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ABSTRACT

This paper analyses the effect of family benefits on childbearing decisions using an intertemporal utility maximising framework, in which the childbirth decisions of households are planned jointly with decisions about life cycle consumption. The model is calibrated using data for Australia drawn, where possible, from the HILDA Wave 7 survey. The simulations suggest that changes in family benefits are likely to have both timing and quantum effects on childbirth but of a small magnitude. This result tends to support findings using alternative empirical approaches. The results also suggest that measures to reduce the time mothers spend out of the workforce while caring for children, such as improvements to child care availability, are likely to be more efficient in boosting fertility than increases in family benefits.

JEL classifications: J1, J2, H2.

Keywords: fertility, family benefits, intertemporal utility.

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1 Introduction

Following forty years of almost continual decrease, Australia's total fertility rate (TFR) increased from 1.73 to 1.97 (ABS 2009) between 2001 and 2008. The increase in fertility coincided with a series of changes to government benefits provided to families with children. These included the popularly named 'baby bonus' in its various forms², an increase in the means tested 'Family Tax Benefits', a tax rebate for child care costs, and 'parenting payments'. These and other forms of direct family assistance provided by the Australian Government accounted for 2 to 3 percent of GDP annually over the decade to 2006 (Lattimore and Pobke, 2008). To the extent that family benefits lower the private costs of children they can be expected to have at least some positive effect on fertility. Indeed a pronatalist effect was one aim of the Baby Bonus when it was first introduced (Costello, 2004; 2006).

However, establishing the magnitude of the effect on fertility of such a reduction in the costs of children has proved to be difficult. The aim here is to investigate this question using a constrained intertemporal utility model, calibrated where possible using data from HILDA Wave 7 survey (see Appendix A) and other sources.

International empirical studies of the effects of tax/transfer systems on fertility consist of two approaches: macroeconometric and microeconometric. The former uses either aggregate time series or panel regressions of fertility on a policy variable (e.g. family benefits) and other macroeconomic variables (Englehart and Prskawetz, 2004; Diprete et al., 2003; Gauthier and Hatzius, 1997; Cigno and Rosati, 1996; Zang et al., 1994; Whittington et al., 1990; Ermisch, 1988). International macroeconometric studies tend to find a small effect

² The 'baby bonus' started as a tax offset for parents of children born after 1.7.01. It was replaced by the 'Maternity Benefit' effective from July 2004, which was a universal flat rate payment to parents of new born children of \$3000 initially, rising to \$4000 for each child born after 1 July 2006, and again to A\$5,000 for each child born after 1 July 2008.

of government policy on total fertility, in the range 1.2 to 2.3 per cent of a typical TFR (of 1.71) for feasible changes in an index of family benefits (Lattimore and Pobke, 2008).

Estimates from two of these international macroeconomic studies were used by Lattimore and Pobke (2008) in order to calculate the effect of family payments on fertility in Australia. Using the parameter estimates in Gauthier and Hatzius (1997) they calculate that the increases in family benefits from 1998-99 to 2006-07 would have raised fertility by 3.7 percent over the period June 1999 to June 2007. Alternatively, using parameter estimates for Britain in Ermisch (1988) they estimate the increase in (completed) fertility would have been 2.5 percent.

A problem with macroeconomic studies is that they do not pick up the effect of policies on the spacing and timing of births. Such ‘tempo’ effects tend to distort aggregate fertility measures such as the total fertility rate (TFR). Indeed part of the increase in Australia’s TFR in recent years is likely to be a tempo effect – a catch-up effect as women aged 30-39 have been giving birth at higher rates having delayed childbirth when they were younger.

