
Article:
Mumford, Karen Ann orcid.org/0000-0002-0190-5544, Pena-Boquete, Yolanda and Parera-Nicolau, Antonia (2020) Labour supply and childcare::Allowing both parents to choose. Oxford Bulletin of Economics and Statistics. pp. 577-602. ISSN 0305-9049

https://doi.org/10.1111/obes.12340

Labour Supply and Childcare: Allowing Both Parents to Choose.*

Karen Mumford
Dept. of Economics. University of York
Institute of Labor Economics (IZA)

Antonia Parera-Nicolau
European Commission, Brussels

Yolanda Pena-Boquete.
AYeconomics Research Centre,
University of Santiago de Compostela (USC)

June 5, 2019

Abstract

We develop and estimate a structural model of labour supply for two parent families in Australia, taking explicit account of the importance of childcare related variables. Our main contribution is to consider the labour supply decisions of both parents and their choice of childcare simultaneously. Labour supply decisions of mothers are found to be substantially more responsive to changes in their own wage (at intensive and extensive margins) than is the case for fathers, with minimal cross-wage labour supply responses from fathers. Our results imply that policies increasing the wage of mothers will be associated with marked increases in labour market participation and in the working hours of mothers in the Australian labour market, with little offsetting decline in the labour supply of fathers.

Key words: childcare; parental labour supply; discrete; unitary JEL J00 J13 J22

*We thank the HILDA data providers. Research on this paper was carried out whilst Karen Mumford held Visiting Fellowships at the Melbourne Institute of Applied Economic and Social Research (MIAESR) and the Centre for Applied Macroeconomic Analysis (CAMA); their hospitality is gratefully acknowledged. Y. Pena-Boquete wishes to acknowledge the financial support of the Galician Government for funding her visiting stay at the University of York through the Fellowship programme Ánxeles Alvariño We would also like to thank Karina Doorley, Alan Duncan, Ron Oaxaca, and Pauline Rossi. Corresponding author: Prof. Karen Mumford, karen.mumford@york.ac.uk Department of Economics and Related Studies, University of York. Heslington York YO10 5DD, UK. (phone +44 904 323756).

1. Introduction.

The greater inclusion of women into the labour force emphasises the importance of social policies reconciling work and family life. Growth in the labour supply of women and the greater sharing of household work across parents (Gershuny, 2003) are associated with an increased demand for family-friendly, work life balance, practices from male and female workers across the full socio-economic spectrum (Blau and Kahn, 2013; Thevenon, OECD, 2013). By introducing legislation and fostering policies, which aim to reconcile work and family life, these efforts are intended to promote not only gender equality in the workplace but also greater quality care for children.

Many developed countries actively link welfare programs to working, especially since the latter part of the 1990s (Anderson and Levine, 1999; Blank, 2001; Blundell and Hoynes, 2004; Fisher, 2016). The Australian Government has similarly adopted a multi-pronged approach to encouraging family-friendly work environments and parental labour supply especially with the introduction of Family Tax Benefit (2000), Child Care Benefit and Child Care Rebate (2000), the Australians Working Together Program (2001), and more recently the Workplace Gender Quality Act (2012), and the National Child Care Quality Framework (2012). Questions abound, however, as to whether such programs will be effective, since ensuring greater workplace equality and encouraging parents to participate in the labour market will be of little long-term benefit if constraints such as childcare provision cannot be accommodated (Budd and Mumford, 2004).

Papers explicitly exploring the relationship between parents' labour supply and the availability of childcare are comparatively recent in the economics literature (early papers are provided by Blundell and Macurdy, 1999; and Duncan et al., 2001). Very few studies attempt to control for the quality of childcare as well as the price, early exceptions are provided by Mumford and Parera-Nicolau (2005) and Gong and Breunig (2017).

The aim of this paper is to help to fill this gap in the literature by developing and estimating a structural model of family labour supply based on the unitary family framework model, i.e. including mother's and father's supply decisions (Blundell and MaCurdy, 1999) and by taking explicit account of childcare-related measures. With the exceptions of papers such as Chiuri (1997) and Mumford and Parera-Nicolau (2005), relevant studies in this area often take the labour supply decision of the father as given and assume that only the mother's choice is affected by childcare issues such as (price and availability). Or authors model the

household labour supply decision of a two-person household considering childcare variables, but still treat the father's time-use decisions as given (Apps et al., 2016).

We develop and estimate a structural model of labour supply for two parent families in Australia, taking explicit account of the importance of childcare related variables. By modelling the labour supply decision of both parents, and not only the mother's, our estimation of a unitary family framework model is a development over simpler "male-oriented" models (Bargain el al., 2014). Thus, our main contribution is to consider the labour supply decisions of both parents and their choice of childcare simultaneously. Previous studies of labour supply and childcare typically focus on the mother's labour supply decision whilst the father's labour supply decision is treated as a predetermined, or essentially exogenous, variable. To the best of our knowledge, no other paper modelling formal childcare has considered the father's labour supply in the utility function (i.e. endogenous in the family decision).

We seek to provide structural estimates of the unitary model which will prove useful in microsimulation exercises (of the impacts of family policies not only on the parents' labour supply decision but also on childcare take-up decisions) and in policy-related decision making. There have been other papers which have estimated structural parameters for this model, but they either only modelled the mother's labour supply decision (Michalopoulos et al., 1992; Ribar, 1995; Kornstadt and Thoresen, 2007; Gong and Breunig, 2017) and/or did not consider childcare take-up among their arguments (Blundell et al., 2007).

A potential concern with the use of the unitary model, however, is the validity of household income pooling implied by assuming the household is maximizing a single objective function.[1] Using tax reforms in the UK, Lundberg et al. (1997), Ward-Batts (2008) and Fisher (2016) all find against income pooling. Evidence from other countries is more mixed, for example, those finding against income pooling include Duflo (2003) in South Africa, Attanasio and Lechene (2010) in Brazil, and Duflo and Udry (2004) for the Cote d'Ivoire. Those finding for income pooling include Braido et al. (2012) in Brazil, Thomas et al. (1999) in areas of Indonesia, and, importantly for our study, Bradbury (2004) and Breunig and McKibbin (2012) in Australia. The latter paper captures much of the inherent concerns with papers testing for income pooling when it concludes "one could speculate that with a better-fitting model we might find income pooling holds for all categories of husbands and wives" (Breunig and

[1] The unitary family framework also encounters other limitations that are well documented in the literature (see Blundell and MaCurdy, 1999).

McKibbin, 2012; page 254). General consensus appears to be that income pooling is more likely to characterize households in developed countries with greater gender equality (Bargain et al., 2014; Doepke and Tertilt, 2014), where a broad range of consumption expenditures (especially public goods) are considered and where the focus is not predominately on low income families.

The remainder of the paper is organized as follows: section 2 describes the theoretical framework underlying the family's decision process and the econometric specification; section 3 discusses the data set used; results are presented in section 4; and section 5 concludes.

2. Issues of theory and estimation.

The unitary family framework (Blundell and MaCurdy, 1999) is adopted throughout this paper. Family members are assumed to make choices regarding consumption (C) of market goods other than childcare, childcare quality (Q), and leisure (L) in such a way as to maximize their utility U subject to a series of constraints.

$$\max U = U(C, L_m, L_f, Q) \qquad (1)$$

$$s.t.$$

$$T = L_m + H_m + K_m \qquad \text{(1.1. mother's time constraint)}$$
$$T = L_f + H_f \qquad \text{(1.2. father's time constraint)}$$
$$Q = Q(K_m, F, I; Z) \qquad \text{(1.3. childcare quality per child)}$$
$$\boldsymbol{C = \sum_{i=m,f} w_i \cdot H_i + \nu - \tau - P_F \cdot F} \qquad \text{(1.4. family budget constraint)}$$
$$T = K_m + F + I \qquad \text{(1.5. child's time constraint)}$$
$$H_m \leq F + I \qquad \text{(1.6. minimum childcare requirement)}$$

Where the subscripts m and f represent mother and father respectively; total time (T) is shared between working hours (H), leisure time (L) and time spent looking after the children by a parent (K); (F) is childcare provided in the market for which the family has to pay (the number of hours of formal childcare that the family uses); (I) is informal childcare provided for free by friends or relatives; (Z) represents a set of family characteristics thought to influence childcare quality and/or the family's perception of childcare quality; (w_m) is the mother's hourly wage; (w_f) is the father's hourly wage; (v) is the family's unearned income; (τ) is family's taxes net of benefits; and (P_F) is the hourly price of formal childcare.

For the benchmark model, we assume that father's time is only spent working or enjoying leisure time, in other words, the father does not spend time caring for the children. We need to impose this constraint since the HILDA data set does not separate between the hours of

childcare provided by the mother or the father. There is an unfortunate loss of generality imposed by this assumption. Nevertheless, the model is still an advance over those used in earlier studies (for example, the father's labour supply is not taken as given but is determined by the model itself). We return to consider further, and to relax, the father's time constraint below.

