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Trends of Educational Mobility Across Three Generations in Latin America

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This paper provides new evidence on long term intergenerational mobility in developing countries. We gather data linking schooling outcomes across three generations for six Latin American countries. Our work complements recent evidence going beyond two generations in more mobile, developed nations. Our main findings indicate that (i) the empirical multi-generational persistence is higher than what seminal theoretical models predict, with a much larger upward bias for Latin America than for developed countries; (ii) absolute mobility has increased but relative mobility remains constant over fifty years, and (iii) compulsory schooling laws plausibly contribute to explaining these mobility patterns, because they increased education levels but also reduced the dispersion of schooling. Overall, this paper contributes to our understanding of long run intergenerational mobility with novel evidence for the highly immobile Latin American region, where family background effects tend to be comparatively longer-lasting.

KEYWORDS
Developing Countries, Intergenerational Mobility, Schooling, Educational Policy, Multiple Generations

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Tendencias en movilidad educativa a lo largo de tres generaciones en América Latina

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Este trabajo presenta nueva evidencia de movilidad intergeneracional en el largo plazo en América Latina. Recolectamos datos que vinculan resultados educativos a lo largo de tres generaciones para seis países de América Latina. Nuestro trabajo complementa evidencia reciente que se extiende más allá de dos generaciones, en países más móviles y desarrollados. Nuestros principales hallazgos indican que (i) empíricamente la persistencia multi-generacional es más elevada que las predicciones de modelos teóricos, con un sesgo al alza más importante para América Latina en comparación a países desarrollados; (ii) la movilidad absoluta se ha incrementado pero la movilidad relativa permanece constante a lo largo de cincuenta años; y (iii) las leyes de escolaridad obligatoria probablemente contribuyen a explicar estos patrones de movilidad, en cuanto incrementaron el nivel educativo al tiempo que también redujeron la dispersión de la escolarización. Este trabajo contribuye al conocimiento de la movilidad intergeneracional en el largo plazo, con nueva evidencia para América Latina (región de baja movilidad), donde el contexto familiar tiende a contar con un efecto comparativamente más duradero.

KEYWORDS
Países en desarrollo, Movilidad intergeneracional, Escolaridad, Política educativa, Múltiples generaciones

1 | INTRODUCTION

The transmission of socio economic status across generations has several implications for the dynamic of economic systems and for individual welfare (see, Erikson and Goldthorpe, 1992, Benabou and Ok, 2001, and Braun and Stuhler, 2016). Most of the previous studies on the topic are restricted to parents and their children (Hertz et al., 2007; Ferreira et al., 2012; Torche, 2019). There is growing evidence going beyond two generations but overwhelmingly based on studies for developed countries,[1] likely due to the availability of data. There is much less empirical evidence on mobility across multiple generations in lower income regions, which would inform questions on how opportunities for economic success evolve in the long run.

This paper contributes to fill this gap with new evidence on long term educational mobility in developing countries. We gather multigenerational educational records for a set of Latin American countries and examine them in a comparative perspective, complementing the new wave of American and European studies that go beyond two generations to understand the evolution of inequality.

Our work documents educational mobility over 50 years in six Latin American countries, linking educational attainment across three generations of the same family. We first document educational mobility measures across generations and contrast our findings to similar studies in higher income regions and to empirical findings based on two generations. Next, we study how mobility measures change with the distribution of schooling over time. Finally, we examine the role of compulsory schooling laws in explaining mobility across generations of the same family.

We use survey data from six Latin American countries: Chile, Colombia, El Salvador, Mexico, Paraguay, and Uruguay. All surveys were designed to collect information on individuals' employment and social security history. These surveys are representative at the national and subnational level. In each survey, respondents report their own education and are also asked about their parents' and children' age and education. We use this information to link educational attainment across three generations within families.

Our first set of results compare schooling attainment of adjacent generations in absolute measures –years of schooling – and relative schooling measures – standardized within country and cohort of birth.

Using data on two generations, we find that younger generations consistently attain higher levels of education than their ancestors, but their relative position in the schooling distribution does not change significantly from one generation to the next.

We then go beyond two generations and address longer run dependence by studying how grandparents' education affects educational levels of their grandchildren. We find large associations between the educational attainment of grandparents and grandchildren, even after controlling for parents' education. An additional year of grandparental schooling is associated to an increase of 0.53 years of schooling for their grandchildren. This magnitude is large compared to estimates for Sweden (Lindahl et al., 2015), Germany, United States, and United Kingdom (Neidhöfer and Stockhausen, 2019).

Our second set of findings documents trends in educational mobility across birth cohorts. We find that the association of schooling attainment between generations has decreased across birth cohorts, indicating that mobility has improved over fifty years. The relative position in the schooling distribution remains stable across time, consistent with our first set of results.

[1] See for instance, Braun and Stuhler (2018) for Germany , Ferrie et al. (2021) for the U.S., Lindahl et al. (2015) for Sweden, and Neidhöfer and Stockhausen (2019) for Germany, United States, and the United Kingdom.

Next, we explore the role of compulsory schooling laws in explaining these educational mobility patterns. We take advantage of the fact that some cohorts were exposed, and others were not affected by the reforms according to their year of birth. This descriptive exercise suggests that compulsory schooling laws produced two outcomes. First, younger cohorts attained more schooling than their ancestors. Second, the laws significantly reduced the dispersion of schooling among exposed cohorts. These results translate into increased absolute mobility and stagnant relative mobility.

Our work produces new evidence on long term educational mobility in developing countries. We provide three new contributions to the literature. First, we document that Latin America is behind by an entire generation in terms of mobility gains when compared to higher income countries. For example, Nybom and Stuhler (2021) find similar mobility patterns for Swedish cohorts born around the 1940s, although they start at much higher levels of mobility (lower coefficients). These results are in line with Landersø and Heckman (2017) and Nybom and Stuhler (2021), who argue that changes in the distribution of education or income over time affect absolute measures of mobility because. While younger generations attain more schooling, their relative position in the distribution remains similar even after three generations.

Second, we extend the standard two generations analysis to show that lack of mobility is persistent in the longer-run by examining grandparents and grandchildren. Persistence in educational inequality over several generations is much greater than usual predictions based on correlations between two adjacent generations. This result is consistent with the available evidence for higher income regions, though the upward bias from predicting long-term mobility from a two generation model is much larger in our sample of Latin American countries (see Braun and Stuhler, 2016; Lindahl et al., 2014; Lindahl et al., 2015). These results suggests that a deeper understanding of longer term mobility needs data that goes beyond two generations. These findings complement important related studies documenting mobility over two generations in Latin America (Neidhöfer et al., 2018; Neidhöfer, 2019) and developing countries (Torche, 2019).

Third, we contribute to the literature on the role of institutions at explaining educational mobility (Acemoglu et al., 2014; Machin, 2007; Nybom and Stuhler, 2021). Our results show that compulsory schooling laws significantly affect the distribution of schooling by shrinking the variance in schooling for generations exposed to these laws. These findings are aligned with the evidence on the sources of intergenerational mobility in Denmark and the U.S. (Landersø and Heckman (2017)). This new evidence on educational reforms is important because they affect schooling attainment of generations for long periods, thus producing consequences to intergenerational mobility patterns that persist later on (Oreopoulos et al., 2006; Björklund and Salvanes, 2011; Piopiunik, 2014).

The rest of the paper is organized as follows. Section 2 describes the data. In section 3 we discuss the measurement mobility, and include graphical illustration of mobility across three generations. We describe our econometric specifications and methods in section 4 and present our results in section 5. Section 6 concludes.

2 | DATA AND DESCRIPTIVE STATISTICS

We use data from six Latin American countries: Chile, Colombia, El Salvador, Mexico, Paraguay and Uruguay. For all countries but Mexico, we work with the first wave of the Longitudinal Social Protection Survey (LSPS). For Mexico, in particular, we use the first wave of the Mexican Health and Aging Study (MHAS).[2] All surveys were designed to

[2]To access the LSPS data visit this link; to access the MHAS data visit this link.

collect information on individuals' employment and social security history.

In each survey, respondents are asked about their own education, their parents' and their childrens'. We use these responses to link educational attainment across three generations within the same family. Chile and Mexico collect educational data for all children of the interviewees, while the rest of the countries collect data on children currently living in the interviewees' household. Following standard procedures Behrman et al. (2001); Hertz et al. (2007), we keep in our analysis respondents with children who are at least 23 years old, when schooling accumulation is mostly completed. We use cohorts born between 1920 and 1970 of the parental (interviewee) generation.

