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**JEL Codes: I21, I24, J62**

**Keywords: multigeneration, education, Mexico**



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# Good things come in threes: multigenerational transmission of human capital

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## Abstract

This paper examines the effect of grandparental education on their children's and grandchildren's educative outcomes. The endogeneity of parental schooling is addressed by the use of a two-fold instrumental variable approach. A natural experimental set up from a regional war that occurred in 1926 is exploited to instrument years of schooling of the “grand-parents” generation whereas labour market indicators serve as an instrument for the education of the “parents” generation. Using a nationally representative Mexican survey that gathers retrospective information on the three generations, the paper first shows that accounting for endogeneity unveils less mobility than ignoring it. This allows documenting more persistence of family background in the older pair of parent-child link than in the younger pair in the three generations at hand. Finally, results also suggest that the influence of the grandparents' educative legacy, conditional on parental education, does not seem to reach the grandchildren's generation.

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# 1 Introduction

This paper provides empirical evidence on the transmission of human capital across three generations from a middle-income country. The endogeneity of paternal schooling (the fact that other 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. Firstly, a regional and religious civil war provides a natural experimental set up to instrument the effect of grandfathers' education (G0) on their children's and grandchildren's outcomes. Secondly, local minimum wage at adolescence is used to instrument the parents' generation (G1), which in turn is used to examine its effect on their grandchildren's education (G2). The goal of this unified framework is examining both the degree of educative 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 educative mobility tends to focus on the association of two adjacent generations from well-developed or Nordic countries mainly (see Björklund & Salvanes (2011), Black & Devereux (2011), and Holmlund, et al. (2011), Solon (1999) and Jäntti & Jenkins (2015)). Some of these empirical studies exploit rich administrative records that are only found in few countries (see Hällsten (2014), Lindhahl, et al. (2015), Møllegaard & Jæger (2015)) while others resort to retrospective surveys to overcome this limitation (see Mare (2014) and Pfeffer (2014)). Studies exploring more than two generations are even scarcer, due again to data restrictions (Solon, 2018), and largely rely on cross-sectional correlations.

In search for causality, the literature on intergenerational mobility of education has recently moved away from OLS estimates and has turned to the use of alternative identification strategies. These strategies range from the use of twins and adopted children to natural experiments often taking an instrumental variable approach (Black & Devereux, 2011). Most of these instruments exploit changes in education laws that increase the length of compulsory schooling (Holmlund et al. (2011) and Black & Devereux (2011)), however two recent studies stand out in clear contrast. 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, while Carneiro et al. (2013) exploited the variation in the direct and opportunity cost of education across counties and cohorts to identify the effect of maternal education on children's' outcomes. Both studies find significant effects of parental education on children's grade repetition and tests performance (math and reading) respectively.

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. There is however little evidence supporting this prediction. For instance, Behrman and Taubman (1985) found a positive but not statistically significant coefficient of grandparental education from regressing the education of the children on the education of parents and grandparents education in USA. Similarly, Lindahl et al. (2014) found a positive but not statistically significant estimate of grandparental education in Sweden. Both used close relatives’ education to instrument parental education.<sup>1</sup>

This paper exploits a unique dataset, “*Encuesta de Movilidad Social Inter-generacional*” (EMOVI) on a national representative sample of adults aged 25-64 in Mexico. It contains information on the education level of the “parents” generation (so called the first generation or G1) whom 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. The survey also collects data on the respondents’ residence and household’s characteristics at birth and adolescence.

To examine the effect of grandparental education on their offspring the study follows two identification strategies. The first one relies on the geographic distribution of a regional and religious conflict occurred at the beginning of the twentieth century whilst the second, a robustness check, uses historical records of the territorial variation of the Church as provider of education three decades before the uprising. 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 will be used as an instrument of the grandparents’ education to determine the effect of grandparents’ education on the parents’ generation and the unconditional effect on the grandchildren’s generation.

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<sup>1</sup>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.

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. Here the cross-sectional and time series variation of minimum wage during adolescence is used to instrument parental education. This strategy exploits the institutional origins of this indicator, initially defined in the Mexican constitution of 1917, and historical records from its municipal variation gathered by the Mexican Statistical Office (INEGI). Once equipped with an independent set of identification strategies for each of the first two generations, the paper examines the long-run transmission of human capital and the conditional effect of grand-fathers' education on the grand-children's education.

The analysis first shows that the direct 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 larger than the OLS estimate, which implies that accounting for endogeneity unveils a larger importance of familiar background (less educational mobility) than ignoring it. This conclusion holds for any of the two contiguous pairs of parent-children links (G01 and G12). Finally, the conditional effect of the grandfathers' education on their grandchildren's education appears to be not statistically significant suggesting that the persistence of some part of the current inequality can be traced back to the preceding generation.

The contributions of this paper to the literature on the multigenerational mobility run in several directions. Firstly, the paper exploits a unified framework to account for endogeneity biases across three generations. This framework differs from previous studies focusing on shorter-time analysis (i.e. two generation), on statistical associations (i.e. OLS estimates mainly), or relying on instruments within the family domain (i.e. using close relatives' data only). Secondly, the study focuses on a shock on grandparents' childhood in a period where the average schooling was very low. This implies that the long run effect of grandparental education is larger than the marginal effect often identified by studies that exploit changes in compulsory schooling laws affecting a specific part of the education distribution only (these reforms are usually addressed to population with low education levels). Lastly, results from a middle income country that belongs to the region with the lowest levels of intergenerational educative mobility (Hertz, et al., 2007) might complement previous research from countries in more advanced stages of economic development.<sup>2</sup> Indeed the influence of our ancestors' education might vary from cultural differences across societies or among social groups as recently suggested by Solon (2016).

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<sup>2</sup>According to Hertz et al. (2007) the Latin-American region possesses the highest intergenerational persistence estimates relative to eastern Europe, western Europe (+USA), Africa and Asia.