Tempo effects are better captured in microeconomic studies which typically start with a constrained household lifecycle utility model, the solution to which results in a number of theoretical determinants of fertility such as the woman’s and man’s income, the monetary and time costs of children, the stock of human capital, preferences for children, the interest rate and the rate of time preference. The standard approach is to adopt these variables as regressors in reduced form regressions with birth likelihood as the dependent variable. For a survey of this large literature see Gustafson (2001) and the more recent but limited surveys in Rees and Scholz (2010) and Lattimore and Pobke (2008). These studies tend to produce somewhat larger effects of family policies on fertility but there is more variability in the results. For Australia, the microeconomic analysis in Drago et al. (2009) finds that the Baby Bonus (up to 2006) had a small but statistically significant and positive effect on fertility intentions. The small effect of the Baby Bonus on fertility is perhaps not surprising given that, according to Lattimore and Pobke (2008), it represents only a one percent (roughly) percent reduction in the lifetime costs for a first child for a typical family.

This paper contributes to the microeconomic literature by running numerical simulations of a household constrained lifetime utility model, calibrated using the HILDA survey and other data. The aim is to determine the optimal birth sequence for a representative household under alternative assumptions about parameters and exogenous variables – the focus here being on family benefits. A feature of the simulation approach, compared with

econometric estimation of reduced form equations, is that it can answer ‘what if’ questions involving parameters and variables that are well outside the range of historical data. There are no existing studies that adopt a simulation approach based on calibration using a consistent set of survey data such as the HILDA data. Perhaps the closest is Rees and Scholz (2010). Although their model is richer than the model here in some respects, their calibration is mostly based on casual “observation” and their focus is on the fertility implications of woman’s life cycle wage patterns rather than family benefits.

2 The model of optimal childbirth sequencing³

Drawing partly on Cigno and Ermisch (1989),⁴ a representative couple derives utility over their working lifetime from their consumption and from the number of children born to them, according to the following joint intertemporal utility function:⁵

$$U = \sum_{i=0}^T \left[\ln(C_i) + \ln \left(\sum_{j=0}^{i \leq T_F} \theta_j N_j + 1 \right) \right] (1 + \rho)^{1-i} \quad (1)$$

subject to the couple’s joint lifetime budget constraint

$$\sum_{i=0}^T \left[\sum_{j=0}^{i \leq T_F} N_j (Q_{i-j} - B_{i-j}) + C_i \right] (1+r)^{a-i} = A_0 + \sum_{i=0}^T Y_i (1+r)^{1-i} \quad (2)$$

and a terminal wealth constraint: $A_T = \bar{A}$.

In (1) and (2), T is the couple’s working lifetime starting from the date of the couple’s union (time 0)⁶ and $T_F (< T)$ is the reproductive span of the couple, again starting from the date of the couple’s union; i is the age of the union (henceforth the couple’s age refers to age of the union); C_i is the adults’ consumption at age i ; N_j is a dichotomous variable (0,1) indicating a birth ($N_j=1$) or no birth ($N_j=0$) at age j , and hence the child is of age $i-j$ when the couple are aged i ; Q_{i-j} is the cost of supporting a child of age $i-j$; B_{i-j} is the family benefits for a child of age $i-j$; A_i is the couple’s stock of financial wealth at the end of age i ; θ_i is an age-specific utility weight on a birth at age i which captures the preference for births over the reproductive

³ Sequencing refers to the number and timing of births following the union of a couple.

⁴ Unlike Cigno and Ermish (1989), in this model: (i) all children are treated equally by their parents (there is no differential ‘quality’ of children); (ii) N as a discrete rather than continuous variable; (iii) the cost of a child varies by age; (iv) the man’s wage is determined differently (see below); (v) T is the working lifetime rather than the total lifetime, and the reproductive lifetime, T_F , is set explicitly; (vi) the functional form for intertemporal preference for children is different (see below).

⁵ Note that the term in the utility function for the utility from children is augmented by 1 to avoid an undefined result for zero number of children.

⁶ The planning period is truncated at the end of the couple’s working life as a simplifying assumption.

span (discussed further below); ρ is the pure rate of time preference; r is the constant interest rate; and Y_i is the couple's joint income at age i .

