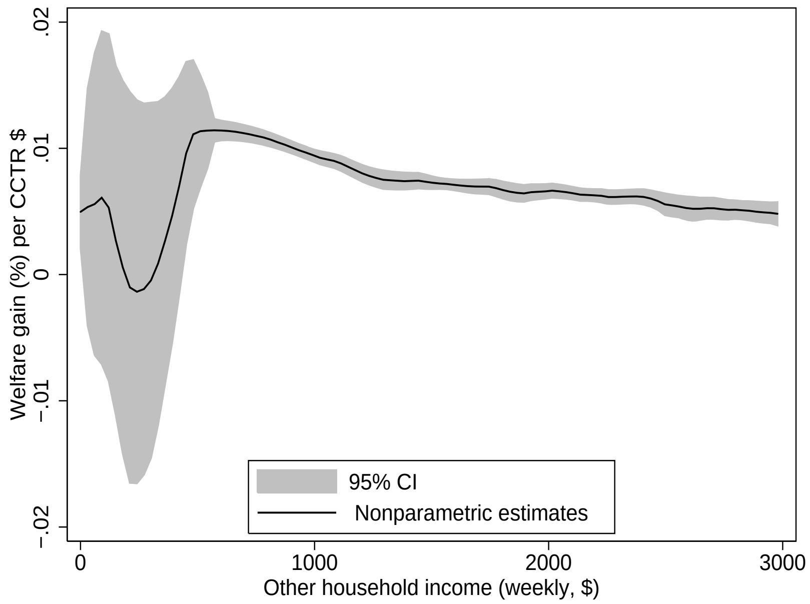

Figure 3. Nonparametric regression of welfare gain per CCTR dollar against non-labor income

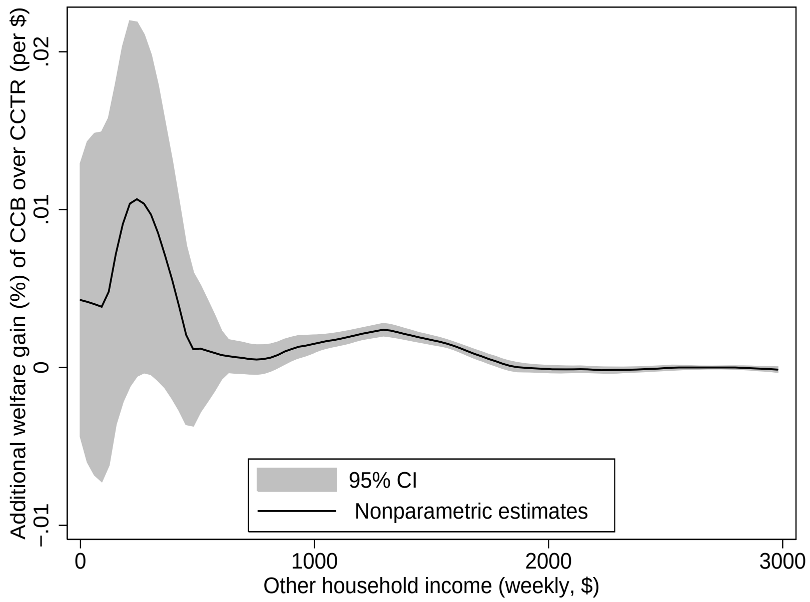

Figure 4. Nonparametric regression of additional welfare gain of CCB over CCTR (per dollar) against non-labor income

Tables

Table 1. Sample statistics

Variables	Whole sample	Pre-sch. children only
Hours worked per week by the working mothers	24.682(13.19)	24.599(13.02)
Labor force participation rate of the mothers	0.571	0.614
Average hours of children using formal child care	18.387(12.90)	18.520(13.14)
Proportion of families using formal care	0.429	0.457
Wage rate of the mother (at June 2005 price)	24.348(16.53)	25.743(17.62)
Other household income[a]	1243.169(1268.96)	1307.078(1344.03)
Median child care prices (at June 2005 price)	4.829 (1.03)	4.770(1.04)
Age of the mother	33.079(5.45)	31.843(5.58)
Dummy, mother received higher edu.	0.333	0.413
Dummy, mother received vocational edu.	0.244	0.241
Dummy, mother finished Year 12 only	0.206	0.214

