Randomness and the Measurement of Intergenerational Mobility: An Application to Educational Attainment

Pablo A. Peña*

Mexican Institute for Competitiveness

and

Universidad Iberoamericana

November 5, 2010

Abstract

Using a standard model of the intergenerational transmission of outcomes I develop a methodology to estimate the intergenerational transmission of ability taking into account the presence of random shocks to outcomes. The methodology uses grandparental outcomes as instrumental variables in the regressions of children outcomes on parental outcomes. I apply this methodology using survey data on educational attainment for three generations of adults in three samples: the Health and Retirement Study, the Wisconsin Longitudinal Study and the Mexican Health and Aging Study. The suitability of the instrumental variable is supported by the data but not fully. The results are consistent across the three samples. Without accounting for random shocks, the estimates of the intergenerational transmission of ability are downward biased and therefore overstate intergenerational mobility.

Keywords: intergenerational mobility

JEL classification: J62

---

* This work has benefitted from the comments of Gary Becker, Casey Mulligan, Graciela Teruel, Yuri Sánchez, Mathis Wagner and seminar participants at Universidad Iberoamericana, Banco de México and Colegio de México. All errors and omissions are my responsibility. Correspondence can be sent to pablo.pena.munoz@gmail.com.

1 Introduction

Outcomes are used in a number of studies in the economics literature to measure intergenerational mobility. The extent to which opportunities are passed across generations is inferred from the transmission of outcome variables such as earnings and education from one generation to the next. Those studies have been surveyed by Becker and Tomes (1986), Mulligan (1997), Solon (1999), and more recently by Black and Devereux (2010).

Outcomes are imperfect measures of opportunities. Thus the transmission of outcomes is an imperfect measure of the transmission of opportunities.

Opportunities are an ex ante concept. They are defined by what a person is *able* to do, i.e. a person's ability. Outcomes are ex post measures of opportunities. They are what the person *does* with that ability.

Two people with the same ability might decide to follow different paths in life depending on what they have been exposed to, which in many ways is random. Despite having the same opportunities they may end up with different outcomes. The evidence on identical twins supports this idea. Their earnings and years of schooling differ despite having the same opportunities.[1]

The difference between what one is able to do and what one actually does can be interpreted as the result of random shocks. There are events beyond our control that had they not occurred or had they occurred differently, our life would not be the same. For instance, had a traffic jam not occurred when a business person was on her way to the airport, that person wouldn't have missed that important meeting that perhaps meant a promotion. Those events may have deterministic explanations (even traffic jams have a reason to occur). But from the perspective of a person making choices, those events are random.

Not only are our possibilities affected by seemingly random events. Our preferences can be shaped by sequences of those events. What we have been exposed to in the past determines what we like and dislike. For instance, a person might like mathematics because she had a fun and engaging teacher in elementary school. But she might have had that particular teacher and not other thanks to what we can call randomness.

[1] Ashenfelter and Krueger (1994), Miller et al. (1995), and Ashenfelter and Rouse (1998) show correlations among identical twins between .563 and .680 for the logarithm of wage and between .658 and .752 for years of schooling.

Thus, from a practical standpoint our life is shaped to some extent by randomness.[2] How much a person makes, whether a person graduated from college, or a person's body mass index are partially determined by random events—what we call luck.

Good or bad, the luck that strikes parents can also affect the outcomes of their children. A person involved in a random car accident might see diminished her ability to invest in her children's human capital. The accident may prevent her from earning enough to put her children through college. In that case part of the shock would be passed to the next generation. It would manifest through the children's outcomes—e.g. fewer years of schooling and lower earnings. This idea is by no means new.

Exogenous shocks affecting parental outcomes have been used in the economics literature to measure the causal effect of the outcomes of one generation on the outcomes of the next. Oreopoulos, Page and Stevens (2008) use father's displacement from work as a shock to parents' earnings. Rege, Telle and Votruba (2007) use plant closures in a similar way. Black, Devereux and Slavanes (2005), and Oreopoulos, Page and Stevens (2006) use changes to compulsory schooling laws as exogenous shocks affecting parental education.

There are many exogenous shocks affecting parental outcomes besides job separations and changes to compulsory schooling laws. And economic theory does not establish whether the effect of all those shocks (the exogenous or causal effect of the outcome) is transmitted in the same degree as the part of parental outcomes that is not related to luck (the endogenous or non-causal effect). The part that is not related to luck is what I define as ability.

A common method to measure intergenerational mobility is a regression of the outcomes of one generation on the outcomes of the previous generation. In the presence of a random component in parental outcomes the resulting coefficients are weighted averages of the rates of intergenerational transmission of ability and random shocks.

The distinction between the rates of transmission of ability and random shocks is crucial for making inferences about intergenerational mobility. The same rate of intergenerational transmission of outcomes would be interpreted very differently depending on what is being passed, ability or random shocks.

---

[2] Leonard Mlodinow in *A Drunkard's Walk: How Randomness Rules our Lives* and Nassim Nicholas Taleb in *Fooled by Randomness: The Hidden Role of Chance in the Markets and in Life* explicitly argue that the role of randomness in our lives is understated.

Suppose that an economy has an intergenerational elasticity of earnings of .6.[3] If we are told that in this economy only ability is passed. Then 10% higher grandparental earnings are associated with 6% higher parental earnings and 3.6% higher children earnings.

Now suppose we are told that only random shocks are passed. Then 10% higher grandparental earnings would be associated with 6% higher parental earnings but 0% higher children earnings. In this case grandparental luck affects parental ability. But greater parental ability is not passed to children.