The preference for births, captured by the parameter θ_i , is an age-specific subjective desire to have a child. It is assumed to follow a standard normal function:

$$\theta_i = \frac{\theta_0}{\sigma\sqrt{2\pi}} \exp\left(\frac{-(i-\bar{i})^2}{2\sigma^2}\right) \quad (3)$$

This specification is chosen to reflect evidence on (i) the typical sequence of childbirth following the union of a couple, and (ii) the reported subjective desire for children by age. Regarding (i), the median number of children born to coupled women who have most recently reached the end of their productive span is 2 children, based on Wave 7 of the HILDA data.⁷ The median time from start of a union to the first of the two births is 3.5 years and the median number of years between births is 3. Hence for this sample a typical sequence would be $\{0, 0, 0, 1, 0, 0, 1, 0, \dots\}$ where 0 and 1 indicate no birth and birth in that year, respectively. This pattern may reflect an inherent desire for children that rises after the union is formed to a peak several years later, then falls. It may also reflect liquidity and/or wealth constraints, caused by either the fixed costs of having a child or the need to accumulate wealth as a precaution against uncertainties of income following childbirth. These constraints may force the couple to delay having children for a few years while they build liquidity and/or wealth. Such constraints are not modelled here explicitly, but can be captured to some extent by the desire for children parameter, θ_i .

Evidence on the subjective desire for children from HILDA is based on a survey question asking 'how much you want to have a child/more children in the future', measured on a Likert scale and reported by age of women.⁸ This is not quite the same as the desire for a child at a particular age, θ_i . Nevertheless it provides proxy information for θ_i . The subjective

⁷ The estimates are derived from the fertility histories of women aged 45-54 (i.e those who have most recently reached the end of the reproductive span) who are currently either married or in a cohabiting/de facto union, had not had a child before their current union and who (if married) had not been married prior to the start of their current union.

⁸ The relevant survey question is: 'Pick a number from 0 to 10 to show how much you want to have a child/more children in the future'. The results vary depending on how many children the women has already had. The most relevant group is women who have had one child as these women have revealed a preference for children and include women who will have the median number of children (=2) in their lifetime. (Women who have had no children include those who have no intention of having children at any age. And women who have had more than one child already and are planning more children are not typical.)

desire for children has a single peak at age 25-29, declining monotonically thereafter. This lends further tentative support for the assumed functional form for θ_i .

The duration of the reproductive span, T_F , is assumed to be 20 years (measured from the date of the couple's union as mentioned). This reflects the assumption that the couple is no longer fertile beyond age 45¹⁸ and that the age at union of the representative couple is 25. The working lifetime, T , of the couple (post-union) is assumed to be 40 years based on a retirement age of 65.

The amount of time, t_{i-j} , that a woman⁹ with a child of age $i-j$ reduces her time in the paid labour force, decreases with the child's age:

$$t_{i-j} = \varepsilon^{i-j-1} \quad 0 < \varepsilon < 1 \quad (4)$$

Hence until the child is age 1, the women withdraws completely from the labour force ($t_{i-j} = 1$). The total time a woman spends with her children¹⁰ is given by $\sum_{j=1}^i N_j t_{i-j}$ and her labour supply is therefore

$$L_{F,i} = m - \sum_{j=1}^i N_j t_{i-j} \quad (5)$$

where m is her maximum annual work capacity (set equal to 1). Therefore $L_{F,i}$ decreases with the number of children and the amount of time required to spend with them which depends on their age.

The woman's wage in year i is given by

$$W_{F,i} = K_{F,i} L_{F,i} \quad (6)$$

where $K_{F,i}$ is her stock of human capital at i . Human capital accumulates with work experience, so that

$$K_{F,i} = K_{F,0} + \beta \sum_{\tau=0}^{i-1} L_{F,\tau} \quad (7)$$

where β is a positive constant. $K_{F,0}$ depends on the woman's natural talent, education and work experience, prior to the couple's union. The woman's income depends crucially on both the number and timing of births because the time required to spend with the child implies less

⁹ We assume that the primary carer is female. Only a very small minority of men take paid or unpaid paternity leave, and the durations of paternity leave taken tend to be much shorter than those of maternity leave (ABS 2006; Whitehouse et al. 2006).