The paper is organized as follows. The second section describes the general approach to examine both the intergenerational and the multigenerational transmission of education in the literature, which corresponds to an autoregressive process of first, or higher, order. The third section 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. Section six examines the conditional effect of grand-parental education on the grandchildren education taking advantage of the two independent instruments for the first two generations. The last section concludes. Finally, Annex A document the effect of the civil war on the affected generation (the grandparents' generation).

## 2 Theoretical framework end empirical approach

Intergenerational mobility is often approximated by a first-order auto regression process. This functional form emerges from the seminal model of Becker & Tomes (1979) where parents decide an optimal allocation of their income between current consumption and investments in the human capital of their children. The model introduces the notion of human capital endowment,  $e$ , received by the child which refers to inheritance of both genetic and cultural attributes that the child receives independently of deliberated investment choices. The model assumes that the human capital endowment follows a first order auto-regressive process:

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

Where  $\tau-1$  refers to some index generation and  $\tau$  refers to their offspring. The heritable parameter  $\lambda$  is bounded between zero and one, whereas  $\nu$  stands for a white-noise term uncorrelated with  $e_{\tau-1}$ . The maximization of the parental utility function is subject to a budget constraint where parents cannot borrow against their offspring's future earnings and do not bequeath assets to their offspring. The solution to this optimization problem leads to a bivariate expression that relates some ancestors' outcome  $y$ , i.e. income or education, with their offspring's as follows:

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

Where  $\rho$ , the intergenerational persistence parameter, is positive and  $\epsilon$  is the error term. Two interesting facts emerge from this expression. Firstly, 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,  $\lambda$ , and the income return to human capital investments,  $\gamma$  that is assumed to be positive, as follows:  $\rho = (\gamma + \lambda)/(1 + \gamma\lambda)$ . Secondly, the error term is not well-behaved as the unobserved child's endowment,  $e_\tau$ , 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,  $\gamma$ , and because richer (poorer) parents also tend to pass more (less) favorable endowments to their offspring,  $\lambda$ .

The implications of this model to multiple generations is obtained by lagging expression (1) by one generation and multiplying it by the heritability coefficient,  $\lambda$ . This yields the customary expression of an AR(2) process:

$$y_\tau = \alpha + \rho_1 y_{\tau-1} - \rho_2 y_{\tau-2} + v \quad (2)$$

Where  $v$  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, initially noted by Becker and Tomes, has give rise to recent empirical research. Lindhal et al. (2014), for instance, argues that a negative sign in grandparental coefficient is related to the presence of credit constraints limiting parents' human capital investments. According to this approach, the empirical test of grandparental coefficient is then a way of testing the presence of credit constraints.<sup>3</sup> Solon (2018) argues that this negative coefficient does not mean that the model is wrong, instead that it might be incomplete due to: a) the effect of the grandparental transmission of cultural inheritance, b) omitted variables-bias (the presence of group effects like racial discrimination), and c) measurement errors.<sup>4</sup>

From these two last expressions it is clear that OLS estimates yield biased estimates. Both the parents coefficient,  $(\gamma + \lambda)$ , and the grandparental coefficient,  $(\gamma\lambda)$ , are estimated with

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<sup>3</sup>Their logic is as follows. In the presence of credit constraints, higher grandparental human capital implies lower parental ability, for a given level of parental human capital, because parental ability and grandparental investments are substitutes in the parental human capital accumulation.

<sup>4</sup>Solon (2018) points that this negative 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.



a negative and a positive bias respectively. Because of this, the empirical analysis builds on the above-referred expressions and makes use of a two-stage least squares instrumental variable (IV) approach . In particular the paper follows Equation (1) to assess the effect of parental education on the two pairs of parent-child at hand to examine the mobility patterns over the twentieth century. The analysis resorts to Equation (2) to examine the *conditioned* effect of grandparental education on their grandchildren’s education. The IV approach allows addressing three potential statistical problems related to endogeneity: omitted variable problem, the reverse causality problem, and errors in measurement. <sup>5</sup>

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 IV 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 parental education on their children’s outcome for the subgroup of parents for which the instrument has an impact.

Following related literature, the study uses standardized outcome variables (mean zero and standard deviation of one) to net out educational inequalities within each generation. Standardized variables allow dealing with the fact that each generation possesses different distributions and implies that the correlation coefficient ( $r$ ) and the OLS regression coefficient ( $\beta$ ), are also the same.<sup>6</sup> This empirical implementation includes a set of controls which include birth year, sex, family size and regional fixed effects in line with the international review of Lindahl, et al. (2015) in related studies. Finally, 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.

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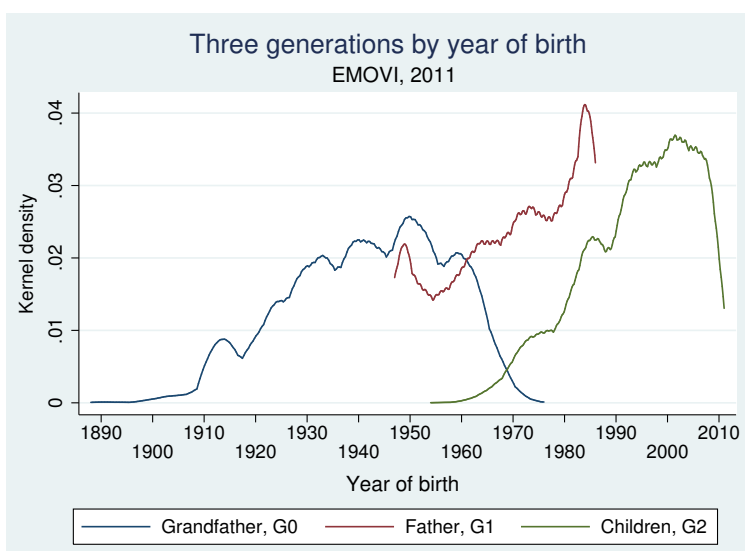
<sup>5</sup>In our case, the omitted variable problem appears as the educational choice might be correlated with unobserved characteristics like ability, the propensity to exert effort or any other endowment transmitted to children beyond of the family’s conscious choices. The reverse causality problem implies that highly educated parents tend to be associated with highly educated children but it is difficult to disentangle how much of this is due to nature (the genetic transmission for instance) or nurture (the care and environment provided by a high/low educated parents). Finally, 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), however the use of retrospective information on grandparental education can be prone to measurement errors in the current setting.

