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The Quality-Quantity Trade-Off in Fertility across Parent Earnings Levels: A Test for Credit Market Failure

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Abstract

The dominant economic theory of the family explains the negative correlation between family size and child achievement, a 'quality-quantity trade-off', through borrowing constraints and credit market failure. This paper presents a model in which the opportunity cost of time spent with children is increasing, thus creating a trade-off even in economies with perfect credit markets. While both producing a family size effect, temporal and financial constraints predict different patterns for the trade-off across levels of parent income. Using data from the National Child Development Study, the trade-off is found even among high-earning families who presumably do not face credit constraints. Moreover, the trade-off does not grow as parent earnings diminish. Both of these findings suggest that temporal and not financial constraints explain the quality-quantity trade-off.

I. Introduction

In their seminal economic contribution to our understanding of the "quality-quantity trade-off" in fertility (the negative relationship between number of siblings and child achievement), Becker and Lewis (1973) and Willis (1973) (hereafter, BLW) emphasize the role of resource limitations. The key feature of the model is a budget constraint in which number of children and per capita child quality interact. This interaction creates positive correlations between quantity of children and the shadow price of quality and between quality of children and the shadow price of fertility.

The BLW model allows for both temporal and financial inputs into child human capital. However, because BLW assume a constant opportunity cost of time invested in children the quality-quantity trade-off does not result from temporal constraints alone.[1] Credit constraints are essential. This emphasis on financial constraints carries through to discussions within the subsequent empirical literature. (See, for instance, Ermisch and Francesconi 2001 and Iacovou 2001.) There is certainly good reason to think carefully about the possible connection between observed family size effects and credit market failure. However, it seems equally wise to distinguish evidence of resource constraints (broadly) from evidence of financial constraints.

In the following section, an extension of the BLW model is presented. The extension allows that either/both financial and temporal limitations cause the quality-quantity trade-off. The section concludes by identifying an empirical test which distinguishes the two resource constraints. If financial constraints explain family size effects, such effects should be absent

[1]Hanushek (1992) discusses parental time resources but does not reconcile this interpretation of family size effects with BLW.

among high-earning families (who are presumably unconstrained) and increase as parental income decreases. Section III describes the National Child Development Study data used in section IV to implement this test. When adult measures of child achievement are used, the results provide weak evidence in support of both financial and temporal constraint interpretations. However, the results based on child achievement are entirely at odds with the financial interpretation and wholly consistent with a temporal constraint. The final section concludes by noting the importance of differentiating financial from temporal resource constraints.

II. An Economic Theory of Fertility and Child Investments

In the standard economic treatment, the quality-quantity trade-off results from the decisions of the household head who maximizes utility U, a function of own consumption c, her children's per capita "quality" q, and fertility level n

$$U = U(c,q,n). \tag{1}$$

Here, as in much of the literature, child quality is equated with child income/consumption, though the results presented are equally valid if quality is interpreted as earnings or human capital. For simplicity, assume child ability is constant within families.[2] The wage earnings of each child W_c are a function of ability A, human capital goods h which cost π per unit, and parent time (or energy) t

$$W_c = At^{\alpha}h^{\beta} \tag{2}$$

[2]Nothing of relevance to this paper is altered if we allow ability variation within a family. See Becker and Barro (1988) for a discussion of how such heterogeneity can be analyzed.

where $0<\alpha, \beta<1$ and $\alpha + \beta \leq 1$. These wage earnings may be supplemented by a parental bequest x which earns interest at rate r, growing to $x(1+r) \equiv xR$ by the time the child reaches adulthood. Assuming parents dislike variation in consumption across children, these bequests will be equal across children. In total, per child quality q (income) is $At^{\alpha}h^{\beta} + xR$.

The family resources available to the household head include parental resources and, perhaps, future child earnings. Parental resources encompass unearned income I and the head's wage income W_p. Parent's earnings diminish as time is diverted from the workplace toward child investment. The total time devoted to the n children is tn resulting in parent wage income

$$W_p = \omega(1 - tn)^{\theta}. \tag{3}$$

where ω is the parent's per-hour wage and $\theta \leq 1$. (The importance of θ will be taken up in detail once the model is complete.) In total, the family budget constraint is

$$c + \pi nh + nx \leq I + \omega(1 - tn)^{\theta} + nAt^{\alpha}h^{\beta} / R. \tag{4}$$

