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July 30, 2021

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This paper examines the influence of parental and grandparental education in the transmission of human capital. A natural experimental set-up, from a regional conflict that occurred in 1926 is exploited to instrument years of schooling of the *grandparents'* generation whereas local labour market indicators at adolescence serve as an instrument for the education of the *parents'* generation. Using a nationally representative Mexican survey that gathers detailed information on three generations, the paper shows that accounting for endogeneity reveals significantly more inter-generational mobility rather than ignoring it. The paper also documents greater persistence of family background in the older pair of parent-child links, i.e. grandparent-parent, than in the younger pair, i.e. parent-grandchildren. Results show that the direct influence of parental education on the *grand-children's* education is so dominant that the impact of grand-parental education fades away once accounting for parental education.

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1 Introduction

This paper provides empirical evidence on the transmission of human capital across three generations. The endogeneity of parental schooling (the fact that unobserved factors, such as individuals' ability, that influence their decision to accumulate education are also linked to offspring's outcomes) is addressed by the use of a two-fold instrumental variable approach. First, a regional civil war provides a natural experimental set up to instrument the effect of grandparents' education (G0) on their children's (G1) and grandchildren's (G2) outcomes. Then, the cross-sectional and time-series variation of local minimum wage at adolescence is employed to instrument the parents' generation, which in turn is used to examine its effect on the grandchildren's education. The goal of this unified framework is to examine both the long-term trends of education mobility across multiple generations as well as the *direct* and the *conditional* effect of grand-parental education on grand-children's education.

The literature on intergenerational mobility tends to focus on the association of two adjacent generations using the coefficient from a regression of the children human capital outcome on that of his or her ancestor (Jäntti & Jenkins (2015), Björklund & Salvanes (2011), Black & Deveroux (2011), and Holmlund, et al. (2011), and Solon (1999)). Some of these empirical studies exploit rich administrative records that are often found in well-developed or Nordic countries (Adermon, et al. (2021), Lindhahl, et al. (2015), Møllegaard & Jæger (2015), and Hällsten (2014)) while others resort to retrospective surveys to overcome this limitation (Mare (2014) and Pfeffer (2014)). Multi-generational studies are even scarcer, due to data restrictions (Solon, 2018), and largely rely on OLS correlations.

In the search for causality, the literature on intergenerational mobility of education has gradually moved away from OLS estimates and has turned to the use of alternative identification strategies under an instrumental variable (IV) approach. Although many of these studies exploit changes in education laws that increase the duration of compulsory schooling (Holmlund et al. (2011) and Black & Deveroux (2011)), three relevant studies stand out by using alternative identification strategies. Maurin & MacNally (2008) exploited the cohort variation in college attendance from the 1968 student riots in Paris that lead to a one-off larger pass rates to higher education. Alternatively, Carneiro et al. (2013) exploit the variation in the direct and opportunity cost of education across counties and cohorts in US to identify the effect of maternal education on children's' outcomes. Finally, with a survey that collects data of multiple European countries, Havari & Peracchi (2018) use parental exposition to WWII during childhood or adolescence to elicit the effect on their children.

This paper exploits a unique dataset, *"Encuesta de Movilidad Social Inter-generacional"* (EMOVI 2011) on a national representative sample of adults aged 25-64 in Mexico. The survey contains information on the education level of the "parents" generation (the first generation or G1) who provides information on the education level of their children (the "grand-children" generation or G2) independently of their residency status. It also collects retrospective information regarding the "grand-parent" generation (or index generation, G0) which directly allows observing educational outcomes across three generations. This data set also collects information on the respondents' residence and household's characteristics at birth and adolescence.

To examine the effect of grandparental education (G0) on their offspring the study exploits the geographic distribution of a regional and religious conflict occurred 1926-1929. It is argued here that the so-called *Cristero* conflict differently affected the human capital accumulation of the grandparent generation and tests for this by implementing a difference-in-difference-in-differences (DDD) approach. Individuals that were at school age (primary school) or that were born during this insurrection and were living in a rural area of a region affected by the conflict are to be considered as 'treated' group while everyone else are the reference group. This external source of variation is used as an instrument of the grandparents' education to determine the effect of grandparents' education on the parents' generation and the *(un)conditional* effect on the grandchildren's generation.

Similarly, to examine the effect of parental education (G1) on the *grand*-children's education (G2), the study resorts to labour market indicators often used in the labour economics literature. Following Carneiro et al. (2013), the study employs an opportunity-cost approach from the cross-sectional and time series variation of minimum wage during adolescence to instrument parental education. This strategy exploits both the institutional origins of minimum wages in Mexico, as defined in the Mexican Constitution of 1917, and historical records from its municipal variation. Also, similar to Lindhal et al. (2014), the analysis resorts to grandparental education, a valid instrument used in the literature, to validate this approach.

Once equipped with an independent identification strategy for each of the first two generations, the paper examines the conditional effect of grand-fathers' education on the grandchildren's education through a structural System of Equations Model (IV-SEM). This procedure exploits the recursive data-generating process where the schooling of grandparental and the parental generations are simultaneously instrumented to consistently estimate structural parameters in the final stage. This unified framework allows estimating the *joint* impact of parental and grand-parental education on the grandchildren's education.

The analysis first shows that the parental education is the most important family background in the children's years of education though it seems to play a lesser role in successive generations. It also shows that the IV estimate is unambiguously larger than the OLS estimate, which implies that accounting for endogeneity unveils a larger importance of familiar background (or less educational mobility) than ignoring it. These conclusions hold for any of the two contiguous pairs of parent-children links (G_{01} and G_{12}). The *unconditional* effect of grand-parental education on their grandchildren's education turned out positive and statistically significant. However, the impact of grand-parental education, *conditional* on parental education, is non-significant which suggests that the persistence of the inequality observed in current education outcomes can be traced back to that of the preceding generation only.

The contributions of this paper to the literature are manifold. The paper employs a unified framework to account for endogeneity biases across three generations. Therefore, it differs from previous studies that use only two generations, that are based exclusively on OLS estimates, or that solely rely on instruments within the family domain (i.e. using data from close relatives). Second, the study exploits a natural experiment where the shock in grandparents' childhood occurred in a historical period where the average schooling was very low. This implies that the long-term effect of grandparental education is larger than the marginal effect often identified by studies that exploit changes in compulsory schooling laws (i.e. affecting the lower end of the schooling distribution only).

Perhaps more importantly, the use of independent identification strategies for the first two generations allows building into a structural equation model (SEM) the very thing that we are trying to correct for with a single instrument: the presence of omitted variables impacting both the ancestors' and the offspring' education. Finally, the results from a middle income country that belongs to the region with the lowest levels of intergenerational educative mobility (Hertz, et al., 2007) supplement current research mostly coming from Nordic countries or from countries with more advanced stages of development.

The paper is organized as follows. The second section describes the theoretical framework while the third describes the survey and the sample used. The fourth and fifth sections examine the effect of parental education on their offspring for the two pairs of parent-child links at hand. Taking advantage of the two independent instruments for each of the first two generations the sixth section examines the joint effect of parental and grand-parental education on the grand-children education. The last section concludes while the annex examines in detail the effect of this conflict on the affected generation (the grandparents' generation).

2 Theoretical framework and empirical approach

The theoretical foundations of the transmission of human capital across generations were set in the seminal model of Becker and Tomes (1979). The model is grounded on a parental trade-off between current consumption and investments in their children's human capital predicting a small and negative coefficient of grandparents' education on grandchildren's outcomes conditional on parental outcomes.

In the seminal version of that model, parents decide an optimal allocation of their income between current consumption and investments in the human capital of their children. The human capital endowment, e, which is the inheritance of both genetic and cultural attributes that the child receives independently of deliberated investment choices, follows a first order auto-regressive process:

$$e_\tau = \delta + \lambda e_{\tau-1} + \nu$$

Where τ is the offspring of an index generation (τ-1). The heritable parameter λ is bounded between zero and one, whereas ν stands for a white-noise term uncorrelated with $e_{\tau-1}$. In this model, parents cannot borrow against their offspring's future earnings and do not bequeath assets to their offspring. The maximization of the parental utility function, subject to a budget constraint, leads to a bivariate expression that relates some ancestors' outcome y, with their offspring's through an intergenerational persistence parameter (ρ) that is positive:

$$y_\tau = \alpha + \rho y_{\tau-1} + \epsilon \tag{1}$$

Where, ϵ is the error term. Two elements are worth discussing from this expression. First, Solon (2018) proved that in the steady state, when the outcomes of both generations are equally distributed, the intergenerational persistence is determined by two parameters: a serial correlation coefficient, λ, and the income return to human capital investments, γ, that is assumed positive: $\rho = (\gamma + \lambda)/(1 + \gamma\lambda)$. Second, the error term is not well-behaved as the unobserved child's endowment, e_τ, and the parental outcome, $y_{\tau-1}$, depend themselves on parental endowments $e_{\tau-1}$. The persistence parameter therefore is positive as richer (poorer) parents tend to invest more (less) on their children, γ, and because richer (poorer) parents also tend to pass more (less) favorable endowments to their offspring, λ.