Table 1 presents descriptive statistics for our sample and the variables we use in the regression analysis. We show average, standard deviations, and observations used. All statistics are computed pooling surveys from each country. Panel 1 shows statistics for the generation of grandparents (G1), Panel 2 for parents (G2), and Panel 3 for children (G3). On average, the generation of grandparents has 2.8 years of schooling approximately. It is worth mentioning that most grandparents in these cohorts grew up in times where legislation had not established compulsory schooling laws, or if established they mandated very low years of minimum mandatory education. On average, grandfathers tend to be more educated than grandmothers.

For the generation of parents (interviewees) the average schooling is approximately 5.8 years, with fathers achieving one more year of schooling than mothers approximately. At the moment of the interview, the average age of this generation is 61 years, after restricting our sample to parents who have at least one child 23 years or older. We separate age in groups showing that the majority of parents in our sample are concentrated in the 50 to 70 year old bracket. In the parent generation, 45% are male.

The next Panel shows that average years of schooling for the generation of children is 9.8 years, with daughters and sons achieving similar levels of schooling on average. The average age for this generation is 35 years old with 20 to 39 years old comprising 70% of the G3 sample. In this generation, 51% of individuals are male. The bottom Panel in the Table shows the sample composition by country.

3 | MEASUREMENT OF INTERGENERATIONAL MOBILITY

3.1 | Absolute and Relative Mobility measures

The literature has used different measures of intergenerational mobility to describe changes in socioeconomic status across generations within families. In fact, researchers have used income, occupation, and education over time, to proxy welfare measurements of each generation and compute changes across time.[3] Each of them has advantages and disadvantages as proxy measures of lifetime welfare. The main argument for using educational attainment in this paper is that it is highly correlated with long term incomes and it is less subject to typical biases in survey data such as recall and underreporting. Black and Devereux (2011) provide a thorough discussion on the advantages of using education when analyzing intergenerational mobility.[4]

Years of schooling is a simple measure of social status and commonly used in compar-

[3] For measures of income mobility see for instance (Acciari et al., Forthcoming; Chetty et al., 2014; Lee and Solon, 2009; Mazumder, 2005; Nybom and Stuhler, 2017, 2016; Olivetti et al., 2018; Solon, 1992). For studies using occupational mobility, see, for instance, (Corak and Piraino, 2011; Torche, 2015). For studies using education as a measure of welfare see (Ferrie et al., 2021; Neidhöfer et al., 2018; Torche, 2011, 2018).

[4] Long and Ferrie (2013) criticize using educational attainment to study long term mobility since, if subject to measurement error, correlations can be severely biased.

TABLE 1 Descriptive Statistics by Generation

	Mean	Std. Dev.	N
Panel 1: Grandparents			
G1 Schooling Average	2.836	3.234	17,266
G1 Schooling Grandmother	2.573	3.182	17,266
G1 Schooling Grandfather	3.120	3.678	15,448
Panel 2: Parents			
G2 Schooling Average	5.773	4.708	17,266
G2 Schooling Mother	5.461	4.597	9,800
G2 Schooling Father	6.181	4.821	7,466
G2 Age	61.092	9.953	17,266
G2 Age: 40-49 years	0.094	0.292	17,266
G2 Age: 50-59 years	0.394	0.489	17,266
G2 Age: 60-69 years	0.299	0.458	17,266
G2 Age: 70-79 years	0.171	0.376	17,266
G2 Age: 80+ years	0.042	0.201	17,266
G2 Sex (Male=1)	0.432	0.495	17,266
Panel 3: Grand Children			
G3 Schooling Average	9.770	4.519	50,324
G3 Schooling Daughter	9.727	4.522	25,675
G3 Schooling Son	9.815	4.516	24,649
G3 Age	34.678	8.479	50,324
G3 Age: 23-29 years	0.333	0.471	50,324
G3 Age: 30-39 years	0.400	0.490	50,324
G3 Age: 40-49 years	0.203	0.402	50,324
G3 Age: 50-59 years	0.058	0.234	50,324
G3 Age: 60+ years	0.006	0.078	50,324
G3 Sex (Male=1)	0.510	0.500	50,324
Panel 4: Countries in the Sample			
Chile	0.241	0.428	50,324
Colombia	0.062	0.241	50,324
El Salvador	0.042	0.200	50,324
Mexico	0.593	0.491	50,324
Paraguay	0.032	0.176	50,324
Uruguay	0.031	0.173	50,324

Notes: This table presents descriptive statistics of the main variables used in our analysis. The survey respondent in each survey is the family member of the parent generation (G2). He or she provides information about the grandparent generation (G1) and the children generation (G3). We pool all countries together.

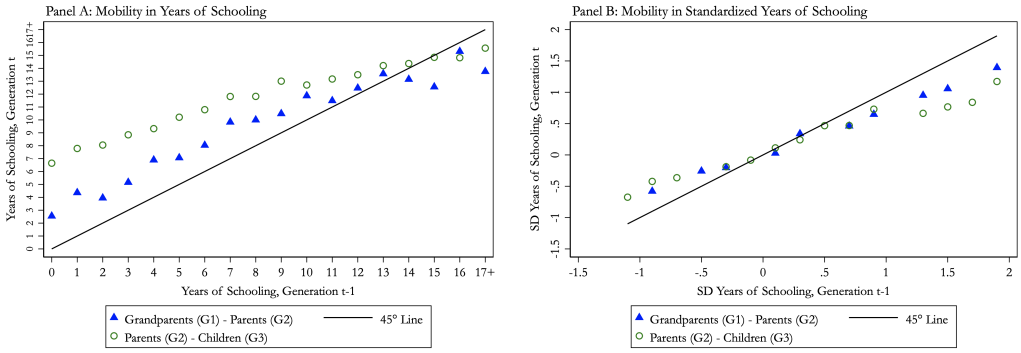
ative studies. An ideal measure in a comparative analysis would account for what does one more (or less) year of schooling means to individuals in terms of wages, which can vary across countries with different institutions and within countries over time. One way to approach this issue is to standardize regular years of schooling within country and generation. This helps to study mobility with an outcome that reflects the relative standing of each individual with respect to the distribution of the same outcome within their generation and country. For this reason we construct a canonical standardization where we subtract the mean within a country and generation to each individual and divide the difference by the standard deviation. We perform all our analyses using both measures.

As noted by several studies of intergenerational mobility there are two typical measures that capture absolute mobility and relative mobility. First, the slope coefficients from a bivariate regression between (grand) children's and (grand) parents' educational attainment capture measures of absolute mobility. That is, how is an increase in one year of schooling of (grand) parents correlated to years of schooling of (grand) children. As such, slope coefficients do not account for changes in the distribution of educational attainment across generations that may have affected all individuals. These changes can hide mechanical changes in mobility that are not related to changes in relative status, i.e. the position of individuals within a society. For this, we also compute a standardized measure of the slope coefficient in a regression using standardized measures of years of schooling. The standardization that we do is at the G2 birth cohort level and country. In the absence of control variables, this measure is equivalent to the Pearsons's correlation coefficient. We treat this measure as a measure of relative mobility as it captures changes in the distribution of years of schooling for each generation.

3.2 | A graphical analysis to mobility across generations

Our descriptive analysis suggests that even though younger generations attain higher levels of education than their ancestors, their relative position in the schooling distribution does not change significantly from one generation to the next. We show this in Figure 1 using descriptive statistics of mobility in graphs that depict schooling transitions from one generation to the next. In the left panel, we plot the average years of schooling of generation t in the y-axis against the average years of schooling of generation $t-1$ in the x-axis. The triangle dots correspond to the analysis of G1 and G2, while the circular dots represent the analysis for G2 and G3. The diagonal is a 45-degree line, which represents the diagonal of a transition matrix. Equally, the right panel plots the same relations using standardized measures of schooling, where we standardized schooling years for each individual within country and generation.

FIGURE 1 Mobility across generations: Transition Matrix Graphs



(a) Absolute Mobility (b) Relative Mobility

Notes: Panel A in this figure shows the average years of schooling of generation t in the y-axis, against the years of schooling of generation $t+1$ in the x-axis. The triangle dots correspond to the analysis of G1 and G2, while the circular dots represent the analysis of G2 and G3. The diagonal is a 45-degree line. Panel B shows a similar analysis using standardized measures of schooling where years of schooling are standardized within country and generation.