[a] Other household income is defined as household income less mother's labor income

Table 1. continued

Dummy, mother did not finish Year 12	0.223	0.132
Dummy, father received higher edu.	0.281	0.307
Dummy, father received vocational edu.	0.422	0.401
Dummy, father finished Year 12 only	0.139	0.162
Dummy, father did not finish Year 12	0.158	0.130
The mother in a sole-parent household at 14	0.195	0.199
The mother not born but educated in Australia	0.148	0.145
The mother not born or educated in Australia	0.052	0.057
The mother speaks a language other than English	0.130	0.118
The mother an Indigenous Australian	0.015	0.013
Couple not born but educated in Australia	0.191	0.201
Couple not born or educated in Australia	0.097	0.082
No. of children aged 0 to 4	1.348(0.56)	1.425(0.56)
No. of children aged 5 to 12	0.593(0.84)	-
No. of children aged 13 to 15	0.097(0.34)	0.056 (0.26)
Age of the youngest child	1.545(1.46)	1.115(1.27)
Dummy, presence of extra female adult	0.027	0.027
Dummy, presence of children older than 12	0.868	0.775
Mean age of the children in the studied group	1.918 (1.35)	1.551(1.26)
% of child care staff w/t exp. (state avg.)	15.8% (4.4%)	15.6% (4.5%)
% of child care staff w/t qual. (state avg.)	66.9% (4.9%)	67.0% (5.0%)
Obs. (number of partnered mothers)	1,015	593

Note: standard deviations in parentheses

Table 2A. SML estimates (utility function)

Parameters of the utility function	Estimates	
$y^2(A_{11})$	0.039[0.19]	
$l^2(A_{22})$	-4.531**[-2.39]	
$c_m^2(A_{33})$	0.258*[1.81]	
$yl(A_{12})$	-0.377[-1.55]	
$yc_m(A_{13})$	-0.011[-0.08]	
$lc_m(A_{23})$	-0.584**[-3.36]	
b_1	3.705**[2.73]	
Parameters of the utility function (b_2 and b_3)	b_2	b_3
Constant	2.413[0.89]	3.063[1.15]
Age of the mother	0.575*[1.69]	0.360*[1.65]
The mother speaks a language other than English	-1.297[-1.25]	0.006[0.01]
The mother is an Indigenous Australian	-6.756[-0.20]	1.272[0.84]
The mother not born but educated in Australia	-0.265[-0.36]	
The mother not born or educated in Australia	-0.246[-0.20]	
Age of the youngest child	0.584**[2.32]	-0.194[-0.53]
No. of children aged 0 to 4	1.466**[2.46]	0.215[0.55]
No. of children aged 5 to 12	-0.813**[-2.11]	-0.010[-0.04]
No. of children aged 13 to 15	0.784[1.23]	-0.565[-1.51]
Presence of extra female adult	1.889[1.49]	0.940[1.12]

Table 2A. continued (utility function)

Parameters of the utility function (b_2 and b_3)	b_2	b_3
Father received higher edu.	0.195[0.31]	-0.613*[-1.73]
Father received vocational edu.	0.180[0.32]	-0.064[-0.19]
Father did not finished Year 12	0.267[0.39]	-0.206[-0.51]
Couple not born but educated in Australia		-0.072[-0.35]
Couple not born or educated in Australia		-0.487[-1.47]
Presence of children older than 12		0.055[0.16]
Mean age of pre-school children		0.043[0.12]
% of child care staff w/t exp. (state avg.)		-0.031[-1.08]
% of child care staff w/t qual. (state avg.)		-0.005[-0.16]
Working hours larger than formal child care hours		0.255**[2.07]
Variance of the unobserved preference (σ_p^2)	4.939[0.69]	0.209**[2.15]
Cov. of the unobserved preference with wage (σ_{wp})	0.066[0.82]	0.131**[3.75]
Likelihood	-1580.56	
Obs.	1,015	

Table 2B -continued (fixed costs and wage equations)