The implications to multiple generations are obtained by lagging equation (1) by one generation and multiplying it by the heritability coefficient, λ, yielding the customary expression of an AR(2) process:

$$y_\tau = \alpha + \rho_1 y_{\tau-1} - \rho_2 y_{\tau-2} + \upsilon \tag{2}$$

Where υ is a white-noise error term. Similarly, Solon (2018) proved that the parental coefficient in the previous expression is $\rho_1 = (\gamma + \lambda)$ and the grandparental coefficient is $\rho_2 = (\gamma\lambda)$. The negative sign on the grandparental coefficient has gave rise to further research, however this author also argues that while the model may be correct this negative sign may simply suggest that the model is incomplete due to: a) the grandparental transmission of cultural inheritance, b) omitted variables-bias (the presence of group effects like racial discrimination), and c) measurement errors.[1]

This theoretical background shows that the OLS estimates yield biased estimates since both the parental and the grandparental coefficient are estimated with a negative and a positive bias respectively. Because of this, the paper makes use of a two-stage least squares instrumental variable (IV) approach where Equation (1) will be the reduced form used to assess the effect of parental education on its offspring for the two pairs of parent-child at hand. Similarly, Equation (2) will be the functional form to examine the *joint* effect of grandparental education on their grandchildren's education. This approach allows addressing three potential endogeneity problems: omitted variable problem, the reverse causality problem, and errors in measurement.[2]

Note that the IV estimates yield the Local Average Treatment Effect (LATE) rather than the Average Treatment Effect (ATE). The instrument can be considered as a treatment indicator that randomly assigns individuals between the treatment group and the control group. Therefore, the estimates equal the ATE only when the instrument perfectly predicts the endogenous variable but this would only happen in the remote case where all individuals are compliers. Here the IV estimate captures only the impact of ancestors' education on its

[1] According to Solon (2018) this negative parameter signals a poor draw on genetic and cultural endowment passed on to some extent to the child regardless of the the advantage from grandparental resources.

[2] The omitted variable problem may arise here as the educational choice might be correlated with unobserved characteristics like individual's ability or with any other endowment transmitted to children beyond of the family's conscious choices. Also, the error-in-measurement is less of a problem for education, as people tend to accumulate human capital in early stages and tend to know their own educational attainment accurately (Pfeifer, 2014). Despite this, the use of retrospective information on grandparental education can be prone to measurement errors in the current setting.

offspring's for the subgroup of parents for which the instrument has an impact.

Finally, the analysis uses standardized outcome variables (mean zero and standard deviation of one) to net out educational inequalities within each generation which implies that the correlation coefficient (r) and the OLS regression coefficient (β), are also the same (since r=$\beta(\sigma_\tau/\sigma_{\tau-1})$ where σ is the standard deviation). The empirical implementation includes a set of exogenous control variables: birth year, sex, and state fixed effects in line with related studies (see Lindahl, et al., 2015). Also, to account for the presence of common unobserved shocks for individuals belonging to the same family, the study reports robust standard errors clustered by family dynasty always.

3 Data and sample selection

The data stems from the "Encuesta de Movilidad Social Inter-generational" survey (EMOVI by its acronym in Spanish from now on), which consists of a random sample of the Mexican population fielded in 2011. The survey's goal is to determine the extent to which parents' resources and living conditions influence their offspring's socioeconomic position, and is designed to gather retrospective information of a nationally-representative sample of adults aged 25-64. The sample is comprised by eleven thousand respondents from the parents' generation (G1). This generation also reports retrospective information about their own adolescence as well as historical information from their direct ancestors.

The EMOVI (2011) contains retrospective information about the grandparents' generation (G0) and the grandchildren's generation (G2). Although, the survey is less complete regarding the grandchildren's information, it does collect schooling information independently of co-residency status. This attribute makes this dataset suitable for inter-generational analysis as traditional household surveys are often biased due to the non-random selection of children that are still at school when co-residing with their parents (Emran et.al, 2018). Previous surveys in Mexico lacks this attribute (such as household income and consumption surveys) or lacks a direct parent-child link (as in Census data).[3]

The used sample consists of grandfathers born during or before the *Cristero* war (1926-1929) with grandchildren that are already out of school. The study focuses on grandfather's education only since no effect of the conflict was detected on grandmothers' education (see

[3]An earlier version of this survey, the EMOVI (2006), covered mostly men (women were only interviewed if living alone) and only asked educational data for the respondents' co-resident children.

appendix). This is expected given the historically low levels of female access to formal education particularly at the beginning of the twentieth century. The analysis will generically refer to grandparents to refer to the grandfathers onward -except when explicitly indicated. The grandchildren's sample was restricted to individuals older than 24 at the time of the survey.[4] **Table 1** contains descriptive statistics for the variable of interest (schooling), and other useful information (fertility, gender and birth year) in panels A, B and C for the each generation. Panel A and B summarize data of around 850 families (i.e. pairs of grandparent-parent links) which corresponds to nearly 1,940 triplets (i.e. G012 links) in panel C.

Table 1: **Descriptive statistics, EMOVI (2011)**

Variables by generation	Obs	Mean	Std. Dev.	Min	Max
Panel A: Grandparents (G0)					
Grandfather's schooling	782	2.1	3.3	0	24
Grandfather's number of children	847	5.5	3.2	1	16
Grandfather's year of birth	847	1922	5.4	1911	1929
Panel B: Parents (G1)					
Parents' schooling	841	6.2	4.3	0	23
Parents' number of children	847	2.8	1.7	1	13
Parents male	847	0.5	0.5	0	1
Parents' year of birth	847	1956	7.5	1947	1981
Panel C: Grandchildren (G2)					
Grandchildren's schooling	1941	9.7	3.6	0	23
Grandchildren male	1941	0.5	0.5	0	1
Grandchildren's year of birth	1941	1983	7.9	1957	1996

Source: own estimates with EMOVI (2011).

4 The effect of grandfathers' education on the education of their children (G_{01}) and grandchildren (G_{02})

The paper exploits a natural experiment from an armed conflict that occurred in Mexico at the beginning of the 20th century to instrument grandparental education. This religious conflict can be briefly summarized as a massive rural rebellion in the western and central states of Mexico after the enforcement of anticlerical laws that emerged from the Mexican Constitution of 1917. However, the conflict did not begin until 1926, nearly one decade

[4]Younger cohorts were only included, i.e. aged 15 and older, if they had already dropped out school.

after the new Constitution was reformed, when the Catholic Church suddenly suspended its religious worship service as a way of protesting against the legal restrictions to its ministry and to secular policies implemented during the President Calles' administration (1924-1928).

The revolt was known as the *Cristero* rebellion as the government mocked the rebels' battle cry *¡Viva Cristo Rey!* (Long live Christ the King!). A key feature of this natural experiment comes from the fact that the magnitude of this conflict was unexpected and short-lived. The conflict was unexpected because the clergy had became used to multiple unbinding legislations from the past and its authorities initially adopted a peaceful reaction (see Buttler (2013)). The uprising was short-lived because it lasted three years only, from 1926-1929 (Meyer, 1973a) so that the scope of actions to cope with its effects was limited.

The section exploits this natural experimental setup to examine the effect of grandfather's education on their children's (G_{01}) and grandchildren's education (G_{02}) separately. The identification strategy then builds on both the place and year of birth of grandparent's generation, two features that are exogenous to parental and children abilities, to elicit the causal effect of the grandparents' education on their offspring. **Annex A** further provides historic and econometric evidence showing that the conflict negatively affected the human capital accumulation of grandparental generation based on their place and year of birth through a diff-in-diff-in-differences approach.

4.1 Identification strategy: The regional variation of the conflict

Meyer (1973a, 1973b and 1973c) examined the *Cristero* conflict through the use of both governmental and *Cristero* sources producing one of the most comprehensive historic studies on this matter. **Figure 1** shows a map of the incidence of the revolt in a region comprised by at least twelve states in western and central in Mexico. This western territory gathered half (48%) of the total population, of 15 million, according to the 1910 Census. The conflict adopted the form of guerrilla warfare in rural localities and produced around 250 thousand deceases (Aspe (2015) and Meyer (2014)). [5]

Meyer (2014) was also able to quantify the number of *Cristero* troops by state confirmed by two independent sources to account for around 50,000 fighters.[6] **Table 2** shows the number

[5]This was clearly a civil war as, according to Buttler (2013), a significant sector of the population remained loyal to the regime, which armed its supporters – the beneficiaries of land reform known as agraristas- and sent them into battle alongside the federal army.