These graphs provide information about the mobility patterns at the bottom and the top of the schooling distribution. Likewise, the plots are useful in that they represent a graphical approximation of the regression coefficients between generations, which we present in the next section. The left panel in Figure 1 depicts how absolute mobility evolves across generations, while the right panel does the same for the standardized measures of schooling.

For G1– G2, the data shows high mobility at the bottom of the schooling distribution of G1, since most of the triangular dots for the first eight years of education in this generation (x -axis) are far above the diagonal in the next generation (y -axis). Individuals continue to have more years of education than their parents until twelve years of school. After that, the triangular dots are not statistically distinguishable from the diagonal,[5] which implies that there is less mobility at the top of the schooling distribution.

A similar result is shown in the transition of the next two generations, G2 – G3. The figure shows that there is even higher mobility at the bottom than for G1 – G2, because circular dots are further away from the 45-degree line before 8 years of schooling. The pattern described is similar: higher mobility at the bottom (dots above the 45 degree line) and lower mobility at the top (dots below). However, while absolute mobility across two generations increases as we move forward in the generational spectrum, Panel B shows that mobility remains basically unchanged when we use measures of relative mobility. In the right panel G1 – G2 and G2 – G3 transitions depict the same pattern, i.e. relative position in the schooling distribution does not change significantly from one generation to the next.

4 | ECONOMETRIC SPECIFICATIONS

4.1 | Estimating Mobility Coefficients

Our econometric specifications follow standard descriptive analyses of mobility between adjacent generations, based on the estimation of a reduced form equation derived from the microeconomic model in Becker and Tomes (1979, 1986). Our analysis pools all countries together so we include country fixed effects. We first estimate a linear regression of years of education of generation t on years of education of an older generation $t-s$ in the same

[5] This is mainly due to the fact that we have very few grandparents with education above 12 years of schooling so that the estimates of the mean for those years are much less precise.

family of the form,

$$S_{ijt} = \beta_0 + \beta_1 S_{ij,t-s} + f(age_{ijt}, age_{ij,t-s}) + X_{ijt}\gamma + \phi_j + \eta_{ijt} \quad (1)$$

Where i indexes individual/family, j indexes country, and t indexes a generation; $s \in \{1, 2\}$ and $f(age_{ijt}, age_{ij,t-s})$ summarizes the fact that we include a flexible functional form the age of each generation in the regression.[6] In this setting, the slope β_1 is a measure of immobility. It can be interpreted as a measure of absolute mobility, as it indicates how an additional year of education in generation $t-s$ changes education for generation t. If S_{ijt} is defined relative to its distribution, then the coefficient β_1 represents a measure of relative mobility, indicating how the education attainment ranking changes from one generation to another. Finally, X_{ijt} includes a vector of controls, ϕ_j are country fixed effects, and η_{ijt} is an error term.

In Appendix B, we extend the two generation model and allow utility-maximizing grandparents to be concerned about the welfare of their grandchildren, so that the process that relates endowments over time is allowed to be AR(2). This opens the possibility of grandparent contribution beyond a mediated contributions through parents. As we derive in Appendix B, the model collapses to the following reduced form equation:

$$S_{ijt} = \beta_0 + \beta_1 S_{ij,t-s} + \beta_2 S_{ij,t-2} + f(age_{ijt}, age_{ij,t-1}, age_{ij,t-2}) + X_{ijt}\gamma + \phi_j + \eta_{ijt} \quad (2)$$

Which previous researchers have estimated for developed countries (e.g., Behrman and Taubman, 1985 for the U.S., Lindahl et al., 2015 for Sweden, Braun and Stuhler, 2018 for Germany.). Equation (2), β_1 is the association between parental education and children's education, conditioning on grandparental education. Likewise, our parameter of interest β_2, reflects the association between grandparents' and children's education, taking into account the parental factor. In particular, using this regression we are interested in testing the null hypothesis $H_0 : \beta_2 = 0$. If rejected, it provides evidence of higher order levels of persistence in educational outcomes. In the next section we present baseline results from the estimation of equations (1) and (2). Then, we extend our analysis to explore how mobility patterns have evolved over time.

4.2 | Changes in Mobility Coefficients and Compulsory Schooling Laws

We also describe how standard measures of intergenerational mobility change with compulsory schooling laws. In our sample of countries, compulsory schooling laws were implemented at different points in time. With these laws changing differentially across countries and cohorts within countries, we are able to study how intergenerational mobility patterns change before and after the reforms are passed using variation in the timing of compulsory schooling laws. We focus on laws implemented around birth cohorts of the children generation that were and were not affected by these changes in compulsory schooling policies. Like Nybom and Stuhler (2021), we want to study how standard measures of mobility patterns change over time after compulsory laws are implemented rather than examine their effect on outcomes as other studies have done (Machin et al., 2012). As such, this is a descriptive decomposition that helps interpreting trends on intergenerational mobility coefficients and not an analysis of the causal effects of compulsory schooling laws

[6] We include a binary indicator for each age group shown in Table 1 and an interaction term of age groups of parent and children.

on long run inequality.

To see how changes in the distribution of schooling affect the standard measures of mobility consider estimating equation (1) that links education of one generation to the next. The OLS coefficient that links educational attainment from one generation to the next can be expressed as,

$$\beta^{IGE} = Corr(S_{ijt}, S_{ijt-1}) \frac{SD(S_{ijt})}{SD(S_{ijt-1})}$$

Where $Corr(S_{ijt}), S_{ijt-1})$ is the Pearsons's correlation coefficient and $SD(S_{ijt}), SD(S_{ijt-1})$ are the standard deviations of the dependent and independent variable in the linear regression. As such, the standard measure of mobility, given by β^{IGE} decreases as the dispersion of schooling for the children generation (dependent variable) is reduced. A similar argument is shown in Landersø and Heckman (2017) comparing patterns of income mobility in Denmark and the U.S. showing that changes in inequality are reflected in smaller β^{IGE} over time for Denmark, but once these changes are accounted for, mobility between countries is similar.

We test whether compulsory schooling laws explain trend breaks in our measures of intergenerational mobility by taking advantage of the variation in the timing of the implementation of the law in each country. This allows constructing an event study analysis to test whether slope coefficient decreases after a country passes a compulsory schooling law, hence increasing mobility in schooling for the next generation. To clean our estimates from the fact that some parents may have been affected by compulsory schooling laws, we drop from our sample families where the parental generation was 18 years old or younger at the moment of the implementation of each reform.

It is worth emphasizing that this exercise is descriptive and, as such, we are not estimating the causal effect compulsory schooling laws.[7] To test for a significant break in trends on coefficients of educational mobility we run the following regression:

$$S_{itcj} = \phi_j + \sum_{c=-4\ /\ c\neq 0}^{9} \beta_c S_{ij,t-s} D_{ctj} + \gamma X_{ijts} + f(age_{ijt}, age_{ij,t-1}) + \omega_{itcj} \qquad (3)$$

Where S_{itcj} is years of schooling for grandchildren i in cohort c from country j, and $t = 3$. In addition, ϕ_j are country fixed effects, S_{it-s} is years of schooling for parental (s=1) or grandparental generation (s=2) and D_{ctj} are binary indicators that equal to one if the child belongs to birth cohort c and country j. In particular, D_{ctj} is a categorical variable that groups the children generation in birth cohorts within each country according to the distance in years to the birth cohort first exposed to compulsory schooling within a country. We group cohorts into those born 15 years or more before the first cohort exposed, born 10 to 14 years before, 5 to 9 years before, 0 to 4 years before, 1 to 5 years after the first cohort exposed, 6 to 10 years, 11 to 15 years, 16 to 20 years, and 21 or more. We leave out as base group cohort born 0 to 4 years before so that β_cs are the differences in mobility coefficients between each cohort with respect to the cohort born before the implementation of the reform in each country. Finaly, X_{ijts} includes gender of G2 and G3, and $f(age_{it}, age_{i,t-1})$ are flexible functional forms of age for the grandchildren and parent generation. We run this regression using years of schooling and standardized years of schooling.

[7] Gathering data necessary to estimate the causal effect of compulsory schooling laws over time across different countries scapes the scope of this paper.

5 | RESULTS

5.1 | Results on Mobility Coefficients

In this section we present our estimates of intergenerational mobility using both absolute and relative measures in the pooled data of countries. We find large associations of school attainment in adjacent generations relative to developed countries (see Table 3). These associations in absolute schooling are reduced as families advance to the next generation; however relative positions in the schooling distribution remain unchanged. These results indicate that absolute mobility has increased importantly, while relative schooling mobility increased only moderately across three generations.