¹⁰ Here we make the simplifying assumption that time spent looking after children increases linearly with the number of children of a particular age.

time in the labour force which reduces both contemporaneous income and human capital accumulation.

The man's wage, W_M , is assumed to be unaffected by the number and time distribution of births. In particular, W_M is assumed to be proportional to the woman's wage at the time of the union and remains constant: $W_{M,i} = \phi W_{F,0}$. Hence total household income, Y_i , is given by

$$Y_i = W_{F,i} + \phi W_{F,0} \quad (8)$$

Intuitively, the decision about the quantum and timing of births is a cost-benefit decision. Children confer direct benefits through their utility value; discounted lifetime utility is higher the greater the number of children and the earlier they are born in the life cycle. However they impose costs, both direct (monetary) costs and indirect costs through reduced labour time which reduces contemporaneous income and also reduces future income through reduced human capital accumulation. These costs are an incentive to have fewer births and to postpone them.

2.1 Calibration and solution method

Households maximise constrained utility by choosing the number and timing of births, N_i , $i=1, \dots, T_F$, and adult consumption, C_i , $i=1, \dots, T$. The solution to (1) and (2) gives the standard equation for optimal intertemporal consumption:

$$C_i = C_{i-1} \left(\frac{1+r}{1+\rho} \right) \quad (9)$$

The optimal birth sequence is found by simulations of household plans for all possible birth sequences.¹¹ The plan that gives the highest utility is the optimal plan and the birth sequence for that plan is the optimal birth sequence. The values chosen for the following parameters: θ_i , ε , β , δ , ϕ , λ , r , ρ are discussed below and are given in Table 1. Where possible they are determined from HILDA Wave 7 data.

The parameters θ_0 , σ and \bar{i} in (3) are chosen such that the optimal birth sequence is the same as the observed median sequence of childbirth according to the HILDA data: $\{0, 0, 0, 1, 0, 0, 1, 0, \dots\}$. The parameter, \bar{i} , determines the age at which the preference for children peaks. The data suggests that this occurs between the third and sixth year from the start of the

¹¹ Given $T=20$ there are $2^{20}=1,048,576$ possible birth sequences and therefore plans. The software is coded in Delphi 5.

union. The parameter θ_0 controls the total number of births over the reproductive span, the median being 2 according to the data. The parameter σ controls the degree to which births are bunched together which reflects how the preference for children changes over the lifecycle. The data suggests that the desire for more children is of similar strength between the ages of 20 and 30, peaking at around age 30, and tailing off very sharply thereafter. The value of σ is chosen such that this pattern is reflected in θ_i . It is further assumed that the preference¹² for a birth at age i is lower if there was a birth in either of the previous two years. This reflects the typical observation of at least a two year gap between the first and second birth. Specifically, if a birth occurs at age i then θ_{i+1} is reduced by 0.75 and θ_{i+2} by 0.5.¹³

The parameter ε determines the reduction in the woman's labour force time following childbirth. It is calculated from the HILDA data on woman's median hours worked per week according to the age of the youngest child.¹⁴ The procedure is to find a value of the parameter ε that would approximately generate the observed data. The resulting value is $\varepsilon=0.8$.