The same estimate of the transmission of earnings has very different implications in terms of mobility. Given the same estimate of the intergenerational elasticity of earnings, if only ability is passed there is less intergenerational mobility than if only random shocks are passed.

Therefore, an essential piece of information when assessing the intergenerational transmission of opportunities is how the transmission rates of ability and random shocks compare in magnitude. In this study I shed some light on how to determine the magnitude and relative importance of the transmission of ability and random shocks.

I propose a methodology to estimate intergenerational transmission of ability taking into account that there is randomness. My starting point is a standard model extended to account for the role of chance in outcomes. The methodology developed relies heavily on functional form assumptions. However, those functional forms are standard in the intergenerational mobility literature.

In sum, the methodology uses grandparental outcomes as instrumental variables for parental outcomes. Thus, its application requires data on the outcomes of three generations. Not many data sets contain this type of information and therefore the applicability is limited. In this study I apply the methodology to three data sets that fit the three-generation requirement: the Health and Retirement Study, the Wisconsin Longitudinal Study and the Mexican Health and Aging Study. The outcome that I measure is educational attainment. The results show that accounting for randomness in outcomes matters.

2 The Model

Let E_t be an outcome of interest for generation t. E_t could stand for earnings, educational attainment or a dimension of health. Outcome E_t can be decomposed into the ex ante

[3] The intergenerational elasticity of earnings is estimated as the coefficient on the logarithm of parental earnings in a regression in which the dependent variable is the logarithm of children earnings.

expectation of the outcome given the opportunities that the person had or what I will refer to as ability, A_t, and an idiosyncratic random shock that made the person end up with the actual level of the outcome (and not the expectation), ε_t. Thus, the outcome can be expressed as the sum of two unobservable variables:

$$E_t = A_t + \varepsilon_t \qquad (1)$$

Among the determinants of A_t are the intellectual and physical skills inherited from the parents, the social environment and connections that the parents provided, and the financial resources supplied by the parents to overcome credit constraints. Thus, ability A_t should be understood as the capacity to succeed along the dimension of outcome E_t. The idiosyncratic shock ε_t refers to anything that affects the outcome but is unrelated to ability. It should be thought of as "lifetime luck" and not as transitory fluctuations.

Let us denote the next generation by t+1. Ability of the next generation, A_{t+1}, is determined by the ability of the previous generation, A_t, some ability "innovation", υ_{t+1}, and the effect of previous generation's idiosyncratic shock, ε_t. The shock itself is not passed. What is passed is some effect of that shock. For instance, if a parent is involved in a car accident that leaves him or her disabled then that parent might invest less in his or her children's human capital. The transmission of ability can be modeled as a linear process as has been done in many other studies (see Solon 1999, and Black and Devereux 2010). Ability of the next generation is given by:

$$A_{t+1} = a + \beta A_t + \upsilon_{t+1} + \gamma\varepsilon_t \qquad (2)$$

βA_t is the ability inherited from the parents, υ_{t+1} is an innovation to ability and $\gamma\varepsilon_t$ is the idiosyncratic shock to the parents that was transformed into ability of the children. All the terms in equation (2) are unobservable. Following equations (1) and (2) the outcome for the children can be expressed as:

$$E_{t+1} = a + \beta A_t + \upsilon_{t+1} + \gamma\varepsilon_t + \varepsilon_{t+1} \qquad (3)$$

Implicit in equation (3) is the assumption that grandparental outcomes are related to grandchildren outcomes only through the parents'. In other words, a random shock to the outcome of the grandparents (ε_{t-1}) does not have an effect on the grandchildren other than through the ability of the parents (A_t).[4]

[4] This assumption implies that grandparental outcomes are a truly exogenous instrumental variable for parental outcomes. This assumption can be tested with a Sargan test.

I make three additional assumptions: (i) luck is unrelated across generations, i.e. $\varepsilon_t \perp \varepsilon_{t+k}$, for all $k \neq 0$; (ii) luck is unrelated to innovations to ability, i.e. $\varepsilon_t \perp \upsilon_k$, for all t, k; (iii) innovations are orthogonal to the inherited component of ability, i.e. $\upsilon_t \perp A_{t-1}$.

The first two assumptions simply define luck. If the "luck" of a person were related to how well her ancestors did or how smart she is, then it is not true luck. Luck is unrelated to anything. That does not rule out the possibility of a high-ability person making more out of good luck than a low-ability person. That is not a fundamental issue as much as a functional form one. If the outcome is expressed in logarithms (as it is typically the case with earnings), the additive property of ability and random shocks in (1) is really multiplicative. Therefore, whether the assumption is that the shocks are multiplicative or additive can be approached as a functional form choice issue.

In the economics literature it is common to regress the outcome of the children, E_{t+1}, on the outcome of the parents, E_t (see Solon 1999, and Black and Devereux 2010). The probability limit of the estimator of the coefficient on the parental outcome in such regressions, which I will denote by b, is:

$$b = \frac{\operatorname{cov}(E_{t+1}, E_t)}{\operatorname{var}(E_t)} = \frac{\operatorname{cov}(\beta A_t + \upsilon_{t+1} + \gamma\varepsilon_t + \varepsilon_{t+1}, A_t + \varepsilon_t)}{\operatorname{var}(A_t + \varepsilon_t)} = \frac{\beta \operatorname{var}(A_t) + \gamma \operatorname{var}(\varepsilon_t)}{\operatorname{var}(A_t) + \operatorname{var}(\varepsilon_t)} \tag{4}$$

The resulting coefficient is a weighted average of the transmission of ability, β, and the transmission of the random shock, γ.[5] If the shocks were relatively small, i.e. $\operatorname{var}(\varepsilon_t) \approx 0$, then b would be approximately equal to β. If the random shocks are non-negligible, then b would differ from β as long as γ and β are not the same.