We also assume that if informal childcare (I) is available, the family will use it (subject to a minimum quality requirement). The number of hours of informal childcare used by the family is treated as a fixed parameter, which only appears in the child's time constraint and in the minimum childcare requirement. No assumption is made as to whether the quality of childcare purchased in the market is less than, equal to, or greater than the quality of childcare provided by the mother. In the conceptual model, childcare quality is therefore defined as $Q = Q(K_m, F; Z)$ and childcare quality is assumed to increase with inputs of maternal care and formal care. The contribution of each input to the overall quality is ambiguous and depends on the quality of each childcare mode relative to the others. When it comes to estimation, the relative quality of the two modes considered is assumed to be exogenously determined. Childcare quality enters this model by introducing relevant variables in the estimation of the price of formal childcare, discussed in greater detail below.

It is not unusual for children to be in formal childcare for some hours when a parent is not working. For example, Chiuri (1997), Mumford and Parera-Nicolau (2005), Apps et al. (2016) and Gong and Breunig (2017) address the possibility of observing a non-working mother using non-parental childcare and, therefore, they present estimates of the labour supply elasticity to the price of formal childcare which are conditional on the mother working. The unitary family framework allows for the possibility of the family considering non-parental childcare as a good in itself and not only as a tool to allow for participation in the labour market. Thus, this model consistently allows for the possibility of observing a family using childcare for more hours than the number of hours the parents are working. The ability to address this empirical reality is an advantage in the model's capacity to explain observed behaviour.

The budget constraint limits the family's consumption in the usual way. The child's time constraint indicates that the time the child is looked after is equal to the time the mother is looking after her/him plus the number of hours s/he is looked after by somebody else (either in formal childcare (F) or in informal childcare (I)). This constraint rules out the possibility that the family leaves the child on its own. Finally, the minimum childcare requirement (MCCR)

states that someone else looks after the child at least during the time the mother is working. This inequality restriction allows us to consider the use of non-parental care by non-working mothers and, in general, to consider formal childcare as a good in itself and not only as a means to facilitate employment. This expression also restricts the mother's leisure time to be non-negative.

In a static (or steady-state, Chetty et al., 2011) modelling approach, it is assumed that the family chooses a point on the edge of their budget set, then consumption (C) can be substituted by income (Y). Substituting also L_m, and L_f by their expressions in the constraints, and taking into account what has been assumed about Q, the model to be estimated can be expressed as:

$$\underset{H_m, H_f, F}{Max} U = U\left(Y, F + I - H_m, T - H_f, F; X\right)$$

s.t.

$$\boldsymbol{Y = w_m \cdot H_m + w_f \cdot H_f + \nu - \tau - P_F \cdot F}$$

where X_i is a vector of regressors capturing observable characteristics expected to be related to utility. Each family in the sample will choose the values of H_m, H_f, and F that maximize its utility function $U = U(Y, L_m, L_f, F)$. Ideally, the indirect costs of informal childcare should be incorporated into the model as shadow costs in the family's consumption so that an equal treatment of both formal and informal childcare would be guaranteed. The estimation of such shadow costs falls outside the scope of our paper, and the model estimated here follows the Ribar (1995) approach, although Ribar does not include the father's labour supply among the utility arguments.

Fixed costs of employment can be addressed in various ways. Van Soest (1995; page 72) includes constants in the utility function to capture fixed costs associated with part-time employment. With relatively few men observed working part-time in most data sets, more recent studies have used a fixed cost of working measure instead. Blundell et al., (2007b, pages 4721-4724) show that it is theoretically equivalent to introduce this fixed cost measure in the budget constraint or the utility function as the fixed costs enter as additional variables in the likelihood function either way. In our case, we introduce a fixed cost measure for working for men and for women in the utility function. We consider how sensitive the results are to this inclusion in section 4 below where robustness issues are addressed.

Labour supply and formal childcare take-up is modelled as the outcome of a discrete choice among a finite set of alternatives, as suggested by van Soest (1995), Keane and Moffitt (1998), Blundell et al. (1999, 2000), and more recently Bargain et al. (2014). The econometric specification used in those papers is preferred for the estimation of the model presented here since: it is more realistic to assume that individuals can not choose to work any desired amount of hours but instead choose among the limited options supplied in the market (usually not to work, to work part-time or to work full-time); it allows for non-linear and possibly non-convex budget constraints (consistent with non-linear taxes and benefit systems); it effectively differentiates between those individuals observed not to work; and it has the capacity to deal with decisions at the level of the household rather than at the level of the individual (Blundell et al., 1999; Blundell and MacCurdy, 1999). These characteristics also allow for a natural extension into simulation.

Furthermore, the discrete approach can readily incorporate fixed costs and random preference heterogeneity; it allows for the introduction of extra preference arguments (which is useful in this case since we are dealing not only with labour supply arguments but also with childcare); and it allows for the estimation of the fully structural model and, therefore, consistency of the parameters with economic theory can be tested rather than imposed.

The formulation of the discrete approach requires that each individual (each parent, in this case) is placed into a limited set of pre-assigned working states. In the extended model dealt with here, the number of hours of formal childcare used by the family is also limited to specific values. The potential introduction of rounding errors in the hours levels considered is possibly the most important drawback to the use of the discrete approach. Because of these rounding errors, the parameters estimated may depend on the hours levels chosen. The use of sensitivity analysis can help to dissipate these doubts[2]. We will return to discuss these issues below.

The actual hours levels to be considered are guided by characteristics displayed by the data sample. We are able to identify three states for the working pattern of mothers based on kernel estimations (see Figure 1). These are non-working mother (working less than 5 hours per week), working part-time (working between 5 and 30 hours), and working full-time

[2] Van Soest (1995) and Blundell et al.(1999) present such sensitivity analysis. Van Soest (1995) concluded, "discretising into 25 or 36 points does not make too much difference". Blundell et al., (1999) found a progressive increase in the marginal utility of income and in the marginal disutility of hours as the number of hours bands increased; however, they concluded that such differences in marginal utilities were not particularly high.

(working more than 30 hours). The hours levels considered are therefore either 0, 20, 40 (corresponding to non-participation, part-time and full-time employment respectively) for the mother.

[Figure 1 around here]

Four states are similarly identified for the working patterns of fathers. These states are non-working father (working hours lower than 5), working part-time (working hours between 5 and 35), working full-time (working hours between 35 and 45), working full-time and extra hours (working more than 45 hours). The hours levels considered for the father are therefore either 0, 20, 40 or 50 (corresponding to non-participation, part-time, full-time and over-time employment respectively).

Finally, three states are identified for the use of formal childcare (Figure 1): not using formal childcare (hours of formal childcare lower than 5), using part-time formal childcare (hours of formal childcare between 5 and 20) and full-time childcare (hours of formal childcare higher than 20), corresponding to 0, 15 and 30, respectively.

Each family therefore faces 36 possible alternatives, defined by a different combination of mother's working hours, father's working hours and formal childcare take-up hours:

Alternative 1, $H_m = 0$, $H_f = 0$, $F = 0$; Alternative 2, $H_m = 0$, $H_f = 0$, $F = 15$;

…;

Alternative 35, $H_m = 0$, $H_f = 50$, $F = 15$; and Alternative 36, $H_m = 0$, $H_f = 50$, $F = 30$.

Random Disturbances are incorporated in the model in the same way as in a Multinomial Logit, they are assumed to follow an iid Type I Extreme Value distribution.

In order to estimate the model, a specific functional form for U must be chosen. Following Ribar (1995), Keane and Moffitt (1998) and Blundell et al., (1999), the chosen functional form for the family's utility function is a generalized quadratic in its arguments, allowing for a broad array of behavioural responses[3].

The family's maximization problem is:

$$\max U(C, L_m, L_f, F / \phi)$$

[3] This functional form presents some disadvantages, however, such as not being globally concave and not guaranteed to be increasing in income across its entire range (Stern, 1997).

where $$U = \begin{bmatrix} \beta_y \cdot Y + \beta_{lm} \cdot L_m + \beta_{lf} \cdot L_f + \beta_F \cdot F \\ +\beta_{ylm} \cdot Y \cdot L_m + \beta_{ylf} \cdot Y \cdot L_f + \beta_{yF} \cdot Y \cdot F \\ +\beta_{lmlf} \cdot L_m \cdot L_f + \beta_{lmF} \cdot L_m \cdot F \\ +\beta_{lfF} \cdot L_f \cdot F + \theta_y \cdot Y^2 + \theta_{lm} \cdot L_m^2 + \theta_{lf} \cdot L_f^2 + \theta_F \cdot F^2 \end{bmatrix}$$

and $\varnothing = [\beta_y\ \beta_{lm}\ \beta_F\ \beta_{ylm}\ \beta_{ylf}\ \beta_{yF}\ \beta_{lmlf}\ \beta_{lmF}\ \beta_{lfF}\ \theta_y\ \theta_{lm}\ \theta_{lf}\ \theta_F]'$

From the data available, the values of Y, L_m, L_f, and F can be calculated in the following way:

$$= \quad = \sum_{i=m,f} \quad _i \cdot \quad _i + \quad - \quad - \quad _F \cdot$$

$$\begin{aligned} L_m &= F + I - H_m \qquad \text{if } F + I \geq H_m \\ &= 0 \qquad\qquad\quad \text{if } F + I < H_m \\ L_f &= T - H_f \end{aligned}$$

HILDA provides data on H_m, H_f, F, and I but not information on total time (T). Following van Soest (1995)[4], we assume that $T = 80$.