Table 2 exhibits the estimated transmission coefficients for years of education across the three generations under study. In particular, we estimate equation (1) and equation (2) including country fixed effects. Column (1) shows that an additional year of education in the grandparent generation (G1) is related to 0.771 years of schooling in the next generation (G2). The association between educational outcomes for the generation of parents (G2) and their children (G3), in column (2), shows that changes in one year of schooling for parents is related to 0.542 of additional schooling for their children.

The next column shows that the persistence of schooling remains high when we examine the relation between schooling of grandparents and grandchildren. The results show that changes in one year of schooling for grandparents is related to 0.534 years of additional schooling for their grandchildren. Moreover, if we were to compute mobility across three generations by the standard two-generation exponentiation procedure, we would be significantly under-predicting intergenerational persistence in educational attainment over three generations. Suppose, as is the typical case, that we only had available the association between educational outcomes for parents (G2) and their children (G3) as shown in column (2). According to the extrapolation by exponentiation method,[8] we would predict a coefficient for the association between G3 and G1, given by $0.542^2 = 0.29$. However, the estimated coefficient 0.534 presented in column (3) is much larger, which corresponds to an over prediction of 84% of the mobility coefficient when using such simple extrapolation. As a benchmark, Braun and Stuhler (2016) find that the over prediction of this method in the case of Germany is 38%.

Grandparental influence can be independent of parents' education. If so, we would expect the coefficient on grandparents' education to be zero when we estimate equation (2). However, column (4) shows that, even after conditioning on parental education, the grandparent factor does not fade out, rejecting the null hypothesis $H_0 : \beta_2 = 0$. In other words, there is a persistent association between G1 and G3, despite the fact that there is one generation or an average of 50 years between them. This association shows that once we control for parents education an additional year of schooling of the grandparent generation is associated to 0.165 additional years of schooling for their grandchildren.

The distribution of years of schooling over time has changed significantly across generations, as evidenced in Table 1. This may generate mechanical shifts in mobility captured by the OLS coefficients presented in Table 2, i.e. absolute mobility coefficients change but not the position of family members in the distribution of years of schooling within their generation. Threfore, we also study relative mobility, i.e. movements relative to the position of each individual within their generation's schooling distribution, standardizing years of schooling within a country and generation. With the standardized measures of schooling we

[8] Consider $S_{it} = \beta_0 + \beta_1 S_{i,t-1} + \eta_{it}$. If we assume the exact same process for the past generation, then $S_{i,t-1} = \beta_0 + \beta_1 S_{i,t-2} + \eta_{i,t-1}$. Replacing the second in the latter, we get $S_{it} = \alpha_0 + \alpha_1 S_{i,t-2} + \varepsilon_{it}$, where $\alpha_0 = \beta_0 + \beta_1$, $\alpha_1 = \beta_1^2$, and $\varepsilon_{it} = \beta_1 \eta_{i,t-1} + \eta_{i,t}$.

TABLE 2 Main Results

Dep. Var. is schooling of	Parents (G2)	Children (G3)		
	(1)	(2)	(3)	(4)
Parents' Schooling (G2)		0.542***		0.480***
		(0.007)		(0.008)
		[0.540]		[0.467]
Grandparents' Schooling (G1)	0.771***		0.534***	0.165***
	(0.010)		(0.011)	(0.012)
	[0.547]		[0.377]	[0.131]
Observations	17,266	50,324	50,324	50,324
Dep. Var. Mean	5.181	4.083	9.067	9.067
Adjusted R^2	0.408	0.303	0.185	0.311

Notes: This table presents the results of estimating equation (1) and equation (2) including country fixed effects. G1: Mean schooling of the grandparent generation. G2: Schooling of the survey respondent. G3: Schooling of respondent's offspring. Column (1): Controls for a binary indicators of age groups of G2 shown in Table 1, sex of G2. Each observation corresponds to a respondent in our sample. Column (2): Controls for a binary indicator of age groups of G2 and G3 shown in Table 1, sex of G2 and G3. Each observation corresponds to a respondents' children in our sample. Column (3): Controls for a binary indicator of age groups of G3 shown in Table 1, sex of G3. Each observation corresponds to a respondents' children in our sample. Column (4): Similar to (3) adding schooling of G1 as a explanatory variable. Each term between brackets ([]) corresponds to the standardized coefficients. Robust standard errors in parentheses clustered at the family level. ***, ** and * indicate statistical significance at the 1, 5 and 10 percent level respectively.

run the same regressions as before. The standardized coefficients are reported in brackets in Table 2. The results show that mobility patterns change less from one generation to the other for relative mobility. An increase in one standard deviation (σ) in the grand parental education is associated with 0.547σ of additional schooling in the parental generation. To picture such change with one example, a one standard deviation in grandparent's years of schooling (3.2σ) is associated with 1.8 additional years of schooling for parents. In the next generation, the association between parents' schooling and that of their children is 0.54, i.e. an increase in one standard deviation in the parental education (4.7σ) is associated with 2.5 additional years of schooling for their children. Overall, the results suggest that changes in the schooling distribution explain a large fraction of the decline in persistence across the three generations.

Table 3 puts our findings in perspective by comparing similar studies for developed countries. G2-G1 coefficients corresponds to the parental-grandparental years of schooling regression, G2-G3 corresponds to the children-parent years of schooling regression, G3-G1 to the children-grandparent years of schooling regression, while the last column estimates the same regression conditioning the children-grandparent years of schooling regression on parent years of schooling. The table shows that the coefficient of educational transmission of grandparents to parents is similar to that of parents to children, which suggests that (im)mobility has been stable over generations in the LAC region compared to other countries. Column (3) shows that grandparental influence on children is much higher in LAC. Furthermore, column (4) shows that, even after conditioning on parental education, the grandparent factor does not fade out, suggesting a persistent association between G1 and G3, despite the fact that there is one generation or an average of 50 years between them.

TABLE 3 Mobility Coefficients in Comparative Perspective

	Relative Mobility Coefficients for regressions:			
	G2-G1	G3-G2	G3-G1	G3-G1/G2
	(1)	(2)	(3)	(4)
LAC	0.55	0.54	0.38	0.13
Germany	n.a.	0.48	0.26	0.10
Sweden	0.28	0.30	0.13	0.06
U.S.	n.a.	0.40	0.17	0.02
U.K.	n.a.	0.21	0.11	0.05

Notes: This table shows coefficients obtained from similar regressions that control for a quadratic polynomial on age and a binary indicator of sex of each generation. We show mobility using standardized coefficients to allow comparability. LAC coefficients are estimated pooling all Latin-American countries together including country fixed effects. Sweden estimates are obtained from Lindahl et al., 2015. Germany, US, and UK estimates are from Neidhöfer and Stockhausen (2019). n.a.: Not available. All correspond to standardized coefficients, statistically significant at conventional levels.

5.2 | Trends in Mobility Coefficients

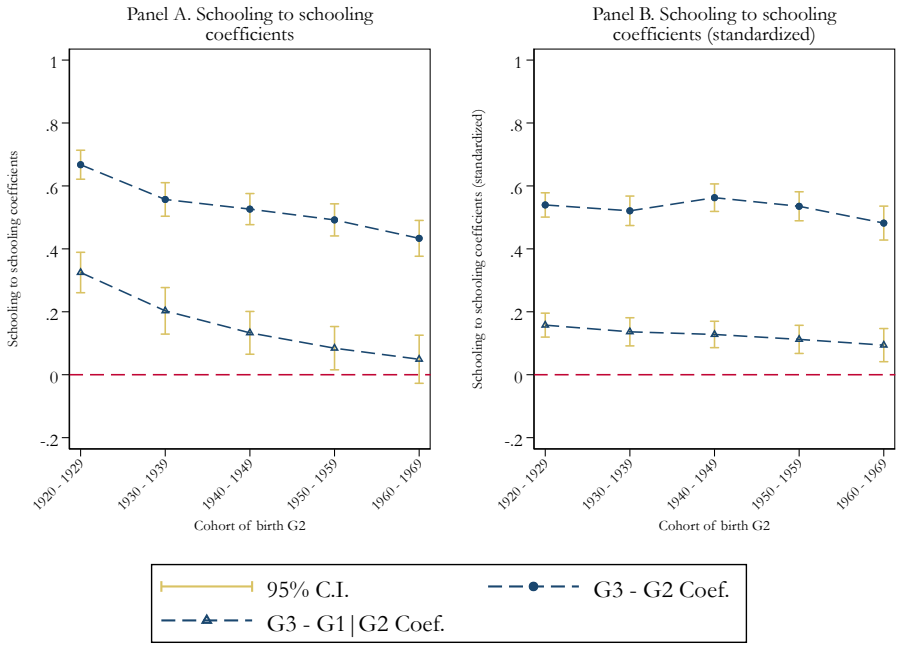
In this section we show how mobility patterns have evolved over fifty years. We find that the association of school attainment between generations has decreased over time, indicating that mobility has improved. However, the relative position in the schooling distribution of different generations of the same family is stable across time.