[6]These sources were the U.S. Department of State Records, the Clark memorandum on the military

Figure 1: **Regional distribution of the *Cristero* war**

Source: Meyer (1973a)

of combatants per state. In absolute terms, the rebel troops were stronger in four western states (Jalisco, Michoacán, Guanajuato, and Zacatecas), although these troops were even stronger in relative terms, i.e. using the share of the rural population engaged in conflict, in three additional states (Colima, Aguascalientes and Nayarit). These troops were clearly feeble elsewhere or did not even a have minimum presence. These two criteria, territory spread and the density of combatants, allows defining a macro region that experienced the greater intensity of the war comprised of seven states that contained around 27% of the national population in 1910.

Table 2: **Regional distribution of *Cristero* fighters by state (1926-1929)**

State	Fighters	% of rural	State	Fighters	% of rural
Michoacán	12,000	1.3%	Durango	2,000	0.4%
Jalisco	10,000	0.9%	Aguascalientes	1,200	1.6%
Guanajuato	4,000	0.4%	Guerreo	3,000	0.5%
Zacatecas	5,400	1.2%	Oaxaca	1,500	0.1%
Nayarit	2,500	1.5%	Central states (a)	1,000	0.1%
Colima	2,000	3.8%	Southern states (b)	1,000	0.05%

Sources: Cristero fighters from Meyer (1973c) and Meyer (2014). % of the rural refers to the percentage of population in rural areas. Rural population refers to areas outside the state capital from the 1910 Population Census (INEGI). (a) Morelos, México, DF, (b) Puebla, Tlaxcala, Veracruz.

The identification strategy relies on three characteristics: (1) the affected cohort, (2) the

situation and Mexican military records.

affected areas, and (3) the geographical distribution of the conflict. First, the effect of the conflict on the grandparental generation is expected to be larger in the states directly engaged in the conflict: Aguascalientes, Jalisco, Michoacán, Guanajuato, Colima, Nayarit and Zacatecas. Second, the effect is expected to be larger in rural areas where the Cristero troops engaged in guerrilla war due to the disproportionate number of federal forces deployed in the conflict (see Meyer (1973a), Jrade (1982), Buttler (2013), and Andes (2014)). Finally, given the low level of education that characterized these cohorts, it is speculated that the war and the enforcement of the constitutional amendments more negatively affected the human capital accumulation of children of school age corresponding to primary education.[7]

Both, the nature and the geographic distribution of this insurgency serve as external sources of variation to instrument grandparents' schooling. The first stage then is the regression of grandparental education, which is the causal variable of interest, on instruments:

$$\begin{aligned}\hat{S_0} &= \alpha + \beta_1 Cristero * Cohort * Rural + \beta_2 Cristero + \beta_3 Rural + \beta_4 Cohort \\ &+ \beta_5 Cristero * Cohort + \beta_6 Cristero * Rural + \beta_7 Cohort * Rural + X'_\tau \beta + \epsilon\end{aligned} \tag{3}$$

Where; '*Cristero*' (or C) is a dummy variable for individuals in this conflict region that refers to the states engaged in conflict; '*Rural*' (or R) is a dummy for individuals living in rural areas (equals 0 for urban areas) and; the variable '*Cohort*' introduces the time dimension (or T) with a dummy variable for children of school age or younger at the moment of the conflict (being 0 for older children –out of school age during the revolt). X_τ refers to a set of exogenous covariates which includes the gender, the birth year, and state fixed effects of the offspring (either τ=1,2 for the parents, or the grandchildren, respectively).[8] In this Diff-in-Diff-in-Diff setting, the coefficient β_1 of the interacted variable '*Cristero*rural*cohort'* (or CRT onwards) identifies the effect of the revolt on the grandparents' education, S_0.

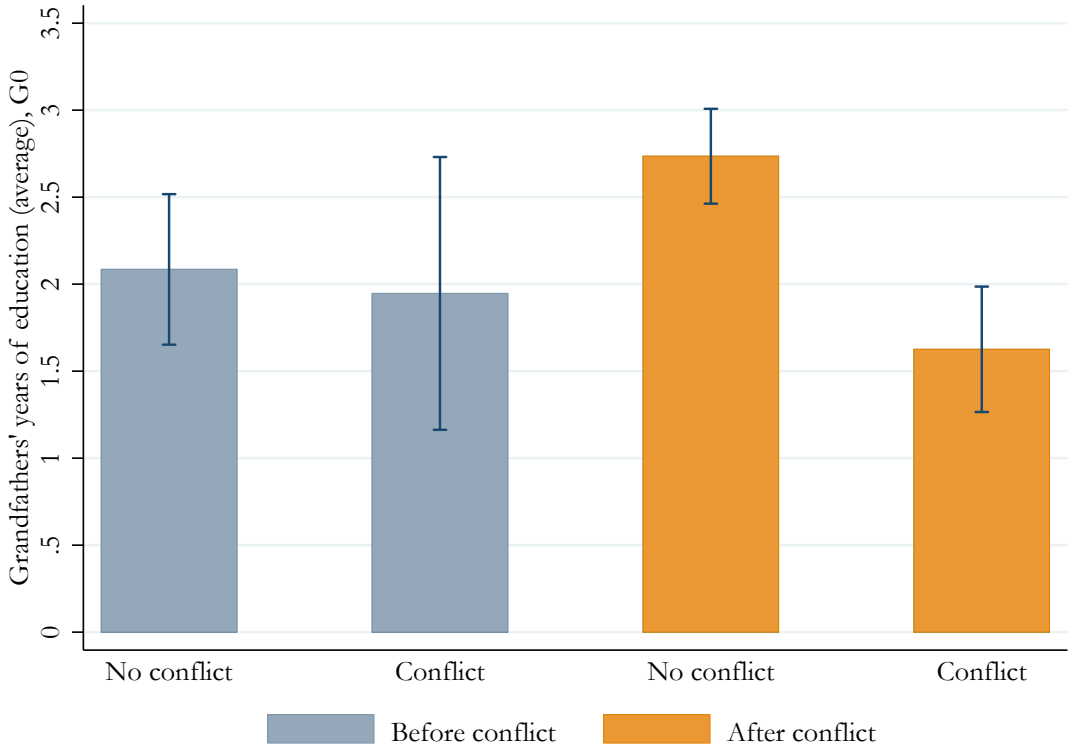
Figure 2 plots a visual inspection of the first stage, showing the average educative trends for two groups. The first group refers to 'treated' children, in rural and *Cristero* areas (hence areas exposed to conflict), while the second group refers to 'untreated' children, in rural and *Cristero* areas but beyond school age at the time of the conflict plus children in rural areas out of the region of conflict (areas not exposed to conflict). The time dimension of the chart allows comparing the affected cohorts (of school age, and younger, at the moment of the

[7] In addition to a small proportion of individuals enrolling in higher levels of education, the number of secondary schools was also very limited at the time, and most of them were located in urban areas.

[8] This is a common set of variables used in the related literature, as surveyed by Holmlund, Lindahl & Plug (2011) used in international comparisons.

conflict) with the unaffected cohorts (older cohorts and hence out of school age at the moment of the conflict). The chart shows that there was not a seemingly difference in the average years of schooling between these two cohorts before the conflict outbreak. More importantly, it shows that *La Cristiada* seems to have altered the human capital accumulation process by creating a significant difference between these two groups.

Figure 2: **Grandparental education trends before and after the *Cristero* Conflict**



Note: The graph shows the average years of schooling of grandparents generation (G0) by areas of conflict exposition, before and after the conflict, and the 95% confidence intervals.

Annex A extends this analysis. It shows that this conflict altered the human capital accumulation process of this cohort by creating a statistically significant difference of contemporaneous boys' education only (not girls) based on their place and year of birth.[9] This finding is robust to the inclusion of sociodemographic controls. Because of this, the analysis focuses on the grandfathers only and the words "grandfather" and "grandparent" are used interchangeably throughout the text. The annex also shows that the conflict did not affect future fertility decisions or any other pattern of wealth accumulation in adulthood. This implies that the instrument has no effect on these important outcomes other than through the

[9]Unsurprisingly, the effect on girls is not significant provided that this group had already accumulated low levels of education even before the uprising.

first-stage channel. Finally, because the human capital accumulation was negatively affected in the insurgent regions the instrument seems to have a clear effect on the causal variable of interest.