One of the advantages of the discrete approach is that it allows for the incorporation of heterogeneity so that the impact of some of the model's variables on the family's utility is allowed to depend on a set of socioeconomic variables. For each family in the sample, $\beta_y = X_y \cdot \jmath_y$ where X_y is the set of attributes assumed to influence β_y ; and $\jmath_y$ is the set of parameters capturing the intensity of the relationship between each variable in X_y and β_y. Random Preference Heterogeneity is incorporated by randomizing those same parameters: $\beta_y = X_y \cdot \jmath_y + \zeta_y$ And similarly for β_{lm} , β_{lf} and β_F. It is further assumed that the relevant error terms follow a multivariate normal distribution $(\zeta_y\ \zeta_{lm}\ \zeta_{lf}\ \zeta_F) \sim MVN(0, \Sigma)$ where Σ is the variance and covariance matrix.

The introduction of random preference heterogeneity factors motivates the application of simulation methods in order to estimate the structural parameters. Stern (1997, page 2032) concludes that for problems such as ours, Simulated Maximum Likelihood (SML) provides

[4] T could be incorporated as a parameter to be estimated. However, van Soest (1995) argues that the estimate of this parameter is imprecise and that giving it a set value has little impact on the other results.

more precise estimators than does Method of Simulated Moments (MSM) and that SML is preferred in terms of statistical performance; we adopt it accordingly.

3. Data.

Data for this study are taken from the Household, Income and Labour Dynamics in Australia (HILDA) Survey[5]; an annual household-based panel study which began in 2001. HILDA collects a range of information including economic measures, labour market dynamics and family structure. Interviews are conducted annually with all adult members of each household. HILDA is the preferred source of data because it contains detailed information about childcare prices and hours by type of childcare; and includes a full tax-benefit model that also allows for child related benefits. These characteristics make HILDA especially relevant to this study. We use HILDA from wave 4 (2003-2004) when the information on childcare prices and hours was introduced, to wave 9 (2008-2009) after which Australia's reaction to the global financial crisis (GFC), could reasonably be expected to impact on the analysis (Junankar, 2016; Mohammad, 2017; Jericho, 2018).[6]

The full HILDA database includes approximately 8,000 households and 20,000 individuals per wave. The sample of interest here, however, consists of families in which the parents are married or cohabiting and there is at least one child aged under 5. The number of couples in the database (from wave 4 to wave 9) with children younger than 5 years old is 4,514. There are also missing observations for some of the variables of interest. The size of the sample used in the analysis subsequently diminishes due to the following reasons: those couples where at least one member was not interviewed (337 observations removed); couples with at least one member not providing country of origin (3 observations); couples with at least one member unemployed (186 observations); couples where at least one member does not report their working hours, or they report zero hours worked, in their main job (14

[5] This paper uses 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 Social Services (DSS) 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 DSS, the Melbourne Institute or the author's employing bodies.

[6] Australia's economy did not formally enter a recession in the immediate aftermath of the Global Financial Crisis (GFC); it was in a relatively strong position at the point of crisis, and was aided by two years of fiscal stimulus. However, unemployment rates amongst young people rose dramatically and there were substantial increases in part-time and casual employment (Junankar, 2016). The employment to population ratio of 25-54 year olds was 80.3% in 2008, it did not return to this level again until 2018 (Jericho, 2018). Unemployment rose from 4% immediately prior the GFC to 6¼% by 2015; Australia experienced a 35% decline in commodity prices between 2011 and 2017, with a similar decline in the terms of trade over 2011-2016; and real GDP fell in Australia from an average of 3¼% before the GFC to an average of 2½% after (Mohommad 2017; page 3).

observations); couples reporting a zero wage in their main job (600 observations); those who do not report their labour market experience (11 observations); couples using more than 80 hours of childcare (8 observations); couples who use formal childcare but do not answer the question on "finding good quality childcare" (178 observations). The final number of couples with children younger than 5 years old included in the analysis is subsequently 3,177. This is a larger sample than that employed by Apps et al. (2016) or Gong and Breunig (2017).

Selected summary statistics are provided in Table 1 (variable definitions are provided in Table A1 of the Appendix). The variable definitions are on the whole self-explanatory; however, there are some features of the data that are worth highlighting here. For example, information on the hourly wage is only available for the main job, whilst hours worked in all jobs is used to measure available leisure time. The measure of accumulated work experience comes from the survey responses to "years in paid work", zero years of experience are assumed for those who are still in school. The regions are measured as the six States and the two Territories found in Australia, there are also within region rural or urban indicators.

On average, the men in the sample are older (at 35 years) than are the women (32.6 years), the men have more years of work experience (16.2 compared to 11.5), slightly less education (11.7 rather than 11.9 years), and they work almost three times as many hours per week. Nine tenths of the sample is born either in Australia or another English-speaking county.

Based on the HILDA User Manual (in accordance with Wilkins, 2009), we simulate a complete tax-benefit model to calculate the net family income for each state depending on the mother's working hours (H_m) and father's working hours (H_f), in each particular case. We simulate the labour income of the family member's $\left(\sum_{i=m,f} \; _i \cdot \; _i\right)$, their Income Tax, Medicare, Tax Offset (LITO, PETO, MATO) and family benefits (Family Tax Benefit Part A and Family Tax Benefit Part B). In greater detail, the family gross household income is the sum of each partner's annual labour and non-labour income; computed as business income, investment income and private pensions. We calculate this family taxable income for each state according to the number of working hours established for each of the partners, in each state, paid at their corresponding estimated hourly wages (family labour income) plus non-labour income (constant for each state). Once we establish taxable income we simulate income tax, medical levy, tax offsets and (some) public transfers related to children, for each state. Deductions for work-related and other expenses incurred in earning income are subtracted from gross income subject to tax to obtain taxable income. Deductions are not reported and so are

assumed to be a fixed percentage of income that depends on the level of the individual's income. Australian Tax Office data on average deductions as a proportion of income for each of 20 income ranges are used to determine the applicable percentage. That is, the proportion of gross income that is assumed to be claimed as a tax deduction depends on the income category into which the individual falls. Average deductions for each income category range from around 6-7% for those with low incomes down to around 4-5% for those with the 8 highest incomes. Average deduction rates are taken from Wilkins (2014). We applied income tax rates taken from Table 8 in Wilkins (2014) to taxable income after deductions to derive the income tax for each state.

The Medicare levy[7] is estimated as applicable in the relevant financial year and added to income tax. The single-person formula also applies to persons in sole parent or couple families, but is augmented by a formula based on family income. For non-retired people, the four standard marginal tax rates are applied to the taxable income estimate. This produces an estimate of income tax payable prior to addition of the Medicare levy and subtraction of applicable tax offsets and credits.

The income tax offsets are: the Low Income Tax Offset (LITO) that accrues to persons with low personal taxable incomes; the Pensioner Tax Offset (PETO) payable to working-age persons (below Age Pension age) who received any government pension or allowance other than the Disability Support Pension at any stage of the financial year[8]; and the Mature Age Workers' Tax Offset (MATO) that applies to employed persons aged 55 years and over and is in addition to any other offsets applicable.[9]

Finally, we simulate the Family Tax Benefit Part A (FTB A) and Part B (FTB B) in each state based on Wilkins (2009). FTB A and FTB A are benefits to help families with the cost of raising children. These benefits depends on the number and the ages of dependent children but

[7] Medicare is an Australian Government funded health insurance scheme providing free, or subsidised, health care services to Australian residents. Medicare was funded by a taxpayer levy of 1.5% of taxable income during the time-period of our study, with exemptions for low income families or an additional levy surcharge of 1% for high income earners (information on historical Medicare levy rates are provided at https://atotaxrates.info/medicare-levy-historical-rates/). The upper and lower family income thresholds for full exemption changed in each year of our study, as did the amount the family income lower limit increased by the number of additional children in the family. Exemption occurred at 8.5% in the dollar above the limit.

[8] We include the following tax offsets: Low Income Tax Offset (LITO), Senior Australians Tax Offset (SATO), Pensioner Tax Offset (PETO), Mature Age Workers Tax Offset (MATO) and Dependent Spouse Tax Offset (SPOUTO).

[9] Introduced from 2004-05, MATO is equal to 5% of wage and salary income net of deductions up to a maximum of $500.)

also on the taxable income of the family. Based on the taxable income per state that we have calculated as above, we apply the corresponding formula in Wilkins (2009). All variables are measured net of taxes where relevant and in real terms. On average, the unadjusted hourly wage is higher for males than females ($31.3 relative to $30), we discuss estimated wages further below.

Considering the household characteristics reported in Table 1, on average the families have 1.4 pre-school children (those children aged under 5). The age and number of children in the household may have implications for the interpretation of childcare expenditure and parental leisure. Walker (1992) and Ribar (1995) found large discounts in childcare fees were offered to families with more than one child with the care provider, implying prices are non-linear with respect to the hours of childcare paid for. Duncan et al. (2001) found, however, that variation in the price measure is not important for the estimated price elasticities for pre-school aged children. With an ideal data set, it would be possible to identify the relevant childcare expenditure for each child in the family separately and the time each parent spends on childcare and leisure. As is common with large-scale income surveys, the HILDA data set does not provide such detailed information; it provides information of the type of childcare used and the total childcare expenditures per household, but not specific payments. It has consequently become common in the literature to include controls for the presence (or number) and the age of children in the model (Kabatek et al., 2014).

