The co-twin methodology and returns to schooling — testing a critical assumption[☆],[☆☆]

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HIGHLIGHTS

- An influential literature on returns to schooling uses data on identical twins.
- These studies assume that twins are identical as to relevant underlying abilities.
- Using a detailed novel dataset, we find strong evidence against this assumption.
- Adolescent IQ differences significantly add to within-pair schooling-wage equations.
- IQ differences reduce the within-pair estimated returns to schooling by about 15%.

ARTICLE INFO

ABSTRACT

Twins-based estimates of the return to schooling have featured prominently in the economics of education literature. Their unbiasedness hinges critically on the assumption that within-pair variation in schooling is explained by factors unrelated to wage earning ability. This paper develops a framework for testing this assumption and shows, in a large sample of monozygotic twins, that the twins-based estimated return to schooling falls if adolescent IQ test scores are included in the wage equation. Using birth weight as an alternative proxy for ability yields qualitatively similar results. Our results thus cast doubt on the validity of twins-based estimates.

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1. Introduction

Knowledge about the causal effect of schooling on earnings and other economic outcomes has important implications for educational policy, for efforts to better understand the evolution of inequality and for studies examining the sources of economic growth (Card, 2001; Katz and Autor, 1999). Yet, it has long been known that efforts to obtain precise estimates of the causal effect of schooling on earnings are complicated by the endogeneity of schooling decisions. In particular, there is a widely shared view that estimates of the marginal returns to schooling will be biased unless proper account is taken of heterogeneities in latent ability. If the propensity to invest in further years of education is also

directly related in a positive way to the ability to earn wages, then this will cause an upward bias in estimates of the effect of an additional year of schooling on wages (see for example Card, 1999, 2001).

A number of approaches to eliminating or mitigating this endogeneity problem have been proposed. One strand of work uses instrumental variable analysis to try to reduce the bias of the estimates (Angrist and Krueger, 1991; Card, 2001).[1] A second influential strand of the literature has exploited within-family variation in general, and variation within monozygotic (MZ) twin pairs in particular, to try to control for unobserved ability. Under the key identifying assumption that within-family variation in schooling is explained by factors unrelated to wage earning ability, resulting estimates are consistent as long as problems of measurement errors in the schooling variable can be dealt with adequately. If two siblings have identical abilities, then the identifying assumption is of course satisfied. Especially with regards to MZ twins, the attraction of the assumption of equal ability is easily understood. MZ twins are the result of a fertilized egg splitting in two shortly after conception, resulting in two identical individuals who are virtually identical genetically (Martin et al., 1997). Furthermore, MZ twins (or "identical" twins, as they are often referred to) are typically raised by the same parents, go to the same school, and are influenced by the same peer groups when growing up.

In labor economics, twins-based estimates of the return to schooling have featured prominently; see, for instance, the survey in Card (1999). A string of papers applying co-twin methodology have been published in prominent economic journals (Ashenfelter and Krueger, 1994; Behrman, Rosenzweig, and Taubman, 1994; Ashenfelter and Rouse, 1998; Miller, Mulvey, and Martin, 1995; Bonjour et al., 2003; Amin, 2011) as well as field journals (Isacsson, 1999; Behrman and Rosenzweig, 1999; Rouse, 1999; Isacsson, 2004; Miller et al., 2006; Zhang, Liu, and Yung, 2007).[2]

The idea that the latent wage earning ability of two individuals in a pair of identical twins would be virtually identical is not hard to accept, a priori. However, identical ability begs the question of what causes observed within-pair differences in schooling, as standard optimizing models predict that two identically able individuals would choose the same level of schooling (Ashenfelter and Rouse, 1998; Becker, 1964; Ben-Porath, 1967). Any observed variation in schooling must then be explained by "optimizing errors", or differences in preferences for schooling which do not affect wage earning ability. Hence, it is assumed that differences in schooling across the population are caused by ability differences, but that this is not true within twin pairs.