4.2 Results 1: The effect of grandfather's education on parents' and grandchildren's education

Under this instrumental variable approach, the second stage or reduced form estimates the effect of the ancestors' education on their offspring's education. For any pair of parent-child link (either G_{01} or G_{12}), and for the unconditional effect of grandparents' education on grandchildren's education (G_{02}), the reduced form corresponds to the following bivariate regression:

$$S_\tau = \alpha + \rho \hat{S}_{\tau-1} + X'_\tau \beta + \epsilon \tag{5}$$

Where S_τ refers to schooling of generation τ=1,2 (for the parents, or the grandchildren) and, $\hat{S}_{\tau-1}$ is the instrumented education of the ancestor; X_τ refers the same set of exogenous covariates used in the first stage (i.e. gender, the birth year and state fix effects).

Table 3 shows both the OLS and IV results for the grandfather-parent link. The first and second stage appear in a single column but each estimate represents the coefficient from a different regression. The OLS results in column 1 show a statistically significant positive relationship between grandparental and parental education where the standardized coefficient for grandfathers years of education is around 0.44. These results are very close to Behrman's, et al. (2001) who found an intergenerational educative persistence of 0.50 using more recent cohorts from Mexican urban employment surveys.

The IV results confirms a negative first-stage relationship between the grandparents' years of education and their exposure to conflict. As discussed in the previous section, the coefficient of the interacted term Cristero*Rural*Cohort is strongly significant and unambiguously negative suggesting that a drop in the grandfathers' education by a year is associated with a reduction on the parents' education -as expected-. Overall, the first stage has significantly explanatory power since the value of the F-statistic is larger than 10 as suggested by Stock, Wright, and Yogo (2002). Beyond this secondary results, the causal relationship described by the second stage is substantially larger than those of OLS at around 0.75. This larger

Table 3: **OLS and IV regression of parents' education (G1) on grandfathers' education (G0)**

Dependent variable:	(1)	(2)
Parental education (G1)	OLS	IV
Reduced form		
Grandfather education (G0)	0.444***	0.756***
	(0.031)	(0.127)
Observations	777	777
R-squared	0.330	0.241
First stage		
Cristero*Rural*Cohort	-	-1.384***
	-	(0.464)
R-squared	-	0.153
F-stat	-	10.55
Endogeneity & overidentification tests		
Wu's score	-	8.207
Wu p-value	-	0.004
Durbin's score	-	8.500
Durbin p-value	-	0.004
Robust-score Chi2	-	7.273
Chi2 p-value	-	0.007
Wooldridge's score	-	4.738
Wooldridge p-val	-	0.578
Sex of G1	Yes	Yes
Birthyear of G1	Yes	Yes
State of residence of G1 at age 14	Yes	Yes

Note: Robust standard errors in parentheses clustered by family. *** p<0.01, ** p<0.05, * p<0.1. Education refers to standardized years of education. Sample of grandfathers born during or before the *Cristero* conflict (1926-1929) with out-of-school grandchildren. Each estimate represents the coefficient from a different regression. Using the regional variation of the conflict to instrument grandparental education. First stage includes main effects (c, r, t) and interactions (cr, tc, tr) where c, stands for Cristerio region, r for rural, and t for the cohort of school age respectively.

order of magnitude appears in line with previous studies from different settings but with a similar IV approach (see Adermon, et al. (2021), Holmlund, Lindahl and Plug (2011), Maurin and McNally (2008)).

Unsurprisingly, the IV estimates are less efficiently estimated than those of the OLS, but all the parameters are strongly significant. The table reports Wooldridge's Chi2 score test of endogeneity which checks that the endogenous variable is actually exogenous. The value of this robust-score-Chi2 of 7.3 is highly significant and rejects the null of exogeneity.[10] This means that it is correct treating grandparental education as endogenous -or that the sacrifice in efficiency by using an instrumental-variables estimator is justified.

The fact that the IV estimate of intergenerational persistence of education is nearly 70% higher than the OLS's (from 0.756/0.444) suggests that the later under-estimate the true causal effect of parents education (Angrist and Krueger (1991) and Verbeek (2012), Behrman and Taubman (1985)).[11] Finally, the table also reports Wooldridge's score test of over-identifying restrictions. The value of this Wooldridge's score of 4.7 confirms the validity of the instrument.[12]

Table 4 shows the OLS and the IV estimates of the *unconditional* effect of the grandfather's education on the grand children's generation. In this case, the independent variable is the grandparental education but the dependent variable is now the grandchildren's educative outcome (the second generation or G2). The OLS estimate is positive and statistically significant but with a much lower coefficient, 0.22, as compared with the estimates from the previous generation. As a matter of fact, the magnitude of this coefficient is around one half of the estimated influence of the grandfather on the parents' generation (0.44 generation).

The IV coefficient is positive, and substantially larger that the OLS estimate. These estimates are much smaller than those from the previous generation and both are statistically significant. These causal estimates seem to suggest that grandfather's education does have some effect upon grandchildren's education. It remains to see whether this effect on grandchildren's education stays after controlling for the direct influence of the pivotal generation (i.e. the conditional effect).

[10] The null hypothesis of this test is that the endogenous variable can be treated as exogenous. This test is suited for cluster–robust estimator of the variance–covariance of the estimator (VCE) instead of the Durbin and Wu–Hausman tests (also shown) that assume that the error term is i.i.d.

[11] Adermon, et al. (2021) used rich Swedish data on extended family to compute a similar inter-generational persistence indicator. Their final parameter, obtained by cumulatively adding more and more extended family members information, is also substantially larger (43%) than the traditional estimates.

[12] Differently from Sargan's and Basmann's tests, the Wooldridge's score test of overidentifying restrictions

Table 4: **OLS and IV regression of grandchildren's education (G2) on grandparent's education (G0)**

Dependent variable:	(1)	(2)
Grandchildren's education (G2)	OLS	IV
Reduced form		
Grandfather education (G0)	0.225***	0.369**
	(0.035)	(0.143)
Observations	1,785	1,785
Adj. R-squared	0.118	0.099
First stage		
Cristero*Rural*Cohort	-	-2.131***
	-	(0.605)
Adj. R-squared	-	0.142
F-stat	-	9.478
Endogeneity & overidentification tests		
Wu's score	-	2.626
Wu p-value	-	0.105
Durbin's score	-	2.673
Durbin p-value	-	0.102
Robust-score Chi2	-	2.496
Chi2 p-value	-	0.114
Wooldridge's score	-	11.40
Wooldridge p-val	-	0.077
Sex of G2	Yes	Yes
Birthyear of G2	Yes	Yes
State of residence of G2	Yes	Yes

Note: Robust standard errors in parentheses clustered by family. *** p<0.01, ** p<0.05, * p<0.1. Education refers to standardized years of education. Sample of grandfathers born during or before the *Cristero* conflict (1926-1929) with out-of-school grandchildren. Each estimate represents the coefficient from a different regression. Using the regional variation of the conflict to instrument grandparental education. First stage includes main effects (c, r, t) and interactions (cr, tc, tr) where c, stands for Cristerio region, r for rural, and t for the cohort of school age respectively.

5 The effect of parental education on their children's education (G_{12})

The analysis now turns to the second, the youngest, pair of parent-child link at hand, where the goal is to instrument the education of the parents' generation (G_1). Under the current natural experimental setup, this is the offspring of the above-referred grandparental generation that was born around mid 1950's as described in **table 1**. The instrument will then supplement that from the previous generation to estimate the joint impact of grand-parental and parental education on the grandchildren's education without resorting to data from close relatives, often used in this literature, not available in this setting.[13]

Carneiro et al. (2013), for instance, employed the opportunity cost and the monetary costs of schooling to examine the intergenerational transmission of education with two generations. Their study used college fees (i.e. the direct cost) and the proximity to a four-year college (i.e. the indirect cost) to instrument parental schooling. Similarly, Arkes (2010) used the states' unemployment rates during a person's teenage years to estimate the returns to schooling. His results were practically identical to those of Angrist and Krueger (1991) who had estimated the impact of changes in the legislation of compulsory school on earnings using data on state and quarter of birth to instrument years of schooling. The paper then follows a similar approach through the use of local labour market indicators at adolescence.

The first identification strategy exploits the regional variation of (real) minimum wages that were originally set in the Mexican Constitution of 1917. Similar to Arkes *op. cit.*, the educational attainment is expected to vary according to both income and substitution effects. With lower minimum wages, teenage children from low-income families may need to quit school prematurely to find a job leading to less years of schooling whereas higher minimum wages may imply higher returns to schooling encouraging higher educational attainments. Naturally, any of these two effects could dominate, either the "additional worker" effect (income effect) or the "discouraged worker" effect (substitution effect), however the identification strategy merely exploits this external source of variation regardless on the direction of the most dominant effect.

is robust to heteroskedastic standard errors which makes it relevant for the fitted model.

[13]Behrman and Taubman (1985), for instance, instrumented parental education with the *great*-grandparental education to assess the effect of the grandparent education on the grandchildren education. Adermon, et al. (2021) use information of extended family to supplement parental information. Card (1999) used twins and siblings' information to estimate the causal effects of additional years of education.