Here I propose a method to estimate β using grandparental outcomes. The generation of the grandparents is denoted by t-1. The outcome of the parents can be expressed as:

$$E_t = \tilde{\alpha} + \tilde{\beta} A_{t-1} + \upsilon_t + \tilde{\gamma}\varepsilon_{t-1} + \varepsilon_t \tag{5}$$

The coefficients in (5) are not necessarily the same as in (3) because the degree of transmission of ability and random shocks might have changed in time.

If grandparental outcome E_{t-1} is used as an instrumental variable in the regression of children outcome E_{t+1} on parental outcome E_t then the probability limit of the estimator is the transmission of ability:

[5] This is the parameter identified in the causal effect literature surveyed by Black and Devereux (2010), section 2.6.

$$\frac{\text{cov}(E_{t+1}, E_{t-1})}{\text{cov}(E_t, E_{t-1})} = \frac{\text{cov}(\beta[\tilde{\beta} A_{t-1} + \upsilon_t + \tilde{\gamma}\varepsilon_{t-1}] + \upsilon_{t+1} + \gamma\varepsilon_t + \varepsilon_{t+1}, A_{t-1} + \varepsilon_{t-1})}{\text{cov}(\tilde{\beta} A_{t-1} + \upsilon_t + \tilde{\gamma}\varepsilon_{t-1} + \varepsilon_t, A_{t-1} + \varepsilon_{t-1})} = \frac{\beta\tilde{\beta}\,\text{var}(A_{t-1}) + \beta\tilde{\gamma}\,\text{var}(\varepsilon_{t-1})}{\tilde{\beta}\,\text{var}(A_{t-1}) + \tilde{\gamma}\,\text{var}(\varepsilon_{t-1})} = \beta \quad (6)$$

By comparing the estimates of b and β we can infer whether ability is more or less transmittable than random shocks. In other words, we can compare non-causal and causal effects of the parental outcome. Since the estimate of b is a weighted average of β and γ, if $b < \beta$ ($b > \beta$) then it follows that random shocks are less (more) transmittable than ability.

The difference between the estimates of b and β in itself is not very informative of the magnitude of γ. Holding constant the estimates of b and β, it is possible to have γ equal to zero and a sizeable variance of the shocks or γ positive and a small variance of the shocks. However, assuming a value for the contribution of random shocks to the variance of outcomes it is possible to compute the degree of intergenerational transmission of random shocks.

The methodology to estimate the intergenerational transmission of ability described above can be applied to any outcome. However, it requires outcome data for three generations and there are not many data sets with that feature. In the remainder of the article I apply the methodology to the educational attainment of three generations of adults to the samples from three studies: the Health and Retirement Study, the Wisconsin Longitudinal Study and the Mexican Health and Aging Study. [6] [7]

3 Health and Retirement Study

The Health and Retirement Study (HRS) provides a nationally representative sample of Americans age 50 and over in 1992 and their spouses or partners regardless of their age. The 1992 wave of the survey includes 12,652 interviews in 7,702 households.

The HRS survey records information on educational attainment for three generations: grandparents, parents and children. The data are reported by the members of the middle generation, i.e. the parents. I use educational attainment to measure intergenerational transmission of ability. I restrict the sample to children who were 25 years or older in 1992. The educational attainment is recorded in years of schooling.

[6] Given the strong log-linear relationship between earnings and years of schooling, using years of schooling as the outcome results in coefficients that can in principle be compared to those obtained using the logarithm of earnings.

[7] There are not many surveys that record outcomes of interest for adults of three generations. And among the surveys that do, some have a relatively small sample or are confined to a particular group of the population. See for instance the Survey of Three Generations of Mexican Americans 1981-1982, and the Three-Generation National Survey of Black American Families 1979-1981.

Table 1 shows descriptive statistics of educational attainment in the HRS sample. Only parents with children age 25 or older were included. The table shows the number of observations, their distribution across categories of educational attainment, and the mean and the standard deviation of years of schooling, by generation and gender.

Table 2 shows the estimates of the intergenerational transmission of ability. The confidence intervals displayed below the coefficients are calculated using robust standard errors. The observations are clustered by parents, since parental years of schooling do not vary across their children and the sample includes different children from the same parents. The regressions also include dummies for parents' and children five-year birth cohorts.

The top panel of Table 2 shows the OLS results computed using the full HRS sample. The estimates of the intergenerational transmission of ability using years of schooling of the mother as the parental outcome range between .32 and .34. Using years of schooling of the father results in estimates between .27 and .30. Finally, using the average years of schooling of both parents results in estimates between .38 and .40.

The middle panel of Table 2 shows the OLS results using the HRS data for which parental and grandparental education is available, i.e. the observations on which the IV method can be applied. The estimates of the intergenerational transmission of ability using years of schooling of the mother as the parental outcome range between .32 and .36. Using years of schooling of the father results in estimates between .28 and .32. Finally, using average years of schooling of both parents results in estimates between .39 and .40. The OLS estimates using the IV sample are similar to the full-sample OLS estimates. In fact, the 95% confidence intervals around the nine OLS estimates using the IV sample contain the full-sample OLS estimates.