First we document trends in intergenerational coefficients using slope coefficients and standardized slope coefficients. We group the sample by birth cohorts of the parental generation, in groups of 10 years. As such, groups range from those born between 1920-1929 to those parents born between 1960-1969, which allows examining patterns of intergenerational mobility over 50 years. To estimate different slope coefficients we interact each schooling variable (G2 or G1) in the right hand side of equations (1) and regression (2) with four binary indicators for cohort of birth of G2, leaving the older cohort as a base group. Results from these regressions are shown in Tables A.1 and A.2 in the appendix.

To illustrate patterns of mobility over time, Figure 2 shows the level of mobility obtained the regression with interactions for each triplet of grandparents, parents and grandchildren and birth cohorts of G2. Panel A shows absolute mobility while Panel B shows relative mobility coefficients. Each panel shows the intergenerational mobility coefficients for parents and their children (G3–G2) in the top (circle dashed lines), and grandparents and their grandchildren (G3–G1) at the bottom (triangle dashed lines). The x-axis corresponds to birth cohorts of G2, grouped in decennials to smooth trends. The y-axis plots the coefficients of regression (1) for G3–G2 and regression (2) for G3–G1, conditioning the grandparent-grandchild regression on schooling of G2.

The results in the left panel show that slope coefficients from a regression of years of schooling of generation t to years of schooling of generation $t-s$ tend to decrease rapidly over time. When analyzing the generation of parents born in the 1920s, the parent-child mobility coefficient is approximately 0.67 and decreases by 0.23 points over 50 years for the parent generation born in the 1960s. Over 50 years, educational mobility, as measured by schooling to schooling regressions increased in 30%. These results are remarkably similar to those found by Neidhöfer et al. (2018) using a different set of Latin-American countries and

FIGURE 2 Trends in Mobility Coefficients across Cohorts of G3



Notes: (a) This figure shows in the y-axis the coefficients between a regression of G3 years of schooling against G2 years of schooling (in circles), and against G1 years of schooling (in triangles), for each birth cohort pooling all countries. (b) This figure shows in the y-axis the coefficients between a regression of G3 years of schooling against G2 years of schooling (in circles), and against G1 years of schooling (in triangles), for each birth cohort pooling all countries.

different survey data. We add to their results by exploring longer term mobility studying mobility across three generations of the same family. Nybom and Stuhler (2021) find a similar pattern for Sweden for G3 cohorts born around the 1940s, although they start at much higher levels of mobility (lower coefficients) and document a rapid decrease over a period of 20 years. Compared to their evidence we find that Latin America is behind by an entire generation in terms of mobility gains.

A similar trend is observed for the grandparent-grandchild slope coefficients. While the (conditional) association of schooling between grandparent and grandchild is 0.33 for older cohorts, it decreases by 0.28 points after 50 years, until no longer statistically different than zero. Only after 50 years, the influence of grandparents' background as measured by years of schooling seems to vanish.

However, when we use standardized years of schooling the results show that grandparents still explain the position of grandchildren in the distribution of years of schooling after 50 years. The results in Panel B of Figure 2 show that standardized slope coefficients remain relatively stable over time. This is similar to regressing ranking within the cohort-country distribution as years of schooling of each generation is defined relative to the mean of each cohort-country. When analyzing the generation of parents born in the 1920s, the parent-child standardized mobility coefficient is approximately 0.54 and decreases slightly to 0.48 for the parent generation born 50 years after. Neidhöfer et al. (2018) find a very similar pattern (and magnitudes) for the parent-child standardized regression coefficients. They show a relatively flat trend over 50 years in standardized regression coefficients and rank-rank correlations. Next, the grandparent-grandchild slope coefficients of a regression using standardized years of schooling show a less dramatic trend than those in Panel A. While the standardized mobility coefficient is approximately 0.16 for the oldest cohort it

decreases to 0.11 over 50 years.

5.3 | Mobility Coefficients and Compulsory Schooling Laws

In this section we find that, similar to arguments in Landersø and Heckman (2017) and Nybom and Stuhler (2021), changes in the distribution of education over time affect absolute measures of mobility because younger generations attain more schooling but the relative position in the distribution remains similar even after three generations. We show that compulsory schooling laws may be behind this over interpretation of increased mobility over time shown in Figure 2.

Chile mandated compulsory schooling of eight years in year 1965. The reform was implemented based on the program *Bases Generales para el Planeamiento de la Educación Chilena* in 1961. The reform sought to reduce school dropouts and introduce different levels of education provision (e.g., preschool, primary and middle school).[9] The timing of the reform affected cohorts born around 1952 as these children were passing on to eight grade when the law became active. In Colombia, in the context of a new constitutional process in 1991, under its 67th article, establishes that the education will be mandatory for children between ages 5 and 15 and will comprise at minimum nine years of education. Children born around 1977 or after were exposed to the law. A similar process went through in El Salvador in 1983. During a new constitutional process in this year, under its 53rd and 54th articles, the country established that schooling will be mandatory, at minimum, for nine years of education. The first cohort eligible for these constitutional change in El salvador was born in 1968. With the return to democracy in 1993, Paraguay engaged in the promotion of mandatory and universal schooling. During this first year of transition the country established a law that mandated nine years of schooling. As such, birth cohorts born around 1979 were first exposed to this law. Mexico went through a radical change in its education system starting year 1959 through its *Plan de Once Años* that, among other initiatives, expanded primary level education throughout the country and mandated it's completion by law. The first cohort exposed was that one born in 1951. Finally, Uruguay also went through a constitutional change in 1967 in which the country established that schooling will be mandatory, at minimum, for twelve years of schooling. The first cohort eligible for these constitutional change was born in 1949.

To describe how compulsory schooling laws can affect mobility patterns, we study how the mean and standard deviations of years of schooling changes for G3 birth cohorts who were exposed and unexposed to the reform according to their year of birth shown in Figure 3. We gathered Census data for each country using data from IPUMS-International that includes age and years of schooling. We pool these data for each country and cohort.[10] Each year in the x-axis is normalized within country as distance in years from the year of birth of the first cohort exposed and the year in which the compulsory schooling law was implemented in each country. As such, a value of zero indicates that that particular birth cohort was exposed, according to its year of birth, for less than one year, while a value of one indicates that that particular birth cohort was exposed for one year, and so on.

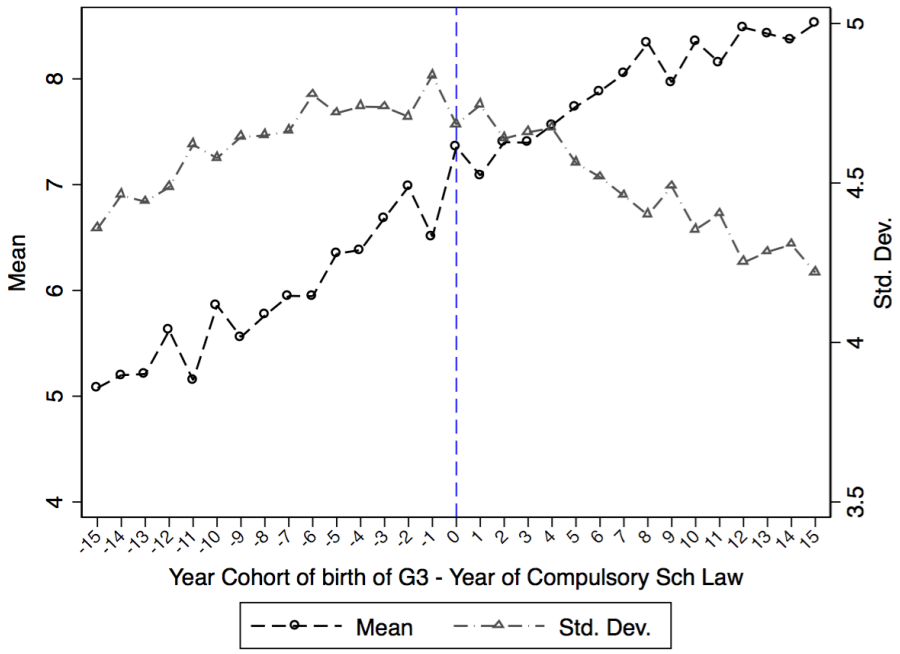
The figure suggests that compulsory schooling laws significantly reduced the dispersion of years of schooling among cohorts exposed to the compulsory schooling laws.[11] The

[9] Details of Chile's 1965 reform can be found in BNCh (2021), for Colombia see BNCo (1991), for El Salvador see BNEs (1983), for Paraguay see Elías (2014), for Mexico see UNAB (2011), for Uruguay see De los Campos and Ferrando (2013).