Variables	Fixed cost function	Wage equation
constant	1.131**[4.81]	2.040**[5.43]
Age of the mother	-0.192**[-3.40]	0.464**[2.10]
Age-squared of the mother		-0.050[-1.53]

Table 2B -continued (fixed costs and wage equations)

Variables	Fixed cost function	Wage equation
Mother received higher edu.		0.475**[12.90]
Mother received vocational edu.		0.076**[1.99]
Mother did not finished Year 12		-0.105**[-2.42]
The mother speaks a language other than English	0.133[1.31]	-0.144**[-2.91]
The mother is an Indigenous Australian	-0.209[-0.93]	-0.073[-0.42]
The mother in a sole-parent household at age of 14		-0.044[-1.09]
The mother not born but educated in Australia	0.070[0.98]	-0.007[-0.17]
The mother not born or educated in Australia	0.189*[1.74]	-0.045[-0.76]
Age of the youngest child	-0.077**[-3.46]	
No. of children aged 0 to 4	-0.002[-0.04]	
No. of children aged 5 to 12	0.132**[3.11]	
No. of children aged 13 to 15	0.222**[2.38]	
presence of extra female adult	0.179[1.17]	
Father received higher edu.	0.045[0.56]	
Father received vocational edu.	-0.097[-1.25]	
Father did not finished Year 12	0.049[0.55]	
Regional dummies		Yes
Dummy, wave 6	0.044[1.14]	
Variance of the wage (σ_w^2)		0.120**[39.53]

t-values in brackets; * Significant at 10% level; ** Significant at 5% level.

Table 3. Observed and simulated averages of outcome variables

Variables	Observed	Simulated
Hours of work (all)	14.080(15.78)	14.096(6.05)
Employment (%)	57.1	57.3
Hours of formal care (all)	7.880(12.41)	8.358(3.54)
Use of formal care (%)	42.9	45.7
Hours of informal care	4.439(9.00)	5.790(3.18)
Net child care costs ($)	37.880(73.12)	36.651(21.38)

Standard deviations in parentheses

Table 4. Elasticities (average over whole sample)

	Labour supply		Child care demand	
With respect to:	Hours	employment	Hours	Use of formal care
Gross child care price	-0.135**(0.04)	-0.085**(0.02)	-0.287**(0.05)	-0.169**(0.03)
Net child care price	-0.099**(0.03)	-0.063**(0.01)	-0.217**(0.05)	-0.129**(0.02)
Wage	0.475**(0.11)	0.299**(0.06)	0.329**(0.07)	0.213**(0.04)
Income	-0.126**(0.05)	-0.090**(0.04)	-0.128**(0.05)	-0.100**(0.04)

Standard errors in parentheses; ** Significant at 5% level; * Significant at 10% level.

Table 5. Elasticities for selected sub-samples

	Labour supply		Child care demand	
	Hours	employment	Hours	Formal care use
With respect to: gross child care price of preschool children				
*T*ertiary	-0.123**(0.04)	-0.078**(0.02)	-0.285**(0.05)	-0.168**(0.03)
*N*o tertiary	-0.150**(0.04)	-0.095**(0.02)	-0.290**(0.05)	-0.172**(0.03)
*O*ne child	-0.097**(0.04)	-0.060**(0.02)	-0.227**(0.04)	-0.136**(0.02)
*M*ore children	-0.206**(0.04)	-0.133**(0.02)	-0.399**(0.08)	-0.232**(0.04)
By other household income				
hh inc. > *m*edian	-0.110**(0.04)	-0.070**(0.02)	-0.247**(0.05)	-0.151**(0.03)
hh inc. < *m*edian	-0.160**(0.04)	-0.101**(0.02)	-0.327**(0.05)	-0.188**(0.03)
With respect to: net child care price				
*T*ertiary	-0.097**(0.03)	-0.061**(0.01)	-0.229**(0.05)	-0.136**(0.03)
*N*o tertiary	-0.102**(0.03)	-0.065**(0.01)	-0.202**(0.04)	-0.120**(0.02)
*O*ne child	-0.074**(0.02)	-0.046**(0.01)	-0.176**(0.03)	-0.106**(0.02)
*M*ore children	-0.147**(0.04)	-0.095**(0.02)	-0.294**(0.07)	-0.173**(0.04)
hh inc. > *m*edian	-0.098**(0.03)	-0.062**(0.01)	-0.223**(0.05)	-0.136**(0.03)
hh inc. < *m*edian	-0.100**(0.03)	-0.063**(0.01)	-0.212**(0.04)	-0.122**(0.02)