The bottom panel of Table 2 shows the IV results. The estimates of the intergenerational transmission of ability using years of schooling of the mother as the parental outcome range between .40 and .42. Using years of schooling of the father results in estimates between .33 and .34. Finally, using the average years of schooling of both parents results in estimates between .41 and .42. In five cases the IV estimates lie above the 95% confidence interval of the OLS estimates computed with the IV sample. In two cases the 95% confidence intervals around the IV and OLS estimates (using the same sample) do not overlap.

The last two rows of Table 2 show the results of the Sargan test. It tests whether the educational attainment of the grandparents is uncorrelated with the residuals of the IV regression. In all the specifications the test is passed at a confidence level of 95%. Thus the data support the assumption that the outcomes of grandparents and children are related only though parental outcomes.

4 Wisconsin Longitudinal Study

The Wisconsin Longitudinal Study (WLS) is a long-term study of a random sample of 10,317 men and women who graduated from Wisconsin high schools in 1957, i.e. most of them were born in 1939. The WLS sample is broadly representative of white, non-Hispanic American men and women who have completed at least a high school education. Minorities are not well-represented in the WLS. There are only a handful of African American, Hispanic, or Asian persons in the WLS sample.

In 1957 the respondent (the high school graduate) was asked about his or her parents' education. In 1975 the respondent was asked about his or her own educational attainment (when most respondents were around 36 years old). In the same year the respondent was also asked about the educational attainment of his or her spouse and the educational attainment of the head of the household in which the spouse was when he or she was 16 years old. I assume the respondent's spouse in 1975 is parent to the respondent's children. For uniformity, when I use the educational attainment of the head of household of the spouse when he or she was 16, I restrict the sample to observations for which such head of the household is the spouse's father. In 2004, the respondent was asked about the educational attainment of his or her children. I restrict the sample to children who were 25 years or older in 2004. The educational attainment of the respondent, the respondent's spouse, their children and the father of the spouse is recorded in years of schooling. The educational attainment of the parents of the respondent is recorded in numeric categories that approximate in years of schooling. For them, the numeric variable was used together with dummy variables for the categories that include more than one level of years of schooling.

Table 3 shows descriptive statistics of educational attainment in the WLS sample. The top panel shows the number of observations, their distribution across broad categories of educational attainment, and the mean and the standard deviation for the records used in the IV estimates, by generation and gender. The bottom panel shows the descriptive statistics for the observations excluded from the IV estimates because of the lack of educational attainment data for the parents or the grandparents. Out of the 20,869 observations for Generation 3, 9,147 are excluded. The educational attainment for the excluded observations is lower than for the ones included.

Table 4 shows the estimates of the intergenerational transmission of ability. The confidence intervals displayed below the coefficients are calculated using robust standard errors. The observations are clustered by parents, since parental years of schooling do not vary across their children and the sample includes different children from the same parents.

The top panel of Table 4 shows the OLS results computed using the full WLS sample. The estimates of the intergenerational transmission of ability using years of schooling of the mother as the parental outcome range between .40 and .42. Using years of schooling of the father results in estimates between .32 and .34. Finally, using the average years of schooling of both parents results in estimates between .48 and .50.

The middle panel of Table 4 shows the OLS results using the WLS data for which parental and grandparental education is available, i.e. the observations on which the IV method can be applied. The estimates of the intergenerational transmission of ability using years of schooling of the mother as the parental outcome range between .37 and .39. Using years of schooling of the father results in estimates between .34 and .39. Finally, using average years of schooling of both parents results in estimates between .47 and .49. The OLS estimates using the IV sample are not that different in magnitude to the full-sample OLS estimates. In fact, in seven out of the nine cases the 95% confidence intervals around the OLS estimates using the IV sample contains the full-sample OLS estimates.

The bottom panel of Table 4 shows the IV results. The estimates of the intergenerational transmission of ability using years of schooling of the mother as the parental outcome range between .62 and .71. Using years of schooling of the father results in estimates between .44 and .46. Finally, using the average years of schooling of both parents results in estimates between .56 and .58. In all nine cases the IV estimates lie above the 95% confidence interval of the OLS estimates computed with the IV sample. In five cases the 95% confidence intervals around the IV and OLS estimates (using the same sample) do not overlap.

The last two rows of Table 4 show the results of the Sargan test. The results are mixed again. In three out of the nine specifications the test is passed at a confidence level of 95%. With a confidence level of 99% the test is passed in six specifications. The data do not offer full support for the assumption that the outcomes of grandparents and children are related only though parental outcomes, but they don’t rule it out either.

5 Mexican Health and Aging Study

The Mexican Health and Aging Study (MHAS) provides a nationally representative sample of Mexicans aged 50 and over in 2001 and their spouses or partners regardless of their age. The survey includes 15,186 interviews in 9,862 households.

The MHAS survey records information on educational attainment for three generations: grandparents, parents and children. The data are reported by the members of the middle generation, i.e. the parents. I use educational attainment to measure intergenerational transmission of ability. I restrict the sample to children who were 25 years or older in 2001. The educational attainment of parents and children can be directly transformed into years of schooling. The records of educational attainment for the grandparents cannot be transformed because they are expressed in four broad categories: no schooling, some elementary schooling, complete elementary, and more than elementary. I use dummy variables for these educational categories of the grandparents as the instrumental variables for the years of schooling of the parents.