A natural hypothesis is that within-pair variation in ability may explain within-pair variation in schooling, thereby violating the assumption of "optimization error".[3] This potential problem with the co-twin methodology was first demonstrated by Griliches (1979); although twins may have very similar levels of ability, the observed similarities in years of schooling and income are also large. Therefore, even though within-pair differences are purged from most of the heterogeneities in ability, they may also lack most of the useful variation in schooling and income. Griliches (1979) noted that when the degree of twin similarity is the same for ability and for schooling, first-differencing contributes nothing in terms of removing ability bias. This critique has been further developed both conceptually and empirically by Neumark (1999) and Bound and Solon (1999), who also point out that a priori the relationship between the degrees of similarity in ability and schooling, respectively, is not clear.

The contribution of this paper is to provide results from empirical assessments which rely on less restrictive assumptions than previous tests in the literature, and which use better proxies for ability than has generally been employed. To this end, we use a large sample of Swedish male pairs of MZ twins. Our data contain information on income, adolescent IQ, birth weight, and two separate measures of schooling. The dataset is distinguished from previous studies as it includes dual measures of schooling as well as appropriate ability measures and that we directly examine how controlling for proxies for ability in a standard co-twin wage regression affects the estimated return to schooling. The main findings of the paper are that (i) within-pair differences in IQ test scores are significantly associated with income even after accounting for differences in schooling, (ii) that within-pair differences in IQ test scores have a statistically and economically significant effect on within-pair differences in schooling, and (iii) controlling for IQ test scores reduces within-pair estimates of returns to schooling by about 15% across various specifications and variable definitions.

These results cast doubts on the validity of the co-twin approach to estimating the returns to schooling, and provide some additional empirical evidence for the critique of within-family estimation advanced by Griliches (1979), Bound and Solon (1999), Neumark (1999) and others. The evidence reported here suggests that the quasi-experiment of MZ twinning does not approximate the ideal experiment, namely random assignment of educational attainment holding ability and other background factors constant, particularly well. In fact, under plausible assumptions about the reliability ratio of the within-pair difference in adolescent IQ and educational attainment, the within-pair correlation between IQ and schooling is about 0.30.

Our results are also complementary to a recent economics literature (e.g. Behrman and Rosenzweig, 2004; Black et al., 2007; Royer, 2009) which documents convincingly in large samples that the within twin pair difference in birth weight – a commonly used proxy for the quality of the prenatal environment – predicts outcomes such as intelligence, earnings and educational attainment. These papers, whilst not framed directly as an attempt to interrogate the "equal ability assumption", provide strong suggestive evidence that the key identifying assumption in twins-based estimates of the return to schooling is violated.[4] They do not allow us to determine the extent to which birth weight acts on income directly, rather than through schooling, and hence leave open the question of whether it is the non-ability or the ability components of schooling which differ between twins.

An additional concern about twins-based estimates relates to measurement error in schooling. As was noted by one of the first authors to apply this methodology (Taubman, 1976), differencing within pairs will usually decrease the signal to noise ratio, and hence serves to exacerbate the problem of imperfectly observed schooling. Furthermore, even with valid instruments for number of years spent in an educational facility, this quantity may not perfectly reflect true education, a distinction pointed out at least as early as in Griliches (1977). In this paper, we follow Isacsson (1999) and use administrative data on educational attainment as an instrument for self-reported educational attainment in an attempt to mitigate the attenuation resulting from measurement error in schooling. As the data of this study present limited opportunity to examine the issue of mismeasured education, the twin methodology will be given the benefit of the doubt; the assumption of perfectly instrumented schooling will be maintained, and focus is instead directed towards the source of the alleged benefits from using twins data — the equal or virtually equal ability within twin pairs.

This paper is structured as follows. Section 2 sets out a simple theoretical framework which encompasses previous examinations and within which we propose two straightforward tests relying on less restrictive assumptions but which require richer data than has previously

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[1] For critiques of the instrumental variable approach, see Bound, Jaeger, and Baker (1995) and Bound and Jaeger (1996).

[2] Isacsson (2004) distinguishes itself from the other papers in this list, as it develops an estimating framework to allow for non-classical measurement errors, and hence is able to provide a substantially more refined analysis than other specialist papers in this literature. Isacsson's estimates suggest that the classical measurement-error corrections are upwards biased by approximately 30%.

[3] For a review of the biological and developmental mechanisms that can give rise to differences between twins, see Martin et al. (1997).

[4] There is also a literature outside economics which reports associations between birthweight and educational attainment within twin pairs, see the review in Bound and Solon (1999).