To validate this identification strategy, the paper follows an already-valid instrument used in Lindhal et al. (2014) that exploits the individual variation of grandfather's education (S_0) to instrument parental education (S_1). This approach, however, serves here as robustness check since the ultimate goal is to get an independent set of instruments to asses the joint effect of grand-parental and parental education on the grandchildren education (to be developed in the final section).

5.1 Identification strategies: minimum wages at adolescence and grandparental education

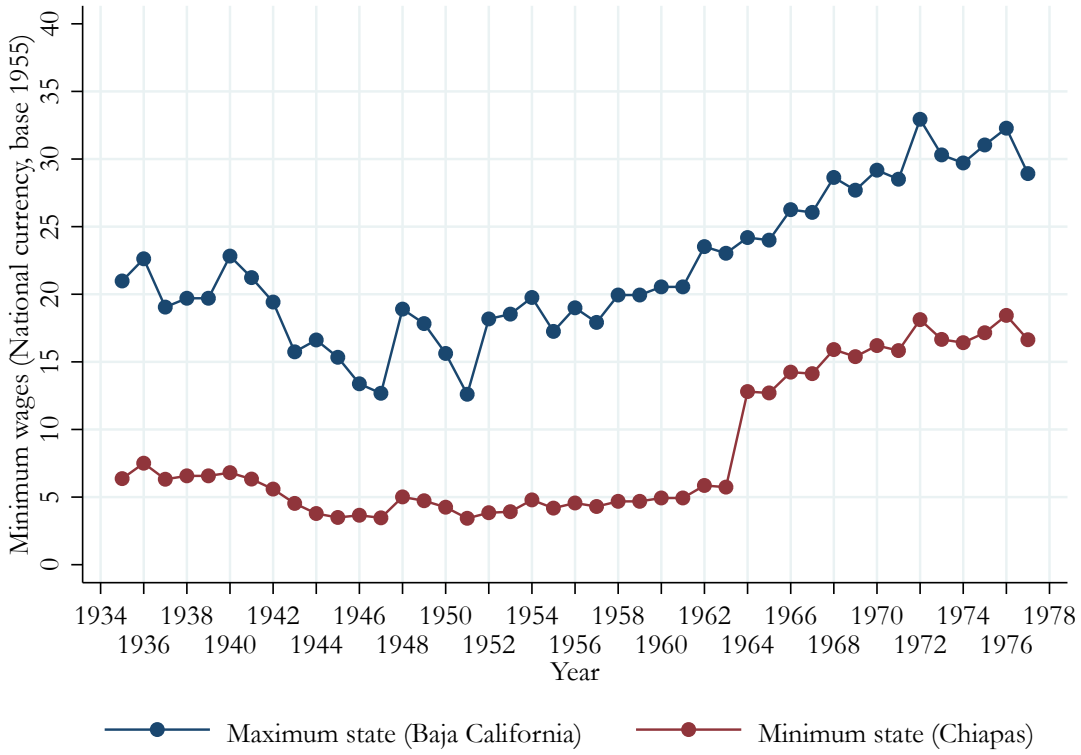
Minimum wages in Mexico were first defined in the Constitution of 1917. In this institutional configuration, minimum wages were to be set by each municipality through local councils in coordination with a state-wise government committee. According to this initial legislation "wages ought to have been defined high enough to meet all basic needs of a family" (CONASAMI, 2017). This mechanism endured until 1980's where a state-level council remained as the most dominant influence on defining the indicator.[14]

This institutional configuration allowed for a regional variation on this indicator based on the differences in the cost of living at a municipality level. **Figure 3** plots the state and year variation of (real) minimum wages in Mexico (1934-1978) from historical records of the National Statistical Office (INEGI, 1994). For the sake of clarity, the graph shows only the two states, out of 32 in total, with the highest and the lowest wage levels as observed in 1955 which is the average birth-year of the used sample. The graph clearly describes both a time-series and a cross-sectional variation in the real minimum wage.

This external source of variation, as captured by individual conditions at adolescence, is exploited to instrument parental education. The main instrument is the real minimum wage at adolescence (MWA) defined by the state (s) and the year (y) at which the survey respondent drooped out school. **Figure 4** plots a visual inspection of the first-stage that describes a highly-significant and positive relationship between schooling and the level of the real minimum wage at adolescence. This is the main identification strategy which will prove

[14]In fact, this mechanism remained until mid 1960's when a new administrative body, The National Commission of Minimum Wages (*Comision Nacional de Salarios Minimos*, CONASAMI) took over. Since then, minimum wages were defined on a regional basis by 111 local councils across the country. By 1980's this council reduced the number of regions to three only with additional changes as described by Conasami (2007) but this does not affect the identification strategy since this is uses the sample of parents that were born earlier than 1980's -as described in Table 1.

Figure 3: **Real minimum wage by state and year 1934-1978**



Note: States with the minimum and the maximum (price adjusted) values observed in 1955 which is the mean year of birth in the sample of the parental generation (G1). Source: INEGI (1994). *Estadísticas Históricas de Mexico.*

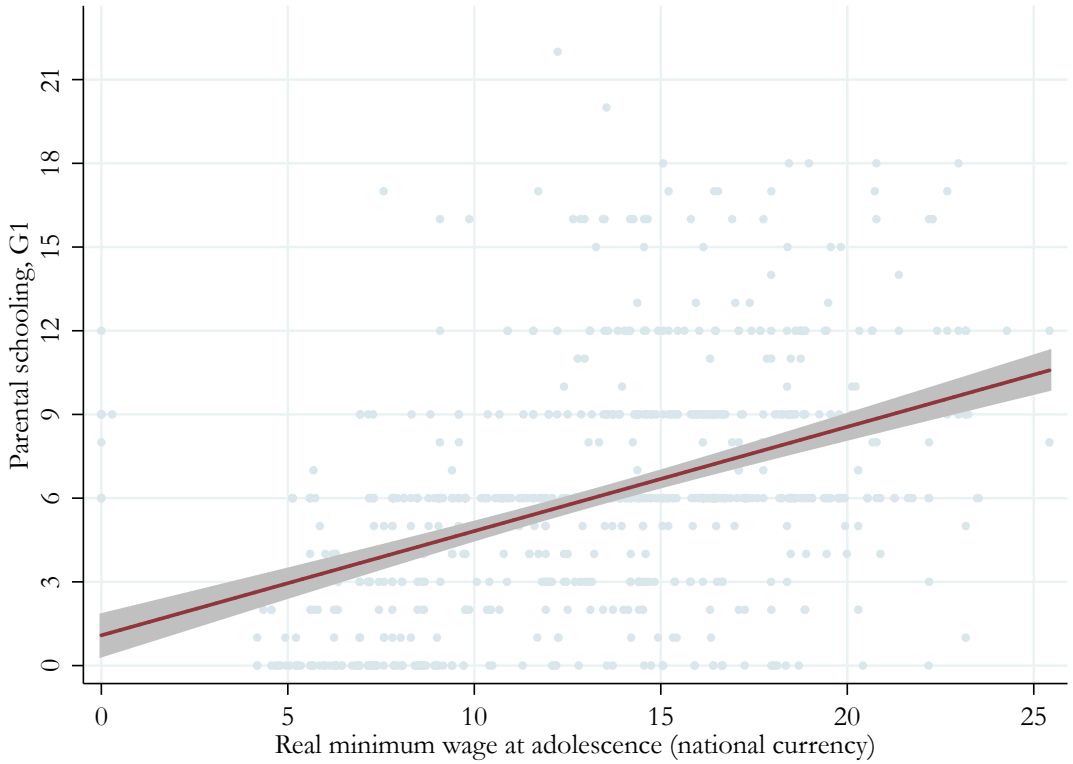
useful in the following sections when all these three generations are used simultaneously. The first stage is:

$$S_1 = \delta_0 + \delta_1 MWA_{s,y} + X_1'\delta + \epsilon \tag{6}$$

Where X stands for exogenous variables described above (i.e. gender, the birth year and state fix effects).

A second identification strategy, a robustness check, relies on the individual variation of grandfather's education (S_0). This approach follows Lindhal et al. (2014) who use the educative outcomes of grandparents as an instrument for the parents' educational outcomes. In the Swedish context, their (standardized) OLS coefficient of parental education on the children's education (at 0.31) turned out smaller than the IV estimate (0.58) -both coefficients

Figure 4: **Parental education (G1) and minimum wages at adolescence**



Note: Own computation with data from INEGI (1994) and EMOVI (2017). 95% confidence interval in shadowed area.

being strongly significant. Because this alternative identification strategy serves here as a robustness check, the remaining sections stick to the main identification strategy only. The first stage for this supplementary identification strategy is:

$$\hat{S}_1 = \gamma_0 + \gamma_1 S_0 + X_1'\gamma + \nu \tag{7}$$

In each case, and similar to the previous section, the second stage corresponds to a bivariate regression described in in Equation (5). Results for the first and second stage appear next.

