CHAPTER 2

EDUCATION TRANSMISSION'S IMPACT ON EARNINGS TRANSMISSION

Abstract:

This chapter proposes and supports the view that the significant reductions in intergenerational earnings transmission that Brazil has experienced over the last half-century are a result of reductions in the intergenerational transmission of education.

To begin to understand how the intergenerational transmission of earnings can be influenced by public policy, it is critical that we investigate the pathways by which earnings are transmitted. This chapter uses a two-sample instrumental variable approach with rich household survey data to examine changes in the intergenerational transmission of earnings that have taken place in Brazil. Brazil is shown to exhibit substantial variation in earnings transmission across both time and region. This variation provides a unique opportunity for a within-country comparison of earnings transmission that incorporates analysis of the determinants of earnings transmission.

Variation in earnings transmission is examined in conjunction with potential determinants of earnings transmission hypothesized in the recent literature: the intergenerational transmission of education and the relative return to education. Both are found to be extremely useful in explaining changes in the transmission of earnings, together explaining over 90% of the observed variation across either time or region. While variation in return to education explains changes in the measurement of earnings transmission across age, variation in the transmission of education explains changes in the transmission of lifetime earnings across populations within Brazil. The reductions in Brazil's level of earnings transmission seen over the last half-century are found to coincide with reductions in the level of educational transmission. This finding is consistent with the view that educational attainment is one of the most significant pathways by which earnings are transmitted intergenerationally.

1. Introduction - Considering the Transmission of Education

Brazil presents an interesting case in which to study changes in the transmission of earnings. While it has particularly high levels of earnings transmission, it has experienced a rapid decline in the level of earnings transmission in recent years.

As seen in Chapter 1, the elasticity of sons' earnings with respect to the earnings of their fathers – the standard measure used to summarize the level of earnings transmission – was estimated to be between 0.53 and 0.69 when sons' earnings are observed at ages 25-34. This figure is higher than the 0.41 to 0.53 range estimated for the United States by Solon (1992) and higher than that found for most other countries. In Chapter 1, I also presented estimates of the elasticity of sons' lifetime earnings with respect to the lifetime earnings of their fathers by incorporating observations of sons and fathers of age 20 through 64, finding this elasticity, as estimated by two-sample instrumental variables, to be 0.85. This elasticity indicates that 85% of the gap in earnings between any two Brazilian fathers is expected to remain as a gap in the earnings of their sons.

Brazil's level of intergenerational earnings transmission, however, is significantly lower than that which existed several decades ago. This chapter utilizes data from three years of Brazilian household surveys in which sons' earnings are observed together with the educations of their fathers. The transmission of earnings can be calculated by two-sample instrumental variables methods, using father's education as an instrument for father's lifetime earnings. Continuous and significant reductions in the level of earnings transmission are observed between sons in the 1982, 1988, and 1996 data. When the age at which earnings are observed is held constant at 40, a 6% reduction in the intergenerational earnings elasticity is observed between those individuals born in 1942 and those born in 1948, while an additional 6% reduction is observed for those born in 1956. The analysis o f this chapter estimates the elasticity of lifetime earnings that will be experienced by the 1975 birth cohort to be 73% of that experienced by the 1935 birth cohort. Observations of the educations and earnings of younger sons indicate that this elasticity should be expected to continue to fall for decades more.

Why has the level of earnings transmission in Brazil fallen? This chapter presents the view that the reductions in the transmission of earnings over time in Brazil were due almost entirely to reductions in the transmission of education. That is, as *educational* outcomes became less dependent on birth status across cohorts, equality in *earnings* opportunity soon followed. Lam (1999, p.2) discusses this hypothesis, stating that an "unequal distribution of education, both in quantity and quality, is viewed as contributing to inequality in labor market earnings, and as a key factor in the intergenerational transmission of inequality". This view coincides with the

belief that education is a significant pathway by which earnings are transmitted across generations. A model is presented in this chapter in which education is a primary mechanism for the intergenerational transmission of earnings. In this model, parents with higher levels of earnings invest more in the education of their children than do less well-off parents, resulting in higher levels of educational attainment for their children. The increased education of these children then results in higher levels of earnings and thus the positive intergenerational correlation of earnings. The two primary determinants of the level of earnings elasticity in the model are the degree of intergeneration education transmission and the return to education.

In order to empirically evaluate the implications of this model, I examine the intergenerational transmission of earnings, intergenerational transmission of education, and return to education for males between age 20 and 64 in cross-sectional surveys of 1982, 1988, and 1996. The return to education is found to vary significantly across the age at which earnings are observed, but varies little across year of observation. The transmission of education, on the other hand, varies across cohorts of individuals but remains relatively stable as a single cohort ages. The intergenerational earnings elasticity varies significantly across both age and birth cohort.

I divide this sample into 27 groups by survey year and five-year age intervals and find that 96% of the variation in the intergenerational transmission of earnings across groups is explained by linear intergenerational transmission of education and return to education terms. Each 0.02 unit increase in the return to education (the difference observed between 30 and 50-year-old males) is found to increase the intergenerational earnings elasticity by 0.08 (the increase observed between using earnings at age 30 and 50). A 0.38 reduction in the intergenerational transmission of education (the reduction observed between the 1935 and 1975 birth cohorts) is found to decrease the intergenerational earnings elasticity by 0.28 (the decrease observed between these cohorts). The significance of these relationships holds even when age and year are controlled for. These results support the view that the return to education influences the measurement of earnings elasticity at a particular age, while the level of intergenerational education transmission determines the transmission of lifetime earnings experienced by a particular cohort.

In an alternative estimation strategy, I compare variation in earnings transmission at a single point in time across individuals born in three distinct regions of Brazil. The causal impact of the intergenerational transmission of education on reductions in intergenerational earnings transmission is further supported by this analysis. Again dividing individuals into 27 groups, this time by three regions of birth and five-year age intervals, I estimate the effect of education

transmission and return to education on the intergenerational transmission of earnings to be equivalent to that estimated using variation across time.

The findings of this chapter are consistent with a model of the intergenerational transmission of earnings through education transmission and the view that Brazil has significantly reduced its level of earnings transmission through increases in the equality of educational attainment.

In the next section, I describe the data and methods used to estimate the intergenerational transmission of earnings, the intergenerational transmission of education, and the return to education. Section 3 then reports the estimates of earnings elasticity and outlines variation across both time and region of birth. Section 4 examines the relationship between earnings elasticity and education transmission and return, finding variation in the intergenerational transmission of education and the return to education to fully explain the observed variation in the intergenerational transmission of earnings. Section 5 concludes the chapter.

2. The PNAD Data and Empirical Methods

The principal requirement of data to be used in the analysis of intergenerational earnings mobility is the joint observation of fathers' and sons' earnings. Many researchers have used panel data to provide this information, while others have used census data, income tax records, or other data that specifically link the earnings of fathers and sons. Large-scale data linking fathers' and sons' earnings is largely unavailable for the developing world, however, contributing to the current scarcity of mobility studies for these countries. In this section, I describe the household survey data and two-sample instrumental variables method of estimation that allow me to examine changes in the transmission of earnings in Brazil.

2.1 The PNAD data

Estimates of intergenerational mobility in Brazil in this chapter are again based on data from the *Pesquisa Nacional por Amostra de Domicílios* (PNAD), a repeated cross-section annual household survey of approximately 400,000 individuals per year. While individuals are included in the PNAD sample with a likelihood that varies by place of residence, all analyses of this chapter weight individuals according to this probability, making the sample representative of all Brazil excluding the sparsely-populated (and not sampled) rural North. The survey contains basic demographic and labor market data, including the education and labor market earnings of all individuals over age ten. The 1982, 1988, and 1996 PNAD surveys asked all heads of household and their spouses to report the highest level of education completed by each of their parents. As in Chapter 1, I use the information on a father's level of education as a pivot point in order to link the earnings of fathers to those of their sons. I relate fathers' reports of their own education to fathers' earnings, while I related sons' reports of their fathers' education to sons' earnings, connecting the earnings of one generation and the next through fathers' education.

2.2 The TSIV method

In this chapter I employ the same two-sample instrumental variables (TSIV) method of intergenerational mobility estimation as I did in Chapter 1, using father's education as an instrument for father's lifetime earnings. As opposed to traditional instrumental variables estimation performed using a single sample, TSIV uses one sample of individuals to estimate the first stage equation – the relationship between fathers' earnings and fathers' education – and a second sample to estimate the second stage equation – the relationship between fathers' predicted earnings (based on fathers' education) and sons' earnings. The sample used in the first-stage regression need not be the actual fathers of sons observed in the second-stage sample. This

allows the use of cross-sectional surveys that do not explicitly link son's and father's earnings, instead requiring only that a piece of information (such as father's education) is shared between the two samples. The requirement for consistency of earnings elasticity estimates in the application of TSIV is only that the relationship between fathers' earnings and fathers' education in the first-stage sample represent that same relationship for the true fathers of the observed sons. While this requirement cannot be tested when the earnings of the true fathers are not observed, it is in part addressed by selecting the first-stage sample to have observable characteristics similar to those the true fathers are expected to hold.

Angrist and Krueger (1992) and Arellano and Meghir (1992) first showed that moments from multiple data sets may be combined for consistent IV estimation. Dearden, Machin, and Reed (1997) and Björklund and Jäntti (1997) applied a similar framework to intergenerational mobility estimation. They each perform a two-stage least squares estimate across two independent samples. Dearden, Machin, and Reed used fathers' education as instruments for fathers' lifetime earnings with British data. Björklund and Jäntti estimated intergenerational mobility in Sweden using eight categories of fathers' occupations, whether the fathers attained higher than compulsory education, and whether the fathers lived in Stockholm as instruments for fathers' lifetime earnings. Björklund and Jäntti also used fathers' education and occupations as instruments with PSID data and compared results for Sweden to those of the U.S.

In this chapter (unlike Chapter 1), six categories of fathers' education instrument for fathers' lifetime earnings: 0 years of completed education, 1-3 years (incomplete lower primary), 4 years (complete lower primary), 5-8 years (at least some upper primary), 9-11 years (at least some secondary), and 12 or more years (at least some post-secondary education).[1] While this question was posed to all heads of household, not all individuals were able to answer it. Father's education was not reported by 13% of heads of household age 20 to 64 surveyed in 1982, 16% of heads of household age 20 to 64 surveyed in 1988, and 25% of heads of household age 20 to 64 surveyed in 1996. The potential for biases caused by these missing reports is examined in Section 3.1.