Table 5 shows descriptive statistics of educational attainment in the MHAS sample. The top panel includes the observations used for the IV estimates. It shows the number of observations, their distribution across broad categories of educational attainment, and the mean and the standard deviation of years of schooling, by generation and gender. The bottom panel shows the descriptive statistics for the observations excluded from the IV estimates because of the lack of educational attainment data for the parents or the grandparents. Out of the 37,011 observations for Generation 3, 5,782 are excluded. The educational attainment for the excluded observations is lower than for the ones included.

Table 6 shows the estimates of the intergenerational transmission of ability. The confidence intervals displayed below the coefficients are calculated using robust standard errors. The observations are clustered by parents, since parental years of schooling do not vary across their children and the sample includes different children from the same parents. The regressions also include dummies for parents' five-year birth cohorts.

The top panel of Table 6 shows the OLS results computed using the full MHAS sample. The estimates of the intergenerational transmission of ability using years of schooling of the mother as the parental outcome range between .64 and .66. Using years of schooling of the father results in estimates between .54 and .56. Finally, using the average years of schooling of both parents results in estimates between .70 and .72.

The middle panel of Table 6 shows the OLS results using the MHAS data for which parental and grandparental education is available, i.e. the observations on which the IV method can be applied. The estimates of the intergenerational transmission of ability using years of schooling of the mother as the parental outcome range between .64 and .67. Using years of schooling of the father results in estimates between .53 and .56. Finally, using average years of schooling of both parents results in estimates between .67 and .71. The OLS estimates using the IV sample are similar to the full-sample OLS estimates. In fact, the 95% confidence intervals around the nine OLS estimates using the IV sample contain the full-sample OLS estimates.

The bottom panel of Table 6 shows the IV results. The estimates of the intergenerational transmission of ability using years of schooling of the mother as the parental outcome range between .88 and .91. Using years of schooling of the father results in estimates between .65 and .72. Finally, using the average years of schooling of both parents results in estimates between .79 and .85. In all nine cases the IV estimates lie above the 95% confidence interval of the OLS estimates computed with the IV sample. Moreover, in all nine cases the 95% confidence intervals around the IV and OLS estimates (using the same sample) do not overlap.

The last two rows of Table 6 show the results of the Sargan test. The results in this case are also mixed. In five out of the nine specifications the test is passed at a confidence level of 95%. With a confidence level of 99% the test is passed in six specifications. The data do not offer full support for the assumption that the outcomes of grandparents and children are related only though parental outcomes, but they don’t rule it out either.

6 Discussion of Results

In the three studies the IV estimates of the intergenerational transmission of ability measured with educational attainment are greater than the OLS estimates. Table 7 presents a summary of the results. The difference between the IV and the OLS estimates ranges between 3 and 20% of the IV estimates using the HRS, between 10 and 44% using the WLS, and between 14 and 27% using the MHAS.

The assumption of grandparental outcomes being uncorrelated to children outcomes other than through the parents' is consistent with the evidence in HRS. However, the evidence in WLS and MHAS is not entirely consistent with the assumption.

Greater IV estimates across the three samples suggest that there are random shocks to outcomes that introduce a downward bias in the estimates of the transmission of ability. Thus, the estimates of the intergenerational transmission of education that are used to infer intergenerational mobility not accounting for these shocks are overstating mobility.

Since the OLS estimates are weighted averages of the rates of transmission of ability and random shocks, the result of IV estimates above the OLS estimates also suggests that random shocks are less transmittable than ability. In other words, the causal effect of schooling is lower than the non-causal effect.

Without data on the contribution of random shocks to the variance of outcomes is not possible to determine their rate of transmission. If random shocks accounted for 50% of the variance of outcomes then a rate of transmission of these shocks consistent with the IV and OLS estimates would range between .24 and .39 in HRS, between .09 and .43 in WLS, and between .39 and .57 in the MHAS. Assuming a lower contribution of shocks to the outcome variance would imply lower transmission rates of the shocks. A contribution of shocks to outcomes below 19% would imply negative rates of transmission of random shocks in the three studies.

It is worth remarking that the methodology presented here can be applied to any outcome: earnings, education, health status, etc. However, it is the scarcity of data on outcomes for three generations what constraints its application.

Finally, the results obtained using educational attainment cannot be generalized to other outcomes. However, nothing suggests that the same bias is not present in estimates of the intergenerational transmission of earnings, health or other outcomes.

References

Ashenfelter, Orley and Alan Krueger, 1994, "Estimates of the Economic Return to Schooling from a New Sample of Twins", *American Economic Review*, Vol. 84, No. 5, pp. 1157-1173.

Ashenfelter, Orley and Cecilia Rouse, 1998, "Income, Schooling, and Ability: Evidence from a New Sample of Identical Twins", *Quarterly Journal of Economics*, Vol. 113, No. 1, pp. 253-284.

Black, Sandra E. and Paul J. Devereux, 2010, "Recent Developments in Intergenerational Mobility", NBER Working Paper 15889.

Black, Sandra E., Paul J. Devereux and Kjell Salvanes, 2005, "Why the Apple Doesn't Fall Far: Understanding Intergenerational Transmission of Human Capital", *American Economic Review*, vol. 95, pp. 437-449.

Becker, Gary S. and Nigel Tomes, 1986, "Human Capital and the Rise and Fall of Families," *Journal of Labor Economics* 4, S1–S39.

Chevalier, Arnaud, 2004, "Parental Education and Child's Education: A Natural Experiment", Discussion Paper No. 1153, Institute for the Study of Labor (IZA).