<sup>6</sup>This is easily observed with the following expression  $r = \beta(\sigma_\tau / \sigma_{\tau-1})$  where  $\sigma$  is the standard deviation.

### 3 Data and sample

The study uses a Mexican survey “Encuesta de Movilidad Social Inter-generational” (EMOVI by its Spanish acronym from now on), which consists on a random sample of the population collected in Mexico in 2011. The survey’s goal is to determine the extent to which parents’ resources and living conditions influence their offspring’s socioeconomic position. The survey is deliberately designed to gather retrospective information on the ancestors of a national representative sample of adults aged 25-64 in Mexico. This data also contains a rich set of retrospective information on the respondents, as well as contemporary information on their children. The EMOVI 2011 contains data of eleven thousand individuals. Graph 1 presents a graphical description of the full sample on these generations whereby the respondents of the survey are to be referred to as first generation, G1, or the parents’ generation interchangeably.

Figure 1: **Density of individuals by year of birth within each generation**



An earlier survey was collected in 2006, but it covered mostly men (women were only interviewed if living alone) and only asked educational data for the respondents’ co-resident children but not for their parents.<sup>7</sup> A more recent survey was recently collected but was not available at the time of writing. Therefore, the 2011 data represent a unique survey that allows us to investigate the intergenerational transmission of education within three generations of household members (grandparents, parents, and grandchildren) along several dimensions. In fact, no other Mexican dataset gathers similar information.

<sup>7</sup>The sample is only representative of the Mexican male population aged 25-64. Similarly the set of questions regarding the respondents’ mother is limited (it does not ask for the year of birth for instance).

The EMOVY 2011 survey gathers information on several characteristics regarding both parents of the respondents. This cross-sectional survey collects information about the respondents' education, earnings, assets and other relevant socio-demographic data. The survey also collects retrospective information about the respondent's parent's socioeconomic status (G0). The dataset is somewhat less complete regarding the respondent's children's data (G2), although it collects information about their schooling independently of their co-residency status. This attribute makes this survey suitable for this analysis as traditional household surveys would be biased due to the non-random selection of children, that are often still at school when co-resident (Emran, Greene & Shilpi, 2018).

The sample used is comprised by the cohort of grandparents in school age or older during the *Cristero* war with offspring (the 'parents') who themselves have children who are out of school age. Table 1 shows descriptive statistics where panel A, B and C contains outcome indicators for the grandparents, parents and grandchildren, respectively. Panel C contains data from around 1960 individuals from the second generation (G2) which corresponds to around 780 families in Panel A and B.

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

Variables by generation	Obs	Mean	Std. Dev.
<b>Panel A: Grandparents (G0)</b>			
Grandfather's schooling	772	2.05	3.34
Grandmother's schooling	607	1.68	2.86
Number of children	786	5.71	3.25
Year of birth	786	1917	3.68
<b>Panel B: Parents (G1)</b>			
Parents' schooling	782	6.22	4.48
Number of children	786	2.86	1.71
Male	786	0.46	0.50
Year of birth	786	1955	6.83
<b>Panel C: Grandchildren (G2)</b>			
Grandchildren's schooling	1962	9.72	3.87
Male	1962	0.53	0.50
Year of birth	1962	1984	8.43

## 4 The effect of grandfathers' education on parental (G01) and on grandchildren's (G02) education

The paper first 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 by 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 start until 1926, one decade 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 got used to multiple unbinding legislations from the past and its authorities initially adopted a peaceful reaction. The uprising was short-lived because it lasted three years only (1926-1929) 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 (G01) and grandchildren's education (G02) separately. The main identification strategy builds on the regional exposition to this civil war, a feature that is exogenous to parental and children ability, to elicit the causal effect of the grandparents' education on their offspring. A second strategy, a robustness check, uses the importance of the Catholic Church in the provision of education long before this uprising. Annex A shows 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. Map 1 shows 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)) where only 90 thousand corresponded to combatants (Andes, 2014).<sup>8</sup>

Figure 1: Regional distribution of the Cristero war (Meyer, 1973a)



Meyer (2014) was also able to quantify the number of *Cristero* troops by state confirmed by two independent sources yielding around 50 thousand fighters.<sup>9</sup> Table 2 show the number of combatants per state. In absolute terms, the rebels' troops were stronger in four western states (Jalisco, Michoacán, Guanajuato and Zacatecas) whereas these troops were much more stronger in relative terms, i.e. using the share of rural population engaged in conflict, in three states (Colima, Aguascalientes and Nayarit) but weaker in other central (DF, México and Morelos) and southern states (Oaxaca, Puebla, Veracruz). These two criteria, territory spread and the density of combatants, allows defining a macro region that experienced the greater intensity of the Cristero war. This region is comprised by seven states that contained around 27% of the total Mexican population in 1910.<sup>10</sup>

The main identification strategy to instrument grandparental education relies on three char-

<sup>8</sup>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.

<sup>9</sup>These sources were the U.S. Department of State Records, Clark memorandum on military situation and Mexican military records.

<sup>10</sup>These states are Aguascalientes, Jalisco, Michoacán, Guanajuato, Colima, Nayarit and Zacatecas.