The determination of fertility follows that described in Becker and Barro (1988). For instance, all else equal fewer children are had by high wage parents, though variation within wage classes may result from preference heterogeneity. The focus of this work is how variations in fertility interact with child quality. The trade-off can be seen by examining two margins of child investment. Along the first margin, parents must decide whether to allocate dollars to purchases of human capital or to financial bequests. The first order condition governing this decision equates the return to financial investment with that to human capital purchases:

$$R\pi = \partial W_c / \partial n \equiv \beta At^{\alpha}h^{\beta-1}. \tag{5}$$

It is easy to show from first order condition (5) that the complementarity between parent time and

human capital goods produces a positive relationship between the two inputs.

The second margin concerns the allocation of parent time between work (where time produces a larger child bequest) and human capital production (where time produces higher child earnings). The first order condition which must be satisfied equates the returns to both activities:

$$\theta R \omega (1 - tn)^{\theta - 1} = \alpha A t^{\alpha - 1} h^{\beta}. \tag{6}$$

Solving (5) for human capital purchases *h* as a function of per child investment time *t* and substituting into (6) produces a first order condition for time allocation as a function of fertility and model parameters:

$$\theta R \omega (1 - tn)^{\theta - 1} = \alpha A (\beta A / R\pi)^{\beta/\beta - 1} t^{\alpha + \beta - 1}. \tag{7}$$

The left side of (7) represents the marginal cost of additional time spent on child investment while the right side represents the marginal benefit. Parent investments in child human capital (both goods and time) and ultimate child earnings respond predictably to changes in the economic environment. All three are negatively related to the prices of human capital goods π, parent time ω, and the rate if interest *r* and positively related to returns to human capital investments (α and β).[3]

Equation (7) is the basis for an economic understanding of the quality-quantity trade-off. The traditional interpretation (as presented in BLW) emphasizes the importance of financial resources and assumes that the opportunity cost of time spent with children is independent of

[3]Of course, this statement assumes child ability is held constant. In particular, the model does not predict a negative relationship between parent and child earnings because average ability almost certainly is higher among children of high-wage parents due to intergenerational ability persistence. So long as the relationship between parent and child ability is strong enough, the model predicts a positive intergenerational earnings correlation as well.

fertility (that is, $\theta=1$).[4] Under this assumption, the right-hand side of (7) simplifies to $R\omega$–a constant unrelated to family size n. In the work of BLW, the quality-quantity trade-off follows from a credit constraint which restricts the parent's ability to borrow against future child earnings.[5] The trade-off is derived if we follow Becker and Tomes (1986) by representing the credit constraint as a higher discount rate (or a larger R). The constraint binds more tightly on large family sizes (R increases in n) because children consume parent resources and add nothing in return. As a result, children in large families receive less parent time t, fewer human capital goods h, and ultimately earn less in adulthood than like-ability peers born into smaller families.

But if credit markets do not fail, and one must wonder whether they do in countries like Britain which provide nearly free education through university, then the BLW model has a difficult time explaining the quality-quantity trade-off observed by so many researchers.[6] It may seem at first that the finite nature of parent time would still present an unavoidable resource

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[4]Certainly BLW allow for parental time as an input in child quality, but they do not consider that the cost of this time may vary with fertility. See p. 149 of Becker's (1991) presentation of the BLW model. Becker allows that the price of *per capita* child quality may vary with the *per capita* level of child investment, that is $\pi = \pi(q)$. (He cites policies like public education subsidies–subsidies which are a function of *per capita* rather than *total* investment–as possible sources for these non-linear prices.) But he does not allow for the cost of parent time to rise as the *total* investment in children increases, that is $\pi = \pi(nq)$.

[5]Willis (1973) explicitly rules out any contribution of child earnings to family resources on p. S22. Becker and Lewis (1973) tacitly make the same assumption when they model family resources as a constant–invariant to changes in either fertility or child quality as would be the case if child earnings contributed to family income.