5.2 Results 2: The impact of parental education on their children's education

Table 5 shows the OLS and IV estimates for the parent-child link. The OLS results show, as expected, a statistically significant positive relationship between (*grand*) children's years of education and their parents' education (G2 and G1 respectively). The coefficient for parental education is around 0.43 which is practically identical to that from the previous generations (of 0.44 for the grandparent-parent generation). The long-term trend revealed by these OLS estimates suggest that the persistence of family backgrounds not only remained high but also unaltered despite the rise of schooling over the 20^{th} century. Indeed, **table 1** showed that the grandchildren's education was almost five times higher than that of the grandparents.

The IV results show a positive and strongly significant first-stage relationship between the parents' years of education and each instrument. The point estimates of intergenerational mobility from the two identification strategies are remarkably close and strongly significant: 0.51 using the individual variation from grand-parental education, and 0.56 using the regional variation of minimum wage at adolescence. This resemblance is reassuring provided that the grandparental education is already considered a valid instrument (Lindhal, et al., 2015). Furthermore, the Wooldridge's robust-score Chi2 test does reject the null hypothesis of exogeneity while the F-statistic strongly rejects the null hypothesis that the instruments are weak. No over-identifying tests are required since the model is just identified.

These casual estimates turn out substantially larger, around 30% (from 0.56/0.43 with the main IV), than the OLS estimates. Interestingly, both instrumented estimates describe a clear canonical upward trend of education mobility over the previous century provided that the persistence of family background from this parent-child link (G_{12}) is statistically different than that from grandfather-parent link (G_{01}) of 0.75, reported in the previous section. Overall, these results confirm that traditional estimates not only under-estimate the effect of parental education but, in the current setting, also substantially underrate the long-term pattern of educative mobility across generations.

Table 5: **OLS and IV regression of children's education (G2) on parents' education (G1)**

Dep. Variable: ***Grand*-children Ed. (G2)**	(1) OLS	(2) IV1	(3) IV2
Reduced form			
Parental education (G1)	0.429***	0.510***	0.556***
	(0.035)	(0.080)	(0.074)
Observations	1,724	1,720	1,720
Adj. R-squared	0.221	0.216	0.208
First stage			
Grandfather education	-	0.441***	-
	-	(0.036)	-
Minimum wage at adolescence	-	-	0.097***
	-	-	(0.009)
Adj. R-squared	-	0.314	0.315
F-stat	-	70.79	78.85
Wu's score	-	2.914	7.163
Wu p-value	-	0.088	0.008
Durbin's score	-	2.968	7.276
Durbin p-value	-	0.085	0.007
Robust-score Chi2	-	2.735	8.219
Chi2 p-value	-	0.098	0.004
Sex, G2	Yes	Yes	Yes
Birthyear, G2	Yes	Yes	Yes
State fixed eff., G2	Yes	Yes	Yes

Note: Robust standard errors in parentheses clustered by family dynasty. *** p<0.01, ** p<0.05, * p<0.1. Education refers to standardized years of education. Sample of grandfathers born during or before the *Cristero* conflict (1926-1929) with out-of-school grandchildren. Each estimate represents the coefficient from a different regression.Using the variation from individuals' grand-parental education to instrument parental education (IV1) as a robustness check. Using the regional variation of real minimum wage at adolescence to instrument parental education (IV2).

6 The conditional effect of grandparental education on their grandchildren education (G_{012})

Previous sections thoroughly examined the direct effect of parental education on their offspring for the two pairs of parent-child at hand using independent instruments in each case. This section examines the *joint* effect of granparental and parental education on the grandchildren education. The analysis builds on the model of Becker and Tomes (1979) that predicts a small negative correlation coefficient for the grandparental education conditional on parental status described in section 2.

When testing for this hypothesis, Behrman and Taubman (1985) found no empirical basis for this theoretical prediction with survey data from the USA since their conditional OLS estimate of grandparental education was positive (around 0.007) but not significant. Their instrumented estimate, using twins' education for parental schooling, was slightly larger (around 0.04) but also insignificant.[15] More recently, Lindahl et al. (2014) tested the model implication with rich Swedish administrative records from four generations in the city of Malmö. They find a positive and statistically significant OLS estimate (0.08) and a positive but non-significant IV estimate of grandparental education on grandchildren's education (around 0.05). These two studies used data of close relatives' education to instrument parental education.[16]

There is little evidence from less advanced or developing countries (Narayan et.al., 2018). In Chile, Celhay & Gallegos (2015) find a positive and statistically significant OLS coefficient for grandparental education of 0.11 after conditioning on parental education (with a coefficient of 0.40) using survey data linked to the Chilean pensions system. Also with NLSY97 survey data, Kroeger & Thompson (2016) examine the grandmother - granddaughter educative link in the USA and found a positive and strongly statistically significant OLS coefficient, of around 0.09-0.12. Finally, Kundu & Sen (2020) obtain a strongly significant OLS coefficient on the grandfather's education of 0.065 conditional on parent's education (0.335) in India with the IHD Survey. None of these studies addresses endogeneity issues.[17]

[15] They use the NAS-NRC sample composed by veterans born between 1917 and 1927 which appear very similar to the period examined here.

[16] Behrman and Taubman (1985) instrumented parental education with siblings' education on a sub-sample of twins from NAS-NRC survey composed by veterans from World War II. Lindahl et al. (2014) used administrative records spanning four generations from the city of Malmö and instrumented the parental and grandparental education with their preceding generations' education. They instrumented parental education with the *great*-grandparental education.

[17] With retrospective survey data in 28 EU member states, Calagrossi et al. (2020) also fails to reject

6.1 Estimation

Once equipped with an independent instrument for each generation, the estimation of the AR(2) model described in Equation (2) is performed with OLS and with a structural equation model (SEM). This framework allows the construction of a recursive set of equations (recursive in the sense that it has clearly defined stages similar to that of a two-stage least squares approach) to consistently estimate the structural parameters in the final stage. The parental and grand-parental education are deliberately instrumented with individual sources of variation to estimate the joint effect on the grandchildren's education in a second stage:

$$\hat{S}_0 = \beta_0 z_0 + X'\beta + \epsilon_0 \tag{8}$$

$$\hat{S}_1 = \beta_1 z_1 + X'\beta + \epsilon_1 \tag{9}$$

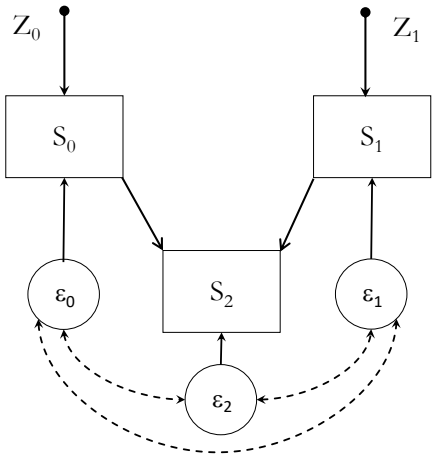
$$S_2 = \rho_0 \hat{S}_0 + \rho_1 \hat{S}_1 + X'\beta + \epsilon_2 \tag{10}$$

where S_τ is the educative outcome for generation $\tau = \{0, 1, 2\}$; $\hat{S}_\tau$ is the instrumented schooling of *grand*-children's ancestors described in equations (3) and (6) for the grandparents or the parents respectively. As before, X_τ stands for a set of exogenous control variables (year of birth, grandfather's state fixed effects, and gender), and ϵ_τ stand for the residuals of each generation. In this unified framework only the final stage's coefficients, ρ_τ, are structural while the β_τ's are reduced-form parameters for identification of the parameters in the structural equation.

The Directed Acyclical Graph (DAG) in **Figure 5** describes this relationship where the estimates of grandparental education (instrumented with the regional variation of the conflict) and parental education (instrumented with cross-sectional and time series variation of minimum wages at adolescence) are used to obtain the structural parameters. For simplicity, this representation omits the set of exogenous control variables to highlight the covariance (*cov*) of residuals involved in: (1) the null correlation implied by OLS and, (2) the covariance implied by 2SLS for each instrument: $cov(\epsilon_1, \epsilon_2)$ in the parent-*grand*children link (where ϵ_1 is the residual for first stage and ϵ_2 is that for second stage), and $cov(\epsilon_0, \epsilon_2)$, in the grandfather-grandchildren link (for first and second stages too). In other words, if there are omitted variables that are impacting both the ancestors' education and the offspring' education, they should produce a 'correlation' between the error term of these two variables.

the hypothesis of a direct grand-parental effect with OLS estimates. Their results, however, are not fully comparable since educational attainment is defined as a dichotomous variable.