2.3 Father and son samples

The sample of individuals used in the first-stage estimation will establish the relationship between fathers' education and fathers' earnings. The objective in the selection of this sample of

[1] In the 1996 survey, father's education is reported in ten categories, dividing some of the categories reported above. For consistency, I collapse these ten categories into the same six reported in the 1982 and 1988 surveys.

representative fathers is that the observed relationship between education and earnings most accurately reflect the relationship between the education and lifetime earnings of the true fathers of the sons used in the second-stage regression. As the relationship between education and earnings is quite stable over time[2], an estimate of this relationship formed using males between the ages of 30 and 50 observed in 1976 is likely to be a good approximation of the relationship between lifetime earnings and education for the fathers of all samples of sons used in this paper. 1976 is chosen because it is the first year of data available, while the age range of 30 to 50 is chosen because earnings at these ages are likely to reflect lifetime earnings well. In Chapter 1, I investigated the validity and effects of this choice of representative fathers for the first-stage sample.

The sample of sons that I use in the second stage of the TSIV regression includes individuals from age 20 through 64 in 1982, 1988, and 1996. Examining individuals from this large age range is vital to both the separation of age effects from cohort/time effects and the identification of the intergenerational transmission of lifetime earnings. As seen in Chapter 1, the age at which sons' earnings are observed has a significant impact on the level of intergenerational earnings transmission that will be estimated. This observation is elucidated through a model of sons' earnings in which log earnings at a particular age, y_i^a, equal the log of their lifetime earnings, y_i^L, multiplied by a scaling factor, λ^a:

(1) $$y_i^a = \lambda^a y_i^L + \varepsilon_i^a \cdot$$

As the earnings of all sons follow this pattern, Equation 1 can also be viewed as indicating that the difference in log earnings between any two sons (or equivalently the standard deviation of the distribution of log earnings) at a particular age will equal the gap in log lifetime earnings multiplied by the lambda for the age at which earnings are observed. Thus, as lambda changes across age, observed intergenerational earnings elasticity will also differ across age, varying directly with the lambda corresponding to the age at which sons' earnings are observed:

(2) $$p\lim \hat{\beta}^a = \lambda^a \beta^L \cdot$$

In section 3.4, the effect of the age at which earnings are observed on the estimate of earnings elasticity is separated from changes occurring across birth cohorts. It is the change in lifetime elasticity across birth cohorts that is of most interest, as opposed to the measurement considerations of observed changes across age.

[2] As was shown in Chapter 1, the relative return to each year of schooling typically changes by less than 20% between 1976 and 1996.

3. Changes in Transmission over Time and across Birth Regions

This section describes the reduction in the intergenerational transmission of earnings that has occurred over the past half-century in Brazil. After discussing the second-stage sample and estimating equations, it describes variation in the intergenerational earnings elasticity across age, cohort, and place of birth.

3.1 Sample selection

The sample of sons used in this chapter consists of males between the ages of 20 and 64 in 1982, 1988, and 1996 with positive earnings[3] and a report of their father's education. **Table 1** outlines the selection of observations into this sample. The majority of males of age 20-64 in each year fall into the category of head of household or spouse and were thus asked the highest level of education of their father. In 98% of the cases these individuals are the head, so I refer to both male heads and male spouses as heads. Of these individuals, those in column ii of Panels A, B, and C of Table 1 both report their father's education and have positive earnings, and are thus included in my sample.

Because three separate years of data are used to analyze changes in earnings transmission across cohorts, I am especially concerned with how changes in sample selection may alter estimates of transmission across time. There are essentially three dimensions by which this sample is selected. Using the case of the 1996 data, shown in Panel C, I examine the effects of each selection dimension. First, individuals must be the head of a household. 25% of all individuals do not meet this requirement. The summary statistics indicate that this dropped group is relatively young and is disproportionately not working. The second dimension on which the sample is selected is the voluntary reporting (or knowledge) of father's education for household heads. The individuals excluded from the sample by this requirement (19% of all individuals) report relatively low levels of earnings. Both the first and second selection dimensions could cause biased estimates of mobility if the relationship between fathers' education and sons' earnings differ between those individuals dropped from the sample and those that remain. As father's education (and thus any measure of earnings) is unavailable for sons dropped by the first and second selection criteria, we unfortunately can not tell whether the dropped individuals are unrepresentative of the population in terms of the similarity between sons' and fathers' earnings.

[3] I use "earnings from all jobs", measured in monthly Brazilian Reals, as my measure of earnings throughout this paper. I convert all values to 1996 Reals using the IBGE official price deflator (1976/1996=4.94, 1982/1996=117, 1988/1996=158).

The third dimension on which sons are selected into the sample is the reporting of positive earnings, a necessary selection requirement if log earnings are used in the analysis. An additional 8% of all individuals are dropped from the sample as a result of this requirement. This standard of selection (and magnitude of selection) is consistent most other studies of intergenerational earnings mobility. The requirement of positive earnings for inclusion in the sample is justified by more than necessity for the use of standard estimation methods. Reports of zero earnings for Brazilian males are frequently a result of temporary unemployment. While these unemployment spells will certainly have an effect on lifetime earnings, they are not an indicator that the lifetime earnings of these individuals will be near zero. Assigning unrepresentatively low values of earnings to the temporarily unemployed (when using these earnings as approximations of lifetime earnings), could inappropriately designate these individuals as having among the lowest lifetime earnings. This inappropriate designation could significantly bias estimates of the intergenerational elasticity of earnings. The alternative that I choose to follow, as I did in Chapter 1, is to drop individuals with no reported earnings from the sample.

3.2 TSIV estimates of earnings transmission

I obtain the first-stage relationship between fathers' earnings and fathers' education through a standard education-earnings regression on 30-50 year-old males with positive earnings in 1976:

(3) $$y_{0i} = \alpha_0 + \chi_1 E_{0i} + \chi_2 age_{0i} + \chi_3 age_{0i}^2 + \varepsilon_{0i}.$$

In this equation, y_0 represents the natural log of fathers' earnings and E_0 represents the vector of six dummy variables for the level of education. Age_0 and age_0^2 control for the age of fathers (within the 30 to 50 year-old range). The results of this regression, which is the regression that was used in the first-stage of Chapter 1, are presented in **Table 2**. As heteroskedasticity was found to be present, robust standard errors are reported. This table clearly indicates the strong dependence of earnings on education in Brazil. The earnings of males with some post-secondary education are 2.5 log points higher (or 12 times greater) than males with no schooling. Substituting a linear education term for the categorical values results in a coefficient estimate of 0.17, quite high by international standards.

The second stage of the TSIV process uses the estimated $\hat{\chi}_1$ vector from Equation 3, along with sons' reports of their fathers' education, to predict fathers' log earnings, y_0^p. The

second-stage procedure entails an OLS regression of sons' log earnings on fathers' predicted log earnings and controls for sons' age:

(4) $$y_{1i} = \alpha_1 + \beta_1 y_{0i}^{p} + \beta_2 age_{1i} + \beta_3 age_{1i}^{2} + \varepsilon_{1i}.$$

The estimated $\hat{\beta}_1$ from Equation 4 is the TSIV estimate of intergenerational earnings elasticity. As an illustration of a single second-stage regression, the results of the second-stage regression using sons of age 40-44 in 1996 are presented in **Table 3**. Because the predicted values of fathers' earnings are used in this regression, the computer-reported standard error of $\hat{\beta}_1$ (which is 0.022) will be inconsistent, as Pagan (1984) describes. I therefore report the bootstrap standard error estimate of 0.026.[4] The TSIV estimated intergenerational earnings elasticity for males 40 to 44 in 1996 reported in Table 3 is 0.92. This value, higher than what is typically seen in almost any other country, demonstrates the significant intergenerational transmission of earnings that has occurred in Brazil.

3.3 Earnings transmission estimates across age

As mentioned in Section 2.3, estimates of the level of earnings transmission are expected to vary significantly with the age at which sons' earnings are observed. **Figure 1** indicates the significance of this effect. This figure plots the elasticity estimates and 95% confidence intervals of 45 TSIV regressions in which the sample of sons (second-stage sample) is varied while the sample of fathers (first-stage sample) is held constant. The sample of sons in each regression consists of male heads of household of a particular age range with positive earnings and a report of their father's education. The particular age range is an eleven-year span[5] with a midpoint that varies from 20 through 64. The elasticity estimates from each regression are graphed according to the midpoint of the age range of sons.

Figure 1 shows that estimates of the intergenerational earnings elasticity grow from 0.60 for sons of age 20 to as high as 1.00 for sons of age 50. Because year is held constant at 1996, differences across age will be due to both age and cohort effects, an issue examined in the next

[4] The bootstrap standard error was calculated as follows: First, a random sample of fathers was drawn (with replacement) from the sample of representative fathers equal in number to the sample size (N=37,396). The relationship between fathers' earnings and education was estimated using this sample. Then, a random sample of sons was drawn (with replacement) equal in number to the sample size (N=6,218). Fathers' earnings were imputed using the relationship between fathers' earnings and education established by the first sample. A single point estimate of the intergenerational elasticity of earnings was then calculated. This process was repeated K=1,000 times and the sample standard deviation was used as the bootstrap standard error.

[5] While the broad eleven-year span beneficially increase sample size (and makes the graph smoother) it also introduces slight sample selection effects on age. The mean age of the sample of sons age 15 through 25 is 22.7.

section. The magnitude of the observed changes indicate that the age at which sons earnings are observed plays a crucial role in the determination of the level of elasticity that will be estimated.

The sample of sons used in the analysis of this chapter consists solely of household heads, unlike the sample used in Chapter 1 that also included sons living in a household headed by their father. This distinction is predominantly important at young ages – just 22% of the 20-year-old sons included in the sample of Chapter 1 were heads of household (while 97% of the 40-year-olds were). The difference in samples accounts for the differences reported between chapters in the estimated elasticity for young sons, a gap that is eliminated as sons age. In Chapter 1, I report a 0.15 lower elasticity for sons of age 20, a 0.10 gap at age 25, and a 0.05 gap at age 30.