The HILDA data set does come with a rich variety of alternative childcare options. We define formal childcare as care provided by a paid sitter or nanny, family day care, long day care centre at workplace, private or community long day care centre or kindergarten. Informal childcare includes being cared for by a family friend or neighbour, an elder sibling, the child's grandparent or other relative. More than 70% of the households are using some form of childcare with, on average, some 11 hours of informal and 22 hours of formal childcare per week. The HILDA data set does not separate between the hours of childcare provided by the mother or the father. The implications of this are considered further below when it is assumed that either the mother provides all the additional childcare or the parents divide these hours equally between themselves.

[Table 1 around here]

Returning to consider the wages reported in Table 1, obviously the unadjusted average hourly wage can only be reported for the subsample of parents who work (i.e. those mothers or fathers for whom information on hourly wages is directly available). The Heckman selection model (Heckman, 1979) is used to predict missing wages for the mothers (fathers) and is estimated on the sample of women (men) aged 16-65 who are not disabled or in full-time education, implicitly assuming that hourly wages of mothers (fathers) with small children are set in the same market as the rest of the women (men). The full estimation results for mothers and fathers are reported in Table 2. The variables in the wage equations are standard human capital variables, demand-side regional controls and a demographic indicator.

The human capital measures include years of education and labour market experience (including experience squared). General labour demand is measured by the unemployment rate in the respondents' region of residence, regional controls, and an indicator for residing in an urban area. Nationality (and Aboriginality) are included as demographic indicators. The variables used in estimating the participation probit are those used for the estimation of the hourly wage, with the exclusion restrictions in the participation equations capturing family composition (the presence of children aged under 3, the number of children aged under 5, the number of children aged 5-11) and the family's financial condition (as measured by the family's non-labour income).

[Table 2 around here]

The wage equations are well defined and the results are consistent with prior expectations. The rate of return to an additional year of education is slightly higher for women than men, although not significantly so at standard confidence levels. A rate of return of some 5% is lower than often found but, given the relatively young age of the sample, it is not surprising. Similarly, the rate of return for experience is strong and whilst increasing at a decreasing rate, the latter fall off is still quite low. Local unemployment is associated with lower wages for men and women, and regional wages across Australia are lower than the omitted Australian Capital Territory with its preponderance of Federal Civil Servants. Migrants, especially from mainly English speaking countries, receive a wage premium over those born in Australia and there is a wage premium associated with living in an urban area. Considering the selection equation, of particular interest is the lower probability of migrants working in the labour market, especially so for women from non-English speaking countries. Of note also is the significant finding that women with children under 3 will be less likely to

engage in market work (not a significant relationship for the men) and a strong negative relationship between the number of children aged under 5 and the probability of the mother working (a significant positive relationship is found for the men). A significant Mills ratio is reported for both wage equations. Considering the estimated average hourly wages for mothers and fathers reported in Table 1, the gender wage gap is substantial at 10.7% for working parents and 14.2% for all parents. These results are consistent with more detailed studies of earnings determination in Australia, which have found a persistent and substantial gender pay differential (Daly et al., 2006; Chzhen et al., 2013).

The price of formal childcare is also predicted using a Heckman selection model for married couples with children aged under 5 (results are provided in Table 3). The variables in the price equation are household child composition (the presence of any children aged under 3, the number of children aged under 5 and the number of children aged 5-11) and the childcare quality measure "difficulty of finding good quality childcare in the last 12 months". For those who did not use childcare in the last year, the missing "difficulty finding quality childcare" measure is replaced with the regional average value of this measure. The variables used in estimating the probability of using formal childcare are mother characteristics (age, age squared, years of education, and nationality), household composition (the presence of any children aged under 3, the number of children under 5, the number of children 5-11 and number of adults), the availability of informal child care (use of informal childcare and the father's working hours), and the household financial condition (non-labour income). A measure of potential childcare supply constraint is also included; this is calculated as the difference in the price of formal childcare from the average price in the local area (urban or not urban) and from the average price in the country.

[Table 3 around here]

The estimated price equations are also well defined and consistent with prior expectations. The price of formal childcare is found to be decreasing with the number of children in the family and increasing with the reported difficulty of finding good quality childcare. The probability of using formal childcare is positively associated with the household having a high non-wage income, with older and better educated mothers who come from mainly English speaking countries (including Australia), with fewer adults in the household, and with families that are also using informal childcare. The Mills ratio is found to be significant and negative. The hours of use for different childcare modes, and the average hourly

prices, vary substantially (see household panel of Table 1). For example, children tend to spend about 20 hours per week in day care places but only around 11 hours per week in a kindergarten/preschool or with a paid sitter/nanny (for the families using these modes). It costs more than twice as much per hour to use nanny care than kindergarten or family day care.

4. Results

As discussed above, we employ the Simulated Maximum Likelihood (SML) method of estimation that consists in obtaining R draws from the assumed distribution of the error terms, where R has been set to 100 draws from Halton sequences (Keane and Moffitt, 1998; Train, 2003). The panel nature of the data set is fully allowed for in the estimations with standard errors corrected accordingly. The observed and simulated means of the outcomes variables are reported in Table 4. There is some tendency to underestimate the fathers working hours and the use and hours of formal childcare, however, these discrepancies are not large (and are not significantly different at standard confidence levels).

[Table 4 around here]

The structural parameter estimates, and their associated standard errors, are reported in columns 1 and 2 of Table 5. The model is well defined with the log-likelihood and the pseudo coefficient of determination (R^2) being analogous to those found in other studies (Bargain et al., 2014; page 733). Comparison of the observed frequencies and predicted probabilities for the 36 states used in the preferred specification also supports model fit (results available upon request).

[Table 5 around here]

The parameters estimates in Table 5 should not be directly interpreted as either the direction or the magnitude of the impacts of the variables on labour supply or formal childcare; these relationships need to be calculated through the simulations (see the calculation of elasticities below). Instead, the parameters reflect the direction in which characteristics affect preferences. For example, university education is significantly related to lower marginal utility of leisure of both mothers and fathers. In the case of fathers, this decrease in the marginal utility of leisure could be interpreted as an increase in the propensity for working. However, for mothers it needs to be interpreted as a combined effect on work and maternal care. The number

of children under five increases the marginal utility of leisure and it decreases the marginal utility of formal care. This might indicate that the number of children decreases the propensity to work for the mother and, as a result, decreases the number of hours of formal childcare used. Additionally, informal childcare appears to complement, rather than substitute for, formal childcare since the number of hours of informal childcare increases the marginal utility of formal childcare.

As discussed in section 2 above, since van Soest (1995) it has become standard to include fixed cost measures for working in labour supply analyses[10] and this is the approach adopted in this paper. We also consider excluding these fixed costs from the model; the estimation results are provided in columns 3 and 4 of Table 5. There is evidence that the model including fixed costs fits better, for example, the pseudo R^2 is higher (at 0.231 rather than 0.213) and the log likelihood is higher. The inclusion of fixed costs is found to be significant and negatively related to labour supply for both mothers and fathers, with a considerably stronger relationship found for fathers. These results support the inclusion of fixed working costs in the labour supply model and it is consequently our preferred model.

The minimum childcare requirement (MCCR) assumption in the model is that the mother provides childcare when the child would otherwise be unattended. We consider relaxing the MCCR assumption as a robustness consideration and allow both parents to equally share child care (as a 50-50 division) when the child is otherwise unattended. We compare the simulated labour supply, for mothers and fathers, and the childcare demand with the observed data. The results indicate that the alternative models perform similarly and that they replicate the observed data reasonably well (see Table 4). The labour supply estimates are provided in columns 5 and 6 of Table 5.

As discussed above, the interpretation of the labour supply estimates presented in Table 5 is not intuitive. Table 6 reports the more readily interpreted estimated elasticities. These estimated elasticities are calculated as the average over the whole sample's individual (i.e., per

[10] There are alternative approaches in the literature, for example, Gong and van Soest (2002, page 168) argue that when non-market work may be particularly valuable, such as the multi-generational caring role of women in developing countries, it may be preferred to include fixed revenue measures of non-working instead. Donald and Hamermesh (2009) include interaction terms between the fixed cost of working and time use measures in the utility function, arguing that the relevant parameters capture relative time-use efficiency. Whilst the HILDA data set provides some information on time use within the household, unfortunately it does not contain sufficiently complete information on the distribution of time use in the period for a similar analysis.

family) elasticities. The elasticities quantify the reactions (changes in %) of two-parent families with children aged under 5 to a 1% increase in the value of the relevant explanatory variable.