Figure 5: **DAG for the joint impact of parental and grand-parental education on the grand-children's education**



Note: Following the representation used in Greenland & Pearl (2011) and Cunningham (2021), dots refer to exogenous variables or root nodes (Z_τ), that in this case are independent, for each generation τ. Boxes refer to observed variables. Arrows describe paths connecting one variable to another implying that the first variable affects the second. If there are omitted variables that are impacting both the ancestors' and the offspring' education, they should produce a correlation between the error term of these two variables. The curved path in dotted lines then states that there is a correlation to be estimated between variables.

6.2 Results 3: The joint impact of parental and grand-parental education on the *grand*-children's education.

Table 6 shows both the OLS and the SEM estimates. The OLS coefficient for the parental education in column (1) is strongly significant with an estimate of 0.41, whereas the grand-parental estimate, of 0.04, is not statistically significant. These standardized estimates are close to those in Lindahl's *et al.* whose standardized OLS estimates are 0.37 and 0.12 for parental and grand-parental education respectively.[18] Note that these results are equivalent to those from SEM with the two instruments when all the co-variance of residuals' across generations (i.e the curved paths in dotted lines in the DAG) is assumed to be nil as reported in column (2).

[18]These estimates refer to their sample of children whose great-grand parents were dead when they were born -which appear closer to the prevailed conditions at the beginning of the twentieth century in the examined Mexican setting.

Table 6: **OLS and SEM of children's education on parents' and grandparents' education**

Dep. Var:	(1)	(2)	(3)	(4)
Grandchildren education (S_2)	OLS	SEM	SEM	SEM
Parental education (S_1)	0.407***	0.407***	0.597***	0.655***
	(0.038)	(0.038)	(0.077)	(0.095)
Grand-father education (S_0)	0.043	0.043	-0.021	-0.091
	(0.038)	(0.038)	(0.181)	(0.286)
Observations	1,720	1,720	1,720	1,720
Adj. R-squared	0.225	0.201	0.201	0.201
Parents' equation				
Minimum wage at adolescence	-	0.096***	0.096***	0.077***
	-	(0.010)	(0.010)	(0.009)
Observations	-	1,720	1,720	1,720
Adj. R-squared	-	0.417	0.417	0.417
Grand-parents' equation				
Cristero*Rural*Cohort	-	-2.427***	-2.589***	-2.605***
	-	(0.641)	(0.842)	(0.828)
Observations	-	1,720	1,720	1,720
Adj. R-squared	-	0.077	0.077	0.077
$\text{cov}(\epsilon_1, \epsilon_2)$	-	0.0	-0.166***	-0.165
	-	-	(0.056)	(0.122)
$\text{cov}(\epsilon_0, \epsilon_2)$	-	0.0	0.053	0.021
	-	-	(0.153)	(0.250)
$\text{cov}(\epsilon_0, \epsilon_1)$	-	0.0	0.0	0.332***
	-	-	-	(0.049)

Note: Robust standard errors in parentheses clustered by family dynasty. *** p<0.01, ** p<0.05, * p<0.1. Education refers to standardized years of education. Sample of grandfathers born during or before the *Cristero* conflict (1926-1929) with out-of-school grandchildren. Each estimate represents the coefficient from a different regression. Using the regional variation of real minimum wage at adolescence to instrument parental education (S_1). Using the regional variation of the conflict to instrument grandparental education (S_0). First stage includes main effects (c, r, t) and interactions (cr, tc, tr) where c, stands for Cristerio region, r for rural, and t for the cohort of school age respectively.

Interestingly, the SEM coefficients suggest larger impacts than OLS. In this case, the coefficient of parental education of 0.60, in column (3), turns out nearly 45% larger (from 0.60/0.41) than traditional estimates but the conditional coefficient of grand-parental schooling (-0.02), while smaller than OLS, turns out non-significant. As a matter of fact, the confidence interval of the grand-fathers' estimate includes positive and negative values which does not allow rejecting the model's prediction. Note that this SEM estimates are equivalent to 2SLS IV in the sense that it allows for the empirical covariance between the error terms of the first and the second stage: $\text{cov}(\epsilon_1, \epsilon_2)$=-0.17 for the parent-child link which is significant, and $\text{cov}(\epsilon_0, \epsilon_2)$=0.05 for the grandparent-grandchildren link which is not statistically different from zero (the two short curved paths in the DAG).

The results are more salient when all the empirical covariance of residuals across generations are included in the model. Column (4) shows that the coefficient of parental education, around 0.60, is now 60% larger (0.66/0.41) than OLS while the conditional coefficient of grand-parental schooling (-0.09), while larger in absolute value from previous estimates, remains non-significant. This time, however, the covariance between the first and second stage for the older generations, i.e. grandparent-parent link ($\text{cov}(\epsilon_0, \epsilon_1)$=0.33), is the only one statistically significant. This result may suggest the presence of other factors, like cultural heritage or other unobserved elements, as suggested by Solon (2018), that are being transmitted directly from the parents to their offspring. The fact that only the covariance of residuals from contiguous generations are significant may imply the these other characteristics have a relevant role in the transmission of human capital across three generations although it seems to fade away across more distant ancestors.

All in all, these results bring about two additional conclusions. First, accounting for endogeneity bias reveals less long-term persistence of direct parental origins (more canonical mobility) than ignoring it. Second, the conditional effect of grand-parental education on grandchildren education turned out non-significant which implies less importance of more distant familiar background. This means that the influence of the grandparents' educative legacy do not remain further away from the first generation (at least for the cohorts from this setting). While this results don't claim to have external validity, it is interesting to note that no conditional effect can be inferred from grand-parental education on grandchildren education. Indeed, it seems that the persistence of some part of the current inequality in education outcomes, at least from this particular context, can then be traced back to the preceding generation only.

7 Conclusions

This paper examined the transmission of human capital across three generations. A natural experimental set-up from a regional conflict that occurred during 1926-1929 was used to instrument grandparental education whereas the regional variation of minimum wages at adolescence served as an instrument for their offspring's education (i.e. the parental generation). These identification strategies delivered long-term trends of education mobility over the twentieth century with retrospective information from a nationally representative survey in Mexico. These two independent sources of variation also produced a unique framework to estimate the *joint* impact of grandparental and parental education on the grandchildren's education with a structural equation model (SEM).

The findings with the two contiguous pairs of parent-children links at hand show that the causal estimates unveil a much larger importance of direct familiar background than what is traditionally obtained with OLS. This conclusion holds for any of the two parent-child links used in this paper since the inter-generational persistence of grandparent-parent education turn out 70% larger with IV than with OLS, and 30% larger for the parent-child pair. This findings suggest that addressing endogeneity issues certainly plays a relevant role in determining the importance of direct family background.

The IV estimates also suggest a stronger persistence of the family origins in the older pair of generations than in the younger pair. Indeed, the standardized coefficients of inter-generational persistence for the grandparent-parent link of 0.76 is statistically larger than that of the parent-grandchild link of 0.56. These findings unveil an unequivocal upward trend of long-term education mobility and suggest that the influence of direct family background, while still high relative to other countries and settings, seems to play a lesser role in more recent generations. This trend is undetected with OLS since the coefficient of inter-generational persistence between these two pairs remained essentially unaltered over the twentieth century (at 0.44 and 0.43 for the grandparent-parent and parent-grandchildren respectively).

Interestingly, the *unconditional* coefficient of grandparental education on the grand-children's education turned out positive and highly significant for both OLS and IV estimates. However, both the IV and OLS estimates for the *conditional* effect of the grandparents' education turned out non-significant. In fact, the 95% confidence interval of this conditional estimates contains both positive and negative values and hence fails to reject the Becker and Tomes (1979) model's prediction of a small and negative coefficient of grandparental education

on their children. In other words, the results from this setting suggest that the influence of parental education on their offspring is so important that no conditional effect can be inferred from grandparental education on the grandchildren's education.

Finally, the SEM implementation allowed to fully account for the serial correlation of residuals across generations yielding the most salient results. This analysis suggests that on top of the ancestors' education, the presence of other factors, like cultural heritage or other unobserved elements directly transmitted from grandparents to their offspring, may have a significant role in the transmission of human capital across three generations as recently suggested by Solon (2018). These results further confirm the direct and leading influence of the parents' education in their children's educational outcomes. In other words, the transmission of human capital between successive generations is so dominant that the legacy of more distant ancestors seems to fade away in the second generation.

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Appendices

A The *Cristero* conflict and grandparental education.