Ferreira and Veloso (2003) also note the decrease in intergenerational transmission (they examine the transmission of wages) observed across cohorts of Brazilian sons seen 1996, noting a decline of almost 30% between the 1932-36 (age 60-64 in 1996) birth cohort and the 1967-71 (age 25-29) birth cohort. Though Ferreira and Veloso interpret this decline in elasticity as a cohort reduction, they note (p. 18), "the impossibility of identifying cohort and age effects from a cross-section of just one year." In the following section, I present analysis that overcomes this obstacle by encompassing measures of the intergenerational elasticity of earnings utilizing data from the 1982, 1988, and 1996 PNAD surveys. The consequent separation of true cohort reductions in the transmission of earnings from life-cycle measurement effects proves valuable to the estimation of the determinants of earnings transmission.

3.4 Changes in lifetime earnings elasticity across cohorts

In the PNAD surveys of 1982, 1988, and 1996, all heads of household are asked to report their parents' levels of education. TSIV estimates of mobility can therefore be estimated in each of these years. **Figure 2** plots these elasticities, estimated by the methods described in the previous section (those of 1996 are identical to Figure 1). The sample of fathers consisted of males age 30 through 50 with positive earnings observed in 1976 in the regressions of each of the three years. Holding the sample of fathers used in the first-stage regression constant maintains the same relationship between fathers' earnings and fathers' education, an assumption largely supported by empirical observation. The variation in elasticity estimates observed over time is therefore a result of changes in the relationship between fathers' education and sons' earnings.

The elasticity age profile is fairly similar in each of the three years. Although the peak of the elasticity estimates is much earlier in 1982 (at age 38) than it is in 1988 (age 47) or 1996 (age 51), a concave profile of estimated elasticity is present in each year between the ages of 20 and

55. Elasticity estimates formed using sons of 40 to 50 are roughly 60% greater than those using sons of age 20. The increases in elasticity observed after age 55 in all three years is due to significant increases in the variance of log earnings, in part a result of the reduction in work hours by some individuals. At almost any age between 20 and 45, the elasticity estimated for 1982 is significantly greater than that estimated for 1988, which is in turn greater than that estimated for 1996. At age 35, where these differences are quite large, elasticity was estimated to be 0.96 in 1982, 0.88 in 1988, and 0.82 in 1996 (an interesting pattern).

The changes seen in elasticity across time are likely the result of changes in the underlying elasticity of lifetime earnings across birth cohorts. **Figure 3**, which displays the data used in Figure 2 in cohort (rather than year) form, shows significant reductions in elasticity across cohorts, visible at ages 25 through 45.

Modifying Equation 2, which described changes in elasticity estimates across age, The following equation models earnings elasticity for a particular birth cohort, c, at a particular age, a, as a function of the elasticity of lifetime earnings for this cohort and a return to education age-specific lambda coefficient:

(5) $$p\lim \hat{\beta}_c^a = \lambda^a \beta_c^L.$$

Using this equation in log form, I estimate the separate effects of age and cohort on the elasticity estimates shown in Figures 2 and 3. I regress the 135 log elasticity estimates at single ages from 20 through 64 in 1982, 1988, and 1996 on linear and squared terms for the log of age at which individuals are observed and the log of the birth cohort to which individuals belong. The results of this regression are displayed in Figures 4 and 5.

Figure 4 plots the estimated partial effect of age of earnings observation on elasticity, holding the cohort constant at the 1948 birth cohort. The results indicate that elasticity estimated for any cohort of individuals across their life-cycle is expected to peak near age 45. Estimates using earnings observed at age 20 will be just 75% of those seen at age 45, while those using earnings at age 30 are expected to be just over 90% of those at age 45.

Figure 5 plots changes in elasticity estimated across birth cohorts when age of earnings observation is held constant at 40. As this figure shows, individuals born in 1935 are estimated to have experienced a 38% higher level of earnings elasticity than individuals born in 1975. In other words, elasticity is shown to have fallen by nearly 30% across a 40-year span of individuals. Section 4 will examine the possibility that changes in the intergenerational transmission of education are responsible for this decrease in intergenerational earnings transmission across cohorts.

Using 20-64 years-olds observed in the 1982, 1988, and 1996 PNAD surveys, I form the sample of sons which will be used to examine changes in earnings elasticity across time. This full sample of sons consists of 178,422 individuals, which I divide into 27 groups, by year of observation and five-year age clusters. For each of these groups, I then estimate the intergenerational earnings elasticity by TSIV. I continue to use the same sample of representative fathers in the first stage of this regression. The sample sizes and resulting intergenerational elasticity estimates of each group are presented in the **Table 4**. As was shown in Figures 2 through 5, significant reductions in earnings elasticity are observed across time, while the effect of age of earnings observation on elasticity estimates is also present.

3.5 Changes in lifetime earnings elasticity across region of birth

The 1988 and 1996 PNAD surveys, in addition to asking sons to report their fathers' education, include a question asking all respondents to report the state in which they were born. This information allows the examination of differences in intergenerational earnings transmission across place of birth. Brazil's vast 8.5 million km^2 landscape is home to 180 million people, with diversity across Brazil as large as across other continents. This variation can prove extremely useful when examining differences in earnings transmission across place of birth within Brazil. Related work by Ferreira and Veloso (2003) has found that the intergenerational wage mobility of sons in Brazil varies significantly across regions. Ferreira and Veloso find wage mobility to be higher for individuals living in the Southeast of Brazil than for those living in the Northeast, a result consistent with my findings reported below. They also find significant differences in intergenerational wage mobility across individuals by race, finding higher mobility for blacks than for other racial groups, an issue that this chapter does not investigate.

I compare individuals across place of birth in this paper, as opposed to place of residence, as significant migration has occurred in the last half-century in Brazil. I want the grouping of individuals to reflect differences in the education system individuals experienced during their schooling, as I compare intergenerational earnings transmission to intergenerational educational transmission. When individuals have moved, I believe it more likely that they were educated in the region of birth than the region of current residence.

Although both 1988 and 1996 data may be used in cross-region comparisons, aggregating the data would confound regional differences with time trends. I therefore choose to analyze each year separately, and focus on the use of the 1996 survey. I will, however, also report the results obtained using the 1988 data. Choosing the sample of sons observed between age 20 and 64 in 1996 with positive earnings, reports of father's education, and birth within Brazil, results in just

under 40,000 observations. To maintain sample size, I choose to cluster states of birth into three main regions of Brazil: the West, Northeast, and South.[6] Supporting this choice, I find the degree of variation in both earnings elasticity and the determinants of mobility to be higher across regions of birth than across states of birth within regions.

Table 5 presents summary statistics outlining some of the differences between the individuals of the three regions used in this analysis. The South region (containing both Rio de Janeiro and São Paulo) makes up 59% of the country's population. This region is also the region with the highest mean age, mean education, fraction of females working, and earnings for both males and females. The West region (which contains the capital of Brazil, Brasilia) is not far behind the South in terms of education and earnings. It is the most highly urbanized region largely due to the exclusion of the rural population of some of its states in the PNAD sample. The Northeast region clearly lags behind the other two in terms of education and earnings. Perhaps a testament to the lack of earnings opportunity (as well as it not sharing a foreign border), 98% of all individuals of age 30-49 living in the Northeast were born there.

Figure 6 plots estimates of earnings elasticity by birth region across age. At any age, it is clear that those individuals born in the Northeast region experienced the highest levels of intergenerational earnings transmission, with elasticity estimates climbing above 1.00 in the 40 to 50 year-old age range. Those individuals born in the West region experienced the lowest levels of earnings transmission, though levels still quite high by international standards. The sample sizes and resulting intergenerational elasticity estimates of each of the 27 groups used in the comparative analysis are presented in the **Table 6**. Estimates of earnings elasticity for the group of individuals of age 20-64 combined born in each region are also presented in Table 6. These estimates summarize the finding of the highest level of earnings transmission for individuals born in the Northeast, followed by those born in the South, with the lowest levels found for those born in the West. These results are consistent with those of Ferreira and Veloso (2003), who estimate intergenerational wage elasticities for individuals living in the Northeast, Southeast, South, and Central-West (the Southeast and South are combined as the South region in this chapter, while the Central-West, together with the North, form the West region in this chapter). Using estimation methods similar to those of this chapter[7], Ferreira and Veloso estimate the intergenerational

[6] What I call the West region consists of those states in the traditional North and Central-West regions, while the South region includes the traditional Southeast and South regions. The PNAD does not sample individuals in rural areas of the North region

[7] Ferreira and Veloso use a TSIV method of estimation and samples of individuals similar to those of this paper. They use information on both father's education and father's occupation (at the time the son was 15), categorizing occupations into six categories according to occupational prestige. The samples of first-stage fathers and second-stage sons used by Ferreira and Veloso also differ slightly from those of this

elasticity of wages for sons 25-65 to be 0.75 for individuals living in the Northeast, 0.56 for individuals in the Southeast, 0.65 for individuals in the South, and 0.58 for individuals living in the Central-West. The analysis of the next section examines the link between differences in earnings transmission across region of birth and differences in the level of education transmission.

paper. For the first-stage, they select males 25-65 working 40 or more hours per week in all jobs and living in urban areas as the sample of representative fathers, combining individuals present in the 1976, 1981, 1986, and 1990 PNAD surveys that fit these criteria. For the second-stage sample of sons, Ferreira and Veloso select males in the 1996 PNAD survey reporting their father's education and occupation, working 40 or more hours per week in all jobs, and living in urban areas. Their second-stage regression includes controls for race.

4. Educational Mobility as a Determinant of Earnings Mobility

There are a number of potential pathways the intergenerational transmission of earnings can, and likely does, take. There are genetic factors, such as ability and physical attractiveness, passed from parents to child. There are experiences, traits, and knowledge children gain through growing up with their parents. And there are experiences that parents provide children indirectly. In this last category fits the most significant experience of most children's lives - education. In Brazil education is an experience that both results in significant return in the labor market and is provided severely disproportionately according to the income of one's parents. Education may therefore be the most significant pathway by which earnings are transmitted across generations. Furthermore, it is the mechanism by which Brazil may have achieved the 30% reduction in the intergenerational transmission of lifetime earnings observed across forty years.