Health and Retirement Study, http://hrsonline.isr.umich.edu/.

Mexican Health and Aging Study. http://www.mhas.pop.upenn.edu/.

Miller, Paul, Charles Mulvey, and Nick Martin, 1995, "What Do Twins Studies Reveal About the Economic Returns to Education? A Comparison of Australian and U.S. Findings", *American Economic Review*, Vol. 85, No. 3, pp. 586-599.

Mulligan, Casey B., 1997, *Parental Priorities and Economic Inequality* (Chicago: University of Chicago Press).

Oreopoulos, Philip, Marianne E. Page and Anne H. Stevens, 2006, "The Intergenerational Effects of Compulsory Schooling", *Journal of Labor Economics*, vol. 24, pp. 729-760.

Oreopoulos, Philip, Marianne E. Page and Anne H. Stevens, 2008, "The Intergenerational Effects of Worker Displacement", *Journal of Labor Economics*, vol. 26, pp. 455-483.

Solon, Gary, 1999, "Intergenerational Mobility in the Labor Market," in Orley C. Ashenfalter and David Card (Eds.), *Handbook of Labor Economics,* Vol. 3A, (Amsterdam: Elsevier North Holland).

Rege, Mari, Kjetil Telle and Mark Votruba, 2007, "Parental Job Loss and Children's School Performance", Discussion Paper No. 517, Research Department, Statistics Norway.

Wisconsin Longitudinal Study. http://www.ssc.wisc.edu/wlsresearch/.

Table 1. Educational Attainment for Three Generations: Health and Retirement Study

Generation and Gender	Obs.	Distribution across Educational Categories (%)					Years of Schooling	
		Less than high school	High school	Some College	College	More than College	Mean	S.D.
Generation 1 (Grandparents):								
Males	8,950	66.2	23.3	4.5	3.7	2.4	8.8	3.9
Females[1]	9,308	63.0	27.5	5.4	3.1	1.0	9.1	3.6
Generation 2 (Parents):								
Males	4,629	31.2	32.9	17.3	9.3	9.4	11.9	3.5
Females	5,703	30.2	39.4	18.6	6.2	5.6	11.8	2.9
Generation 3 (Children):								
Males	9,346	15.7	47.1	17.2	13.8	6.2	12.8	2.3
Females	9,136	13.4	44.5	20.3	16.2	5.6	13.0	2.3

Includes observations for which the children were 25 years or older when the data on their educational attainment was collected (1992). There were 17 observations of children excluded because the years of schooling of the parents or the grandparents were not reported.

Table 2 Intergenerational Transmission of Ability: Health and Retirement Study

Independent Variable:	Dependent Variable: Children's Years of Schooling								
	Males			Females			Both		
OLS Estimates, Full Sample									
Mother's Years of Schooling	.325			.337			.331		
(95% Confidence Interval)	*(.301,.350)*			*(.312,.363)*			*(.310,.352)*		
Father's Years of Schooling		.298			.275			.286	
(95% Confidence Interval)		*(.274,.322)*			*(.252,.298)*			*(.266,.306)*	
Parents' Average Years of Schooling			.392			.380			.385
(95% Confidence Interval)			*(.360,.423)*			*(.351,.408)*			*(.361,.408)*
R-square	0.173	0.204	0.244	0.200	0.199	0.261	0.185	0.199	0.248
Observations	8,764	7,027	4,029	8,508	6,756	3,781	17,272	13,783	7,810
Clusters	4,542	3,682	2,292	4,515	3,642	2,214	5,650	4,616	2,922
OLS Estimates, Sample Compatible with IV Estimates									
Mother's Years of Schooling[1]	.325			.351			.337		
(95% Confidence Interval)	*(.298,.352)*			*(.323,.379)*			*(.314,.360)*		
Father's Years of Schooling[2]		.320			.289			.304	
(95% Confidence Interval)		*(.293,.346)*			*(.263,.315)*			*(.281,.327)*	
Parents' Average Years of Schooling[3]			.397			.397			.396
(95% Confidence Interval)			*(.360,.434)*			*(.363,.432)*			*(.367,.424)*
R-square	0.170	0.222	0.243	0.203	0.208	0.272	0.185	0.213	0.254
Observations	7,225	5,818	3,005	7,001	5,592	2,829	14,226	11,410	5,834
Clusters	3,792	3,073	1,725	3,768	3,049	1,676	4,747	3,877	2,222
IV Estimates									
Mother's Years of Schooling[4]	.404			.418			.410		
(95% Confidence Interval)	*(.357,.451)*			*(.368,.467)*			*(.370,.450)*		
Father's Years of Schooling[5]		.336			.334			.333	
(95% Confidence Interval)		*(.288,.384)*			*(.287,.380)*			*(.294,.373)*	
Parents' Average Years of Schooling[6]			.410			.418			.411
(95% Confidence Interval)			*(.352,.468)*			*(.364,.471)*			*(.366,.456)*
R-square	0.161	0.222	0.243	0.197	0.204	0.271	0.177	0.211	0.253
Observations	7,225	5,818	3,005	7,001	5,592	2,829	14,226	11,410	5,834
Clusters	3,792	3,073	1,725	3,768	3,049	1,676	4,747	3,877	2,222
Sargan test passed at 95%	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sargan test passed at 99%	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Confidence intervals in parentheses. Confidence intervals at 95% using robust standard errors clustering by the parent respondent of the survey. All regressions include dummies for year-of-birth groups of five years each, for parents and children. [1] Includes only the observations for which there is data on educational attainment for both maternal grandparents. [2] Includes only the observations for which there is data on educational attainment for both paternal grandparents. [3] Includes only the observations for which the educational attainment of all four grandparents is known. [4] Includes only the observations for which there is data on educational attainment for both maternal grandparents, which are used as instruments. [5] Includes only the observations for which there is data on educational attainment for both paternal grandparents, which are used as instruments.[6] Includes only the observations for which the educational attainment of all four grandparents is known, which are used as instruments.