[Table 6 around here]

Columns 1 and 2 of Table 6 present estimated elasticities at the intensive and extensive margins (respectively) for the unitary model with the MCCR. Columns 3 and 4 provide estimated elasticities assuming the fathers labour supply decision is exogenous; and columns 5 and 6 present results for the unitary model assuming the parents share the care 50:50 when the child is otherwise unattended. Table 7 provides estimates and pairwise tests of the differences in the estimated elasticities, at the intensive and extensive margins, for the three models.[11]

[Table 7 around here]

The differences in the estimated elasticities in Table 6 are presented in columns 1 to 4 of Table 7 and are all statistically significant at, at least, the 95% confidence level. We find that responses to an increase in the mothers wage are positive and larger in the unitary model than when the fathers labour supply is treated as exogenous (panel 1 of Table 7); and that responses to an increase in the price of childcare are negative and also larger (panel 3). In contrast, changing the MCCR is found to have little impact on the results; the estimated elasticities are consistently smaller when parents share the care 50:50 for the otherwise unattended child (comparing columns 1 and 2 of Table 6 with columns 5 and 6, respectively), but they are not statistically significantly different (see columns 5 and 6 of Table 7).

Returning to consider the results presented in columns 1 to 4 of Table 6 in more detail, Australian mothers labour supply elasticity to their own wage is positive (see panel one of Table 6) and relatively large compared to the cross elasticity between the mother's wage and father's working hours. This is true at both the intensive and the extensive margins. Increases in the mother's wage are also associated with increased demand for formal childcare; with

[11] Column 1 of Table 7 compares estimated elasticities at the intensive margin between the unitary model (with MCCR) and the father labour supply decision exogenous model. In other words, comparing the elasticities presented in columns 1 and 3 of Table 6. Column 2 of Table 7 compares elasticities at the extensive margin for these two models (columns 2 and 4 of Table 6). Analogously, column 3 of Table 7 compares estimated elasticities between the unitary model (with parents sharing care 50:50 for an otherwise unattended child) and the father labour supply decision exogenous model at the intensive margin (columns 3 and 5 of Table 6); and column 4 of Table 7 compares these models at the extensive margin (columns 4 and 6 of Table 6).

increases in hours used and also choosing to use this type of childcare. Moreover, mother's own wage elasticities are substantially higher when we consider father's labour supply in the utility functions (unitary framework).

In contrast, for the unitary model, an increase in the father's hourly wage (see panel 2 of Table 6) has no significant relationship with the mother's labour supply and only a modest increase in the family's use of formal childcare. The fathers labour supply elasticity to their own wage (0.58) is positive but considerably less sensitive to that found for mothers own wage elasticities (1.72). The relative gender differences in own wage effects on participation in the labour market is even more striking (0.32 versus 1.35 for men and women). This finding is consistent with other countries that have a substantially lower participation rate for mothers than fathers (Bargain et al, 2014; Bargain and Peichl, 2016); the participation rate for the mothers in our sample is 54%, some 40 percentage points below the participation rate for their partners.[12]

An increase in the price of formal childcare reduces both the father's and the mother's working hours, (panel 3 of Table 6) suggesting that an increase in cost makes families less willing to pay for formal childcare. The number of formal childcare hours reduces with the mother covering considerably more of these hours of childcare than the father. Nevertheless, the labour supply response of the mother to a change in her own wage (1.72) is substantially greater than her response to a change in the price of childcare (-0.20).

Findings from other studies of the own wage elasticity of women vary with different time periods studied and/or the countries explored (Kornstadt and Throesen, 2007; Bargain et al., 2014; Bargain and Peischl, 2016), with marital status and the presence of young children. Kornstadt and Throesen (2007, page 796) provide a useful list of estimated elasticities from previous studies for married mothers, assuming father labour supply to be exogenous. Our comparable findings for mothers own wage elasticity at 0.78 for participation sits close to the maximum of 0.85 (Canada, 1998) they report; and our estimated intensive margin elasticity of 1.00 is high but below the maximum estimate of 1.6 (USA, 1997) listed in their table. Our equivalent estimated elasticities for the unitary model of 1.35 and 1.72 (respectively) exceed both maxima.

[12] The labour force participation rate of Australians aged 20-64 years is 65.1% for women and 78.3% for men, however, the rate is considerably lower for coupled mothers with children aged under 5 years old (at 53.6%) and considerably higher for their husbands (at 93.6%). Universal paid parental leave was introduced in Australia in 2012.

Bargain et al. (2014, page 738) find that own wage elasticities are largest for married women, typically laying between 0.2 and 0.6: countries with the highest own wage elasticities for married women are those with low participation rates for these women; and there is also evidence that having children is associated with further increases in own wage elasticities for these women. This would suggest larger own wage elasticities for the women in our sample, all of whom are married mothers with at least one child under 5, when the female labour market participation rate is lowest. Bargain and Peichl (2016) show considerable dispersion in estimates of own wage elasticities for married women and argue that estimation method does not appear to be a primary explanation for this dispersion. They find that international differences in labour supply parameters reflect national work preferences. This suggests that contemporaneous within-country comparisons are important when considering the policy implications of alternative models.

We can compare our results with recent studies for Australia by Apps et al. (2016) and Gong and Breunig (2017), both of which model the fathers labour supply decision as exogenous. At the intensive margin, assuming father as exogenous, our estimated mother's own wage elasticity of 1.00 falls between the 0.48 estimated by Gong and Breunig (2017) and 1.35 estimated by Apps et al. (2016); and we find a child care demand elasticity with respect to the mother's wage of 0.68 (again sitting within the range between the 0.7 found by Apps et al. (2016) and 0.27 found by Gong and Breunig (2017). Our estimated elasticities from the unitary model are larger at 1.72 and 1.13, respectively, unsurprisingly as we allow for both parents work decisions in the utility function.

5. Conclusions.

We develop and estimate a structural model of labour supply for two parent families in Australia, taking explicit account of the importance of childcare related variables. Our main contribution is to consider the labour supply decisions of both parents and their choice of childcare simultaneously. Previous studies of labour supply and childcare typically focus on the mother's labour supply decision whilst the father's labour supply decision is treated as an exogenous variable. We find labour supply increases with the wage of either parent in the household but that mothers are much more sensitive to increases in their own wage than are fathers. This is true at both the intensive and extensive margins with women responding with greater increases in working hours and labour market participation.

Nevertheless, in the typical Australian family with at least one child aged under five, the mother is the preferred provider of parental childcare. Whilst an increase in child care prices is associated with less hours worked for mothers and for fathers, the results show the mother's labour supply decision is more responsive to childcare price than is the father's. When the price of formal childcare increases, families care for their children by substituting out of formal childcare and disproportionately substituting into maternal care.

In conclusion, our results suggest that lowering the cost of formal childcare in Australia will increase the working hours of parents, especially women. However, increasing the wage of mothers will have a more dramatic effect on their labour supply; increasing both the participation of these women into the labour market and also the hours of those already working, whilst having little effect on the labour supply of fathers.

Compliance with Ethical Standards: This project was not directly funded. Research on this paper was carried out whilst Karen Mumford held Visiting Fellowships at the Melbourne Institute of Applied Economic and Social Research (MIAESR) and the Centre for Applied Macroeconomic Analysis (CAMA); their hospitality is gratefully acknowledged. Y. Pena-Boquete received financial support of the Galician Government to fund her Visiting Fellowship stay at the University of York through the Fellowship programme Ánxeles Alvariño. The authors declare that they have no conflict of interest.

References

Apps, P.F. Kabatek, J. Rees, R. and van Soest, A. (2016). Labor supply heterogeneity and demand for child care of mothers with young children. Empirical Economics, 51, 1641–1677.

Attanasio, O. and Lechene, V. (2010). Conditional cash transfers, women and the demand for food. IFS Working Papers W10/17, Institute for Fiscal Studies.

Bargain, O. Orsini, K. and Peichl, A. (2014). Comparing labor supply elasticities in Europe and the United States. Journal of Human Resources, 49(3), 721-838.

Bargain, O. and Peichl, A. (2016). Own-wage labour supply elasticities: Variation across time and elasticities methods. IZA Journal of Labor Economics, 5(10), 1-31.

Blank, R.M. (2001). Declining caseloads/increased work: What can we conclude about the effects of welfare reform? Economic Policy Review, 7(2), 25-36.

Blau, F. and Kahn, L. (2013). Female labor supply: Why is the US falling behind? American Economic Review, 103(3), 251-256.