A.1 Historical background

In January 1926 a Mexican archbishop was put in prison after endorsing a public statement in a national newspaper against the enforcement of secular legislation from the Constitution of 1917. Under this institutional framework the provision of education was stated secular and the clergy had an explicit constraint to manage primary level schools (3rd article of this new constitution). [19] In reaction a countrywide civic association, named the National League for the Defense of Religious Liberty, called for a general uprising while the Catholic hierarchy claimed for a peaceful resistance. However, as the anticlerical measures became stricter the clergy protested by suspending sacramental worship on July 1926 leading to a severe armed conflict where thousands of individuals, mainly peasants from rural areas rose to defend their "faith, their communities and the church" (Meyer (1973a), Buttler (2013), and Aspe (2015)).

The revolt was known as "*La Cristiada*", or *Cristero* conflict, after the rebels' battle cry ¡Viva Cristo Rey! (Long live Christ the King!), and constituted the major conflict between the Catholic Church and the Mexican State during the 20th century. The stringent enforcement of constitutional provisions in 1926 configured an unprecedented situation for the Mexican clergy accustomed to the unbinding legislations from the past. The *Cristero* uprising soon spread over western and central states of Mexico and constituted a multilevel conflict: both a local-regional guerrilla war and a national-international diplomatic dispute (Andes, 2014) that came to its end in 1929 after mutual concessions between the Mexican government and the Catholic hierarchy.

[19] Also, religious worship services were confined to the temples (Art. 24) and a maximum number of priests were to be set by civil authorities. The priests were forbidden to express their opinion on issues related to government, the laws or the performance of any civil power (Art. 130). These legal provisions also seized the real estate assets of the Catholic Church and prevented the acquisition of new ones (Art. 27). Freedom of religion was also declared and priests lost the right to vote and to participate in politics.

A.2 The effect of the conflict on the grandparents' generation

As described on the main text, the main identification strategy exploits the conflict characteristics and relies on the influence of this insurgency on the grandparents' education determined by three characteristics: the affected cohort, the affected areas and the geographical distribution of the conflict. It is argued here that the largest effect of the conflict is to be found on younger cohorts in school age that might have been prevented to enroll or complete elementary education. The focus then are children that were born during the conflict or that were in school age in primary education (aged 7-12 back then). The most affected cohorts were then those born between 1917 and 1929. The oldest cohort encompasses those children that were enrolled in the 2nd year of primary education at the beginning of the struggle in 1926. Conclusions are robust to selecting other cohorts in close age intervals.[20] Given the nature of the conflict, it is expected that the children most negatively affected were those living in rural localities, as they were more prone to be exposed to this civil conflict.

The goal is to identify the effect of the *Cristero* conflict on the grandparents' educative achievement. To show that the conflict differently affected the children according to their place and year of birth, the empirical strategy exploited the regional variation of the conflict under a difference-in-difference-in-differences (DDD) specification. In this setting, older cohorts, those born before this uprising, were selected as comparison group as younger cohorts, born after the conflict, would most likely be affected by its direct or collateral consequences.[21] Following Imbens & Wooldridge (2007) the empirical implementation is the following:

$$\begin{aligned} S_0 = \alpha + \beta_1 Cristero * Cohort * Rural + \beta_2 Cristero + \beta_3 Rural + \beta_4 Cohort \\ + \beta_5 Cristero * Cohort + \beta_6 Cristero * Rural + \beta_7 Cristero * Rural + \epsilon \end{aligned} \tag{A1}$$

where 'Cristero' is a dummy variable for individuals in Cristero region (comprised by a set of states engaged in conflict as described in the main text), 'rural' is a dummy for individuals living in rural areas (equals 0 for individuals in urban areas), and 'cohort' variable introduces the time dimension in a dummy for children in school age at the moment of the conflict (being 0 for older children –out of school age during the revolt). **Table A1** shows descriptive statistics for these groups and variables. The outcome variable is grandparents' education, S_0.

[20] Very consistent effects are found when using a more restricted sample of cohorts that was at school age during the conflict. To gain precision we stick to the most ample sample reported here.

[21] With a similar goal Singh and Shmyyakina (2016) found a substantial and statistically significant negative effect of localized insurgencies on children's educational attainment using a DDD approach too.

Table 1: **Descriptive statistics for the Diff-in-Diff-in Differences implementation**

Variable	Obs	Mean	Std. Dev.	Min	Max
Grandfathers					
*Cristero**rural*cohort (CRT)	782	0.16	0.37	0	1
Cristero region (C)	782	0.24	0.43	0	1
Rural area (R)	782	0.83	0.38	0	1
Affected cohort (T)	782	0.79	0.41	0	1
*Cristero**cohort (CT)	782	0.18	0.39	0	1
Rural*cohort (RT)	782	0.64	0.48	0	1
*Cristero**rural (CR)	782	0.22	0.41	0	1
Grandmothers					
*Cristero**rural*cohort (CRT)	535	0.19	0.39	0	1
Cristero region (C)	535	0.24	0.43	0	1
Rural area (R)	535	0.83	0.38	0	1
Affected cohort (T)	535	0.84	0.37	0	1
*Cristero**cohort (CT)	535	0.17	0.38	0	1
Rural*cohort (RT)	535	0.60	0.49	0	1
*Cristero**rural (CR)	535	0.21	0.41	0	1

Sources: EMOVI (2011). Cristero data from Meyer (1973c) and Meyer (2014).

Table A2 shows the results of a baseline specification of Equation (A1) for the grandfathers' and the grandmothers' education using standardized years of education. The estimated coefficient for the affected boys is negative and statistically significant. This means that children exposed to the conflict accumulated less education as compared with those not affected by the conflict. The coefficient for the grandmothers is not statistically significant provided that this group already accumulated less years of education in comparison with their masculine counterparts. More importantly, this table confirms that the effect on the educational outcomes varies according to the age and the place of residence at the time of the conflict for the male cohort considered.

Table 2: **The effect of *Cristero* civil war on grandparents' education (G0)**

Years of education (standardized)	(1) Grand-Father	(2) Grand-Mother
Cristero*rural*cohort (CRT)	-1.543***	0.219
	(0.498)	(0.230)
Dummy *Cristero* region (C)	-1.091***	-0.565*
	(0.351)	(0.296)
Dummy rural area (R)	-0.732**	-0.828***
	(0.358)	(0.184)
Dummy affected cohort (T)	0.156	0.100
	(0.379)	(0.140)
*Cristero**cohort (CT)	1.114**	-0.127
	(0.457)	(0.203)
Rural*cohort (RT)	0.081	0.056
	(0.388)	(0.123)
*Cristero**rural (CR)	1.347***	0.498
	(0.396)	(0.323)
Constant	0.446	0.519***
	(0.351)	(0.193)
Observations	782	535
Adj. R-squared	0.071	0.075

Note: Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

A.2.1 Other channels

Other non-contemporaneous outcomes were examined to assess other channels: fertility (number of children) and wealth holdings of grandparents in adulthood.[22] **Table A3** reports the interacted term of interest (*Cristero**rural*cohort) that confirms a negative effect on the grandfathers' years of schooling. These results control for birth-year including state fixed effects. Estimates suggest no effect on fertility or in the future wealth holdings patterns of the affected cohort for both the grandfathers and grandmothers. This suggests that the low levels of education and the *primitive* Mexican labour marked in the early twentieth century did not produce larger differences in wealth accumulation in adult ages. It also suggests that the fertility decisions were not fundamentally driven by education but, instead, on social norms or other economic criterion in this customary society from the preiouvs century. The identification strategy then relies on this external source of variation to assess the effect of grandparents' education on their offspring builds on these results.

Table 3 The effect of *Cristero* conflict on other grandparental outcomes (G0)

Variables	Grand-father (G0)			Grand-mother (G0)		
	(1)	(2)	(3)	(1)	(2)	(3)
	Schooling	Children	Wealth	Schooling	Children	Wealth
*Cristero**rural*cohort	-1.456***	0.647	0.207	0.279	-0.590	0.659
	(0.481)	(1.901)	(1.588)	(0.238)	(0.901)	(0.718)
Main Effects	Yes	Yes	Yes	Yes	Yes	Yes
Interaction terms	Yes	Yes	Yes	Yes	Yes	Yes
Birhtyear	Yes	Yes	Yes	Yes	Yes	Yes
State fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	782	847	835	535	669	659
Adj. R-squared	0.084	0.049	0.150	0.094	0.049	0.128

Notes: Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. Wealth corresponds to the PCA of assets reported by G1 at age 14. Standardized schooling. Main effects (c, r, t) and interactions (cr, tc, tr) where c, r and t stands for Cristerio region, r for rural, and t for cohort in school age respectively.

[22]Wealth holdings were computed by PCA from assets reported by the survey respondent when he or she was at age 14. Wealth variable refers to rank decil.