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

State	Fighters	Percent of rural Pop.
Michoacán	12,000	1.3%
Jalisco	10,000	0.9%
Guanajuato	4,000	0.4%
Zacatecas	5,400	1.2%
Nayarit	2,500	1.5%
Colima	2,000	3.8%
Durango	2,000	0.4%
Aguascalientes	1,200	1.6%
Guerreo	3,000	0.5%
Oaxaca	1,500	0.1%
Morelos, México, DF	1,000	0.1%
Puebla, Tlaxcala, Veracruz	1,000	0.05%

Sources: Cristero fighters from Meyer (1973c) and Meyer (2014). Rural population from 1910 Census (INEGI). Rural population refers to areas outside the state capital.

acteristics: the affected cohort, the affected areas, and the geographical distribution of the conflict. Firstly, the effect of the conflict on the grandparental generation is expected to be larger in the states directly engaged in the conflict. This incidence is presumably larger in states with the higher share of combatants relative to their rural population which led us to a small set of states from central and occidental region. Secondly, the effect is expected to be larger in the rural areas where the Cristero troops were able to engage in guerrilla war due to the disproportionate number of federal forces (see Meyer (1973a), Buttler (2013) and Jrade (1982)). 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 in school age corresponding to primary education.<sup>11</sup> Older cohorts, born before the *Cristero* uprising, were chosen as comparison group as younger cohorts, those born after the conflict, would most likely be affected by its consequences.

The geographic distribution of this insurgency, as captured by the place and the year of birth of the affected cohorts, serves here as instrument for the grandparents' years of schooling. The first stage is then the regression of grandparental education, the causal variable of

<sup>11</sup>In addition to 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.

interest, on covariates and instruments as follows:

$$\begin{aligned} \hat{S}_0 = & \alpha + \beta_1 \text{Cristero} * \text{Cohort} * \text{Rural} + \beta_2 \text{Cristero} + \beta_3 \text{Rural} + \beta_4 \text{Cohort} \\ & + \beta_5 \text{Cristero} * \text{Cohort} + \beta_6 \text{Cristero} * \text{Rural} + \beta_7 \text{Cristero} * \text{Rural} + X'_\tau \beta + \epsilon \end{aligned} \quad (3a)$$

Where; ‘*Cristero*’ (or C) is a dummy variable for individuals in *Cristero* conflict region (comprised by a set of 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’ (or ‘time’ variable, T) 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). Here, the coefficient of the interacted variable ‘*Cristero*\*rural\*cohort’ (CRT1 onwards) identifies the effect of the revolt on the grandparents’ education, S0. X refers to a set of exogenous covariates which includes the sex, the year of birth, and state fixed effects of the offspring (either  $\tau=1,2$  for the parents or the grandchildren respectively).<sup>12</sup>

For illustrative purposes, figure 2 plots a visual inspection of the first stage. The graph plots the average educative trends for two groups. The first group refers to ‘affected’ children, in rural and *Cristero* areas, while the second group refers to ‘unaffected’ children, in rural and *Cristero* areas but above school age at the moment of the conflict plus children in rural areas out of the region in conflict. The time dimension of the chart refers to the affected cohorts (in school age at the moment of the conflict) and the unaffected cohorts (older cohorts and hence out of school age at the moment of the conflict). Some interesting facts emerge from this chart. First, that there was not a seemingly difference in years of schooling between these two cohorts before the conflict outbreak. Second, that *La Cristiada* seems to have altered the human capital accumulation process creating a significant difference between these two groups after the conflict.

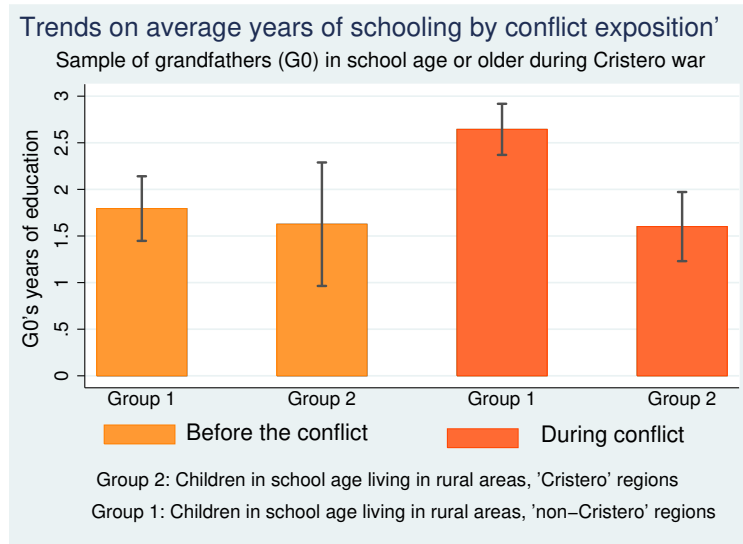
Annex A extends these findings. It shows that the civil war altered the human capital accumulation process of this cohort by creating a statistically significant difference on boys’ education based on their place and year of birth.<sup>13</sup> This finding is robust to the inclusion of sociodemographic controls. Because of this, the analysis focuses on the grandfathers’ generation only. 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

<sup>12</sup>This is a common set of variables used in the related literature as surveyed by Holmlund, Lindahl & Plug (2011) so we stick to it for international comparisons.

<sup>13</sup>Unsurprisingly, the effect on girls is not significant provided that this group had already accumulated low levels of education even before the uprising.

has no effect on these important outcomes other than through the first-stage channel. 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.