4.1 The transmission of earnings through education

Most researchers who have theoretically addressed the determinants of intergenerational mobility have employed human capital acquisition models similar to that laid out by Becker and Tomes (1979). Becker and Tomes model private investments in the human capital of children as a function of parents' earnings and the value parents place on their children's consumption, relative to their own. In one of the most recent papers of this genre, Solon (2003) models human capital attainment as a function of investments made by parents and government and an individual specific level of human capital endowment. Solon shows the intergenerational elasticity in a particular society at a point in time to be a function of the return to human capital, the productivity of investments made to human capital, the progressivity of public investment in human capital, and the heritability of human capital endowment. I present a considerably simplified version of Solon's model to investigate the impact of the progressivity of human capital attainment and the return to human capital on the intergenerational transmission of earnings.

The following equation models a son's level of human capital attainment as a function of parental investments (I_{oi}), government investments (G_{0i}), and an inherited human capital endowment (e_{1i}):

(6) $$h_{1i} = F(I_{0i} + G_{0i}) + e_{1i}.$$

We may expect that both parental investments in human capital and the inherited endowment of human capital will be increasing in fathers' earnings. It is unclear whether government investments are increasing with fathers' earnings and especially whether the marginal impact of

government investments would be greater for sons of richer or poorer fathers (especially if the investment transformation function is concave). The relative progressivity (with respect to fathers' earnings) of parental and government investment, the investment transformation function F, and the progressivity of inherited human capital endowment determine the progressivity of human capital attainment, or in other words, the intergenerational transmission of human capital. In the empirical analysis of this chapter, I assume no functional form for the transformation of investments to human capital, and instead examine human capital attainment (not investments) in the empirical analysis.

The following equation models a son's lifetime log earnings as equal to a constant term plus his level of human capital multiplied by the return to human capital (*p*):

(7) $$y_{1i}^{L} = \mu + ph_{1i}.$$

If the return to human capital decreases, while holding the variance of this return constant, each son's earnings will depend to a greater extent on the constant term, and cross-sectional inequality of earnings will be reduced. An *increase* in the return to human capital would create greater dispersion in sons' earnings and would thus be expected to increase the estimated intergenerational earnings elasticity. The partial derivative of sons' log earnings with respect to fathers' log earnings (or the intergenerational earnings elasticity) will equal the return to human capital multiplied by the partial derivative of sons' human capital attainment with respect to fathers' earnings:

(8) $$\partial y_{1i}^{L} / \partial y_{0i}^{L} = p^{*}(\partial h_{1i} / \partial y_{0i}^{L}).$$

Differences in intergenerational mobility across countries, regions within a country, or across time may therefore be seen as a result of differences in the return to human capital, and the intergenerational transmission of human capital.

4.2 Estimation methods

Using completed years of education as a proxy for human capital, I estimate both the return to education and the intergenerational transmission of education as measures by which to evaluate the model presented in the previous section. These variables are estimated for each group within the samples of individuals used in the analysis of changes in intergenerational earnings transmission across time and across region of birth.

I estimate the return to education through a standard regression of log earnings on a linear education term and controls for age:

(9) $$y_i = \alpha + \phi_1 educ_i + \phi_2 age_i + \phi_3 age_i^2 + \varepsilon_i .$$

The estimated $\hat{\phi}_1$ coefficient is the linear return to education. Examples of this coefficient are the 0.16 estimate for all 40-44 year-olds in 1996 and the 0.13 estimate for 40-44 year-olds in 1996 born in the West region of Brazil.

As a summary measure of the intergenerational transmission of education, I use the slope coefficient obtained by a regression of sons' education on fathers' education:

(10) $$educ_{1i} = \delta + \gamma_1 educ_{0i} + \upsilon_{1i}.$$

Examples of this estimate are the 0.88 slope coefficient estimated for all 40-44 year-olds in 1996 and the 1.02 slope coefficient estimated for 40-44 year-olds in 1996 born in the Northeast region of Brazil.

4.3 Explaining changes in earnings transmission over time

Brazil has seen rapid expansion of schooling institutions and significant growth in completed education in the past fifty years. The growth in schooling is apparent in the gap in education between sons and their fathers, as was seen in Table 1. As Panel C of Table 1 showed, 20-64 year old male heads of household reported a mean value for their fathers' education of just 2.43 years of completed schooling. The sons themselves had mean schooling of 5.86 years, well over twice as much. More recent advances in schooling can be seen through the comparison of 30-34 year-old males from 1976 through 2002, as show in **Figure 7**. This figure plots, for 1976, 1982, 1988, 1996, and 2002, the percent of the population who had attained each grade or higher. Continual significant advances in the educational attainment of each grade through grade eleven (the completion of secondary school) can be seen throughout this time period (the lack of advancement in attainment of college and post-graduate schooling after 1982 is, however, quite startling). While in 1976 just over half of males 30-39 had attained at least four years of schooling (the typical grade at which lower primary schooling is completed), nearly 80% of individuals had in 2002, 26 years later. Similarly, while under 20% of individuals in 1976 had completed upper primary schooling (with eight or more years of education), nearly half of all individuals in 2002 had. Finally, the percent of individuals completing secondary schooling (at grade eleven) has grown from 12% in 1976 to over 30% in 2002.

While the growth in educational attainment has been rapid, the relationship between fathers' and sons' education is remarkably stable across time. **Figure 8** shows the mean value of the education of sons (age 30-49) for each of the six reported levels of fathers' education in 1982, 1988, and 1996. This concave curve has remained relatively stable across this period of growth in mean education, though the mapping appears slightly more progressive in the 1988 and 1996

data than in that of 1982. The pluses on Figure 8 mark the mean values of sons' and fathers' education in each year (with increasing values across time). In the 14 years between 1982 and 1996, the mean education of sons 30-49 increased from 4.4 years to 6.2 years, while that of their fathers increased from 1.6 years to 2.6 years. Increases in mean educational attainment across time can be largely explained by increases in parental education. As the 45° line helps to indicate, an amazing pattern is shown in which sons complete, on average, one *level* of schooling greater than what their fathers did. That is, fathers with no schooling tend to have sons who complete lower primary (4 years), who have sons who complete upper primary (8 years), who have sons who complete secondary school (11 years), whose sons complete two years of college.

The stability of the relationship between fathers' and sons' earnings may appear to indicate that the transmission of education is not changing across time, which is true in a sense. On the other hand, however, the concavity of this relationship means that the slope of the relationship differs at different points along the curve. If fathers' mean education is changing over time (as is indeed the case), then the marginal increase in sons' education for a given increase in fathers' education (the slope of sons' education with respect to fathers' education) will decrease over time. If the return to each year of education is approximately equal (which is also the case) then smaller differences in sons' education will translate directly into smaller differences in sons' log earnings (and, all else equal, decreases in earnings elasticity). For this reason, the slope coefficient of sons' education regressed on fathers' education is the measure I choose to represent the intergenerational transmission of education.

Table 7 reports the estimated levels of intergenerational education transmission (the slope of sons' education regressed on fathers' education) for 20-64 year-olds in 1982, 1988, and 1996. Looking at individuals 40-44, for example, shows an estimated slope coefficient for the regression of sons' education on fathers' education of 0.95 in 1982, 0.93 in 1988, and 0.88 in 1996. Table 7 also shows that the level of education transmission remains relatively constant as any particular birth cohort ages. Interestingly, the intergenerational education transmission slope is shown to decrease both between 1982 and 1988 and between 1988 and 1996. As Figure 8 showed, the relationship between fathers' and sons' education remained stable between 1988 and 1996. This pattern indicates that the change in education transmission over the 1988 to 1996 period was the sole result of movement along the education transmission curve and not due to a shift in it.

It should be noted that these levels of educational transmission are extraordinarily high by international standards. Lam (1999) has compared the intergenerational transmission of education in Brazil and South Africa, two countries with nearly the highest level of cross-

sectional inequality in the world. He finds that there exists a much steeper slope for the relationship between mother's education and children's education in Brazil than in South Africa. For South Africa, Lam finds the mean years of schooling of 17-year-olds of mothers with no schooling to be 7.7 years, while the mean schooling of children of mothers with 15 or more years of schooling was 10.7 years, 39% higher. In contrast, the mean schooling of 17-year-olds of mothers with no schooling in Brazil is 3.8 years, while that of children of mothers with 15 or more years of schooling is 9.4 years, a full 147% higher. Lam goes on to note (1999, p. 17) that, "the much stronger relationship between parent's education and children's education in Brazil is potentially an important factor in the intergenerational transmission of inequality".

In order to examine changes in the transmission of education in Brazil graphically, I estimate changes in the transmission of education across cohorts through a regression of education transmission estimates for 20-64 year-olds in 1982, 1988, and 1996 on a cohort and cohort-squared term and controls for the year of observation. The resulting cohort coefficient estimates are plotted in **Figure 9**, which compares these estimates to the cohort coefficient estimates for earnings elasticity presented in Figure 4. The shapes of the overall relationships appear quite similar, foreshadowing the relationship between earnings transmission and earnings elasticity that will be seen in more detailed regressions below.

Empirical analysis shows the value of return to education to vary across age for any cohort of individuals, while the return is relatively stable across time holding age constant. Table 7 reports the return to education estimated for each of the 27 year-by-age groups. The return varies extensively by age, peaking around ages 45-49. The returns appear relatively stable across cohort but are slightly lower in 1996 than in either 1982 or 1988. A regression of return to education estimates for 20-64 year-olds in 1982, 1988, and 1996 on an age and age-squared term and controls for the year of observation provides the estimates of changes in return to education across age shown in **Figure 10**. As this figure shows, changes in return to education across age match closely with changes in earnings elasticity. This relationship was seen in the US in another study that empirically investigated the determinants of mobility. Reville (1995) used the PSID to show that estimates of mobility in the United States across both age and time are closely related to the college / non-college earnings ratio.

The relationships between the intergenerational earnings transmission, intergenerational education transmission, and return to education can be used to establish the association between the intergenerational transmission of lifetime earnings and the intergenerational transmission of education. Using a single observation for each of the 27 year-by-age groups made of 20-64 year-olds in 1982, 1988, and 1996 presented in Tables 4 and 7, I regress estimated intergenerational

earnings elasticity on linear education transmission and return to education terms. The results of this regression are shown under the heading Regression 1 in **Table 8**. The estimated coefficients on return to education and the intergenerational education slope are both significant at the 1% level. The R^2 value of this regression is an astonishing 0.96, indicating that variation in intergenerational mobility across age and time is almost fully explained by variation in these two determinants.

