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Birth weight and schooling and earnings: estimates from a sample of twins

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Abstract

Based on analysis of a sample of twins, this study suggests that birth weight is not related to levels of schooling, that it plays only a minor role in the determination of earnings, and that ability differences that are not removed in the within-twins model of earnings are not biasing the results in twins studies such as Ashenfelter and Krueger [Ashenfelter, O., Krueger, A., 1994. Estimates of the economic return to schooling from a new sample of twins, American Economic Review, 84(5) pp. 1157–1173].

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1. Introduction

Earnings are influenced by a wide range of factors, though the main ones of interest appear to be ability, environment, schooling and experience. Various approaches have been taken to assess the roles these play and one that has stimulated considerable interest in the recent literature uses samples of twins.

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Ashenfelter and Krueger's (1994) study of the increments in earnings associated with extra schooling for identical twins in the US labour market led them to conclude that family and genetic effects make virtually no contribution to the returns to schooling. Their research has been replicated for the US (Ashenfelter and Rouse, 1998; Rouse, 1999) and other countries (see Miller et al., 1995 for study of Australia and Isacsson, 1999 for study of Sweden).

The approach taken in these studies has been questioned by several authors. One important line of criticism suggests that Ashenfelter and Krueger's (1994) findings may be adversely affected by ability differences between identical twins that are not removed in the fixed effects model and which are correlated with twin differences in years of schooling (Neumark, 1999; Bound and Solon, 1999). Moreover, any ability differences between identical twins that remain in the fixed effects model are shown by Neumark (1999) to be associated with greater biases in Ashenfelter and Krueger's (1994) within-twins IV model than in the standard within-twins estimator.

This has led to search for measures of the ability differences between identical twins that remain in the fixed effects model. Two possibilities that have been considered are birth weight (Neumark, 1999) and birth order (Ashenfelter and Rouse, 1998).

This paper presents further analyses of the links between birth weight and schooling and earnings using a sample of Australian identical twins. It is structured as follows. Section 2 outlines the data. Section 3 presents statistical analyses of the links between birth weight differences within twin pairs and differences in schooling and earnings outcomes. Section 4 contains a summary and conclusion.

2. The Australian twins survey

The sample of twins analysed in this study are identical twins in the young adult cohort of the Australian Twin Register. They constitute a volunteer twin panel born between 1964 and 1971. Nearly all were first registered with the panel between 1980 and 1982 by their parents. As with the data analysed by Ashenfelter and Krueger (1994), Miller et al. (1995) and Ashenfelter and Rouse (1998), each twin provided reports on both their own level of education and on that of their co-twin. This permits application of the IV estimators proposed by Ashenfelter and Krueger (1994). Moreover, for about one-half of the sample, there is information on birth weight. Again, each twin reported on both their own birth weight and on that of their co-twin.[1] Further details are presented in Le et al. (in press) and Miller et al. (2004).

The identical twins included in the study range in age from 23 to 36 years. The mean age is 30 years. On average the twins have almost 14 years of schooling. The sample is reasonably evenly balanced between males and females, and also between twins who are married and those who are not married. Around 80% of the twins were employed on a full-time basis.[2]

Birth weight is measured in ounces in this analysis: in comparison, in studies such as Conley and Bennett (2000) and Boardman et al. (2002) the emphasis is on binary indicators of very small birth

[1] While there is information on birth weight for about one-half of the sample, imposing the requirement that there must be valid birth weight data for both members of a set of twins reduces the usable sample to around one-third of the larger sample used in analyses of these data by Miller et al. (2004).

[2] To omit part-time workers would require omitting sets of twins where either member was employed on a part-time basis. Fully 30% of the sample would be lost if such a sample selection criterion were applied.

Table 1
Correlation coefficients between selected variables: identical twins from the Australian twins survey

Variable	Variable					
	BW_1^1	BW_2^2	$EDUC_1^1$	$EDUC_2^2$	Income 1	Income 2
BW_1^1	1.000					
BW_2^2	0.753	1.000				
$EDUC_1^1$	−0.008	−0.052	1.000			
$EDUC_2^2$	−0.085	−0.094	0.613	1.000		
Income 1	0.001	−0.028	0.346	0.284	1.000	
Income 2	0.040	0.099	0.247	0.281	0.439	1.000

BW_1^1=twin 1's report on own birth weight, BW_2^2=twin 2's report on own birth weight, $EDUC_1^1$=twin 1's report on own educational attainment, $EDUC_2^2$=twin 2's report on own educational attainment, Income 1=twin 1's income, Income 2= twin 2's income.
Sample size=278 twin pairs.

weight.[3] The average birth weight of the identical twins is 87 oz. However, the members of specific sets of identical twins differ appreciably in this regard; with about 63% of pairs having birth weight differences in excess of 4 oz. and about 46% of pairs having birth weight differences in excess of 8 oz. There is agreement among twins on the weight at birth (that is, one twin's self-reported birth weight matches the co-twin's report on the first twin's birth weight) in approximately 70% of cases.