Table 3. Educational Attainment for Three Generations: Wisconsin Longitudinal Study Sample

Generation and Gender	Obs.	Distribution across Educational Categories (%)					Years of Schooling	
		Less than high school	High school	Trade/business school or some college	College	More than College	Mean	S.D.
Observations Included in IV Regressions:								
Generation 1 (Grandparents):								
Males	7,516	52.2	25.9	10.5	7.5	3.9	10.5	3.4
Females[1]	3,758	47.8	29.0	11.6	10.7	0.9	10.8	3.0
Generation 2 (Parents):								
Males	3,758	3.8	46.5	14.6	16.3	18.7	14.1	2.7
Females	3,758	2.2	61.2	15.5	16.1	4.9	13.2	1.9
Generation 3 (Children):								
Males	5,897	2.5	32.7	19.7	31.5	13.6	14.5	2.4
Females	5,825	1.4	27.7	22.2	34.8	13.9	14.7	2.2
Observations Excluded from IV Regressions:								
Generation 3 (Children):[2]								
Males	4,616	4.0	41.4	22.0	23.4	9.2	13.9	2.3
Females	4,529	2.3	37.8	23.4	26.7	9.9	14.1	2.2

Includes observations for which the children were 25 years or older when the data on their educational attainment was collected (2004). [1] Spouses of respondents report the years of schooling of the head of household where the spouse was when he or she was 16 years old or younger. The cases where the head of household was not the father were excluded. [2] Excluded because the years of schooling of the parents or the grandparents was not reported. Two observations with no gender reported are omitted in this table but used in the regression analysis when both genders are included.

Table 4 Intergenerational Transmission of Ability: Wisconsin Longitudinal Study Sample

Independent Variable:	Dependent Variable: Children's Years of Schooling								
	Males			Females			Both		
OLS Estimates, Full Sample									
Mother's Years of Schooling	.407			.416			.410		
(95% Confidence Interval)	(.375,.440)			(.384,.447)			(.385,.436)		
Father's Years of Schooling		.339			.324			.332	
(95% Confidence Interval)		(.317,.361)			(.305,.344)			(.316,.348)	
Parents' Average Years of Schooling			.499			.488			.493
(95% Confidence Interval)			(.469,.529)			(.460,.515)			(.471,.516)
R-square	0.116	0.170	0.187	0.147	0.191	0.215	0.129	0.178	0.199
Observations	9,947	9,758	9,315	9,813	9,594	9,171	19,760	19,352	18,486
Clusters	5,390	5,301	5,054	5,298	5,205	4,967	6,349	6,243	5,935
OLS Estimates, Sample Compatible with IV Estimates									
Mother's Years of Schooling[1]	.376			.390			.382		
(95% Confidence Interval)	(.318,.435)			(.334,.445)			(.336,.428)		
Father's Years of Schooling[2]		.389			.343			.366	
(95% Confidence Interval)		(.349,.430)			(.306,.381)			(.336,.396)	
Parents' Average Years of Schooling[3]			.488			.473			.480
(95% Confidence Interval)			(.449,.526)			(.438,.507)			(.451,.508)
R-square	0.114	0.183	0.190	0.134	0.198	0.213	0.120	0.188	0.199
Observations	3,001	2,841	5,842	2,934	2,830	5,764	5,935	5,671	11,606
Clusters	1,599	1,597	3,196	1,562	1,572	3,134	1,860	1,895	3,755
IV Estimates									
Mother's Years of Schooling[4]	.701			.625			.671		
(95% Confidence Interval)	(.562,.840)			(.512,.739)			(.569,.774)		
Father's Years of Schooling[5]		.442			.454			.451	
(95% Confidence Interval)		(.343,.541)			(.371,.537)			(.381,.522)	
Parents' Average Years of Schooling[6]			.576			.574			.568
(95% Confidence Interval)			(.508,.644)			(.515,.633)			(.520,.616)
R-square	0.066	0.178	0.183	0.099	0.184	0.204	0.078	0.179	0.193
Observations	3,001	2,841	5,842	2,934	2,830	5,764	5,935	5,671	11,606
Clusters	1,599	1,597	3,196	1,562	1,572	3,134	1,860	1,895	3,755
Sargan test passed at 95%	Yes	No	No	No	Yes	Yes	No	No	No
Sargan test passed at 99%	Yes	Yes	Yes	No	Yes	Yes	No	Yes	No

Confidence intervals in parentheses. Confidence intervals at 95% using robust standard errors clustering by the parent respondent of the survey. All regressions include dummies for year-of-birth groups of five years each, for children. [1] Includes only the observations for which there is data on educational attainment for both maternal grandparents. [2] Includes only the observations for which there is data on educational attainment for both paternal grandparents. [3] Includes only the observations for which the educational attainment of both grandfathers is known. [4] Includes only the observations for which there is data on educational attainment for both maternal grandparents, which are used as instruments. [5] Includes only the observations for which there is data on educational attainment for both paternal grandparents, which are used as instruments.[6] Includes only the observations for which the educational attainment of both grandfathers is known, which are used as instruments.