The estimated coefficients on education transmission and return are quite large. A change of one unit of education transmission results in a 0.74 unit change in elasticity. This implies that a change in the intergenerational education slope of 0.38 units, the difference observed between the 1935 and 1975 birth cohorts, is estimated to increase earnings elasticity by 0.28 units, the change in elasticity observed across these cohorts. The estimated coefficient of 3.91 for the return to education is also quantitatively significant. Each 0.02 unit increase in the return to education, the difference observed between 30 and 50-year-old males, is found to increase the intergenerational earnings elasticity by 0.08, the increase observed between using earnings at age 30 and 50.

As was apparent from Table 7, education transmission changes significantly across cohorts, while return to education varies across age. The return to education therefore explains why estimated levels of earnings elasticity change significantly across sons' ages, while education transmission explains changes in the transmission of *lifetime* earnings across cohorts. While the analysis of Chapter 1 was concerned with the measurement of elasticity across age, the analysis of this chapter is concerned with the relationship between the intergenerational transmission of lifetime earnings and the intergenerational transmission of education. It may therefore be of use to modify Regression 1 to better control for changes across age. The addition of controls for the age of individuals, through a set of eight dummy variables, tests the possibility that the significance of education transmission is due to correlation with other age-specific unobservables that drive earnings elasticity. The results of this regression are indicated as Regression 2 in Table 8.

As is consistent with casual observation of Table 7, the effect of education transmission is robust to the inclusion of age controls. While the coefficient estimate declines slightly to 0.61, it remains statistically different from zero at even the 1% level. The coefficient on return to education declines significantly to 2.07 in Regression 2, a result of its strong correlation with age, though it also keeps statistical significance.

As a further robustness check on the causality of education transmission on earnings transmission, I add dummies for the year of observation in Regression 3. This addition tests for

the possibility that exogenous changes over time, correlated with education transmission, drive changes in earnings elasticity. As seen in Table 8, the year dummies are significant neither quantitatively nor statistically, while the coefficient estimate and statistical significance of education transmission does not change. As nearly all variation in education return is captured by the age and year dummies, the linear education return term is no longer significant in Equation 3. The intergenerational transmission of education is therefore highly correlated with the intergenerational transmission of earnings, even when controls for age and year are included in the regression.

While the regression results presented in Table 8 are all consistent with a direct link between education transmission and return and earnings elasticity, the possibility exists that one or more omitted variables may be driving these results. If an omitted variable were highly correlated with both educational attainment and labor market earnings, then the significant relationships shown in Table 8 could be estimated in the absence of a causal mechanism. As Bowles (1972) suggested, a strong causal effect of social class background (which is left unobserved in the above regressions) could be misinterpreted as a causal effect of education on earnings and thus education transmission on earnings transmission. While this possibility can not be ruled out, the comparison of changes across birth region, in addition to those across time, lends additional support to the view that the reductions in education transmission are directly linked to reductions in earnings transmission in Brazil.

4.4 Explaining differences in earnings transmission across birth region

Why do individuals born in the Northeast region of Brazil experience the greatest levels of intergenerational earnings transmission? Are the differences in intergenerational earnings transmission across cohorts related to changes in the education transmission these individuals have experienced? This section compares the variation in intergenerational earnings transmission across region of birth for individuals 20-64 to variation in education transmission and return. The findings, like those of the previous section, point to education transmission as a primary determinant of the transmission of lifetime earnings.

As was shown in Table 5, the mean level of schooling varies significantly by region of birth. As **Table 9** shows, the level of intergenerational education transmission varies significantly across region of birth as well. Individuals age 20-64 born in the Northeast experienced, overall, an education transmission coefficient of 0.93. This is significantly greater than the average 0.76 experienced by individuals born in the South or the 0.71 experienced by individuals born in the West. While individuals born in the South had the highest mean level of

schooling, those born in the West experience the lowest level of intergenerational education transmission. Significant variation across cohorts within birth region exists as well. Individuals between age 45 and 49 (in the 1947-51 birth cohort) report the highest levels of education transmission of any group.

Table 9 also reports the 27 estimates of return to education. The relationship between age and education return is again apparent, while there appears to be substantial variation across region of birth as well. Individuals born in the Northeast and South regions appear to have experienced slightly higher levels of return to education than those born in the West.

To estimate the relationship between intergenerational earnings transmission, intergenerational education transmission, and education return, I again begin with a regression of linear education transmission and return variables on earnings elasticity. I use one observation for each of the 27 groups of individuals. The results, which appear as Regression 1 in **Table 10**, are strikingly similar to those examining variation over time. The R^2 of this regression is 0.90, while the coefficient estimates of 0.84 for education transmission and 2.37 for education return are similar to those of the cross-time regression presented in Table 8. The 0.84 coefficient estimate on education transmission implies that a 0.22 difference in education transmission slope (the 20-64 year-old combined difference between individuals born in the Northeast and those born in the West) is associated with a 0.18 difference in earnings elasticity (near the 0.21 difference observed between individuals born in the Northeast and West).

Regression 2 again modifies Regression 1 by adding age dummies, testing for the presence of exogenous variation in earnings elasticity by age. This addition actually increases the coefficient estimates of education transmission and return slightly, to 0.88 and 3.83, respectively. It appears that variation in return to education across birth region is sufficiently uncorrelated with age as to retain its predictive power in this regression.

As a further robustness check, I add dummy variables for region of birth, as shown by Regression 3. These controls should capture regional differences in earnings elasticity unrelated to education transmission or return. These region-of-birth dummies are not statistically significant at the 95% level and serve to increase the education transmission and return coefficients to 1.14 and 4.19, respectively. This fact suggests that education transmission and return capture nearly all of the variation in mobility across age and region of birth. Differences in the intergenerational transmission of earnings, the intergenerational transmission of education, and return to education again point to the transmission of education as primary pathway for the intergenerational transmission of earnings.

As mentioned, the 1988 data also contain information on region of birth. I have also run an analysis on these individuals identical to that performed using the 1996 data. The results of the above three regressions using the 1988 data are quite similar to those using the 1996 data in terms of both coefficient magnitudes and statistical significance. The framework of Regression 1 estimates a coefficient on education transmission of 0.92 (the 1996 coefficient was 0.84) and a return to education coefficient of 3.88 (in comparison to the 2.37 1996 estimate). Regression 2 found education transmission to have a 0.96 coefficient and return to education to have a 5.98 coefficient. The Regression 3 framework estimates a 0.92 coefficient on education transmission and a 5.53 coefficient on education return, both significant at the 1% level. Each of the three regressions frameworks again explain over 90% of the variation in earnings elasticity.

As a final check on the robustness of these results, I compare the difference in the intergenerational earnings transmission, intergenerational education transmission, and education return in each region of birth at each age as reported in 1988 and 1996. Using the differences of these values, I perform regression analysis consistent with the framework of Regressions 1, 2, and 3 above. This analysis estimates a statistically significant (at greater than 99% confidence) relationship between education transmission and earnings elasticity, with a coefficient estimate near 1.2, similar to that estimated using data from a single year. The relationship between return to education and earnings elasticity was not found to be statistically significant.

5. Concluding Remarks

This chapter provided a unique analysis of the determinants of intergenerational earnings mobility. The significant variability of earnings transmission across both time and region of birth in Brazil provided the unparalleled opportunity for a within-country comparison of the transmission of earnings to that of education. The hypothesis that education transmission shapes the level of intergenerational lifetime earnings mobility faced by a population was supported.

This chapter examined the earnings elasticities of individuals born over a 58-year span. Building on the findings of Chapter 1, and using data from the 1982, 1988, and 1996 PNAD surveys, life-cycle measurement effects were separated from changes in the underlying transmission of lifetime earnings across cohorts. Life-cycle measurement effects were shown to produce elasticity estimates for sons of age 20 75% of those formed for sons of age 45. At the same time, the cohort of individuals born in 1975 was found to have experienced an elasticity of lifetime earnings just 73% of that experienced by the 1935 birth cohort.

Like the significant differences in earnings elasticity observed across cohorts in Brazil, substantial differences were found across individuals born in different regions of Brazil. Individuals of age 20-64 who were born in the Northeast region of Brazil were found to experience an earnings elasticity 32% greater than that for individuals born in Brazil's West. The significant variation observed both across region of birth and cohort provided the unique opportunity for a comparison of variation in earnings elasticity to variation in potential determinants of earnings transmission, most importantly the intergenerational transmission of earnings.

The level of intergenerational education transmission experienced by a population, measured in this chapter as the gradient of sons' education with respect to fathers' education and estimated by a regression of sons' education on fathers' education, has been theorized as a significant determinant of the intergenerational elasticity of lifetime earnings. In order to examine this relationship, earnings elasticity was regressed on education transmission and education return, estimated in populations with variation across age and either birth cohort or region of birth. Taken together, education transmission and education return were found to explain over 90% of the variation in earnings elasticity across age and either cohort or region of birth. The return to education was found to vary with the age at which earnings were observed, while the level of education transmission was found to vary with earnings elasticity changes across cohort or region of birth. The estimated coefficients, which were consistent through several robustness checks, found a 0.02 unit increase in the return to education, the difference observed between 30 and 50-year-old males, to coincide with an increase in the intergenerational

earnings elasticity of 0.08, the increase observed between using earnings at age 30 and 50. Additionally, a 0.38 unit reduction in the intergenerational transmission of education, the difference observed between the 1935 and 1975 birth cohorts, was estimated to coincide with a decrease in earnings elasticity of 0.28 units, the change in elasticity observed across these cohorts.

The reductions in Brazil's level of lifetime earnings transmission seen over the last half-century were found to coincide with reductions in the level of educational transmission. This reduction in educational transmission was shown to have come about largely through the continual growth of education, seen through rising means in both generations. This increase in education served to move the relationship between sons' and fathers' educations to a point where fathers' education played less of a role in determining the educations of their sons. The findings of this chapter are consistent with the view that educational attainment is one of the most significant pathways by which earnings are transmitted intergenerationally.