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



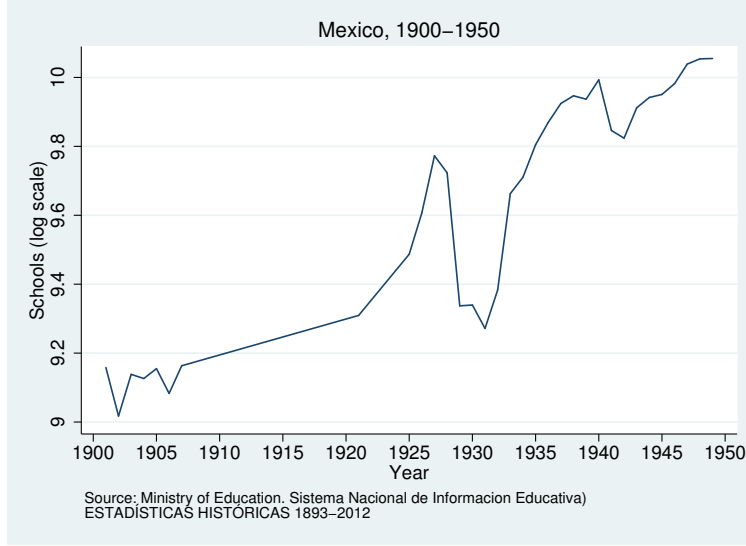
As a robustness check, a second identification strategy exploits other intrinsic characteristic of the conflict. The paper exploits the fact that the stringent application of the educative provisions from the Mexican constitution of 1917 (Article 3 prevented the clergy to manage primary schools) produced a supply shock in the number of active schools. This means that the law enforcement strongly affected schools administered by the Catholic Church that had had an important role in the provision public services over centuries. Figure 3 shows historical administrative records for the total number of primary schools during the first half of the 20th century describing a harsh reduction in a clear u-shaped trend during the *Cristero* conflict. This pattern exemplifies the potential effect of these law provisions as it took nearly ten years to return to pre-conflict levels.

These measures might have prevented children to enroll in school or, for those already in school, might have increased the probability of interrupting education due to the abrupt shutdown of schools. This suggests that the legal enforcements of 1926 and the *Cristero* conflict may have had affected the human capital accumulation of children in school age.<sup>14</sup>

<sup>14</sup>The effect on educational outcomes might have taken place through several channels. As the violence escalated, and the number of casualties increased, the negative impact on schooling could have also been stronger in the insurgent areas not only due to the destruction of schools but also because of shortages of civilian and religious educators/teachers. This is a special characteristic of this conflict as only around 35% of the casualties concerned to combatants. Historiographical research documents that a substantial number



Figure 3: Number of schools for primary education



The effect of the war on schooling then would presumably be larger in states where the historic provision of education by the clergy was more important. Table 1 in Annex B shows the share of religious schools by state in 1985 and illustrates the preeminence of the Church as school administrator. This indicator reveals the heterogeneous influence of the clergy in public affairs and particularly its strength in the provision of education. On average almost one out of five schools was managed by the clergy ranging from 5 to 55% percent in Guerrero and Guanajuato respectively. Indeed, the clergy had a preeminent role in the provision of education ever since the Spanish Catholic monarchy ruled over the Mexican territory over the preceding centuries.

This is the basis of the second identification strategy that relies on the fact that the impact on educative outcomes does not depend solely on the regional intensity of the conflict, but on the historical dominance of the Catholic Church in the provision of public services. The paper then exploits the state variation in the share of religious schools thirty years before the conflict started. This data stems from the first National Census of 1895 published by the former head of the National Institute of Statistics back then (See Peñafiel (1900) and De la Peña (1991)). The functional form of the first stage is as follows:

$$\begin{aligned} \hat{S}_0 = & \alpha + \beta_1 ClergyS * Cohort * Rural + \beta_2 ClergyS + \beta_3 Rural + \beta_4 Cohort \\ & + \beta_5 ClergyS * Cohort + \beta_6 ClergyS * Rural + \beta_7 Cohort * Rural + X'_\tau \beta + \epsilon \end{aligned} \quad (3b)$$

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of priests were killed, imprisoned or deported during the conflict. See Andes (2014), Aspe (2015), and Meyer (2014).

Where; ‘ClergyS’ is the share of schools managed by the clergy as observed in the statistical records of 1895. Like in the previous case, the coefficient of the interacted variable ClergyS\*rural\*cohort (CRT2 onwards) identifies the effect of enforcing the legal provisions from the Constitution of 1917 on the grandparents’ education, S0. This alternative identification strategy relies on the fact that the impact on educative outcomes does not depend solely on the regional incidence (and intensity) of the conflict, but on the importance of the Catholic Church in the provision of public education. A key attribute on this identification strategy is that it departs from the war incidence, and more importantly, it introduces heterogeneity in the effect captured by the IV.<sup>15</sup>

Figure 4 illustrates this approach. The graph shows the regression line between grandparental education and the state variation of the clergy as school administrator. The graph contains two population groups (rural and urban individuals) belonging to two cohorts: the younger cohort (in school age during the conflict), and the older cohort (above school age during the conflict). Note first the divergent pattern between the younger cohorts during the conflict. The most affected group appears in a solid and downward-sloped line which corresponds to rural individuals. On the contrary, the solid and upward-sloped line corresponds to urban individuals. The diverging trend between these two lines describes the effect of the conflict.

Interestingly, this pattern was absent in older cohorts where these groups described a parallel trend as observed in the corresponding dotted lines. To wrap up, the parallel upward slope in dotted lines (older cohorts during the conflict) describes a positive relationship between years of schooling and the share of clergy schools whereas the divergent trajectory observed in the solid lines describes the effect of this supply shock on younger cohorts in a context where the Clergy used to have a predominant role in the provision of education (younger cohorts in school age during the conflict). The difference between the dotted and the solid lines illustrates the associated loss on education between cohorts.