[6]Even if credit markets are not complete in the sense that people can borrow against future earnings for literally any purpose, government policies which facilitate borrowing for educational investments may effectively mitigate the effects of credit constraints on child human capital. Lochner and Monge-Naranjo (2004) shows that this distinction between constraints which limit parental consumption and those which limit child investment may be practically significant in the United States given existing federally subsidized educational loan programs.

constraint that would create a negative relationship between family size and child achievement. After all, parents have but 24 hours in a day. This is the essence of child development models like Zajonc (1976) which posit that child achievement is a function of the "maturity level" in the household. However, economic models of optimal choice suggest that parent time can be "borrowed" to a substantial degree if credit is accessible. In particular, parents may free up their own time from the task of producing income by borrowing against income from the future–even from their children's earnings if credit markets allow. Analytically, if the interest rate r is not a function of family size n and the opportunity cost of time with children is constant ($\theta=1$), then family size does not enter either first order condition (5) or (6). And so in this case investments in children are in no way diminished by the addition of siblings because the prices faced by the household head are independent of family size.

This paper argues for an alternative interpretation of the quality-quantity trade-off emphasizing parent time as an input to child human capital. In particular, it seems likely that the cost of time spent with children tn rises as the total time away from work increases, that is $\theta<1$. Initially, parents are able to divert time from work toward child investment at low cost because they can give up that time or energy which is least productive at work. However, as the total time spent with children increases, parents are forced to make ever more costly choices even to the point of giving up particular jobs or altering occupational choices. The role of time investments in creating a family size effect can be seen by differentiating first order condition (7) with respect to fertility. Since the marginal benefit of per capita time with children is independent of fertility, the marginal cost (the left-hand side of (7)) is all we must consider:

$$\partial MC(t) / \partial n = t(1-\theta)\theta R\omega(1-tn)^{\theta-2} > 0. \qquad (8)$$

As fertility rises, the cost of allotting each child a given amount of time rises. Figure 1 shows this connection between family size and child quality, graphing the equilibrium condition (7) for two families which are identical but for family size. Even though capital markets are complete, children in the large family receive less parent time t which in turn results in lower returns to educational goods h, lower levels of child educational attainment, and lower child earnings W_c. Moreover, the increase in the marginal cost of child time t due to an additional sibling is greater as the parent wage is higher (the vertical shift of MC(t) in Figure 1 is greater for high wage parents). Depending on the elasticities of the marginal cost and benefit of time with children, the quality-quantity trade-off may be positively or negatively related to parent wages.

[Figure 1 goes here]

A comparison of the financial and temporal interpretations of the family size effect suggests an empirical test which can distinguish one from the other. Equation (8) suggests that while having high parent earnings reduces/eliminates financial constraints, it does not relax the temporal constraint and may even intensify it. If the trade-off is caused by credit market failure, then no trade-off should be found in children born to very high earning parents. As we look down the parent earnings distribution, the quality-quantity trade-off should emerge.[7] By contrast,

[7]This test for credit constraints mirrors the conjecture in Becker and Tomes (1986) that credit constraints will produce greater intergenerational earnings persistence at lower levels of parent earnings. In the context of intergenerational mobility, Corak and Heisz (1999), Grawe (2004a), and Han and Mulligan (2001) note that earnings are not likely monotonically related to credit constraint susceptibility because child ability (and so education expenditure) is likely correlated with parent earnings. Grawe further argues it is impossible to test for credit constraints based on non-linearities in intergenerational mobility because theory predicts a positive intergenerational earnings correlation even absent credit constraints. This critique does not apply to the test proposed here, however because no quality-quantity trade-off is predicted by the BLW model when credit is available.

a trade-off produced by the scarcity of parent time will be found at all parent earnings levels and may even be more pronounced among high earning parents. If both constraints are present, then a trade-off will be found in children of high-earning parents (due to temporal constraints), but this family size effect will be smaller than that found in low- or middle-earning families (due to financial constraints).[8]

III. The Data

The data used to distinguish the financial and temporal explanations for the family size effect are drawn from the National Child Development Study (NCDS). A panel survey which follows all children born in Britain during the first full week of March 1958, the NCDS includes measures of childhood achievement at ages seven, 11, and 16 as well as adult earnings observations at ages 33 and 41. Because several childhood achievement measures are available at each age, factor analysis is employed to create achievement indices for ages seven, 11, and 16. I calculate the indices for boys and girls separately to allow for differences in achievement patterns by sex. The age-seven index combines observations of earlier achievements in the areas of speech, physical coordination, and toilet training problems in addition to contemporaneous measures of math and reading test scores, a doctor's determination of emotional maladjustment, and the total Bristol Social-Adjustment Guide (BSAG) score (a standardized test score which estimates the number of social syndromes for which an individual is susceptible). At age 11 the index incorporates contemporaneous math and reading test scores as well as a general ability