References

Angrist, Joshua and Krueger, Alan. (1992) "The Effect of Age at School Entry on Educational Attainment: An Application of Instrumental Variables with Moments from Two Samples." *Journal of the American Statistical Association*, *87*(418), pp. 328-36.

Arellano, Manuel and Meghir, Costas. (1992) "Female Labour Supply and On-the-Job Search: An Empirical Model Estimated Using Complementary Data Sets." *The Review of Economic Studies*, *59*(3), pp. 537-59.

Barros, Ricardo and Lam, David. (1996) "Income and Education Inequality and Children's Schooling Attainment in Brazil." N. Birdsall and R. Sabot, *Opportunity Foregone: Education in Brazil.* Washington: Inter-American Development Bank,

Becker, Gary and Tomes, Nigel. (1979) "An Equilibrium Theory of the Distribution of Income and Intergenerational Mobility." *The Journal of Political Economy*, *87*(6), pp. 1153-89.

Björklund, Anders and Jäntti, Markus. (1997) "Intergenerational Income Mobility in Sweden Compared to the United States." *American Economic Review*, *87*(5), pp. 1009-18.

Bowles, Samuel. (1972) "Schooling and Inequality from Generation to Generation." *The Journal of Political Economy*, *80*(3, Part 2), pp. S219-S51.

Dearden, Lorraine; Machin, Michael and Reed, Howard. (1997) "Intergenerational Mobility in Britain." *The Economic Journal*, *107*(440), pp. 47-66.

Ferreira, Sergio and Veloso, Fernando. (2003) "Intergenerational Mobility of Earnings in Brazil." *Unpublished.*

Lam, David. (1999) "Generating Extreme Inequality: Schooling, Earnings, and Intergenerational Transmission of Human Capital in South Africa and Brazil." *Population Studies Center Research Report No. 99-439.*

Lam, David and Duryea, Suzanne. (1999) "Effects of Schooling on Fertility, Labor Supply, and Investments in Children, With Evidence From Brazil." *Journal of Human Resources*, *34*(1), pp. 160-92.

Lam, David and Levison, Deborah. (1992) "Declining Inequality in Schooling in Brazil and its Effects on Inequality in Earnings." *Journal of Development Economics*, *37*(1), pp. 199-225.

Pagan, Adrian. (1984) "Econometric Issues in the Analysis of Regressions with Generated Regressors." *International Economic Review*, *25*(1), pp. 221-47.

Reville, Robert. (1995) "Intertemporal and Life Cycle Variation in Measured Intergenerational Earnings Mobility." *Unpublished.*

Solon, Gary. (1992) "Intergenerational Income Mobility in the United States." *The American Economic Review*, *82*(3), pp. 393-408.

Solon, Gary. (2003) "A Model of Intergenerational Mobility Variation over Time and Place." *Unpublished.*

Table 1: Selection of Second-Stage Sample

Sons age 20-64 in 1982, 1988, and 1996

Panel A: 1982

	Household Head				Not Head		
	Father's Educ Reported		Father's Educ Not Reported		Father's Educ Missing		
	Zero Earnings	Positive Earnings	Zero Earnings	Positive Earnings	Zero Earnings	Positive Earnings	All Individuals
	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)
N	6,845	70,073	1,243	10,406	7,024	19,477	115,068
Weighted %	6.0%	61.7%	1.1%	8.5%	6.2%	16.5%	100%
Age, mean	49.1	39.0	43.9	37.2	26.4	25.9	36.6
Education, mean	3.68	4.35	3.73	4.02	5.35	5.79	4.58
Earnings, mean	0	591	0	453	0	337	459
Log earnings, mean	-	5.84	-	5.68	-	5.47	-
Father's educ., mean	1.57	1.64	-	-	-	-	-

Panel B: 1988

	Household Head				Not Head		
	Father's Educ Reported		Father's Educ Not Reported		Father's Educ Missing		
	Zero Earnings	Positive Earnings	Zero Earnings	Positive Earnings	Zero Earnings	Positive Earnings	All Individuals
	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)
N	3,922	40,623	972	7,472	4,315	12,914	70,218
Weighted %	5.8%	59.1%	1.3%	9.7%	5.9%	18.2%	100%
Age, mean	49.7	39.5	42.9	37.3	27.3	26.3	36.8
Education, mean	4.63	5.18	4.44	4.49	5.61	6.33	5.31
Earnings, mean	0	644	0	409	0	329	481
Log earnings, mean	-	5.81	-	5.53	-	5.34	-
Father's educ., mean	1.60	1.71	-	-	-	-	-

Panel C: 1996

	Household Head				Not Head		
	Father's Educ Reported		Father's Educ Not Reported		Father's Educ Missing		
	Zero Earnings	Positive Earnings	Zero Earnings	Positive Earnings	Zero Earnings	Positive Earnings	All Individuals
	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)
N	6,425	40,125	2,498	13,047	6,969	13,663	82,727
Weighted %	7.8%	49.7%	2.8%	15.0%	8.3%	16.4%	100%
Age, mean	48.0	39.8	44.0	38.3	28.1	27.3	37.3
Education, mean	5.07	5.98	4.69	5.25	5.78	7.01	5.92
Earnings, mean	0	744	0	515	0	392	511
Log earnings, mean	-	6.01	-	5.77	-	5.56	-
Father's educ., mean	2.15	2.47	-	-	-	-	-

Notes: "Household Head" includes male spouses of head.
Individuals with missing earnings are coded as having zero earnings.

Table 2: Fathers' Earnings by Education
Regression Results
Males 30-50 with positive earnings, 1976

Log earnings ressed on:	N = 37,396	R^2 = 0.434
Variable	Coef.	Std.Err.
Education		
0 years (omitted)	0.000	-
1-3 years	0.492	0.011
4 years	0.939	0.013
5-8 years	1.182	0.015
9-11 years	1.799	0.020
12+ years	2.534	0.020
Age	0.0517	0.0104
Age^2	-0.0005	0.0001
Constant	3.880	0.203

Table 3: Intergenerational Earnings Elasticity
Regression Results
Sons age 40-44 in 1996

Sons' log earnings ressed on:	N = 6,218	R^2 = 0.218
Variable	Coef.	Std.Err.
Fathers' predicted log earnings	**0.916**	**0.026**
Sons' Age	0.468	0.693
Sons' Age^2	-0.005	0.008
Constant	-4.61	14.53

Note: The standard error reported for fathers' predicted log earnings coefficient is the bootstrap estimate.

Table 4: Variation in Intergenerational Earnings Elasticity across Time

Sons: male household heads with positive earnings reporting father's education
Fathers: males 30-50 with positive earnings in 1976

	Sample Size			Elasticity Estimate		
Age range	1982	1988	1996	1982	1988	1996
20-24	5,581	2,790	2,458	0.64	0.57	0.58
25-29	11,213	5,939	5,067	0.78	0.73	0.67
30-34	12,430	7,019	6,920	0.93	0.88	0.80
35-39	10,583	6,731	6,787	1.03	0.92	0.83
40-44	9,432	5,627	6,218	1.01	0.96	0.92
45-49	7,391	4,434	4,978	0.98	1.00	1.01
50-54	6,287	3,599	3,543	1.00	0.99	0.97
55-59	4,413	2,657	2,487	0.89	0.96	0.96
60-64	2,743	1,827	1,667	0.98	0.94	0.92
Combined	70,073	40,623	40,125	0.92	0.88	0.84

Table 5: Summary Statistics by Region of Brazil

Individuals age 30-49, 2001

Variable	West	Northeast	South
% of population	13%	29%	59%
% urban[1]	91%	70%	89%
Age, mean	26.5	27.3	30.3
Educ, mean	5.5	4.2	6.2
% of females working	29%	24%	32%
Male earnings, mean[2]	332	171	408
Female earnings, mean[2]	133	70	169
% born in region	77%	98%	91%

1 - Rural regions are excluded from some states of the West
2 - Mean of those working

Table 6: Variation in Intergenerational Earnings Elasticity by Region

Sons: male household heads with positive earnings reporting father's education in 1996
Fathers: males 30-50 with positive earnings in 1976

	Sample Size			Elasticity Estimate		
Age range	West	Northeast	South	West	Northeast	South
20-24	429	879	1,147	0.38	0.54	0.49
25-29	691	1,752	2,617	0.52	0.67	0.58
30-34	853	2,134	3,913	0.59	0.76	0.75
35-39	737	2,041	3,988	0.76	0.89	0.72
40-44	614	1,925	3,644	0.78	1.02	0.76
45-49	414	1,794	2,726	0.89	1.05	0.89
50-54	303	1,319	1,879	0.93	1.09	0.83
55-59	176	933	1,345	0.55	0.76	0.89
60-64	124	601	910	1.10	0.77	0.81
Combined	4,341	13,378	22,169	0.65	0.86	0.74

Table 7: Variation in Education Transmission and Return across Time

Sons: male household heads with positive earnings reporting father's education
Fathers: males 30-50 with positive earnings in 1976

	Education Transmission			Return to Education		
Age range	1982	1988	1996	1982	1988	1996
20-24	0.75	0.63	0.59	0.12	0.13	0.12
25-29	0.85	0.75	0.66	0.14	0.15	0.13
30-34	0.94	0.84	0.76	0.16	0.16	0.14
35-39	0.99	0.91	0.83	0.16	0.16	0.15
40-44	0.95	0.93	0.88	0.17	0.17	0.16
45-49	0.94	0.90	0.98	0.17	0.17	0.16
50-54	0.91	0.86	0.95	0.17	0.17	0.16
55-59	0.87	0.92	0.94	0.16	0.16	0.16
60-64	0.92	0.90	0.89	0.17	0.16	0.17
Combined	0.93	0.87	0.84	0.16	0.16	0.15

Table 8: Regressions of Intergenerational Earnings Transmission Determinants Using Variation across Time