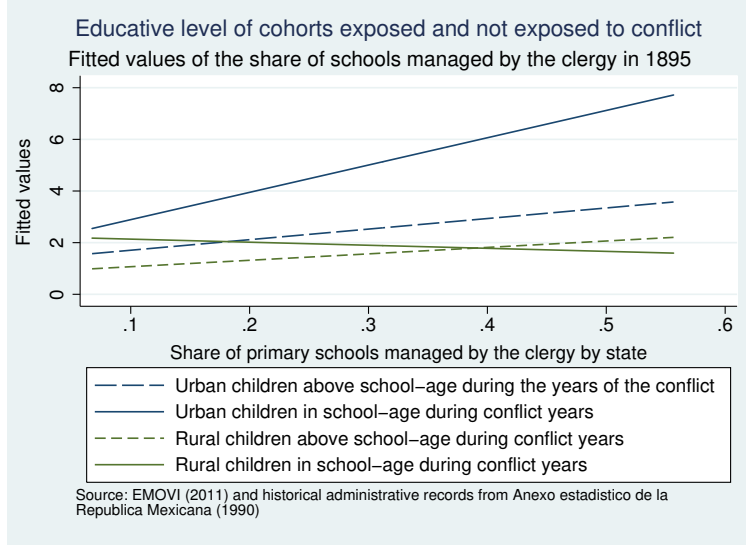
## 4.2 Results: Grandfather’s Ed. on parents and on grandchildren

Under this instrumental variable approach the second stage, or reduced form, estimate the effect of the ancestors’ education on their offspring’s education. For any pair of parental-child

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<sup>15</sup>The correlation between the share of schools managed by the clergy and the number of *Cristero* fighters by state is 0.44. This means that this strategy serves a robustness check, as it does not solely rely on the specific states involved in the armed struggle, but also on the regions across the country where the clergy had maintained its customary influence in the provision education, and where the application of secular provisions had a harsher effect.

Figure 4: **Grandparental education and the share of Clergy schools**



link (G01 or G12), or for the unconditional effect of grandparents’ education on grandchildren’s education (G02), the reduced form corresponds to the following bivariate regression:

$$S_{\tau} = \alpha + \rho \hat{S}_{\tau-1} + X'_{\tau} \beta + \epsilon \quad (4)$$

Where  $S_{\tau}$  refers to schooling of generation  $\tau$  and,  $\hat{S}_{\tau-1}$  is the instrumented education of the relevant ancestor. X here refers to same set of variables used on the first stage.

Table 3 shows both the results from OLS and IV for the grandfather-parent link. The table shows the first and second stage results for both identification strategies where each estimate represents the coefficient from a different regression. The OLS results in column 1 show a statistically significant positive relationship between the grandfathers-parents years of education. The coefficient for grandparental education is around 0.44. These results are consistent with related empirical evidence like Behrman, et al. (2001) who found an intergenerational educative persistence of 0.50 for Mexico using a more restricted sample from urban employment surveys.<sup>16</sup>

The IV results confirms a negative first-stage relationship between the grandparents’ years of education and their exposition to conflict. In the current context, these estimates suggest

<sup>16</sup>This is also consistent with Hertz et al. (2007) estimates showing that the regional Latin-American average (around 0.60), Mexico not included, is the highest relative to other regional averages. These regions are: Asia, Africa, Eastern countries, Western Europe and USA. The LA average stems from a sample of adults aged 20-69 from seven countries: Colombia, Peru, Ecuador, Chile, Brazil, Panama and Nicaragua.

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

Dependent variable:	(1)	(2)	(3)
Parental education (G1)	OLS	IV1	IV2
<b>Reduced form</b>			
Grandfather education (G0)	0.435*** (0.0317)	0.710*** (0.129)	0.649*** (0.122)
Observations	786	786	786
Adj. R-squared	0.335	0.266	0.293
<b>First stage</b>			
CRT1	-	-1.10** (0.463)	-
CRT2	-	-	-1.56 (1.638)
Adj. R-squared	-	0.159	0.161
F-stat	-	8.7	6.7
Robust score chi2(1)	-	5.33	3.51
p	-	(0.02)	(0.06)
Sex, G1	Yes	Yes	Yes
Birthyear, G1	Yes	Yes	Yes
State fixed eff., G1 at 14	Yes	Yes	Yes
Number of children, G0	Yes	Yes	Yes

Note: Robust standard errors in parentheses. \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . Education: Years of education (standardized). Sample of grandparents in school age, or older, during the civil war regardless of having grandchildren. Each estimate represents the coefficient from a different regression. Using the regional variation of the conflict (CRT1) and prominence of the clergy in the provision of education (CRT2) as instruments. First stage include main effects (c, r, t) and interactions (cr, tc, tr) where c, r and t stands for Criterio region or Clergy share, r for rural, and t for cohort in school age respectively.

that a drop in the grandfathers' education by a year is associated with a reduction on the parents' education as expected. This relationship is strongly significant and unambiguously negative. The causal relationship described by the IV results are larger in absolute value than OLS', at around 0.65-0.70, which also appears in line previous studies.<sup>17</sup> This higher order of magnitude is confirmed by the second identification strategy in column 3.

Unsurprisingly, the IV estimates are less efficiently estimated than OLS's however all the parameters are strongly significant. The table reports the Wooldridge's score test of endogeneity which checks that the endogenous variable is actually exogenous. Here the robust score Chi2 is highly significant, so it is possible to reject the null of exogeneity.<sup>18</sup> 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. Finally, the fact that the IV estimate of intergenerational persistence of education is higher than the OLS's suggests that the later under-estimate the true causal effect of parents education (Angrist and Krueger (1991) and Verbeek (2012)) -a result that was also observed in Behrman and Taubman (1985).

Finally, table 4 shows the OLS and the IV estimates of the unconditional effect of the grandfather's education on the grand children's generation. This exercise reports the two instruments described above. The independent variable is the instrumented grandparental education again but the dependent variable is now the grandchildren's educative outcome (the second generation). The OLS estimate appears positive and statistically significant but with a much lower coefficient, 0.22, as compared with the estimates from the previous generation. The magnitude of this coefficient is around one half of the estimated influence of the grandfather on the parents' generation (0.22 vs 0.45 for this and the previous pair respectively).