Blundell, R., Chiappori, P.A., Magnac,T. and Meghir, C. (2007). Collective labour supply: Heterogeneity and nonparticipation. Review of Economic Studies, 74(2), 417-455.
Blundell, R., Duncan, A., MacCrae, J. and Meghir, C. (1999). Household labour supply, childcare costs and tax credits. Institute for Fiscal Studies Conference Papers 1999.
Blundell, R., Duncan, A., McCrae, J. and Meghir, C. (2000). The labour market impact of the working families' tax credit. Fiscal Studies, 21(1), 75-103.
Blundell, R. and Hoynes, H. (2004). Has 'in-work' benefit reform helped the labour market. In Card, D. Blundell, R and Freeman, R (editors). Seeking a Premier Economy. (NBER, Chicago).
Blundell, R. and MaCurdy, T. (1999). Labour supply: A review of alternative approaches. In O. Ashenfelter and D. Card (Eds.), Handbook of Labour Economics, Volume 3a. Amsterdam: Elsevier Science BV.
Blundell, R., Macurdy, T., & Meghir, C. (2007b). Labor supply models: Unobserved heterogeneity, nonparticipation and dynamics. Handbook of Econometrics, 6, 4667-4775.
Bradbury, B. (2004). Consumption and the within-household income distribution: Outcomes from an Australian natural experiment. CESifo Economic Studies, 50(3), 501-540.
Braido, L.H.B., Olinto, P, and Perrone, H. (2012). Gender bias in intrahousehold allocation: Evidence from an unintentional experiment. The Review of Economics and Statistics, 94 (2), 552–565.
Breunig, R and McKibbin, R (2012). Income pooling between Australian young adults and their parents. LABOUR Review of Labour Economics and Industrial Relations, 26(2), 235-265.
Budd, J.W. and Mumford, K. (2004). Trade unions and family-friendly policies. Industrial and Labor Relations Review, 57(2), 204-222.
Chetty, R. Guren, A. Manoli, D. and Weber, A. (2011). Are micro and macro labor supply elasticities consistent? A review of the intensive and extensive margins. American Economic Review, 101, 471-475.
Chiuri, M. (1997). The unitary vs collective model of household labour supply with childcare: An empirical test on a sample of Italian households. University of York Discussion Paper No. 97/6.
Chzhen, Y., Mumford, K. and Nicodema, C. (2013). The gender pay gap in the Australian private sector: Is selection relevant across the wage distribution. Economic Record, 89(286), 367-381.
Daly, A. Kawaguchi, A. Meng, X. and Mumford, K. (2006). The gender wage gap in four countries: A rehearsal of the Gregory contribution. Economic Record, 82(257), 165-176
Doepke, M. and Tertilt. M. (2014). Does female empowerment promote economic development? CESifo Discussion Paper 4661.
Donald, S. G. and Hamermesh, D. S. (2009). A structural model of the fixed time costs of market work. Economics Letters, 104(3), 125-28.
Duflo, E. (2003). Grandmothers and granddaughters: Old-age pensions and intrahousehold allocation in South Africa. World Bank Economic Review 17 (1), 1–25.
Duflo, E. and Udry, C. (2004). Intrahousehold resource allocation in Cote d'Ivoire: Social norms, separate accounts and consumption choices. NBER Working Paper 10498.
Duncan, A., Paull, G and Taylor, J. (2001). Price and quality in the UK childcare market. Institute for Fiscal Studies Working Paper WP01/14.
Fisher, P. (2016). British tax credit simplification, the intrahousehold distribution of income and family consumption. Oxford Economic Papers, 68(2), 444-464.
Gershuny, J. (2003). Web use and net nerds: A neo functionalist analysis of the impact of information technology in the home. Social Forces, 82(1), 139-166.

Gong, X., and Breunig, R. (2017). Child care assistance: Are subsidies or tax credits better? Fiscal Studies, 38(1), 7-48.
Gong, X., and van Soest, A. (2002). Family structure and female labor supply in Mexico City. Journal of Human Resources, 37(1), 163-191.
Heckman, J. (1979). Sample selection bias as a specification error. Econometrica, 47 (1), 153-61.
Jericho, G. (2018). Ten years post-GFC we're still working. That's the good news. Guardian, March 12, 2018.
Junankar, P.N. (2016). The impact of the global financial crisis on youth labour markets. Economic and Labour Relations Review, 26(2), 1-27.
Kabatek, J. van Soest, A. and Stancanelli, E. (2014). Income taxation, labour supply and housework: A discrete choice model for French couples. Labour Economics, 27, 20-43.
Keane, M. and Moffitt, R. (1998). A structural model of multiple welfare program participation and labor supply. The International Economic Review, 39(3), 553—589.
Kornstad, T. and Thoresen, T. (2007). A discrete choice model for labor supply and childcare. Journal of Population Economics, 781-803.
Michalopoulos, C., Robins P. and Garfinkel, I. (1992). A structural model of labor supply and childcare demand. Journal of Human Resources, 27(1), 166—203.
Mohommad, A. (2017). Labour market adjustment shocks in Australia. International Monetary Fund Working Paper WP/17/124.
Mumford, K. and Parera-Nicolau, A. (2005). Labour supply and childcare for British mothers in two-parent families: A structural approach. IZA Discussion Paper No. 1908.
Ribar, D. (1995). A structural model of childcare and the labour supply of married women. Journal of Labor Economics, 13, 558-597.
Soest, van A. (1995). Structural models of family labor supply: A discrete choice approach. The Journal of Human Resources, 30(1), 63-88.
Stern, S. (1997). Simulation-based estimation. Journal of Economic Literature, 35, 2006-2039.
Thevenon, O. (2013). Institutional drivers of female labour force participation in the OECD. OECD Social, Employment and Migration Working Papers, No. 145.
Thomas, D. Contreras, D and Frankenberg, E. (1999). Distribution of power within the household and child health. RAND Mimeo.
Ward-Batts, J. (2008). Out of the wallet and into the purse: Using micro data to test income pooling. Journal of Human Resources, 43 (2), 325–351.
Walker, J. (1992). New evidence on the supply of childcare: A statistical portrait of family providers and an analysis of their fees. Journal of Human Resources, 27(1), 40-60.
Wilkins, R. (2009). Updates and revisions to estimates of income tax and government benefits. HILDA Project Technical Paper Series No. 1/09, Feb 2009.

Table 1: Selected summary statistics

	Mother			Father		
Variable	**Obs.**	**Mean**	**Sd**	**Obs.**	**Mean**	**Sd**
Labour experience	3177	11.48	6.14	3177	16.24	7.11
Age	3177	32.55	5.91	3177	35.12	6.88
Years of education	3177	11.86	1.20	3177	11.74	1.34
Higher education	3177	0.35	0.48	3177	0.28	0.45
Higher secondary education	3177	0.23	0.42	3177	0.40	0.49
Lower secondary education	3177	0.24	0.43	3177	0.16	0.37
Aboriginal	3177	0.001	0.03	3177	0.002	0.05
Born in Australia	3177	0.82	0.39	3177	0.80	0.40
Born in a main English speaking country	3177	0.07	0.26	3177	0.10	0.31
Born in other country	3177	0.11	0.36	3177	0.10	0.30
Hours at work	3177	14.19	15.98	3177	42.40	15.26
Hourly wage	1704	29.98	19.97	2975	31.29	17.79
Estimated wage (working parents)	1704	26.05	3.24	2975	28.84	3.68
Estimated wage (all parents)	3177	25.09	3.74	3177	28.66	3.83

	Household characteristics		
	Obs	**Mean**	**SD**
Number of children aged younger than 5	3177	1.35	0.54
Presence of children younger than 3	3177	0.13	0.33
Number of children aged between 5 and 11	3177	0.55	0.79
Using formal childcare	3177	0.37	0.48
Hours of formal childcare per child (all families)	3177	7.90	8.49
Hours of formal childcare per child (if use)	1181	21.90	12.50
Ave price of formal childcare per hour (if use)	1181	5.74	3.39
Uses informal childcare	3177	0.35	0.48
Hours of informal childcare per child (all families)	3177	3.95	8.49
Hours of informal childcare per child (if use)	1121	11.20	11.10
Unemployment rate	3177	4.57	1.06
New South Wales	3177	0.28	0.45
Victoria	3177	0.24	0.43
Queensland	3177	0.23	0.42
South Australia	3177	0.07	0.26
Western Australia	3177	0.11	0.31
Tasmania	3177	0.03	0.17
Northern Territory	3177	0.01	0.10
Australian Capital territory	3177	0.03	0.16
Difficulty finding good quality childcare	3177	2.81	2.44
% of child care sta w/t qual. (state avg.)	3177	57.45	5.60

Table 2: Wage equations

ln(hourly wage)	**Mother**		**Father**	
Years of education	0.050***	(0.004)	0.046***	(0.003)
Experience	0.036***	(0.001)	0.031***	(0.001)
Squared experience	-0.001***	(0.000)	-0.000***	(0.000)
Unemployment rate	-0.025***	(0.004)	-0.026***	(0.005)
New South Wales	-0.037	(0.024)	-0.085***	(0.026)
Victoria	-0.087***	(0.024)	-0.124***	(0.026)
Queensland	-0.150***	(0.023)	-0.156***	(0.025)
South Australia	-0.129***	(0.026)	-0.169***	(0.028)
Western Australia	-0.084***	(0.025)	-0.102***	(0.026)
Tasmania	-0.092***	(0.031)	-0.117***	(0.034)
Northern Territory	-0.054	(0.040)	-0.175***	(0.044)
Australian Capital territory	Reference		Reference	
Aboriginal	0.004	(0.087)	0.131	(0.081)
Born in Australia	Reference		Reference	
Born in a main English speaking country	0.072***	(0.012)	0.061***	(0.013)
Born in other country	0.038***	(0.012)	0.000	(0.013)
Major urban or other urban	0.018*	(0.010)	0.122***	(0.011)
Constant	2.472***	(0.055)	2.536***	(0.049)
Selection equation (employed)				
Years of education	0.237***	(0.007)	0.110***	(0.007)
Experience	0.057***	(0.002)	0.070***	(0.002)
Squared experience	-0.001***	(0.000)	-0.002***	(0.000)
Unemployment	-0.020**	(0.010)	-0.028**	(0.011)
New South Wales	0.009	(0.062)	-0.004	(0.071)
Victoria	0.029	(0.061)	0.033	(0.071)
Queensland	0.128**	(0.060)	0.118*	(0.069)
South Australia	0.016	(0.065)	-0.004	(0.075)
Western Australia	-0.039	(0.062)	0.101	(0.072)
Tasmania	0.096	(0.077)	-0.144*	(0.087)
Northern Territory	0.598***	(0.118)	0.445***	(0.148)
Australian Capital territory	Reference		Reference	
Aboriginal	-0.186	(0.164)	-0.378**	(0.150)
Born in Australia	Reference		Reference	
Born in a main English speaking country	-0.206***	(0.029)	-0.107***	(0.032)
Born in other country	-0.428***	(0.025)	-0.222***	(0.030)
Major urban or other urban	0.148***	(0.022)	0.066***	(0.026)
Presence of children under 3	-0.150**	(0.061)	-0.093	(0.089)
Number of children under 5	-0.364***	(0.018)	0.146***	(0.024)
Number of children 5-11	-0.111***	(0.012)	-0.069***	(0.015)
ln(non-labour income)	0.419***	(0.010)	0.542***	(0.010)
Constant	-7.317***	(0.147)	-6.928***	(0.159)
Mills ratio	-0.235 ***	(0.012)	-0.400 ***	(0.007)
Observations	31197		27223	