Sons: male household heads with positive earnings reporting father's education

Fathers: males 30-50 with positive earnings in 1976

	Regression 1		Regression 2		Regression 3	
N = 27	R^2 = 0.959		R^2 = 0.979		R^2 = 0.979	
	Adj. R^2 = 0.956		Adj. R^2 = 0.966		Adj. R^2 = 0.961	
Intergenerational elasticity regressed on:	Coef.	Std.Err.	Coef.	Std.Err.	Coef.	Std.Err.
Education Transmission	0.74	(0.10) **	0.61	(0.10) **	0.61	(0.12) **
Return to Education	3.91	(0.65) **	2.07	(0.89) **	1.88	(1.61)
Age						
20-24 (omitted)			0.00	-	0.00	-
25-29			0.04	(0.03)	0.04	(0.04)
30-34			0.10	(0.03) **	0.10	(0.05) *
35-39			0.11	(0.04) **	0.11	(0.06) *
40-44			0.12	(0.04) **	0.13	(0.08)
45-49			0.14	(0.04) **	0.15	(0.08) *
50-54			0.14	(0.04) **	0.15	(0.08) *
55-59			0.11	(0.04) **	0.12	(0.07)
60-64			0.11	(0.04) **	0.12	(0.08)
Year						
1982 (omitted)					0.00	-
1988					0.00	(0.01)
1996					0.01	(0.02)
Constant	-0.36	(0.06) **	-0.06	(0.11)	-0.03	(0.22)

Notes: * significant at 10% ** significant at 5%

Table 9: Variation in Education Transmission and Return by Region

Sons: male household heads with positive earnings reporting father's education in 1996
Fathers: males 30-50 with positive earnings in 1976

	Education Transmission			Return to Education		
Age range	West	Northeast	South	West	Northeast	South
20-24	0.42	0.63	0.51	0.09	0.10	0.11
25-29	0.58	0.74	0.58	0.12	0.12	0.12
30-34	0.66	0.84	0.69	0.12	0.13	0.14
35-39	0.80	0.91	0.74	0.14	0.14	0.14
40-44	0.77	1.02	0.77	0.13	0.15	0.15
45-49	1.06	1.07	0.88	0.13	0.15	0.15
50-54	0.96	1.08	0.85	0.12	0.16	0.15
55-59	0.73	0.90	0.88	0.14	0.16	0.15
60-64	0.93	0.80	0.85	0.17	0.15	0.16
Combined	0.71	0.93	0.76	0.13	0.14	0.14

Table 10: Regressions of Intergenerational Earnings Transmission Determinants
Using Variation across Region of Birth

Sons: male household heads with positive earnings reporting father's education in 1996
Fathers: males 30-50 with positive earnings in 1976

	Regression 1		Regression 2		Regression 3	
N = 27	R^2 = 0.898		R^2 = 0.938		R^2 = 0.952	
	Adj. R^2 = 0.889		Adj. R^2 = 0.899		Adj. R^2 = 0.910	
Intergenerational elasticity regressed on:	Coef.	Std.Err.	Coef.	Std.Err.	Coef.	Std.Err.
Education Transmission	0.84	(0.11) **	0.88	(0.14) **	1.14	(0.19) **
Return to Education	2.37	(0.94) **	3.83	(1.39) **	4.19	(1.58) **
Age						
20-24 (omitted)			0.00	-	0.00	-
25-29			-0.06	(0.06)	-0.10	(0.06)
30-34			-0.08	(0.07)	-0.14	(0.07) *
35-39			-0.09	(0.07)	-0.18	(0.09) *
40-44			-0.07	(0.08)	-0.17	(0.09) *
45-49			-0.12	(0.09)	-0.26	(0.11) **
50-54			-0.08	(0.09)	-0.21	(0.11) *
55-59			-0.20	(0.08) **	-0.29	(0.10) **
60-64			-0.11	(0.10)	-0.22	(0.11) *
Region of birth						
West (omitted)					0.00	-
Northeast					-0.07	(0.04) *
South					0.00	(0.03)
Constant	-0.23	(0.09) **	-0.37	(0.14) **	-0.52	(0.16) **

Notes: * significant at 10% ** significant at 5%

Figure 1: Intergenerational Earnings Elasticity across Sons' Age
Sons: household heads with positive earn. reporting father's educ. in 1996
Fathers: males age 30-50 with positive earnings in 1976

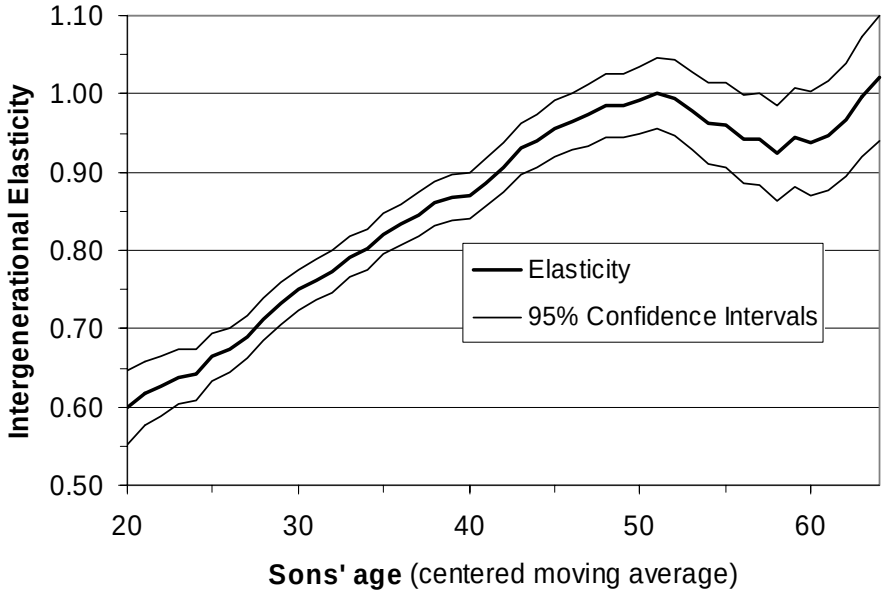

Figure 2: Intergenerational Earnings Elasticity across Age by Year
Sons: household heads with positive earn. reporting father's educ.
Fathers: males age 30-50 with positive earnings in 1976

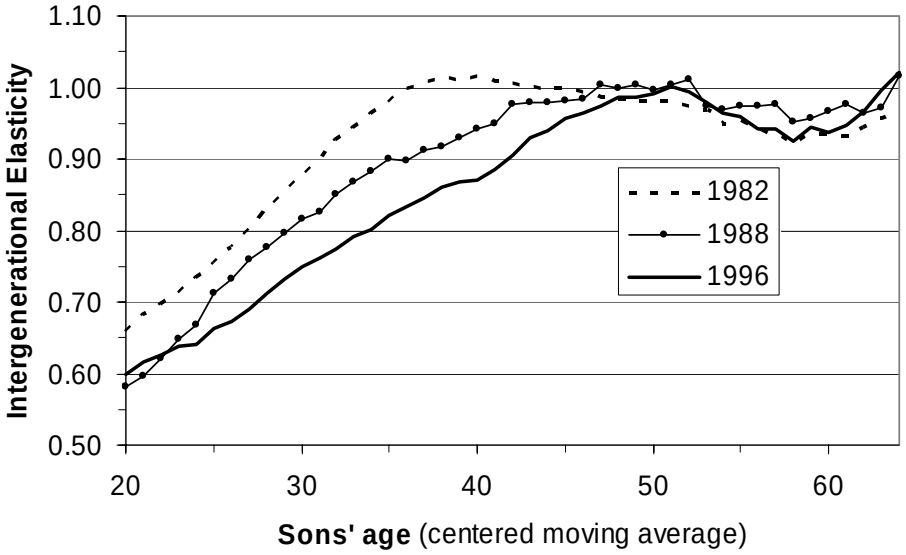

Figure 3: Intergenerational Earnings Elasticity across Age by Cohort
Sons: household heads with positive earn. reporting father's educ.
Fathers: males age 30-50 with positive earnings in 1976

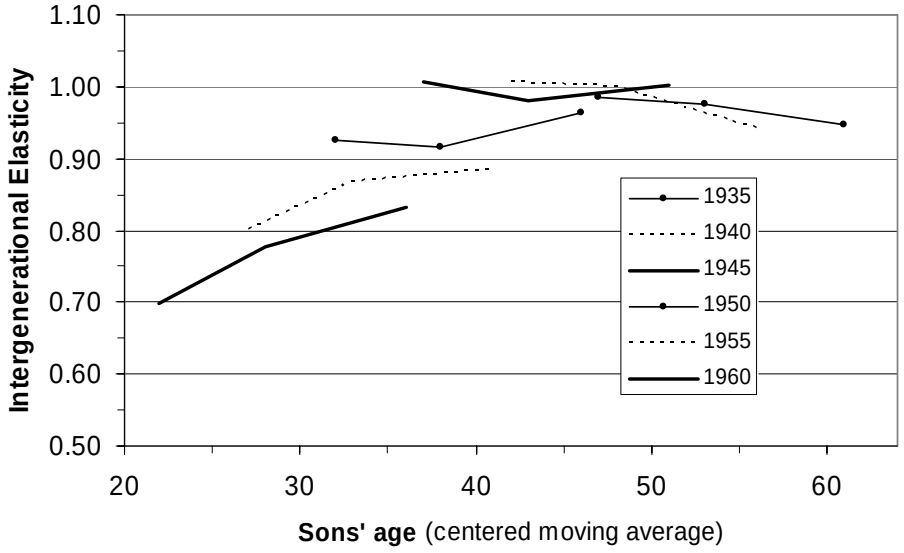

Figure 4: Intergenerational Earnings Elasticity across Age, Holding Cohort at 1948

Sons: household heads with positive earn. reporting father's educ.
Fathers: males age 30-50 with positive earnings in 1976

Figure 5: Intergenerational Earnings Elasticity across Cohort, Holding Age at 40

Sons: household heads with positive earn. reporting father's educ.
Fathers: males age 30-50 with positive earnings in 1976