Table 1 lists a number of correlations that have a focus on birth weight. These are for the twins reports on their own birth weight, and between birth weight and educational attainment and income. These show a correlation of 0.753 between the birth weights of identical twins. The correlation coefficients between birth weight and educational attainment, and between birth weight and income, are all close to zero, and none is in fact significantly different from zero. While birth weight may affect early childhood development, this first review of the evidence suggests that the links between this attribute and both completed education level and adult incomes are very weak.

3. Statistical analyses

Birth weight is an endowment that may be linked to schooling and earnings outcomes. It has been used by Behrman et al. (1994) as an instrument for schooling differences in a within-twins analysis of wages. They report that an increase in birth weight by fours ounces increases schooling by almost one-half a year, but "the use of birth weight as an instrument does not change the first two significant digits of the estimated effects of own schooling on earnings. . ." (Behrman et al., 1994, p. 1162). These authors, however, were not able to explore whether birth weight has a direct impact on wages.[4] In a similar vein, Ashenfelter and Rouse (1998) note that the first born twin is often the heavier and this may reflect pre-birth environmental influences in the womb. They therefore examine the relationship between birth order

[3] These "standard" indicators of low birth weight, based on a benchmark of 5 lb. 8 oz., are not directly applicable to samples of twins.

[4] As the reports on the educational attainment of their co-twin by each twin can be used in the current analysis as an instrument for own educational attainment, there is scope to more fully examine the role of birth weight on earnings within a fixed effects model where measurement errors in the schooling variables are taken into account using an IV estimator. Based on the information obtained from the reports of co-twins, the reliability ratio for the birth weight variables is as high as 0.97.

and both education and earnings outcomes as a way of informing on whether within-twin ability differences that are not removed in the fixed effects model could be biasing their results. Each relationship examined was statistically insignificant, leading Ashenfelter and Rouse (1998) to conclude "These results show little evidence that ability differences are influencing our findings".

In the first instance in the current study, the relationship between level of education and birth weight was examined. This was done within the context of a fixed effects model of education level. However, there were no significant relationships between differences in birth weight within a twin pair and the difference in their levels of education, and these results are not reported here. There appears to be only limited evidence on this matter other than the work of Behrman et al. (1994) and Ashenfelter and Rouse (1998) noted above. Conley and Bennett (2000) find that low birth weight reduces the chances of completing high school "on time" (defined as by age 19) in the US, but do not comment on whether there is an impact on high school graduation rates that do not have this age restriction. Strauss (2000), however, reports that very low birth weight was not associated with educational attainment among young adults in the UK. Similarly, while not focussing on education level, Boardman et al. (2002) have shown that the effect of low birth weight on children's academic test scores is modest, out-weighed by the net effect of maternal education, and diminishes with age. Against this background, the results on the links between education level among young adults and birth weight found with the current sample of young twins are not unusual, and are consistent with the evidence reported by Ashenfelter and Rouse (1998). This may be a reflection of compensatory behaviour by parents.

Table 2 contains estimates of the models of earnings determination for identical twins. The left-hand section of this table presents results from fixed effects models that are distinguished by the exclusion of birth weight. In the OLS estimates, the return to schooling is 1.6%. This is an estimate of the impact of schooling on earnings that is free of biases typically associated with the absence of measures of ability and family background. This estimate is reasonably similar to those reported for the full sample of identical twins (see Miller et al., 2004)[5] and is much lower than estimates of this return, of 7–8%, obtained from samples of individuals in Australia. It is also much lower than the cross-sectional estimate of the return to schooling, of 6%, obtained with these data (see Miller et al., 2004).

Errors of measurement have the potential to constitute a greater problem in the fixed-effects estimator than with the estimators applied to samples of individuals because the measurement error contributes relatively more to the within-family variance of schooling than to the overall variance of schooling. When account is taken of measurement error through the use of Ashenfelter and Krueger's (1994) IV estimators, the return to schooling obtained from the identical twins rises to between 4.4% and 7.1%. The 7.1% estimate is obtained using the difference between the twins' reports on their co-twins' levels of schooling as instruments.[6] The 4.4% estimate is obtained using the IV estimator proposed by Ashenfelter and Krueger (1994) for the case where the two reports (on own and the co-twin's educational attainment) contain a common measurement error.[7] For this situation, a consistent estimator is obtained by expressing the earnings difference as a function of the difference between the respondent's own level of

[5] Table 2 results are obtained from the subset of observations where there is information on all measures of birth weight. This subsample is around one-third that used in analyses by Miller et al. (2004). The similarity of the two sets of estimates discounts the influence that selection bias may have on Table 2 results.