The cost of a child of age $i-j$, $Q_{i,j}$, is based on Percival and Harding (2007). They report figures for a child of a given age that vary depending on the work status of the parents, the level of child care and the number of children in the household. An average of their figures at each age is adopted here, resulting in the cost of the first born child being roughly 20 percent of household income when the child is aged 3 and increasing by 0.4 percent of income for each additional year of age of the child, reaching approximately 25 percent of income by age 14. The age-specific costs of second and subsequent children are assumed here to be 50 percent of the cost of the most recently born child. This is an approximation consistent with the figures reported in Percival and Harding (2007). It implies for example, that given the cost of the first born child at age 3 of 20 percent of household income, when the second child is age 3 the cost of that child is 0.5 of 20 percent (=10 percent) of household income, giving a total cost of the two children (aged 3 and 6) of 30 percent. Once the child reaches the age of 18, the cost of that child is reduced by 50 percent for each year thereafter.

¹² This 'preference' may be due to conception not taking place during the roughly 9 months of a pregnancy, to medical factors, and/or to any change in the inherent desire for a child in the year following a birth.

¹³ That is, that is, $\theta_{i+1|N=1} = 0.25\theta_{i+1|N=0}$ and $\theta_{i+2|N=1} = 0.5\theta_{i+2|N=0}$.

¹⁴ The data are for women aged 16 to 60, using hours worked per week in all jobs and including women not working as zero hours per week. Family sizes of 3 or more have been pooled into a single category because the numbers become too small otherwise.

Hence the cost of a 19 year old child is 50 percent the cost of an 18 year old, and the cost of a 20 year old is 25 percent of the cost of an 18 year old, and so on.

Family benefits per child of age $i-j$ are expressed as a proportion of the costs of a child at age $i-j$. Lattimore and Pobke (2008) calculate the value of Australian Government family benefits to be about one quarter of the full private costs of children. These figures are based on aggregate government benefit payments¹⁵ and aggregate costs of children calculated from age-specific costs using data from AMP & NATSEM (which are consistent with the figures in Percival and Harding, 2007). Based on these figures, $\delta = 0.25$. The Productivity Commission (2008) estimated that changes to family benefits between 1998-99 and 2005-06 increased this cost “subsidy” percentage by 2.3 percent. Increases in family benefits of this magnitude, and much larger, are simulated here.

The parameter β measures the rate at which the woman’s human capital increases with increases in workforce experience. The value of β was determined from Gray and Chapman (2001) who find that a woman with no children increases her annual after-tax earnings by 55 percent over the 10 years from the age of 30 to 40, which implies $\beta=0.055$. This estimate is chosen even though it applies to woman with no children, because the model separately takes account of the effect of children on labour time and therefore on earnings.

The man’s wage is the multiple $\phi=1.07$ of the woman’s wage at the time of the union and remains constant¹⁶ since it is unaffected by childbirth decisions as noted above. This parameter is calculated from median annual gross wages and salaries from all jobs of male partners of childless women aged 25-34 with wages close to the median level for the year 2006-7, determined from HILDA Wave 7 data.

Target financial wealth at the end of the planning period, T , is set equal to five times the household income at the time of the union. This is based on HILDA Wave 7 data for median household financial assets for couples aged 60-69 who have children.

The real interest rate, r , and the rate of time preference, ρ , are both set at 3 percent which implies a constant consumption profile (from (9)). This standard consumption smoothing result is subjected to sensitivity analysis (Appendix B).

¹⁵ Payments are restricted to direct transfer payments to parents and do not therefore include government expenditure on education or other services provided to children.

¹⁶ This implies no productivity growth. Relaxing this assumption tilts the income profile upwards over time but does not affect the sensitivity of income to childbirth decisions.