[8]Clearly the impact and importance of credit constraints can be tested in many contexts other than the quality-quantity trade-off. For instance, Cameron and Heckman (1998) and Mulligan (1997, 1999) study credit constraints through the lenses of educational choice and intergenerational mobility respectively.

standardized test score and a second observation of the total BSAG score. Finally, the age-16 index combines contemporaneous math and reading test scores.[9]

Family size represents the total number of siblings at the time achievement is measured. Because some siblings were born after the subjects reached age seven or 11, family size may be higher in later observations. Both theory and empirical work indicate that birth spacing affects the magnitude of the family size effect. The NCDS does not have enough information to create a very good measure of the number of children close in age to the study subject. Responses to questions such as "How many children under 21 reside in the household?" asked in several waves can be used to group sibling births into relatively broad time periods. Specifically, if one assumes that mothers with children born after 1965 did not also have children before 1949, then it is possible to infer how many siblings were born within the seven years after and the four years prior to the birth of the NCDS subject child. When the analysis was repeated counting only siblings within this 11-year span, the results remained substantively unaltered.[10]

The measurement of parental income in the NCDS presents three challenges. First,

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[9]The regressions below were repeated for each of the underlying measures of achievement. The results generally conformed to those based on the achievement indices. Not surprisingly, however, regressions based on only one component of achievement produced larger standard errors making it harder to distinguish between competing hypotheses. Results of these regressions are available from the author. (The only cases which showed a weaker family size effect among high-earning families were physical coordination and toilet training among girls.)

[10]The only notable change was found in the results for boys at age 16. In this one case, while the results based on total family size match the hypothesis of limited parental time, "near" siblings results are somewhat consistent with credit constraints; family size is insignificant for boys from high-income families, but significant for boys from middle- and low-income families. Directly testing the equality of the family size effect in high-income families with that of middle- and low-income families shows no statistical difference, however, contrary to the credit market explanation.

parental income is reported in only one year–the 1974 (wave 3) survey. Moreover, earnings of mother, earnings of father, and income from other sources are reported separately and only in broad brackets. As a result, it is not possible to create a credible measure of total family income. Given the available variables, father's earnings is used to represent family income. The final oddity of the NCDS stems from the fact that nearly half of the observations took place during the coal workers job action of 1973-74. Micklewright (1986) reports that within the NCDS administrators there was concern that a significant number of these earnings reports may reflect the irregularities of the three-day week energy policy which followed. Fortunately, Grawe (2004b) provides evidence supporting the reliability of the data. The reported earnings brackets are merged into four annual earnings groups: (≤£1260, £1272-£1740, £1752-£2280,≥£2292). These groups include 15, 41, 25, and 19 per cent of the sample respectively.[11] Dummies for these income groups and their interactions with family size are included in the regressions.

The regressions also include several control variables. A measure of the years of mother's education captures much of the spurious family size effect which results when women with meager market prospects choose to have more children who, due to intergenerational transmission of market ability, tend to attain lower levels of achievement. This control is complemented by a father's years of education (assuming assortative matching in the marriage market predicted by Becker 1973 and empirically confirmed in Lam and Schoeni 1993 and 1994). The possible confounding effects of birth order raised by Kessler (1991) among others are addressed with dummies indicating first- and last-born status. A dummy variable captures

[11]It is possible to divide each of the two middle brackets in half to create six brackets with roughly 15 to 20 percent of the sample in each. This alternative division does not meaningfully alter results.

the effect of the subject being a twin or triplet. Finally, to eliminate effects of lone-parent families, the sample is restricted to only those families with both biological parents in the household in waves one, two, and three of the NCDS.[12] Table 1 displays summary statistics for all variables by sex.[13]

[Table 1 goes here]

IV: Testing for Family Size-Earnings Interactions

Tables 2 and 3 present resulting estimates of the family size effect across levels of father earnings. In both tables, column one reports the family size effect in each of the four brackets of father's earnings. The second column reports the difference between the family size effect in a given earnings bracket and that in the highest bracket (families in which the father earned $\geq$£2292). If credit constraints explain the quantity-quality trade-off, then we expect to see two patterns. First, because those from high-earning families are not likely credit constrained (especially in a country like Britain with extensive public education subsidies) we expect no family size effect in the highest earnings bracket. By contrast, if temporal constraints create the trade-off then we expect a trade-off in all families. Of course, it is possible that both constraints are relevant. In this case, credit constraints manifest themselves as stronger family size effects among middle- and low-earning families.