Table 5. continued

With respect to: wage				
*T*ertiary	0.517**(0.11)	0.325**(0.06)	0.370**(0.08)	0.239**(0.05)
*N*o tertiary	0.419**(0.11)	0.265**(0.06)	0.274**(0.06)	0.176**(0.03)
*O*ne child	0.471**(0.11)	0.292**(0.06)	0.362**(0.08)	0.241**(0.04)
*M*ore children	0.484**(0.11)	0.314**(0.06)	0.268**(0.06)	0.159**(0.03)
hh inc. > *m*edian	0.436**(0.11)	0.278**(0.06)	0.315**(0.07)	0.203**(0.04)
hh inc. < *m*edian	0.515**(0.09)	0.321**(0.05)	0.344**(0.08)	0.222**(0.04)
With respect to: income				
*T*ertiary	-0.166**(0.05)	-0.120**(0.04)	-0.150**(0.06)	-0.117**(0.04)
*N*o tertiary	-0.072**(0.05)	-0.049**(0.04)	-0.097**(0.04)	-0.076**(0.03)
*O*ne child	-0.125**(0.05)	-0.085**(0.04)	-0.125**(0.05)	-0.096**(0.03)
*M*ore children	-0.128**(0.05)	-0.100**(0.04)	-0.132**(0.05)	-0.106**(0.04)
> *m*edian	-0.208**(0.05)	-0.639**(0.04)	-0.185**(0.07)	-0.149**(0.05)
< *m*edian	-0.045(0.05)	-0.017(0.04)	-0.070**(0.03)	-0.051**(0.02)

Standard errors in parentheses; ** Significant at 5% level;
* Significant at 10% level.

Table 6. Estimated labour supply elasticity of child care prices using alternative model specifications)

	$h \leq c_f$		$h = c_f$	
With respect to:	Hours	employment	Hours	employment
Gross child care price	-0.262**(0.08)	-0.180**(0.05)	-0.290**(0.06)	-0.190**(0.04)
Net child care price	-0.187**(0.06)	-0.129**(0.04)	-0.227**(0.06)	-0.149**(0.03)
Wage	0.397**(0.12)	0.276**(0.07)	0.375**(0.08)	0.250**(0.05)
Income	-0.101(0.10)	-0.071(0.08)	-0.036 (0.04)	0.038*(0.02)

Standard errors in parentheses; ** Significant at 5% level; * Significant at 10% level.

Table 7. Simulated effects of CCB and CCTR (whole sample)

		Effects of per dollar child care assistance		
	No subsidy	CCB	CCTR	Diff
Hours of work	13.765(3.47)	0.021**(0.01)	0.033**(0.01)	0.012**
Employment (%)	56.1(4.1)	0.064**(0.01)	0.059**(0.01)	-0.005
Formal care hrs/child	7.696(1.41)	0.037**(0.01)	0.042**(0.01)	0.005**
Use of formal care (%)	42.9(3.5)	0.165**(0.03)	0.166**(0.03)	0.001
Informal care hrs/child	6.106(2.51)	-0.015**(0.01)	-0.009(0.01)	0.006**
Disposable income ($)	1306.700(36.53)	0.963**(0.06)	1.069**(0.07)	0.106**
Net child care costs ($)	48.578(9.48)	-0.760**(0.04)	-0.727**(0.04)	0.033**
Net gov. tax revenue ($)	229.911(36.98)	-0.811**(0.05)	-0.681**(0.07)	0.131**
Child care subsidy ($)	0.0	16.754**(2.05)	22.161**(3.38)	5.408**

Standard errors in parentheses; ** Significant at 5% level; * at 10% level.
The hour and dollar values are weekly.