[10] We downloaded samples of each national census from IPUMS international: https://international.ipums.org/international/. We use census year 2002 for Chile, 2005 for Colombia, 2007 for El Salvador, 2002, for Paraguay, 2006 for Uruguay and year 2000 for Mexico.

[11] See Ram (1990) for a discussion of movements in the average and inequality in schooling over time.

FIGURE 3 Schooling Before and After Compulsory Reform



Notes: This figure shows the mean and standard deviations of years of schooling for G3 birth cohorts who were exposed and unexposed to a compulsory schooling reform according to their year of birth. We gathered Census data for each country using data from IPUMS-International. Each year in the x-axis is normalized within country as distance in years from the year of birth of the first cohort exposed and the year in which the compulsory schooling law was implemented in each country. As such, a value of zero indicates that that particular birth cohort was exposed, according to its year of birth, for less than one year, while a value of one indicates that that particular birth cohort was exposed for one year, and so on.

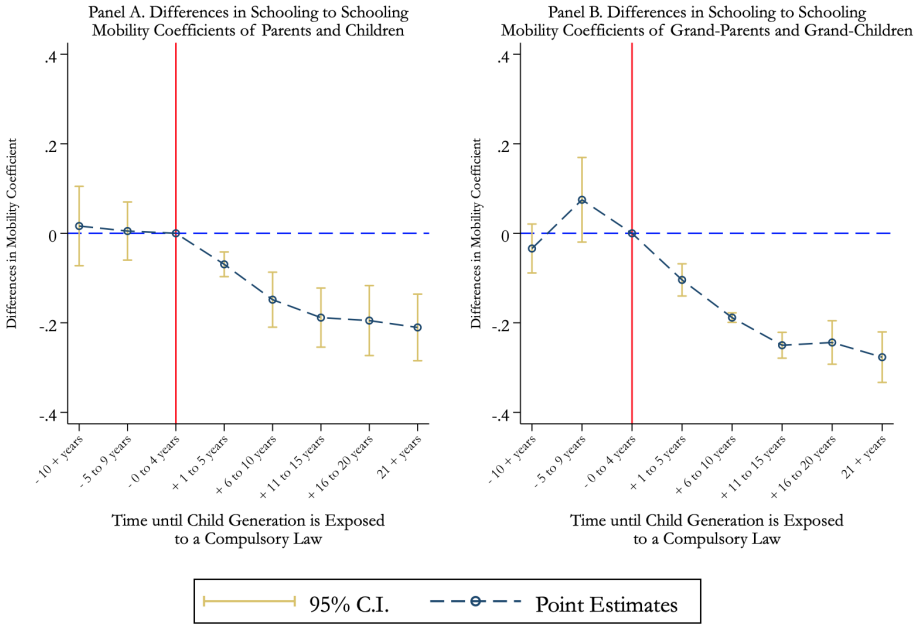
dashed blue line separates birth cohorts that were first exposed according to their birth year. The Figure shows that there is a consistent increase in the mean of years of schooling over time, with no break around the implementation of the laws. However, while the standard deviation of years of schooling increases slightly over the pre-reform period, it starts to decline rapidly for birth cohorts exposed to a minimum of mandated schooling.

To test how these changes in the distribution might affect slope coefficients, Figure 4a shows the estimates of coefficients β_cs of equation (3) using years of schooling as our measure of educational attainment. The results are available in Table A.3 and A.4 in the Appendix. The left panel shows the differences in mobility coefficients of a regression of child education on parental education between children cohorts unexposed and exposed to the compulsory schooling reform within each country. We plot differences in mobility coefficients of each cohorts with respect to the cohort that was just unexposed to the compulsory schooling reform. The Figure shows that mobility coefficients for cohorts that were not exposed to the compulsory reform (to the left of the red line) are very similar to each other. Once the reform takes place mobility coefficients decrease consistently with respect to the reference cohort.

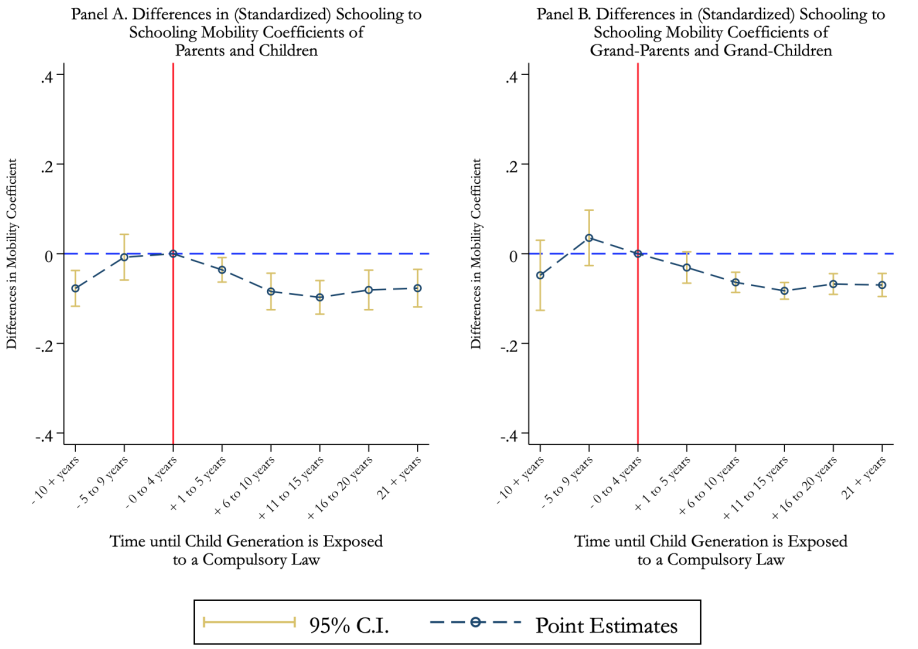
The right panel shows a similar story. The figure shows the differences in mobility coefficients of a regression of child education and grandparental education interacted with cohort of birth of the child. While mobility is stable before compulsory schooling reforms,

FIGURE 4 Estimated Mobility coefficients Before and After Compulsory School Reforms

(a) Differences in Grandparent-Child Mobility Coefficients Before and After Reform



(b) Differences in Grandparent-Child (Standardized) Mobility Coefficients Before and After Reform



Notes: This figure shows in the y-axis the coefficients between a regression of G3 years of schooling against G2 years of schooling (in circles), and against G1 years of schooling (in triangles), for each birth cohort pooling all countries. (b) This figure shows in the y-axis the coefficients between a regression of G3 years of schooling against G2 years of schooling (in circles), and against G1 years of schooling (in triangles), for each birth cohort pooling all countries.

rapidly increases (coefficient decreases) after the reforms are implemented. These results

show that compulsory schooling laws may be important to explain trends observed in Figure 2.

Results above show that compulsory schooling laws affect schooling attainment of the child generation and so increase mobility in absolute measures; however they have a small influence on relative measures. Figure 4b shows the estimates of β_cs of equation (3) using standardized years of schooling as our measure of educational attainment. The left panel shows the differences in mobility coefficients of a regression of child education on parental education between children cohorts unexposed and exposed to the compulsory schooling reform within each country. After standardizing schooling attainment measures, the coefficients remain relatively stable before and after compulsory schooling reforms are passed.

6 | DISCUSSION

This paper provides new evidence on long term intergenerational mobility in developing countries. We gathered data for six Latin American countries linking schooling outcomes for children, parents and grandparents of the same family over 50 years. We compare educational attainment of adjacent generations in absolute measures and relative schooling measures – standardized within country and cohort of birth. Our results show a high persistence in education attainment between grandparents and grandchildren even after conditioning for parental education. Our results show that longer run mobility in education is much lower than usual predictions based on correlations between parents and children.