The magnitude of the quality-quantity trade-off observed in adult earnings is comparable to those reported in previous studies. (See Table 2.) When the family size effect is estimated

[12]This restriction on family structure reduces the sample size by just under 15 percent and does not substantively alter any results.

[13]The table reports statistics only for those with data on family size, birth order, multiple birth status, mother education, father education, and father earnings.

without regard to father's earnings sons lose between two and three percent of earnings for each additional sibling. The earnings loss for women is between three and four percent. Looking across father-earnings brackets, family size effects on adult earnings provide weak evidence of credit constraints. The pattern found in age-33 male earnings matches the predicted pattern: no effect is found in high-earning families while the effect among lower-middle earning households is negative and statistically more negative than that in high-earning households. Earnings of women at age 33 also show no significant effect among high-earning families (though the point estimate is quite large) and a significant effect among those in low- and upper-middle earning households. However, the test for difference across earnings brackets finds these differences to be insignificant.

[Table 2 goes here]

At age 41, male earnings continue to show no sibling effect in high-earning families and a negative effect in lower-middle earning households. However, the difference between these estimated coefficients is not statistically significant. Entirely contrary to the credit constraint hypothesis, women from high-earning homes show a very large family size effect and middle-earning families exhibit significantly smaller effects. In total, family size effects in high-earnings families are statistically insignificant in three of four cases, but the differences between earnings brackets are not generally significant and are sometimes positive.

The evidence from childhood achievement presented in Table 3, however, lends no support to the financial constraint and is entirely consistent with the temporal constraint. In both sexes and at every age, strong family size effects are observed among the highest-earning families. The addition of a sibling results in a 0.10- to 0.20-standard deviation reduction in

performance. (The magnitude of this effect is comparable to that when both parents acquire one additional year of education.) Moreover, in both sexes and at every age, the family size effect is independent of father earnings. In fact, the point estimates are twice as likely to indicate a larger quality-quantity trade-off among high-earning families than lower-earners. In sum, these results are difficult to explain by means of a financial constraint and are perfectly consistent with limitations of parental time.

[Table 3 goes here]

V. Conclusions

The model presented in this paper extends the work of Becker and Lewis (1973) and Willis (1973) to allow for family size effects created by limits on parent time even when credit markets are well-functioning. Using National Child Development Study data, the paper then tests for financial and temporal constraints by examining the pattern of family size effects across father earnings groups. The credit constraint interpretation predicts no quality-quantity trade-off among high-earning (presumably unconstrained) families. By contrast, the temporal constraint interpretation predicts a trade-off at all earnings levels. Moreover, the financial constraints interpretation predicts a family size effect which grows as parent earnings diminish whereas temporal constraints may actually create greater trade-offs in high-earning families.

When child achievement is measured by adult earnings, the results provide weak evidence of credit market failure. No family size effect is observed among high-earning families (consistent with a credit constraint), but no pattern is identified across family earnings levels (consistent with a temporal constraint). However, when childhood achievements are considered, the evidence is entirely opposed to the financial constraint interpretation and completely

consistent with temporal constraints: strong family size effects are observed among the highest-earning families and these effects are statistically independent of family earnings level. Point estimates often indicate a larger trade-off in high-earning families. In total, these results are consistent with Grawe (2005) which reports similar results in data drawn from the American Panel Study of Income Dynamics Data.[14]

These results suggest that it is the limits of parent time, not parent financing, that limits the achievement of children. Distinguishing between these alternative resource constraints is important to several current policy questions. If credit market failure explains the family size effect, then both efficiency and equity concerns justify expanded public provision and subsidization of education. Recent increases in university tuition would clearly be questionable policy. However, if the relevant constraint is temporal and not financial, then expanded subsidies will only result in greater inefficiency in education choice and expanded economic inequality.[15] It is difficult to devise an effective policy response to temporal limitations. Expansions of day care programs appear tempting at first glance. However, the model suggests that because such services can be purchased, they properly fall in the class of 'financial resources'. In other words,

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[14]Grawe (2005) also finds strong family size effects among children who receive large financial bequests–children whose educational choices were presumably not limited by financial constraints.