* p < .1, ** p < .05, *** p < .01 . Standard errors in parentheses

Table 3: Price of formal childcare

Presence of children under 3	0.316	(0.374)
Number of children under 5	-0.480**	(0.229)
Number of children 5-11	-0.377**	(0.147)
Diff. finding good quality childcare	0.134***	(0.031)
Constant	7.757***	(0.410)
Selection equation (Using formal childcare)		
Disposable non-wage income	0.077***	(0.029)
Mother age	0.109***	(0.034)
Mother age squared	-0.001*	(0.001)
Mother years of education	0.042**	(0.021)
Presence of children under 3	-0.153*	(0.087)
Number of children under 5	0.078	(0.054)
Number of children 5-11	-0.158***	(0.033)
Number of adults in the household	-0.314***	(0.064)
Father working hours	0.006***	(0.002)
To use informal childcare	0.357***	(0.047)
Mother born in Australia	Reference	
Mother born in a main English speaking country	0.087	(0.087)
Mother born in other country	-0.191**	(0.076)
% of childcare sta w/t qual. (state avg.)	0.022***	(0.004)
Constant	-5.159***	(0.708)
Mills ratio	-1.703 ***	(0.232)
Observations	3177	

* p < .1, ** p < .05, *** p < .01 Standard errors in parentheses

Table 4: Observed and simulated averages of selected outcome variables

	Observed	***Mother assumes the child care when child is unattended***	***Both assume the child care (50%) when child is unattended***
Hours of work (Mother)	14.19 (15.98)	14.52 (6.30)	14.52 (6.36)
Hours of work (Father)	42.40 (15.26)	39.45 (4.15)	39.45 (4.63)
Employment Mother (%)	53.64%	53.63%	53.62%
Employment Father (%)	93.64%	93.64%	93.64%
Hours of formal care	10.61 (17.39)	8.12 (2.52)	8.12 (244)
Use of formal care (%)	39.16%	37.80%	37.79%
Employment part-time (Mother)	34.66%	34.67%	34.67%
Employment part-time (Father)	8.15%	8.15%	10.27%

Table 5: Labour supply estimates

	Fixed cost included		**Fixed cost not included**		**MCCR: Parents 50/50**	
$y^{\wedge 2}$	-1.676***	(0.462)	-1.353***	(0.446)	-1.402***	(0.399)
$l_f^{\wedge 2}$	-0.521***	(0.028)	-0.192***	(0.023)	-0.346***	(0.023)
$l_m^{\wedge 2}$	-0.229***	(0.019)	-0.223***	(0.020)	-0.403***	(0.034)
$F^{\wedge 2}$	0.200***	(0.030)	0.215***	(0.031)	0.061**	(0.029)
$y*L_f$	-0.846***	(0.182)	-0.734***	(0.177)	-0.541***	(0.158)
$y*L_m$	-0.584***	(0.169)	-0.506***	(0.165)	-0.501***	(0.150)
y*F	0.356***	(0.109)	0.317***	(0.108)	0.312***	(0.103)
l_f*l_m	-0.158***	(0.034)	-0.174***	(0.038)	-0.109***	(0.031)
l_f*F	0.039	(0.026)	0.055**	(0.027)	0.303***	(0.029)
l_m*F	0.037	(0.029)	0.005	(0.028)	0.021	(0.029)
y	3.924	(3.423)	-0.447	(3.608)	-3.146	(3.066)
y*Father age	0.076	(0.113)	0.135	(0.121)	0.090	(0.118)
y* Father $age^{\wedge 2}$	-0.001	(0.001)	-0.002	(0.002)	-0.002	(0.001)
y* Mother age	0.258**	(0.105)	0.303**	(0.119)	0.287***	(0.106)
y*Mother $age^{\wedge 2}$	-0.002	(0.002)	-0.003	(0.002)	-0.002	(0.002)
y*University father	-0.619***	(0.191)	-0.575***	(0.202)	-0.380**	(0.173)
y*University mother	0.262	(0.167)	0.306*	(0.176)	-0.130	(0.179)
y*Presence of children aged <3	-0.478	(1.394)	-1.097	(1.423)	-0.493	(1.382)
y*Number children aged 0- 4	1.003	(0.859)	0.838	(0.868)	0.877	(0.851)
y*Number children aged 5-11	0.020	(0.413)	-0.292	(0.426)	-0.145	(0.413)
l_f	5.432***	(0.609)	2.466***	(0.599)	-1.788***	(0.519)
l_f*Father age	-0.005	(0.024)	-0.015	(0.025)	-0.005	(0.025)
l_f*Father $age^{\wedge 2}$	0.000	(0.000)	0.001	(0.000)	0.000	(0.000)
l_f*University father	-0.197***	(0.052)	-0.183***	(0.051)	-0.111***	(0.041)
l_f*Presence of children<3	0.030	(0.258)	-0.072	(0.256)	0.003	(0.254)
l_f*Number children 0-4	0.158	(0.160)	0.139	(0.158)	0.115	(0.157)
l_f*Number children 5-11	0.073	(0.077)	0.038	(0.078)	0.022	(0.076)

Table 5: Labour supply estimates, continued.

	Fixed cost included		**Fixed cost not included**		**MCCR: Parents 50/50**	
l_m	2.021***	(0.596)	2.045***	(0.607)	-0.336	(0.551)
l_m*Mother age	-0.042	(0.030)	-0.001	(0.069)	-0.033	(0.032)
l_m*Mother age^2	0.001**	(0.000)	0.001**	(0.000)	0.001*	(0.000)
l_m*University mother	-0.089**	(0.041)	-0.094**	(0.042)	-0.228***	(0.049)
l_m*Presence of children aged<3	0.072	(0.250)	-0.025	(0.252)	0.081	(0.248)
l_m*Number children aged 0-4	0.341**	(0.152)	0.344**	(0.153)	0.336**	(0.151)
l_m*Number children aged 5-11	-0.018	(0.072)	-0.038	(0.073)	-0.048	(0.072)
F	-3.327***	(0.546)	-3.580***	(0.549)	-1.338***	(0.510)
F*Father age	0.032	(0.025)	0.032	(0.025)	0.036	(0.028)
F*Father age^2	-0.000	(0.000)	-0.000	(0.000)	-0.001*	(0.000)
F*Mother age	0.048	(0.034)	0.061*	(0.034)	0.026	(0.030)
F*Mother age^2	-0.001	(0.000)	-0.001	(0.001)	-0.000	(0.000)
F*Presence of children aged<3	-0.178	(0.159)	-0.128	(0.159)	-0.143	(0.160)
F*Number children aged 0-4	-0.196**	(0.097)	-0.200**	(0.097)	-0.040	(0.099)
F*Number children aged 5-11	-0.090*	(0.047)	-0.084*	(0.048)	-0.100**	(0.049)
F*hours informal childcare	0.012***	(0.002)	0.014***	(0.002)	0.002	(0.002)
Fixed cost of working (Father)	-5.131***	(0.269)			-3.493***	(0.234)
Fixed cost of working (Mother)	-0.302***	(0.112)			-1.599***	(0.177)
Observations	114372		114372		114372	
Log likelihood	-8759.67		-8965.16		-8840.49	
Pseudo R2	0.231		0.213		0.223	