Table 1. Base case parameter values		
Description	Symbol	Value
Parameter determining time that mother is diverted from labour force to care for child	ε	0.8
Parameters governing desire for children	$\theta_0 ; \sigma$	12.0; 3.0
Rate at which the woman's human capital increases with increases in workforce experience	β	0.055
Family benefits per child as a proportion of the costs of a child	δ	0.25
Initial human capital of the woman	$K_{F,0}$	1.0
Maximum annual work capacity of the woman	m	1.0
Man's wage as a multiple of the woman's wage at time of union	ϕ	1.07
Target financial wealth at end of working life, as a proportion of household income at the time of the union		5.0
Interest rate	r	0.03
Rate of time preference	ρ	0.03
The cost of the first born child at age 3, as proportion of household income at that time		0.2

3 Simulations

The aim of the simulations is to determine the effect of family benefits on the optimal sequence of births. The method is to run simulations for a range of values of the parameter, δ , which represents family benefits as a proportion of the costs of a child. Six alternative values of δ are chosen for simulation, ranging from zero to 2.0, the base case being 0.25. The range zero to 2.0 captures the extremes of no family benefits to family benefits equal to twice the monetary cost of children. These values are well outside historical experience. For example, Lattimore and Pobke (2008) estimate that the changes in family benefits over the period 1988-89 to 2005-6 reduced the net costs of children by only 4 percent. In the model this would imply an increase in δ from 0.25 to 0.28. Those authors also estimate that such a reduction in the cost of children would have increased completed fertility by the order of 0.04 babies per woman. Trial simulations of the model here (but not reported) showed that such a small change in δ , from 0.25 to 0.28, has no change in the discrete number or timing of births for the representative couple. The approach therefore is to choose larger changes in δ in order to ascertain the magnitudes that would be required in order to change the quantum and/or timing of births.

The simulation results are given in Table 2. The birth sequence is given for each year of the 20 year fertile span.

3.1 Direct family benefits

The values of δ of zero, 0.1, 0.25 (baseline) and 0.4 all produce the same birth sequence (see Table 2); there is no effect on fertility in this range. A value of 0.5, which is double the baseline value, increases completed fertility from two to three births and the first two births occur one year earlier than in the base case. A further doubling of family benefits ($\delta=1.0$) brings forward the first birth even more so that it now occurs at the beginning of the second year after the couple's union, compared with the beginning of the fourth year in the base case. However completed fertility remains at three births. An even further doubling of family benefits ($\delta=2.0$) increases completed fertility to four births and each of the first three births are brought forward one year compared with the $\delta=1.0$ case.

The conclusion is that substantial increases in family benefits – much larger than have been contemplated in policy discussions – would be required to alter the fertility patterns of the typical couple. Also, any such changes in fertility patterns tend to consist of a change in both the timing and the quantum of births.

3.2 Indirect family benefits: paid maternity leave and child care.

Family benefits as defined here consist of direct transfer payments conditional only on the birth of a child. However indirect family benefits such as paid maternity leave and the availability of child care opportunities for working mothers also affect the cost of children and therefore could also affect fertility.

Simulations were conducted of the effect of paid maternity leave by assuming that x weeks of pay is offered to the mother immediately following the birth. Three values of x were simulated: $x=18$, 26 and 52 (a full year).¹⁷ For the baseline rate of family benefits ($\delta=0.25$), the timing or quantum of births is unaffected for $x=18$ and 26 (Table 2). However at $x=52$ there is an extra birth and the first two births are brought forward by one year (see Table 2). There is also some indication of an interaction between family benefits and paid maternity

¹⁷ The Australian Government has promised to introduce a scheme in 2011 in which the maternity leave payment is 18 weeks of pay at the federal minimum wage. The Federal Opposition has promised (at February 2009) to offer 26 weeks if elected. A value of $x=52$ is also simulated as an extreme case. In the simulations, the woman's wage at the time of the union is the wage on which the maternity payment is based.

leave at all levels of x . With paid maternity leave at even low levels ($x=18$ and 26), fertility is somewhat more responsive to increases in family benefits above the base level. For example, an increase in δ from 0.25 to 0.4 causes an extra birth and a bringing forward of the first two births. The intuition is simply that at $\delta=0.4$ the additional reduction in the cost of a child from paid maternity leave tips the decision in favour of an additional child and a bringing forward of the first two births. For $x=52$ the same interaction effect occurs at a lower level of family benefits – at the base case level of $\delta=0.25$ (Table 2).