[15]The claim that, absent credit market failure, education subsidies increase economic inequality rests on the assumption that those with the highest levels of education also experience the greatest returns to human capital investment. This potentially regressive impact of education subsidies has been widely discussed beginning with the work of Hansen and Wiesbrod (1969). It is also consistent with recent work by Björklund et al. (2005) who study the earnings of adopted children. They find a positive interaction between the earnings of biological and legal parents and conclude that this is evidence of a positive relationship between returns to human capital and innate market ability.

the results point to a unique role for parent time. As such, the quality-quantity trade-off is an inevitable consequence of the household production technology and not a signal of any missing market.

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Figure 1
Choosing time spent on child investment given family size

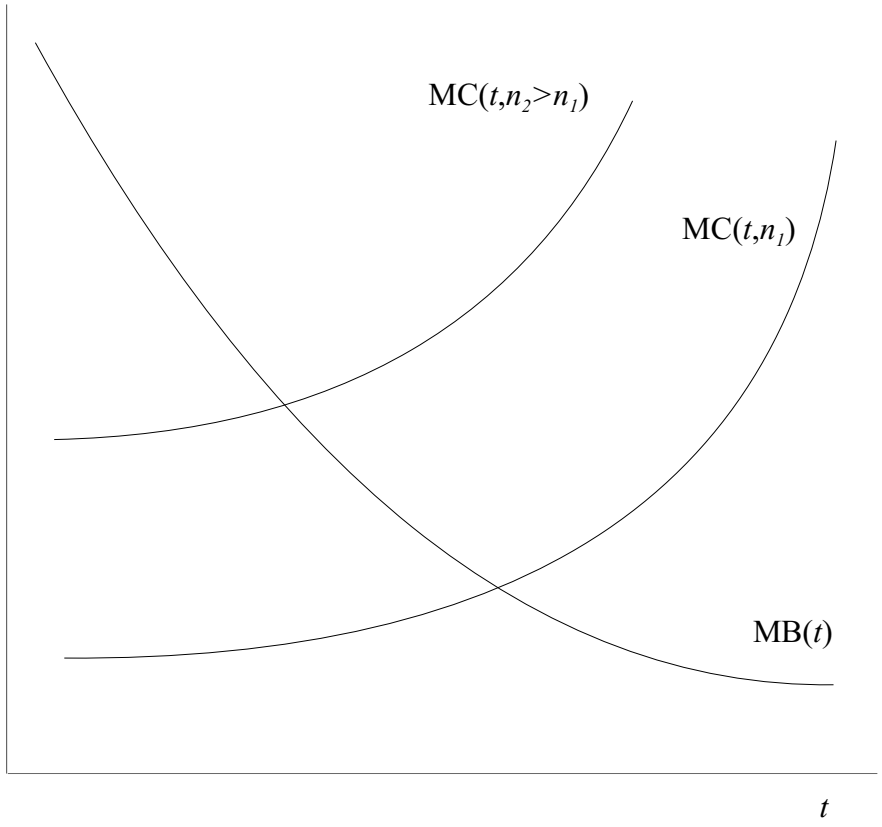

Table 1
Summary statistics

	Male children		Female children	
Variable	mean (variance)	min/max	mean (variance)	min/max
Log earnings (age-31)	9.39 (0.43)	6.69/12.47	8.56 (0.78)	5.82/11.53
Log earnings (age-41)	9.72 (0.66)	6.42/15.17	8.94 (0.81)	2.56/13.68
Achievement score (age 7)	0.02 (0.80)	-2.99/1.30	0.02 (0.79)	-3.71/1.19
Achievement score (age 11)	0.03 (0.93)	-2.52/2.27	0.03 (0.93)	-2.60/2.25
Achievement score (age 16)	0.02 (0.81)	-2.60/1.60	0.01 (0.80)	-2.60/1.68
Family size (number of siblings+1, age 16)	3.31 (1.65)	1/13	3.31 (1.67)	1/15
First born (1 if first born)	0.44 (0.50)	0/1	0.43 (0.49)	0/1
Last born (1 if last born)	0.25 (0.43)	0/1	0.27 (0.44)	0/1
Multiple birth (1 if a multiple)	0.18 (0.13)	0/1	0.02 (0.15)	0/1
Mother's education (years)	9.98 (1.64)	5/19	10.06 (1.72)	5/19
Father's education (years)	9.98 (2.02)	5/19	10.01 (2.04)	5/19

Table 2
The effect of family size on adult achievement, by father earnings bracket