* p < .1, ** p < .05, *** p < .01. Standard errors in parentheses

Table 6: Estimated elasticities

	Mother assumes childcare when child is unattended (unitary)		Father exogenous		Both assume childcare (50%) when child is unattended (unitary)	
	(1)	(2)	(3)	(4)	(5)	(6)
Mothers hourly wage increased by 1%						
	Hours	**Participation**	**Hours**	**Participation**	**Hours**	**Participation**
Father working hours	0.03 ** (0.01)	0.01 (0.01)			0.001 (0.01)	-0.01 (0.01)
Mother working hours	1.72 *** (0.18)	1.35 *** (0.14)	1.00 *** (0.20)	0.78 *** (0.16)	1.57*** (0.17)	1.23*** (0.14)
Formal childcare hours	1.13 *** (0.14)	0.93 *** (0.12)	0.68 *** (0.13)	0.56 *** (0.11)	1.04*** (0.13)	0.86*** (0.11)
Fathers hourly wage increased by 1%						
	Hours	**Participation**	**Hours**	**Participation**	**Hours**	**Participation**
Father working hours	0.58 *** (0.06)	0.32 *** (0.04)			0.53*** (0.06)	0.29*** (0.04)
Mother working hours	0.002 (0.07)	-0.02 (0.06)			0.01 (0.07)	-0.01 (0.06)
Formal childcare hours	0.18 ** (0.08)	0.15 ** (0.07)			0.13 (0.08)	0.11 (0.07)
Childcare price increased by 1%						
	Hours	**Participation**	**Hours**	**Participation**	**Hours**	**Participation**
Father working hours	-0.01 *** (0.002)	-0.01 *** (0.001)			-0.01*** (0.002)	-0.003** (0.001)
Mother working hours	-0.20 *** (0.03)	-0.15 *** (0.02)	-0.12 *** (0.02)	-0.08 *** (0.02)	-0.19*** (0.02)	-0.14*** (0.02)
Formal childcare hours	-0.52 *** (0.06)	-0.43 *** (0.05)	-0.33 *** (0.07)	-0.28 *** (0.06)	-0.48*** (0.06)	-0.41*** (0.05)

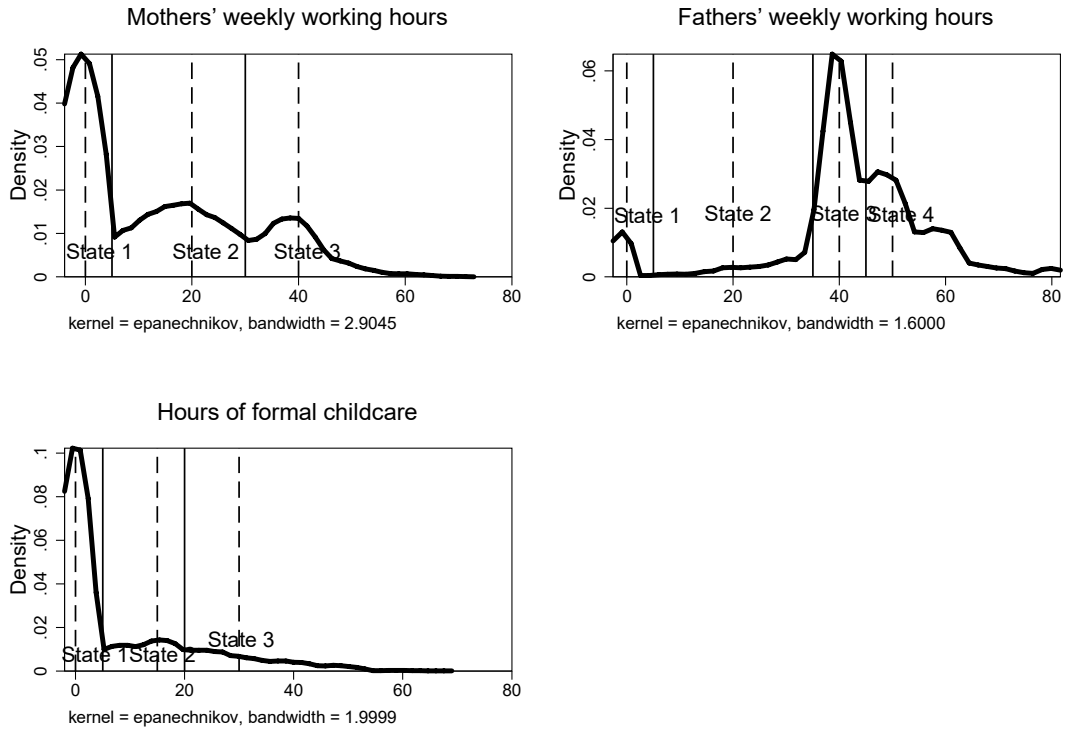
* p < .1, ** p < .05, *** p < .01. Bootstrapped standard errors in parentheses

Table 7. Difference in estimated elasticities

	Mother assumes childcare when child is unattended (unitary) versus Father exogenous		Both assume childcare (50%) when child is unattended (unitary) versus Father exogenous		Mother assumes childcare when child is unattended versus Both assume childcare (50%)	
	(1)	(2)	(3)	(4)	(5)	(6)
Mothers hourly wage increased by 1%						
	Hours	**Participation**	**Hours**	**Participation**	**Hours**	**Participation**
Father working hours					0.028 (0.018)	0.017 (0.011)
Mother working hours	0.719 *** (0.245)	0.572 *** (0.193)	0.566 *** (0.192)	0.453 *** (0.150)	0.153 (0.245)	0.119 (0.193)
Formal childcare hours	0.444 ** (0.179)	0.362 ** (0.149)	0.361 *** (0.126)	0.296 *** (0.105)	0.084 (0.179)	0.067 (0.149)
Fathers hourly wage increased by 1%						
	Hours	**Participation**	**Hours**	**Participation**	**Hours**	**Participation**
Father working hours					0.045 (0.090)	0.036 (0.055)
Mother working hours					-0.006 (0.100)	-0.006 (0.080)
Formal childcare hours					0.042 (0.104)	0.036 (0.088)
Childcare price increased by 1%						
	Hours	**Participation**	**Hours**	**Participation**	**Hours**	**Participation**
Father working hours					-0.004 (0.003)	-0.003 (0.002)
Mother working hours	-0.085 ** (0.033)	-0.064 ** (0.024)	-0.073 *** (0.023)	-0.055 *** (0.017)	-0.012 (0.033)	-0.009 (0.024)
Formal childcare hours	-0.189 ** (0.080)	-0.157 ** (0.068)	-0.155 ** (0.062)	-0.130 ** (0.052)	-0.034 (0.080)	-0.028 (0.068)

* p < .1, ** p < .05, *** p < .01. Bootstrapped standard errors in parentheses

Figure 1: Identifying states.



Appendix Table A1: Variable definitions.

Socio-Demographic Variables	
Age	Age last birthday at June 30th
State	NSW (New South Wales); VIC (Victoria); QLD (Queensland); SA (South Australia); WA (Western Australia); TAS (Tasmania); NT (Northern Territory); ACT (Australian Capital Territory).
Aboriginal	[1] Aboriginal, Torres Strait Islander or Both - [0] Otherwise
Country of birth	
Australia	[1] Born in Australia - [0] Otherwise
English speaking country	[1] Born in a main English speaking country - [0] Otherwise (Main English speaking countries are United Kingdom, New Zealand, Canada, USA, Ireland and South Africa)
Non-English speaking country	[1] Other country different from Australia and Main English speaking countries - [0] Otherwise
Education highest education level achieved	
Higher education	[1] Postgrad - masters or doctorate, Grad diploma, grad certificate, Bachelor or honours) - [0] Otherwise
Higher secondary education	[1] Adv diploma, diploma, Cert III or IV - [0] Otherwise
Lower secondary education	[1] Cert I or II, Cert not de ned, Year 12 - [0] Otherwise
Lower education	[1] Year 11 and below - [0] Otherwise
Years of education	Age left school-5 (Age -5 if they are still at school)
Labour market	
Hourly wage	Ratio between Current weekly gross wages & salary in main job and hours per week usually worked in main job
Working hours	Hours per week usually worked in all jobs
Labour experience	Years in paid work
Unemployment rate	Australian Bureau of Statistics unemployment rate in major statistical region (October of interview year)
Household Composition	
Presence of children under 3	[1] presence of children aged 0-2 - [0] Otherwise
Number of children under 5	Number of children aged 0-4 years
Number of children 5-11	Number of children aged 5-11 years
Number of adults in the household	Number of persons aged 15+ years in the household
Major urban or other urban	[1] Major Urban or Other Urban - [0] Bounded Locality, Rural Balance, Migratory
Non labour income	Household financial year business income +investments + private pensions + private income + Australian public transfers (including family benefits)($)
Disposable income	Household financial year disposable income ($)

Childcare	
Formal childcare	A paid sitter or nanny, Family day care, Long day care centre at workplace, Private or community long day care centre, Kindergarten / preschool
Use of formal childcare	[1] Formal Childcare used for any not yet at school child while parents work and not employment related childcare - [0] Otherwise
Hours of formal childcare	Hours of formal childcare or any not yet at school child while parents work and not employment related childcare - [0] Otherwise
Price of formal childcare	Ratio between Childcare cost ($) for all not yet at school children across formal childcare types while parents work and not employment related childcare and Hours of formal childcare
Informal Childcare	The child's brother or sister, A friend or neighbour coming to our home, A friend or neighbour in their home, Child's grandparent who lives with us, Child's grandparent who lives elsewhere, Other relative who lives with us, Other relative who lives elsewhere
Use of informal childcare	[1] Informal Childcare used for any not yet at school child while parents work and not employment related childcare - [0] Otherwise
Hours of informal childcare	Hours of informal childcare or any not yet at school child while parents work and not employment related childcare - [0] Otherwise
Difficulty finding good quality childcare	Difficulty in last 12 months - finding good quality childcare: 1 [Not a problem at all] - 10 [Very much a problem]
Childcare supply constraint	the difference in the price of formal childcare from the average price in the local area (urban or not urban) and from the average price in the country relative to the average price in the country