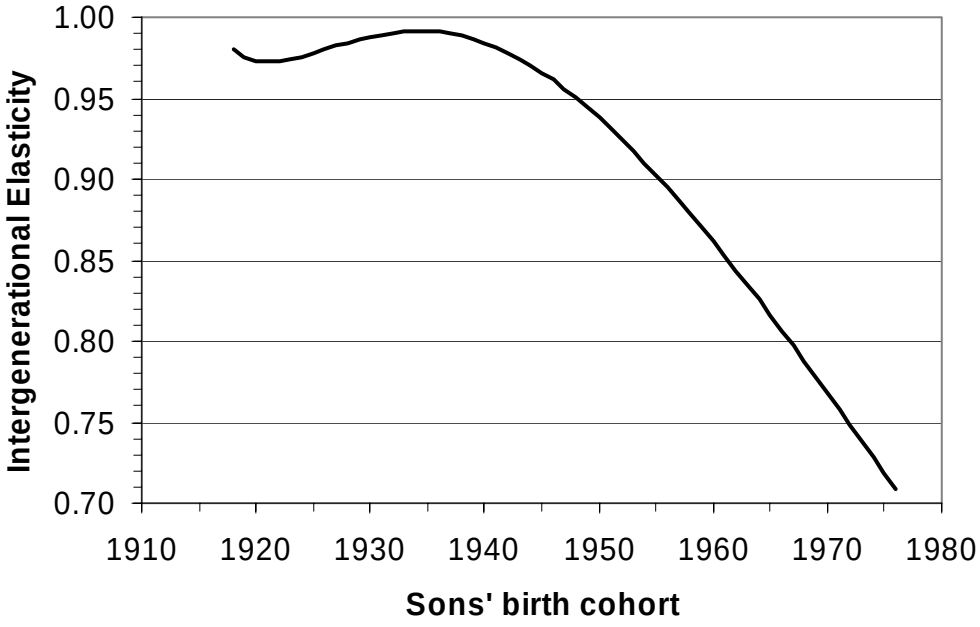

Figure 6: Intergenerational Earnings Elasticity by Region

Sons: household heads with positive earn. reporting father's educ. In 1996

Fathers: males age 30-50 with positive earnings in 1976

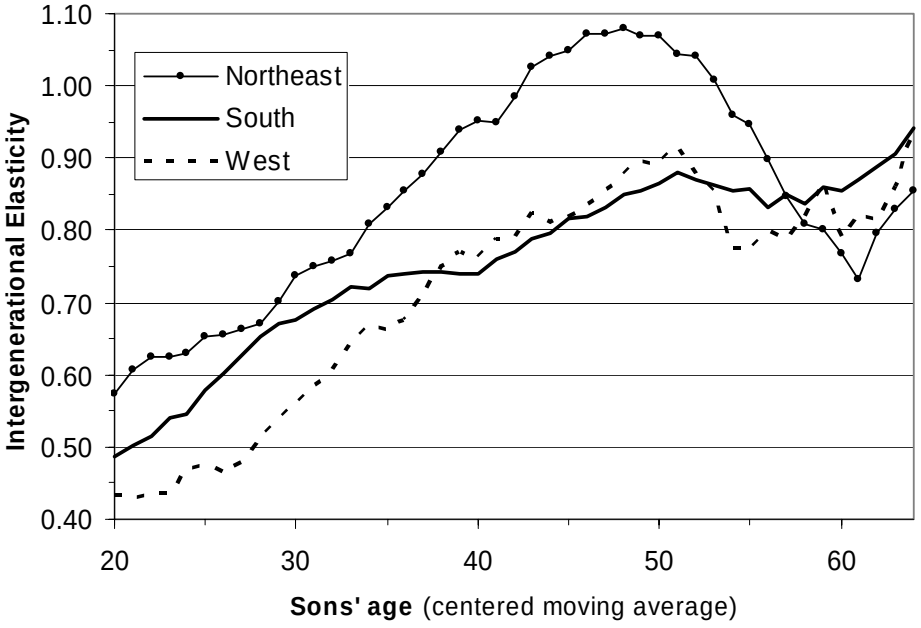

Figure 7: Educational Attainment across Time

30-34 year-old males

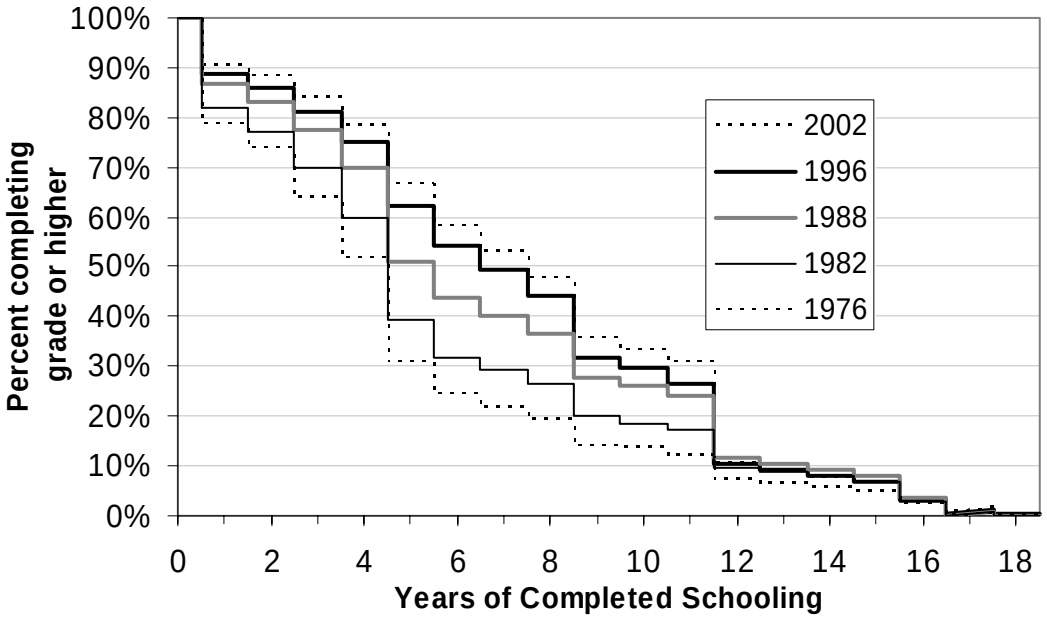

Figure 8: Education Transmission across Time

30-49 year-old sons

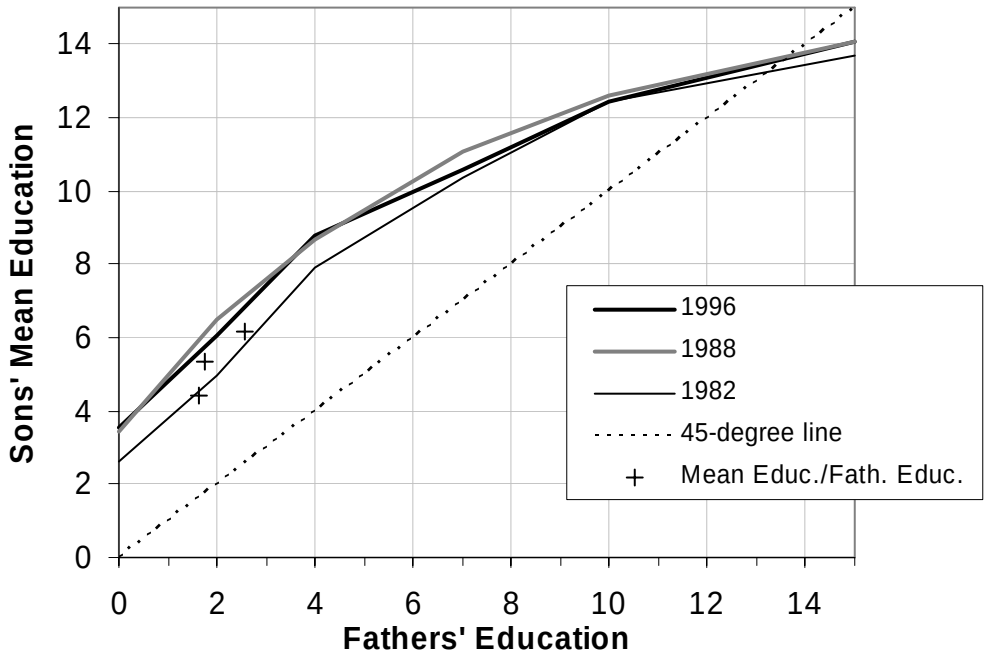

Figure 9: Intergenerational Earnings Elasticity and Education Transmission, Holding Age at 40

Sons: household heads with positive earn. reporting father's educ.
Fathers: males age 30-50 with positive earnings in 1976

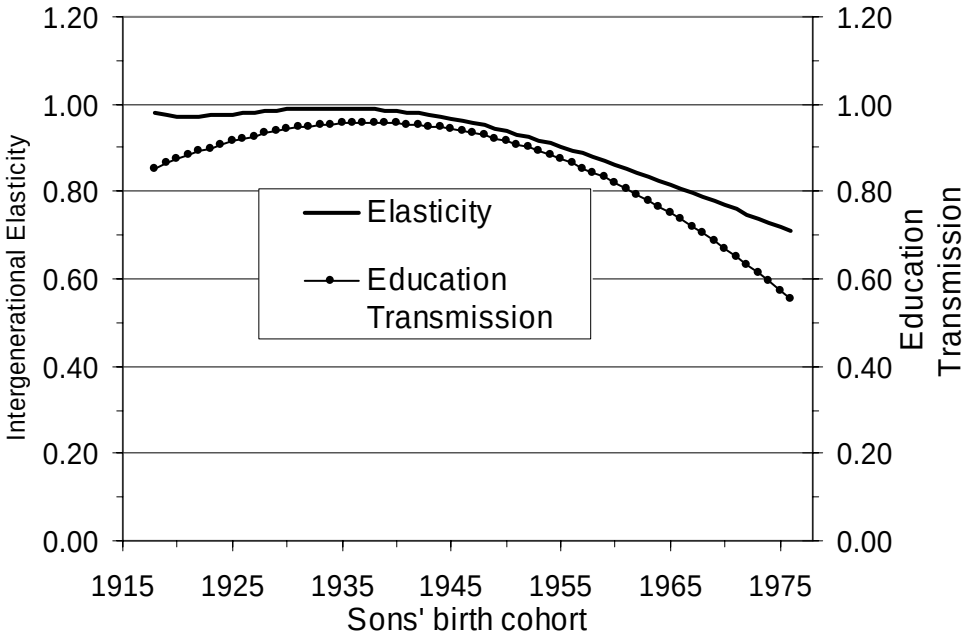

Figure 10: Intergenerational Earnings Elasticity and Education Return, Holding Cohort at 1948

Sons: household heads with positive earn. reporting father's educ.
Fathers: males age 30-50 with positive earnings in 1976