We also find that while future generations have higher educational attainment than their ancestors their relative position in the distribution of education remains similar in the long run. We complement important previous evidence on two generations mobility (see Neidhöfer et al., 2018; Neidhöfer, 2019), showing that lack of mobility is persistent in the longer-run by examining three generations, i.e., including grandparents and grandchildren.

A cohort-analysis examining fifty years of data confirms the long-term persistence of education. Younger cohorts attain higher levels of schooling, than their ancestors, which translates into an improvement in absolute mobility measures over time. However, the relative position of families in the educational distribution remains much stable across cohorts. Nybom and Stuhler (2021) find a similar pattern for Sweden but for families with children born around the 1940s, which corresponds to the median birth year for parents in our data. As such, Latin America is behind by an entire generation in terms of mobility gains.

We also use changes in compulsory schooling laws over time and across countries in our sample to describe how educational attainment changes around their implementation. We show that after the compulsory laws, the level of schooling increases but its dispersion decreases. These results translate into both increased absolute mobility and stagnant relative mobility.

This paper contributes to a recent and increasing literature studying intergenerational mobility across multiple generations. It is one of the first to address long-run educational mobility for a set of Latin American countries in a comparative perspective, complementing the new wave of American and European studies that go beyond two generations to understand the evolution of inequality. In particular, we present novel evidence on educational mobility patterns across three generations in Chile, Colombia, El Salvador, Paraguay, Mexico, and Uruguay. Using similar methods to other studies we can place long run mobility in Latin America in a comparative perspective and benefit our understanding of long-run mobility.

Intergenerational mobility across generations in educational attainment and income inequality are closely linked (Blanden et al., 2022). While in the past decades we have seen significant gains in school attainment, the ability to turn more years of education in to better economic outcomes show large variation across countries (Blanden et al., 2022, Ram, 1990). Challenges for future work are directed to better understanding the causal channels behind the long run persistence of poverty, education, and income. We provide evidence highlighting that family background effects can be longer-lasting than previously shown.

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A | ADDITIONAL TABLES

TABLE A.1 Mobility Coefficients and Interactions with Birth Cohorts of G2

	Years of Schooling of Children (G3)	
	(1)	(2)
Schooling of G2	0.667***	0.479***
	(0.023)	(0.008)
Schooling of G1		0.325***
		(0.033)
Sch. (G2) x Chrt: 1930 - 39	-0.110***	
	(0.027)	
Sch. (G2) x Chrt: 1940 - 49	-0.141***	
	(0.025)	
Sch. (G2) x Chrt: 1950 - 59	-0.175***	
	(0.026)	
Sch. (G2) x Chrt: 1960 - 69	-0.234***	
	(0.029)	
Sch. (G1) x Chrt: 1930 - 39		-0.122***
		(0.038)
Sch. (G1) x Chrt: 1940 - 49		-0.192***
		(0.035)
Sch. (G1) x Chrt: 1950 - 59		-0.241***
		(0.035)
Sch. (G1) x Chrt: 1960 - 69		-0.276***
		(0.039)
Observations	50,324	50,324
F-test interactions	1484.284	42.573

Notes: This table presents results of OLS estimates of equation (1) and equation (2) including country fixed effects and interactions of right hand side schooling variables with birth cohorts of G2 grouped in five years. G1: Mean schooling of the grandparent generation. G2: Schooling of the survey respondent. G3: Schooling of respondent's offspring. All regressions control for a binary indicators of birth cohorts of age groups of G2 and G3, and sex of G2 and G3. Each observation corresponds to a respondents' children in our sample. Robust standard errors in parentheses clustered at the family level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

TABLE A.2 Mobility Coefficients and Interactions with Birth Cohorts of G2

	Years of Schooling of Children (G3)	
	(1)	(2)
Std. Schooling of G2	0.540***	0.465***
	(0.020)	(0.008)
Std. Schooling of G3		0.158***
		(0.019)
Sch. (G2) x Chrt: 1930 - 39	-0.019	
	(0.024)	
Sch. (G2) x Chrt: 1940 - 49	0.023	
	(0.022)	
Sch. (G2) x Chrt: 1950 - 59	-0.004	
	(0.024)	
Sch. (G2) x Chrt: 1960 - 69	-0.058**	
	(0.028)	
Sch. (G1) x Chrt: 1930 - 39		-0.021
		(0.023)
Sch. (G1) x Chrt: 1940 - 49		-0.030
		(0.021)
Sch. (G1) x Chrt: 1950 - 59		-0.045**
		(0.023)
Sch. (G1) x Chrt: 1960 - 69		-0.064**
		(0.027)
Observations	50,324	50,324
F-test interactions	1496.741	53.751

Notes: This table presents resultas of OLS estimates of equation (1) and equation (2) including country fixed effects and interactions of right hand side schooling variables with birth cohorts of G2 grouped in five years.All schooling variables are standardized within country and birth cohort. G1: Mean schooling of the grandparent generation. G2: Schooling of the survey respondent. G3: Schooling of respondent's offspring. All regressions control for a binary indicators of birth cohorts of age groups of G2 and G3, and sex of G2 and G3. Each observation corresponds to a respondents' children in our sample. Robust standard errors in parentheses clustered at the family level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

TABLE A.3 Mobility Coefficients and Interactions with cohorts of G3 (Un)Exposed to Compulsory Schooling Laws

	Years of Schooling of Children (G3)	
	(1)	(2)
Schooling of G2	0.656***	0.489***
	(0.062)	(0.029)
Schooling of G1	0.161*	0.377***
	(0.066)	(0.076)
Sch. G2 × **1**(- 10 + years)	0.016	
	(0.054)	
Sch. G2 × **1**(- 5 to 9 years)	0.005	
	(0.039)	
Sch. G2 × **1**(+ 1 to 5 years)	-0.069**	
	(0.017)	
Sch. G2 × **1**(+ 6 to 10 years)	-0.148**	
	(0.037)	
Sch. G2 × **1**(+ 11 to 15 years)	-0.188***	
	(0.040)	
Sch. G2 × **1**(+ 16 to 20 years)	-0.195**	
	(0.048)	
Sch. G2 × **1**(21 + years)	-0.210***	
	(0.045)	
Sch. G1 × **1**(- 10 + years)		-0.034
		(0.033)
Sch. G1 × **1**(- 5 to 9 years)		0.075
		(0.057)
Sch. G1 × **1**(+ 1 to 5 years)		-0.104***
		(0.022)
Sch. G1 × **1**(+ 6 to 10 years)		-0.188***
		(0.006)
Sch. G1 × **1**(+ 11 to 15 years)		-0.250***
		(0.018)
Sch. G1 × **1**(+ 16 to 20 years)		-0.244***
		(0.030)
Sch. G1 × **1**(21 + years)		-0.277***
		(0.034)
Observations	50,414	50,414

Notes: This table presents results of OLS estimates of equation (3) including country fixed effects and interactions of right hand side schooling variables with birth cohorts of G2 grouped in five years. G1: Mean schooling of the grandparent generation. G2: Schooling of the survey respondent. G3: Schooling of respondent's offspring. All regressions control for a binary indicators of birth cohorts of age groups of G2 and G3, and sex of G2 and G3. Each observation corresponds to a respondents' children in our sample. Robust standard errors in parentheses clustered at the family level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

TABLE A.4 Mobility Coefficients and Interactions with cohorts of G3 (Un)Exposed to Compulsory Schooling Laws

	Std. Years of Schooling of Children (G3)	
	(1)	(2)
Std. Sch. G2	0.548***	0.474***
	(0.026)	(0.008)
Std. Sch. G1	0.126***	0.187***
	(0.014)	(0.015)
Std. Sch. G2 × **1**(- 10 + years)	-0.077**	
	(0.024)	
Std. Sch. G2 × **1**(- 5 to 9 years)	-0.008	
	(0.031)	
Std. Sch. G2 × **1**(+ 1 to 5 years)	-0.036*	
	(0.017)	
Std. Sch. G2 × **1**(+ 6 to 10 years)	-0.084**	
	(0.025)	
Std. Sch. G2 × **1**(+ 11 to 15 years)	-0.097**	
	(0.023)	
Std. Sch. G2 × **1**(+ 16 to 20 years)	-0.081**	
	(0.027)	
Std. Sch. G2 × **1**(21 + years)	-0.077**	
	(0.025)	
Std. Sch. G1 × **1**(- 10 + years)		-0.048
		(0.048)
Std. Sch. G1 × **1**(- 5 to 9 years)		0.035
		(0.038)
Std. Sch. G1 × **1**(+ 1 to 5 years)		-0.031
		(0.021)
Std. Sch. G1 × **1**(+ 6 to 10 years)		-0.064***
		(0.014)
Std. Sch. G1 × **1**(+ 11 to 15 years)		-0.083***
		(0.011)
Std. Sch. G1 × **1**(+ 16 to 20 years)		-0.068***
		(0.014)
Std. Sch. G1 × **1**(21 + years)		-0.070**
		(0.016)
Observations	50,414	50,414