The availability of child care opportunities¹⁸ affects the length of time that mothers spend out of the labour force in order to look after young children. This is simulated by reducing ε , which has positive implications for human capital accumulation and therefore future income. At the same time, however, it is assumed that the cost of taking up child care opportunities implies increases in the private costs of children, $Q_{i,j}$. The improved availability of child care is assumed to reduce ε from 0.8 to 0.4 , which implies a 50 percent reduction in the proportion of time that the mother spends out of the labour force in the year after the first birth; and at the same time the monetary child care costs are assumed to increase by 25 percent.

The effect on fertility is significant (Table 2). Completed fertility increases from two to three and the first two births are each brought forward by two years, given the base case level of direct family benefits ($\delta=0.25$). A similar effect is evident for other values of δ .

The policy implication is that improvements to child care availability and other measures that reduce the time mothers spend out of the workforce while caring for children, are likely to be more efficient in boosting fertility than increases in family benefits. For example, compare two scenarios that yield the same birth sequence: (i) a reduction in ε from 0.8 to 0.4 (coupled with the assumed increases in child care expenses) given the base value of $\delta(=0.25)$; and (ii) an increase in δ from 0.25 to 1.0 given the base value of $\varepsilon(=0.8)$. The fertility outcome in both cases is, compared with the base case, one extra birth and the first two births brought forward one year. Scenario (ii) implies a fourfold increase in direct family benefits (0.25 to 1.0). Such a fourfold increase in direct Australian Government family benefits would be sufficient to meet the full private costs of children and would represent at least 8 percent of GDP (based on Lattimore and Pobke (2008)).

¹⁸ These may include additional places available at child care centres (public or private) and/or family friendly work places, but not direct child care subsidies to families as these would affect the costs of children, Q .

As a guide to the cost of scenario (i) consider the following data at June 2008 (ABS, 2009b). There were 43 percent of children aged 0-12 ‘with usual child care arrangements’, which amounted to nearly 2 million children. The mean private cost (after government subsidies) per annum was \$1612 which amounts to \$3.2 billion for the 2 million children, or 0.4 percent of GDP. Suppose that reducing by half the time that mothers spent out of the workforce (reducing ε from 0.8 to 0.4) led to a doubling of the proportion of children aged 0-12 ‘with usual child care arrangements’. This would imply an additional 0.4 percent of GDP in child care expenditure. This is a lower order of magnitude than the cost of a fourfold increase in family benefits - around 8 percent of GDP – under scenario (ii), yet the effect on fertility is the same.

Hence increases in child care availability are likely to be a much more efficient way of achieving a given increase in fertility than an increase in family benefits. The reason is that reducing time spent out of the labour force boosts not only contemporaneous earnings but also future earnings through the accumulation of human capital, driven in this model by the parameter, β . Higher earnings also have a compounding effect on financial assets through the interest rate.

4 Conclusion

The empirical approach applied here is complimentary to the more common econometric estimating approaches found in the literature. An advantage is that it can address ‘what if’ questions involving parameters and variables that are well outside the range of historical data. However, an important limitation of the model is the assumption of a representative couple household with perfect knowledge of future incomes and child costs. In an attempt to mitigate this limitation, care was taken to calibrate the model so that the preferences, income and costs facing the representative household match those of the typical intact couple household in Australia according to HILDA and other data.

The results here suggest that changes in family benefits can have both timing and quantum effects on fertility. An increase in completed fertility is achieved by bringing forward the first birth and delaying the last birth. This is consistent with increases in age-specific fertility both at the younger and at the older ends of the reproductive age span which have been observed in Australia since 2007 (ABS, 2009a). However, the increase in family benefits would have to be very large – larger than any increase that has been historically observed or indeed proposed - in order to induce a couple to have another child, according to

the empirical results here. The simulations suggest that a more efficient way of achieving a given pronatalist objective is to reduce the time that mothers spend out of the labour force following childbirth by, for example, improving child care availability.