Interestingly both the instruments are slightly positive, and almost twice larger than the OLS estimate. These instrumented estimates are much smaller than those from the previous generation and both appear statistically significant. These causal estimates seem to suggest that grandfather's education does have some effect upon grandchildren's education, however there is still the need to check whether this effect remains beyond the direct effect produced by the influence upon their father's education, in other words the conditional effect.

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<sup>17</sup>See Holmlund, Lindahl and Plug (2011), Maurin and MacNally (2008).

<sup>18</sup>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 that assume that the error term is i.i.d.

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

Dependent variable:	(1)	(2)	(3)
Grandchildren's Ed. (G2)	OLS	IV1	IV2
<b>Reduced form</b>			
Grandfather Ed. (G0)	0.222*** (0.0305)	0.398*** (0.215)	0.383*** (0.170)
Observations	1,920	1,920	1,920
Adj. R-squared	0.131	0.103	0.108
<b>First stage</b>			
CRT1	-	-1.67*** (0.648)	-
CRT2	-	-	-5.19*** (1.785)
Adj. R-squared	-	0.144	0.151
F-stat	-	7.02	6.47
Robust score chi2(1)	-	1.77	1.90
p	-	(0.18)	(0.17)
Sex, G2	Yes	Yes	Yes
Birthyear, G2	Yes	Yes	Yes
State fixed eff., G2	Yes	Yes	Yes
Number of children, G1	Yes	Yes	Yes

Note: Robust standard errors in parentheses clustered by family. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. Education: Years of education (standardized). Sample of grandparents in school age, or older, during the *Cristero* war with grandchildren. Each estimate represents the coefficient from a different regression. Using the regional variation of the conflict (CRT1) and prominence of the clergy in the provision of education (CRT2) to instrument grandparental education. First stage include main effects (c, r, t) and interactions (cr, tc, tr) where c, r and t stands for Cristerio region or Clergy share, r for rural, and t for cohort in school age respectively.

## 5 The effect of parents' education on their children's education, G12

We now turn to the second, the youngest, pair of parent-child link at hand. The first step now is to instrument parental education for a cohort born around mid fifties. For instance, Behrman and Taubman (1985) used the great-grand parental education to instrument parental education to assess the effect of the grandparent education on the grandchildren education. When abstracting from the use of close relatives' data, the literature on similar cohorts tends to use two-stage least-squares (2SLS) and alternative identification strategies to address endogeneity issues. Carneiro et al. (2013) for instance used the direct or monetary costs of schooling and the indirect or opportunity cost of schooling to assess the intergenerational transmission of education on two generations. They use college fees and the proximity to a four-year college as instrument of parental schooling.

This and other identification strategies hinges on specific data or on settings that are hard to obtain in the current context.<sup>19</sup> However, labor market indicators are more accessible and also recently used to instrument years of schooling. Arkes (2010) for instance used unemployment rates to estimate the returns to schooling.<sup>20</sup> This section resorts to the institutional origins of minimum wages in Mexico, as described below, to instrument parental education.

### 5.1 Identification strategy: minimum wages at adolescence

Minimum wages in Mexico were first defined in the above-referred Constitution of 1917. According to this legislation minimum wages were to be set by each municipality through local councils in coordination with a state-wise government committee. Wages ought to have

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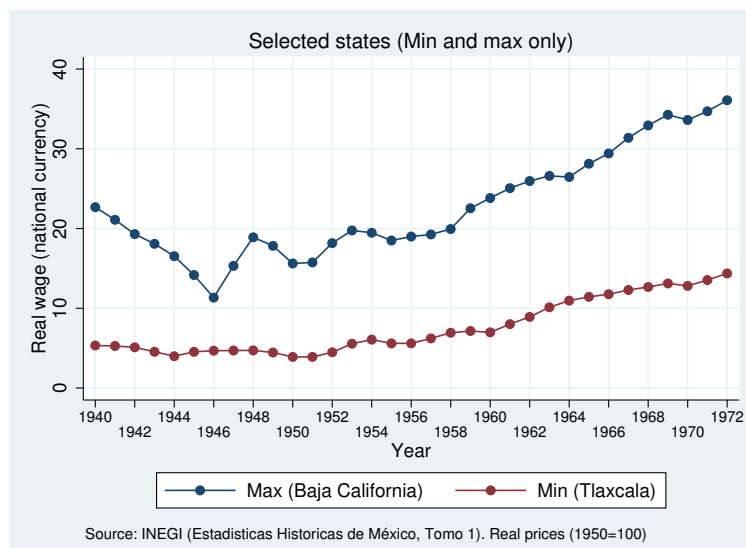
<sup>19</sup>To estimate, for instance, the returns of additional years of education Card (1999) used twins and siblings' information to estimate the causal effects of additional years of education. Similarly, Angrist and Krueger (1991) exploit changes in the legislation of compulsory school to estimate the impact of compulsory school on earnings using data on state and quarter of birth as instrument for education.

<sup>20</sup>Following Arkes (2010), these indicators affect educational attainment both by an income and by a substitution effect. On the one hand, with higher unemployment rates, earnings will be lower so families may need their teenage children to quit school and work (the income effect) leading to lower educational attainment. On the other hand, jobs become scarcer lowering the opportunity cost of attending school. Higher returns to schooling then would improve educational attainment (the substitution effect). Naturally, any of these two effects could dominate over the other: either the "additional worker" effect (income effect) or the "discouraged worker" effect (substitution effect). Regardless on the direction of this effect this paper simply use this variable as an external source of variation.

been defined high enough to meet all basic needs of a family. This mechanism endured until 1980's where a state-level council remained as the most dominant influence on defining the indicator.<sup>21</sup>

The paper exploits the fact that its institutional origins configured a regional variation on this indicator based on the differences in the cost of living at municipality (or micro-regional) level. To illustrate this approach, figure 5 plots the state and year variation of (real) minimum wages in Mexico according to an historical review from the National Statistical Office (INEGI, 1994). For the sake of simplicity the graph shows only the two states with the largest and the smallest wage levels around 1955 which is the average birth-year of the used sample. It is clear that there is both time-series and cross-sectional variation in the real minimum wage during this period.

