Economic Modelling 70 (2018) 383–389

Contents lists available at ScienceDirect

Economic Modelling

journal homepage: www.journals.elsevier.com/economic-modelling

The quality-quantity trade-off among Australian children

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1. Introduction

Over the past decades, the literature has been fairly concentrated on analysing decisions relating to investing in quality of a child versus increasing the quantity of children within a family. Although the underlying theory is sound, the empirical evidence to support such a 'quality-quantity trade-off' is at best ambiguous. Besides, the legitimacy of this theory remains little tested outside of the U.S. and Europe. In this study, we investigate the prevalence of the quality-quantity trade-off in Australia, which not only fills the existing research gap but is particularly relevant in light of the recent policy focus on boosting fertility of Australian women.[1]

The quality-quantity trade-off theory describes the decision for families to have additional children, or increase expenditure on current children to improve child 'quality' (Becker, 1992; Becker and Tomes, 1976; Becker et al., 1960). Improved child quality, typically measured by child outcomes, includes (but is not limited to) improved educational and health outcomes, and additionally leads to higher wages, employability and other labour market outcomes in the longer horizon. Empirically identifying this trade-off suffers from endogeneity concerns as parental decisions on family size and child quality are likely to be made simultaneously (Angrist and Evans, 1998). In addition, investment in child quality may be heterogeneous due to differences in innate ability of children (Angrist et al., 2010). Consequently, we undertake two approaches - use instrumental variables in estimating the causal effect of family size, along with quantile treatment effects to evaluate whether the trade-off between child quality and quantity affects low ability children more.

Empirical evidence on whether an increase in family size adversely affects the cognitive and educational development of children or their adult outcomes is ambivalent (e.g., Frenette, 2011; Angrist et al., 2010; Lee, 2008; C`aceres-Delpiano, 2006; Conley and Glauber, 2006; Black et al., 2005). However, evidence relating to child health outcomes is relatively sparse (Millimet and Wang, 2011; Glick et al., 2007). We examine the impact of family size on both educational and health outcomes, using measures of cognitive development and anthropometric markers. Moving beyond the estimation of average effects, we analyse the impact of additional children across the distribution of these outcome measures, while accounting for the potential endogeneity of family size.

Our findings support the existence of a trade-off between the number of children and their quality as measured by four different cognitive and health outcomes of Australian children. Moreover, the dilution of parental resources is found to affect all children irrespective of their position in the outcome distribution. In light of the Australian government's policy focus on boosting fertility over the last decade, our findings are of particular relevance as the potential adverse impact on quality of children needs to be given due consideration when shaping future policies.

The remaining paper is organised as follows. The empirical model detailing the instrumental variables and quantile treatment effects approach is presented in Section 2. Section 3 briefly reports the data descriptives. Results from the 2SLS and distributional analysis using quantile treatment effects are reported in Section 4. Section 5 concludes with a discussion of the relevance of our findings in the Australian context.

2. Empirical methodology

We provide evidence on the trade-off between quantity and quality of children by using exogenous variation in family size in low and high fertility subsamples based on two instruments. We begin by examining the effect of having two or more siblings to having one sibling on the child's cognitive and health outcomes. We use the *Longitudinal Survey of Australian Children* (LSAC), a survey that commenced in 2004 and follows the progression two cohorts of the study child (henceforth, referred to as "SC") consisting of families with 4–5 year old children (Cohort K) and families with 0–1 year old infants (Cohort B). We use four measures of child quality to capture their cognitive and health development which are likely to be affected by the home environment and parental input. The measures of cognitive development include the Peabody Picture Vocabulary Test (PPVT) and the 'Who am I?' (WAI) test, while the health outcomes are measured by weight-for-height z-scores, and Body Mass

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[1] Over the last decade, the Australian Government has implemented variants of incentives to raise fertility such as maternity tax offsets, family tax benefits, government funded maternity leave and initial cost offsets like the baby bonus incentive scheme.

https://doi.org/10.1016/j.econmod.2017.08.010
Received 11 August 2017; Accepted 13 August 2017
Available online 19 August 2017
0264-9993/

Index (BMI) z-scores.[2] PPVT and WAI are measures of cognitive development among younger children, and can be used in a similar manner to IQ tests or standardised test scores which have been the primarily used for older children and in the quality-quantity trade-off literature. Moreover, by using both tests which are developed to measure different cognitive outcomes, we are able to examine the consistency across outcomes. We rely on weight-for-height for evaluating health outcomes which is considered to be a good indicator of overall health for younger children who are more likely to suffer from nutritional deficiencies. Although it is often preferred to body mass index (see for example, Linnemayr and Alderman, 2011; Onis et al., 2007; Waterlow et al., 1977), we include z-scores for both measures as a robustness check.

A distributional approach allows for a comprehensive examination of the quality-quantity trade-off, beyond average effects which may conceal the impact of family size across the distribution of child outcomes. Furthermore, this approach can help to reconcile the ambivalent results currently observed within the quality-quantity trade-off literature which relies largely on measuring average effects. Although not new to the literature (see Millimet and Wang (2011)), applications of distributional analysis on child outcomes are few and far between. Evaluating the quality-quantity trade-off across the distribution is important particularly due to the potentially heterogeneous impact of family size on child outcomes. The perceived heterogeneity originates from parents choosing to invest more or less in a child given the innate child ability. For instance, consider two children in the family with different ability levels. The child with the high (low) level of ability may be affected in a different manner than the low (high) ability child, when an additional child is added to their family. This occurs due to the dilution of parental investment, specifically the loss of parental time investment, or the loss of physical or monetary investment. On the other hand, parents may choose to compensate for child ability (Winterhalder and Leslie, 2002). Assuming that returns to investment in child quality are concave; if a low ability child is significantly compensated by parents in an attempt to increase their perceived quality, then the marginal effect of reduced child quality may be larger on a child with a high level of ability (expected to be observed by a negative impact at the upper end of the distribution for a high ability child). On the other hand, if resources are reallocated from low ability to high ability children, then the impact of an increase in the number of siblings in the household will negatively impact those children at the low end of the distribution of outcomes. It remains to be seen which impact will be observed. The relationship between child quality (Q_i), and child quantity (T_i) is expressed as:

$$Q_i = \alpha + \gamma T_i + \beta \boldsymbol{X}_i + \varepsilon_i \qquad (1)$$

where Q_i denotes child's test score or health outcome. $\boldsymbol{X}_i$ is a vector of controls including year, age and sex of the SC, along with the age, indigenous status, immigrant status and educational qualification of the study child's parents.[3] T_i is a binary indicator for the SC having at least two siblings versus the SC having one sibling:[4]

$$T_i = \begin{cases} 1 & \text{if SC has two or more siblings} \\ 0 & \text{if SC has one sibling} \end{cases}$$

[2] The Peabody Picture Vocabulary Test (PPVT) is a test for receptive vocabulary which provides an estimate of verbal ability and aptitude of a child. PPVT is conducted in Standardized American English. The 'Who am I?' test is a direct assessment measure that requires children to copy shapes (e.g. circle, triangle, square etc.) and write numbers, letters, words and sentences which is assessed to score a child on a scale of 1 to 100 using Rasch modelling.

[3] Parent's educational qualification is derived from high school completion or highest obtained qualification.

[4] SC being an only child is not considered in our analysis as both instruments require the presence of at least two children in the family, as explained in Section 2.1.

2.1. Instrumental variables (IV)

The two instruments used in this study are derived from previous studies. These are dummies for (a) SC being a part of a multiple birth, and (b) for same sex composition of the two oldest children (e.g., Angrist et al., 2010; Rosenzweig and Wolpin, 1980). A twin/multiple birth causes an exogenous increase in the family size. However, a possible violation of the exclusion restriction using the multiple birth instrument arises if parents allocate resources away from twins towards older singleton-born children due to poorer expected outcomes from twins who have lower average birth weight. Rosenzweig and Zhang (2009) argue that such reallocation would offset any quality-quantity effects making them harder to find using the twin instrument to estimate effects on non-twins. Hence we follow Rosenzweig and Zhang (2009) by looking at the effect of twins on twins themselves, to provide upper bounds for the effect. Angrist and Evans (1998) show that parents with two male, or two female children as the first and second born, are more likely to have a third child due to an inherent preference towards having a gender mix in developed countries.

Although IVs derived from the sibling sex composition do not have the same concern as the twin instrument discussed above, they may positively affect outcomes due to economies of scale in households with same-sex children (Rosenzweig and Wolpin, 2000). Given that our dataset reports the birth order of other children in the family with respect to the SC such that the gender of the two oldest children cannot be ascertained, we need to modify our same-sex composition instrument slightly. Specifically, the gender of the two oldest children are not determinable in cases where the SC is the oldest child with two or more younger siblings who are of mixed gender, or the SC has more than two older siblings who are of mixed gender. We drop the observations for the SC in these cases.

2.2. Quantile treatment effects

In order to analyse the trade-off across the distribution of outcomes of the SC, we utilise recently developed tests of quantile treatment effects (QTE). The QTE estimator uses the classical Quantile Regression estimator by Koenker and Bassett (1978), but allows for heteroscedasticity consistent standard errors (Frölich and Melly, 2010). In the presence of an endogenous treatment (T), and a binary instrument (Z), the treatment effect is consistently estimated at the τ^{th} quantile as in Abadie et al. (2002) by:

$$argmin \sum \rho_\tau \left[\left(Q_i - \alpha_i(\tau) - \beta_i(\tau) \boldsymbol{X}_i - \gamma(\tau) Z_i \right) \right| \right] \qquad (2)$$

where $\rho_\tau = \tau \text{if} Q_i - \alpha_i(\tau) - \beta_i(\tau)\boldsymbol{X}_i - \gamma T_i \leq 0 \text{and} \rho_\tau = (1-\tau) \text{if} Q_i - \alpha_i(\tau) - \beta_i(\tau)\boldsymbol{X}_i - \gamma T_i > 0$. Abadie et al. (2002) identify the following inverse propensity score weighting matrix that allow causal identification:

$$\kappa(T,Z,X) = 1 - \frac{T(1-Z)}{1-\pi_o(X)} - \frac{(1-T)Z}{\pi_o(X)}$$

where $\pi_o(X) = P(Z=1|X)$, and $\kappa = 1$ when $T = Z$. Therefore, the weighted conditional quantile function to be estimated becomes:

$$argmin \sum \kappa \rho_\tau \left(Q_i - \beta_i(\tau) \boldsymbol{X}_i - \gamma(\tau) T_i \right) \qquad (3)$$

3. Data

Within the LSAC, the four outcome measures were not collected in every wave. Specifically, PPVT scores were collected in 2004, 2006, 2008 for Cohort K and 2008, 2010 and 2012 for Cohort B, while WAI scores were collected in 2004 for Cohort K and 2008 for Cohort B. Likewise, BMI z-scores were collected during every wave for each child, but weight-for-height z-score was collected in 2004 for Cohort K and in 2006 and 2008 for Cohort B. Descriptive statistics for SC and parental characteristics can