[6] That is, $(\mathrm{EDUC}_i^{-i} - \mathrm{EDUC}_{-i}^{i})$ is used as an instrument for $(\mathrm{EDUC}_i^{i} - \mathrm{EDUC}_{-i}^{-i})$.

[7] Neumark (1999, p. 146) notes that any amplification of the omitted variables bias in the fixed effects model is less with this IV estimator than for Ashenfelter and Krueger's (1994) IV estimator that does not take into account the correlated measurement error.

Table 2
Fixed effects estimates of models of log annual earnings including birth weight: identical twins, Australian twins survey

Variable	Without birth weight			With birth weight		
	OLS	IV	IV[a]	OLS	IV	IV[a]
Constant	0.086 (2.67)	0.082 (2.49)	0.075 (2.34)	0.077 (2.36)	0.074 (2.25)	0.068 (2.10)
Own education	0.016 (1.17)	0.071 (1.84)	0.044 (2.07)	0.015 (1.08)	0.062 (1.68)	0.040 (1.94)
Married	0.012 (0.20)	0.010 (0.16)	0.015 (0.25)	0.075 (0.12)	0.062 (0.10)	0.011 (0.18)
Employed full-time	0.663 (6.86)	0.640 (6.35)	0.647 (6.62)	0.657 (6.81)	0.638 (6.39)	0.643 (6.60)
Birth weight	–	–	–	0.004 (1.99)	0.004 (1.78)	0.004 (1.79)
R^2	0.242	–	–	0.250	–	–
Sample size	278	278	278	278	278	278

Figures in parentheses are heteroscedasticity-consistent t-statistics.
[a] IV estimator robust in the presence of correlated measurement errors.

education and his or her report on the co-twin's level of education, and instrumenting this using the difference between the co-twin's report on the first twin's level of education and the co-twin's report on his or her own level of education.[8]

The right-hand section of Table 2 contains the fixed effects estimates following the inclusion of the birth weight variable. Each additional ounce of birth weight is associated with 0.4 percent higher earnings. Between 10 and 15 oz. higher birth weight is the equivalent of only one extra year of education in terms of the impact on earnings. Strauss (2000) also reports a positive association between birth weight and weekly income.[9] This partial effect of birth weight on earnings is only marginally lower than that obtained in a simple regression of earnings on birth weight (of 0.52% increase in earnings per ounce of birth weight, t-statistic of 2.12).

It is apparent that the inclusion of the birth weight variable has only a minor impact on the other estimates, reducing the return to schooling by between 0.1 and 0.9 percentage points.[10] Hence, these results suggest that, to the extent that they can be captured by differences in birth weight, ability differences between members of twin pairs, other than those removed by the first-differencing procedure, do not appear to bias the results in the fixed effects model. This mirrors the conclusion of Ashenfelter and Rouse (1998).

4. Conclusion

Birth weight is an endowment that may be linked to schooling and earnings outcomes. It has been argued that it may be related to ability, and therefore the inclusion of birth weight in within-identical twins models of earnings determination can potentially inform on whether within-twins ability differences that are not removed in this model bias the estimates. The analyses reported in this paper suggest that birth weight has no impact on schooling levels and only a minor impact on earnings. And

[8] That is, $(\mathrm{EDUC}_i^i - \mathrm{EDUC}_{-i}^i)$ is used as the explanatory variable and $(\mathrm{EDUC}_i^{-i} - \mathrm{EDUC}_{-i}^{-i})$ is used as the instrument.

[9] Strauss (2000, p. 625) reports that, at age 26, low birth weight for gestational age was not associated with "any differences in years of education, employment, hours of work per week, marital status or satisfaction with life".

[10] Similarly, the inclusion of the other regressors an estimating equation that initially contains only the birth weight variable has only a slight effect on the estimated impact of birth weight on earnings.

while identical twins differ appreciably on this endowment, the inclusion of birth weight differences in models that relate the difference in the earnings of identical twins to differences in their levels of schooling has little effect on the estimates. Consistent with the research reported by Ashenfelter and Rouse (1998), this evidence suggests that ability differences that are not removed in the within-identical twins model of earnings are not biasing the results in twins studies such as Ashenfelter and Krueger (1994).

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