Notes: This table presents results of OLS estimates of equation (3) including country fixed effects and interactions of right hand side schooling variables with birth cohorts of G2 grouped in five years. Schooling variables are standardised within country and birth cohort of G2. G1: Mean schooling of the grandparent generation. G2: Schooling of the survey respondent. G3: Schooling of respondent's offspring. All regressions control for a binary indicators of birth cohorts of age groups of G2 and G3, and sex of G2 and G3. Each observation corresponds to a respondents' children in our sample. Robust standard errors in parentheses clustered at the family level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

B | THE EXTENDED ECONOMIC MODEL OF INTERGENERATIONAL EDUCATIONAL MOBILITY

Building on Solon (2014) and Becker and Tomes (1979, 1986), we a present theoretical intergenerational mobility model of schooling, which adds the possibility of grandparental contribution to the child education The following four equations describe the basics of the model. Parents are budget constrained, so they divide their income into consumption and investment in their child human capital (equation (A.1)); there is a technology that transforms that investment into human capital (schooling) for the child (equation (A.2)); an AR(2) process (hence, allowing grandparental contribution[12] beyond the contribution mediated through the parent) describes how endowments are related over time (equation (A.3)); and human capital (schooling) translates into earnings in the labor market according to equation (A.4).

$$y_{i,t-1} = C_{i,t-1} + I_{i,t-1} \tag{A.1}$$

$$S_{it} = \theta \log I_{i,t-1} + e_{it} \tag{A.2}$$

$$e_{it} = \delta + \lambda_1 e_{i,t-1} + \lambda_2 e_{i,t-2} + \nu_{it} \tag{A.3}$$

$$\log y_{it} = \mu + pS_{it} \tag{A.4}$$

Parents have an altruistic utility function depending on their own consumption $C_{i,t-1}$ and their children's (expected life time) earnings. This variable, in turn, depends on the investment made by parents $I_{i,t-1}$. Parents maximize utility over consumption and investment, subject to the budget constraint (equation (A.1)).

$$\max_{C_{i,t-1}, I_{i,t-1}} (1-\alpha) \log C_{i,t-1} + \alpha \log y_{it} \quad \text{s.t.} \quad \text{(A.1)}$$

Also, note that consider lagging (A.4)

$$\log y_{i,t-1} = \mu + pS_{i,t-1}$$

and therefore,

$$C_{t-1} = \exp(\mu + pS_{i,t-1}) - I_{t-1}$$

Additionally, consider replacing (A.2) in (A.4),

$$\begin{aligned} \log y_{it} &= \mu + pS_{it} \\ \log y_{it} &= \mu + p(\theta \log I_{i,t-1} + e_{it}) \end{aligned}$$

[12] As pointed out by Stuhler (2012), Lindahl (2013B) and others, there are other ways to extend the underlying Becker-Tomes model.

and denote $\gamma_1 = p\theta$ the elasticity of the child's income with respect to investment in the child's human capital,

$$\log y_{it} = \mu + \gamma_1 \log I_{i,t-1} + p e_{it}$$

So if parents are aware of equations (A.2) - (A.4), the objective function can be re-written in terms of $I_{i,t-1}$ as,

$$\max_{C_{i,t-1}, I_{i,t-1}} (1-\alpha)\log C_{i,t-1} + \alpha \log y_{it} \quad \text{s.t.} \quad \text{(A.1)}$$
$$\max_{I_{i,t-1}} (1-\alpha)\log(\exp(\mu + pS_{i,t-1}) - I_{t-1}) + \alpha \log(\mu + \gamma_1 \log I_{i,t-1} + p e_{it})$$

with FOC given by

$$\frac{1-\alpha}{\exp(\mu + pS_{i,t-1})} = \frac{\alpha\gamma_1}{I_{i,t-1}}$$

Hence, the optimal investment in human capital is given by

$$I^*_{i,t-1} = \frac{\alpha\gamma_1}{1-\alpha(1-\gamma_1)} \exp(\mu + pS_{i,t-1})$$

Therefore, replacing in (A.2), we get an equation relating the child's schooling with the parental schooling,

$$\begin{aligned}
S_{it} &= \theta \log I^*_{i,t-1} + e_{it} \\
S_{it} &= \theta \log\left(\frac{\alpha\gamma_1 \exp(\mu + pS_{i,t-1})}{1-\alpha(1-\gamma_1)}\right) + e_{it} \\
S_{it} &= \underbrace{\theta\left[\log\left(\frac{\alpha\gamma_1}{1-\alpha(1-\gamma_1)}\right) + \mu\right]}_{=\gamma_0} + \gamma_1 S_{i,t-1} + e_{it} \\
S_{it} &= \gamma_0 + \gamma_1 S_{i,t-1} + e_{it}
\end{aligned}$$

Still, we need to incorporate the human capital endowment process information (e_{it}). Since we are allowing for grandparental contribution -beyond the parental one-, we are going to get a reduced form that links the child's education with the grandparent schooling.

Let's lag the equation from last line in one and two periods, and premultiply them by λ_1 and λ_2, respectively

$$\begin{aligned}
S_{it} &= \gamma_0 + \gamma_1 S_{i,t-1} + e_{it} \\
\lambda_1 S_{i,t-1} &= \lambda_1\gamma_0 + \lambda_1\gamma_1 S_{i,t-2} + \lambda_1 e_{i,t-1} \\
\lambda_2 S_{i,t-2} &= \lambda_2\gamma_0 + \lambda_2\gamma_1 S_{i,t-3} + \lambda_2 e_{i,t-2}
\end{aligned}$$

Replacing these last two equations in (A.3),

$$e_{it} = \delta + \lambda_1 e_{i,t-1} + \lambda_2 e_{i,t-2} + \nu_{it}$$
$$e_{it} = \delta + \lambda_1 S_{i,t-1} - \lambda_1\gamma_0 - \lambda_1\gamma_1 S_{i,t-2} + \lambda_2 S_{i,t-2} - \lambda_2\gamma_0 - \lambda_2\gamma_1 S_{i,t-3} + \nu_{it}$$

Replacing the expression for e_{it} in the equation we just lagged, we get,

$$S_{it} = \gamma_0 + \gamma_1 S_{i,t-1} + e_{it}$$
$$S_{it} = \gamma_0 + \gamma_1 S_{i,t-1} + \delta + \lambda_1 S_{i,t-1} - \lambda_1\gamma_0 - \lambda_1\gamma_1 S_{i,t-2} + \lambda_2 S_{i,t-2} - \lambda_2\gamma_0 - \lambda_2\gamma_1 S_{i,t-3} + \nu_{it}$$

Rearranging,

$$S_{it} = \underbrace{\delta + \gamma_0(1-\lambda_1-\lambda_2)}_{\beta_0} + \underbrace{(\gamma_1+\lambda_1)}_{\beta_1} S_{i,t-1} + \underbrace{(\lambda_2 - \gamma_1\lambda_1)}_{\beta_2} S_{i,t-2} + \underbrace{\nu_{it} - \gamma_1\lambda_2 S_{i,t-3}}_{\xi_{it}}$$

So, our reduced form equation looks like

$$S_{it} = \beta_0 + \beta_1 S_{i,t-1} + \beta_2 S_{i,t-2} + \xi_{it} \tag{A.5}$$

Note that the coefficient for grandparental schooling may be positive because of the incorporation of a grandparental contribution to the child's genetic/cultural inheritance. In particular, the grandparental coefficient is positive if our structural parameters satisfy $\lambda_2 - \gamma_1\lambda_1 > 0$. This would imply that grandparental contributions to genetic or cultural inheritance are important enough to more than compensate a parental "bad draw" endowment effect (Solon, 2013)[13].

[13] Another point to raise is that the structural parameters from the model (as in the original Becker-Tomes model) are identified since we have three equations and five unknowns ($\delta, \gamma_0, \gamma_1, \lambda_1, \lambda_2$). Fixing, say, δ and γ_0, we could "identify" the rest of the *more* relevant parameters γ_1, λ_1 and λ_2.