Appendix A. A note on the HILDA data

The main data source is the Household, Income and Labour Dynamics in Australia Survey (HILDA for short). HILDA is a large-scale nationwide, longitudinal survey of the household population of Australia. Wave 1 was conducted in 2001 and subsequent waves on an annual basis. Hence the Wave 7 data, the most recently released at the time of writing, are for 2007. The sample design employed a multi-stage cluster sample of households. Remote areas of the country were not sampled (Wooden and Watson 2007). Data are regularly collected on family formation and background, employment and unemployment history and status, and income. Modules of questions on other special topics have been added to the core content for individual Waves (Watson and Wooden 2002a, 2002b, Wooden and Watson 2007).

The data inputs estimated from this source are: the number of children; the intervals from the couple moving in together to the first birth and from first to second birth by age of female partner; female wages and hours worked for all jobs by age for childless woman and by number of children and age of youngest child for women; the male partner's gross annual income from wages and salaries by age and gross income, and gross income from wages and salaries of female partner; the stock of financial assets by age of female partner; and subjective desire for children by age of female partner and number of children. In all cases the estimates of the input parameters are for intact couple families only. Couples include cohabiting/de facto couples as well as married couples. Most data inputs are determined from Wave 7 data, the most recently released data at the time of writing. However, since the modules on wealth were only collected as part of Waves 2 and Wave 6, the wealth data are based on Wave 6.

Appendix B. Sensitivity analysis

Desire for children (θ_j)

In the base case scenario, $\theta_0=12.0$, $\sigma=3.0$. This combination of parameter values drives the desire for children over the fertile span. But this is only one of many combinations of values of θ_0 and σ that could be found to generate the baseline optimal birth sequence: $\{0,0,0,1,0,0,1,0,\dots\}$. It is important to see whether such alternative combinations of θ_0 and σ yield the same fertility response to variations in family benefits as in the base case values of θ_0 and σ . Two test cases were simulated: (i) $\theta_0=5.0$, $\sigma=2.0$ and (ii) $\theta_0=20.0$, $\sigma=2.5$. In both

cases the degree of sensitivity of the optimal birth sequence to variations in δ turned out to be almost the same as that for the baseline values of θ_0 and σ , such that the qualitative conclusions are not altered.

Return to workforce experience

The base value of β is 0.055. This is reduced by more than half to 0.02 which implies that the woman's wage is approximately 13 percent lower after 10 years and 30 percent lower after 20 years compared with the base case. As expected, the lower opportunity cost of children results in higher fertility, at least for values of δ greater or equal to 0.4 (one extra child is born for $\delta=0.4, 0.5$ and 2.0). This is consistent with the empirical evidence reported in Lattimore and Pobke (2008) that fertility varies inversely with the woman's wage.

Man's wage

The base case value of ϕ is 1.07 based on HILDA data. Alternative values of 1.5 and 2.0 were simulated. The effect is to raise fertility at some levels of family benefits – a standard income effect as noted in the literature (Lattimore and Pobke, 2008) – but the responsiveness of fertility to changes in family benefits is not affected.

Consumption smoothing

The pure consumption smoothing outcome from the optimisation process may be considered unrealistic. Empirical research on life cycle consumption over the past two decades has consistently pure consumption smoothing (Campbell and Mankiw 1989, 1990, 1991; Deaton, 1991, 1999; and for Australia, Smith and Song, 2005). Here sensitivity to this assumption was tested by running a simulation in which the couple household are 'rule-of-thumb' consumers who simply consume a given proportion of their income each year. The parameter values were re-calibrated in order to generate a base case optimal fertility pattern that matches the median observed fertility pattern: $\{0,0,0,1,0,0,1,0,\dots\}$. The responsiveness of the optimal fertility pattern to changes in family benefits turned out to be the virtually the same as in the case where consumption was smoothed. Hence the qualitative conclusions remained intact.

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