Table 8. Simulated effects of CCB and CCTR (subsamples)

		Effects of per dollar child care assistance		
	No subsidy	CCB	CCTR	Diff
By education	Women with tertiary education			
Hours of work	15.088(3.31)	0.018**(0.01)	0.030**(0.01)	0.012**
Employment (%)	59.8(0.04)	0.056**(0.01)	0.055**(0.01)	-0.001
Formal care hrs/child	8.206(1.32)	0.035**(0.01)	0.040**(0.01)	0.005**
Use of formal care (%)	44.9(3.3)	0.153**(0.03)	0.151**(0.03)	-0.002
Informal care hrs/child	6.904(2.43)	-0.017**(0.01)	-0.010(0.01)	0.007**
Disposable income ($)	1388.089(42.71)	0.971**(0.07)	1.106**(0.07)	0.134**
Net child care costs ($)	53.586(9.23)	-0.769**(0.04)	-0.736**(0.04)	0.033**
Net gov. tax revenue ($)	341.274(40.27)	-0.825**(0.05)	-0.676**(0.07)	0.149**
Child care subsidy ($)	0.0	16.098**(1.74)	24.451**(3.24)	8.353**
	Women with no tertiary education			
Hours of work	11.958(3.72)	0.026**(0.01)	0.037**(0.01)	0.011**
Employment (%)	51.2(4.8)	0.074**(0.01)	0.069**(0.01)	-0.005
Formal care hrs/child	7.000(1.55)	0.040**(0.01)	0.046**(0.01)	0.005**
Use of formal care (%)	40.2(3.9)	0.181**(0.03)	0.186**(0.03)	0.005
Informal care hrs/child	5.016(2.63)	-0.013*(0.01)	-0.008(0.01)	0.006**
Disposable income ($)	1195.526(28.43)	0.952**(0.06)	1.019**(0.06)	0.067**
Net child care costs ($)	41.737(9.97)	-0.748**(0.04)	-0.716**(0.04)	0.032**
Net gov. tax revenue ($)	77.792(32.73)	-0.793**(0.05)	-0.688**(0.07)	0.105**
Child care subsidy ($)	0.0	17.649**(2.59)	19.034**(3.61)	1.385
By income	> median 'other household income'			
Hours of work	14.212(3.51)	0.015**(0.00)	0.024**(0.01)	0.008
Employment (%)	58.8(4.3)	0.038**(0.01)	0.050**(0.01)	0.012**
Formal care hrs/child	8.131(1.46)	0.029**(0.01)	0.032**(0.01)	0.003
Use of formal care (%)	45.0(3.6)	0.126**(0.02)	0.122**(0.02)	-0.005
Informal care hrs/child	6.106(2.54)	-0.013**(0.01)	-0.008(0.01)	0.005**
Disposable income ($)	1653.747(44.78)	1.017**(0.06)	1.103**(0.06)	0.087**
Net child care costs ($)	53.643(10.34)	-0.803**(0.04)	-0.781**(0.04)	0.023**
Net gov. tax revenue ($)	580.522(40.14)	-0.868**(0.04)	-0.781**(0.05)	0.087**
Child care subsidy ($)	0.0	10.514**(1.32)	24.655**(3.73)	14.141**
	< median 'other household income'			
Hours of work	13.319(3.48)	0.027**(0.01)	0.042**(0.01)	0.015**
Employment (%)	53.4(4.1)	0.070**(0.01)	0.073**(0.01)	0.003
Formal care hrs/child	7.262(1.39)	0.046**(0.01)	0.053**(0.01)	0.007**
Use of formal care (%)	40.8(3.5)	0.203**(0.03)	0.210**(0.04)	0.006
Informal care hrs/child	6.106(2.52)	-0.018**(0.01)	-0.010(0.01)	0.008**
Disposable income ($)	960.337(28.94)	0.909**(0.07)	1.035**(0.07)	0.126**
Net child care costs ($)	43.523(8.85)	-0.716**(0.04)	-0.674**(0.04)	0.042**
Net gov. tax revenue ($)	-120.010(34.39)	-0.755**(0.06)	-0.581**(0.09)	0.174**
Child care subsidy ($)	0.0	22.981**(2.84)	19.673**(3.13)	-3.308

Standard errors in parentheses; ** Significant at 5% level; * at 10% level.
The hour and dollar values are weekly.