Table 5. Educational Attainment for Three Generations: Mexican Health and Aging Study Sample

Generation and Gender	Obs.	Distribution across Educational Categories (%)				Years of Schooling	
		None	Some Elementary School	Elementary School	More than Elementary School	Mean	S.D.
Observations Included in IV Regressions:							
Generation 1 (Grandparents):							
Males	10,239	51.5	32.9	9.3	6.3	N.A.	N.A.
Females	10,341	57.9	29.6	9.0	3.5	N.A.	N.A.
Generation 2 (Parents):							
Males	7,035	15.8	24.3	13.2	46.7	4.76	4.62
Females	7,035	23.9	32.5	16.7	26.9	4.09	3.88
Generation 3 (Children):							
Males	15,698	5.7	12.7	21.8	59.8	8.89	4.79
Females	15,531	6.7	12.6	22.6	58.0	8.72	4.75
Observations Excluded from IV Regressions:							
Generation 3 (Children):[1]							
Males	2,843	7.9	14.4	24.2	53.5	8.26	4.84
Females	2,939	8.5	15.0	24.4	52.1	8.08	4.68

Includes observations for which the children were 25 years or older when the data on their educational attainment was collected (2001). [1] Excluded because the educational attainment of the parents or the grandparents was not reported.

Table 6. Intergenerational Transmission of Ability: Mexican Health and Aging Study Sample

Independent Variable:	Dependent Variable: Children's Years of Schooling								
	Males			Females			Both		
OLS Estimates, Full Sample									
Mother's Years of Schooling	.647			.653			.650		
(95% Confidence Interval)	*(.620,.673)*			*(.627,.680)*			*(.627,.673)*		
Father's Years of Schooling		.545			.557			.551	
(95% Confidence Interval)		*(.520,.571)*			*(.532,.583)*			*(.528,.574)*	
Parents' Average Years of Schooling			.704			.717			.710
(95% Confidence Interval)			*(.672,.736)*			*(.686,.749)*			*(.682,.737)*
R-square	0.259	0.273	0.306	0.295	0.299	0.335	0.275	0.284	0.318
Observations	16,508	11,720	9,707	16,394	11,546	9,489	32,902	23,266	19,196
Clusters	6,375	4,600	3,841	6,271	4,501	3,757	7,296	5,289	4,421
OLS Estimates, Sample Compatible with IV Estimates									
Mother's Years of Schooling[1]	.648			.661			.655		
(95% Confidence Interval)	*(.620,.677)*			*(.632,.690)*			*(.630,.679)*		
Father's Years of Schooling[2]		.536			.555			.545	
(95% Confidence Interval)		*(.507,.565)*			*(.527,.584)*			*(.520,.570)*	
Parents' Average Years of Schooling[3]			.678			.705			.690
(95% Confidence Interval)			*(.640,.716)*			*(.668,.742)*			*(.658,.723)*
R-square	0.271	0.278	0.308	0.311	0.307	0.349	0.289	0.290	0.325
Observations	13,015	9,081	6,398	12,919	8,947	6,335	25,934	18,028	12,733
Clusters	5,135	3,595	2,601	5,036	3,534	2,555	5,898	4,156	3,018
IV Estimates									
Mother's Years of Schooling[4]	.888			.909			.899		
(95% Confidence Interval)	*(.831,.944)*			*(.853,.964)*			*(.850,.948)*		
Father's Years of Schooling[5]		.652			.711			.680	
(95% Confidence Interval)		*(.599,.704)*			*(.652,.770)*			*(.631,.730)*	
Parents' Average Years of Schooling[6]			.790			.841			.815
(95% Confidence Interval)			*(.735,.845)*			*(.782,.900)*			*(.765,.865)*
R-square	0.242	0.268	0.301	0.279	0.289	0.339	0.258	0.276	0.316
Observations	13,015	9,081	6,398	12,919	8,947	6,335	25,934	18,028	12,733
Clusters	5,135	3,595	2,601	5,036	3,534	2,555	5,898	4,156	3,018
Sargan test passed at 95%	Yes	No	Yes	Yes	No	Yes	Yes	No	No
Sargan test passed at 99%	Yes	Yes	Yes	Yes	No	Yes	Yes	No	No

Confidence intervals in parentheses. Confidence intervals at 95% using robust standard errors clustering by the parental household. All regressions include dummies for year-of-birth groups of five years each, for parents and children. [1] Includes only the observations for which there is data on educational attainment for both maternal grandparents. [2] Includes only the observations for which there is data on educational attainment for both paternal grandparents. [3] Includes only the observations for which the educational attainment of all four grandparents is known. [4] Includes only the observations for which there is data on educational attainment for both maternal grandparents, which are used as instruments. [5] Includes only the observations for which there is data on educational attainment for both paternal grandparents, which are used as instruments.[6] Includes only the observations for which the educational attainment of all four grandparents is known, which are used as instruments.

Table 7. Summary of Results

Data	IV estimates	Downward Bias in OLS estimates[1]	Specifications that passed the test of exogeneity of IV at 95% (99%) confidence[2]
Health and Retirement Study	.33 to .42	3 to 20%	9 (9) out of 9
Wisconsin Longitudinal Study	.44 to .70	12 to 46%	3 (6) out of 9
Mexican Health and Aging Study	.65 to .91	14 to 27%	5 (6) out of 9

Source: Tables 2, 4 and 6. [1] Expressed as percentage of the IV estimates. [2] Sargan test.