Achievement measure	Level of father's earnings	Family size effect (1)	Difference from high-earnings family size effect (2)	Sample size (3)
Age-33 log earnings				
Men	≤£1260	-0.004 (0.26)	0.001 (0.05)	
	£1272-£1740	-0.044 (3.81)***	-0.039 (1.82)*	
	£1752-£2280	-0.022 (1.46)	-0.017 (0.73)	
	≥£2292	-0.005 (0.24)	-	1658
Women	≤£1260	-0.074 (2.02)**	-0.021 (0.45)	
	£1272-£1740	-0.014 (0.70)	0.040 (1.12)	
	£1752-£2280	-0.099 (3.24)***	-0.045 (1.09)	
	≥£2292	-0.053 (1.62)	-	1350
Age-41 log earnings				
Men	≤£1260	-0.012 (0.54)	-0.000 (0.00)	
	£1272-£1740	-0.044 (2.45)**	-0.032 (0.98)	
	£1752-£2280	-0.030 (1.28)	-0.018 (0.51)	
	≥£2292	-0.012 (0.40)	-	1664
Women	≤£1260	-0.037 (1.30)	0.061 (1.52)	
	£1272-£1740	-0.003 (0.16)	0.096 (2.70)***	
	£1752-£2280	0.002 (0.05)	0.101 (2.45)**	
	≥£2292	-0.099 (3.09)***	-	1669

*Note: Absolute t-statistics in parentheses. Control variables include mother's and father's years of education, first- and last-born dummies, multiple birth dummy, and dummies for father's earnings bracket. *, **, and *** note statistical significance at 10%, 5%, and 1% levels respectively*

Table 3
The effect of family size on childhood achievement, by father earnings bracket

Achievement measure	Level of father's earnings	Family size effect (1)	Difference from high-earnings family size effect (2)	Sample size (3)
Age-7 achievement				
Boys	≤£1260	-0.073 (3.63)***	0.018 (0.55)	
	£1272-£1740	-0.088 (5.32)***	0.003 (0.09)	
	£1752-£2280	-0.051 (2.10)**	0.040 (1.14)	
	≥£2292	-0.091 (3.18)***	-	2944
Grls	≤£1260	-0.123 (5.53)	-0.010 (0.31)	
	£1272-£1740	-0.110 (6.44)	0.003 (0.12)	
	£1752-£2280	-0.143 (6.36)	-0.030 (0.94)	
	≥£2292	-0.113 (4.32)***	-	2828
Age-11 achievement				
Boys	≤£1260	-0.111 (5.10)***	-0.002 (0.05)	
	£1272-£1740	-0.098 (5.59)***	0.012 (0.38)	
	£1752-£2280	-0.109 (4.48)***	0.001 (0.03)	
	≥£2292	-0.110 (3.78)***	-	2870
Girls	≤£1260	-0.161 (6.81)***	0.021 (0.63)	
	£1272-£1740	-0.143 (8.27)***	0.039 (1.34)	
	£1752-£2280	-0.166 (7.18)***	0.017 (0.51)	
	≥£2292	-0.182 (6.82)***	-	2764

Note: Absolute t-statistics in parentheses. Control variables include mother's and father's years of education, first- and last-born dummies, multiple birth dummy, and dummies for father's earnings bracket.
, **, and * note statistical significance at 10%, 5%, and 1% levels respectively*

Table 3 (cont.)
The effect of family size on child achievement, by father earnings bracket

Achievement measure	Level of father's earnings	Family size effect (1)	Difference from high-earnings family size effect (2)	Sample size (3)
Age-16 achievement				
Boys	≤£1260	-0.095 (5.09)***	0.001 (0.04)	
	£1272-£1740	-0.108 (6.97)***	-0.011 (0.38)	
	£1752-£2280	-0.102 (4.94)***	-0.005 (0.16)	
	≥£2292	-0.097 (3.61)***	-	2588
Girls	≤£1260	-0.168 (8.00)***	-0.017 (0.59)	
	£1272-£1740	-0.120 (8.04)***	0.030 (1.22)	
	£1752-£2280	-0.126 (6.20)***	0.025 (0.89)	
	≥£2292	-0.151 (6.76)***	-	2496

Note: Absolute t-statistics in parentheses. Control variables include mother's and father's years of education, first- and last-born dummies, multiple birth dummy, and dummies for father's earnings bracket.

, **, and * note statistical significance at 10%, 5%, and 1% levels respectively.*