Figure 5: **Real minimum wage by state and year**



This external source of variation, as captured by the place and age at adolescence, is exploited here to instrument parental education. Figure 6 plots a visual inspection of the first stage. The graph describes a positive relationship between schooling and the level of the real minimum wage at adolescence for the used sample. This is the main identification strategy which will prove useful in the following sections when all these three generations are used

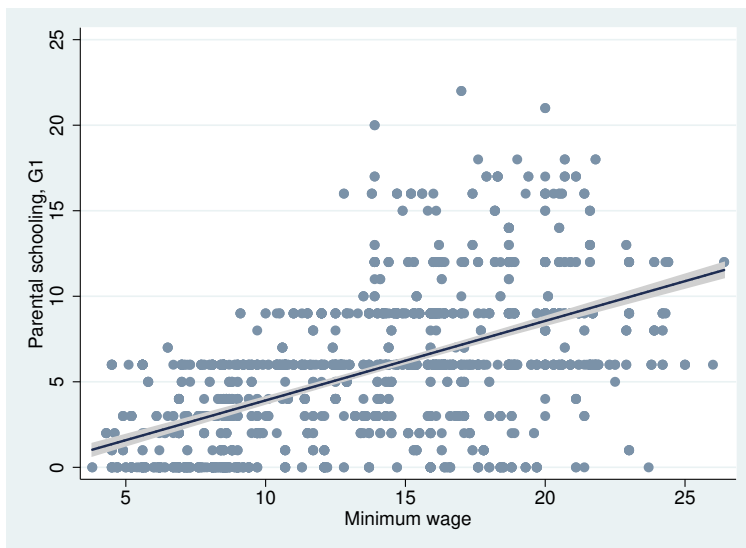
<sup>21</sup>This mechanism slightly changed in early 1930's when the first labour law emerged in response to the constitutional legislation (Conasami, 2017). It was until mid 1960's when a new administrative body, The National Commission of Minimum Wages (*Comision Nacional de Salarios Minimios*, CONASAMI) became the official entity in charge of defining this and other related indicators. 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. Since then there has been additional changes as described by Conasami (2007). This paper use a sample of parents that were borned earlier than 1980's.



simultaneously.

The paper also use a second identification strategy that relies on the individual variation of grandfather’s education. This is an interesting instrument described in Lindhal et al. (2014) who use the educative outcomes of grandparents as an instrument for the outcomes of parents. In the Swedish context, their (standardized) OLS coefficient (0.31) of parental education on the children’s education appears much smaller than the IV estimate (0.58). Both coefficients are strongly significant. Because this alternative identification strategy serve as a robustness check, the remaining sections use the main identification strategy only. Finally, and similar to previous section, the second stage corresponds to a bivariate regression described in Equation (4).

Figure 6: **Parental education and minimum wages**



## 5.2 Results: parental education on their children’s education

Table 5 shows both the results from OLS and IV for the parent-child link. The OLS results show, as expected, a statistically significant positive relationship between the (grand) children’s years of education and their parents’ education (G2 and G1 generations respectively). This time, the coefficient for parental education is around 0.42. This order of magnitude is very close to the one observed in the previous generations (0.44 for the grandparent-parent generation) suggesting that despite the improvements in educative outcomes in Mexico, the

(high) persistence of family backgrounds did not changed over the twentieth century.<sup>22</sup>

The IV results show a positive and strongly significant first-stage relationship between the parents' years of education and the instruments (second panel of columns 2 and 3). These casual estimates turn out larger, around 20% in absolute value, than the OLS estimates which seem to suggest that traditional estimates not only under-estimate the true causal effect of parental education but, in the current setting, also underrate the long run pattern of educative mobility across generations. Contrary to OLS, the IV estimates clearly imply a canonical upward trend of educative mobility over the previous century as the persistence of family background from the parent-child link appear statistically smaller relative to that from grandfather-parent link: around 0.51 vs 0.71 for the younger and the older parental-child links respectively.<sup>23</sup>

Interestingly, the point estimates of intergenerational mobility from the two identification strategies are remarkably close and strongly significant. Although the Wooldridge's score test does not reject the null hypothesis of exogeneity at conventional significance levels for the proposed instrument, both estimates of intergenerational persistence are not statistically different from each other. Indeed their 95% confidence interval overlap almost fully. This is interpreted here as indirect evidence in favour of the relevance of the proposed instrument given that the grandparental education is already considered as a valid instrument of parental education (See Lindhal, et al (2015)). The analysis then will continue using the proposed instrument as it is reassuring that the 2SLS estimates are consistent. Finally, the F-statistic strongly rejects the null hypothesis that the instruments are weak.

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<sup>22</sup>Indeed, the average of schooling increased five-fold from the grandparental generation to the grandchildren generation.

<sup>23</sup>The point estimate in the intergenerational persistence of the grandfather-parent link, described in table 3, lies well above the 95% confidence interval of the parental-children link in table 5.

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

Dep. Variable: Grand-Children education (G2)	(1) OLS	(2) IV1	(3) IV2
<b>Reduced form</b>			
Parental education (G1)	0.422*** (0.031)	0.525*** (0.064)	0.509*** (0.061)
Observations	1,912	1,912	1,849
Adj. R-squared	0.233	0.224	0.238
<b>First stage</b>			
Grandfather education	-	0.437*** (0.038)	-
Minimum wage	-	-	0.115*** (0.007)
Adj. R-squared	-	0.347	0.421
F-stat	-	82.21	281.60
Robust score chi2(1)	-	3.39	1.22
p	-	(0.07)	(0.26)
Sex, G2	Yes	Yes	Yes
Birthyear, G2	Yes	Yes	Yes
State fixed eff., G2	Yes	Yes	Yes
Number of children, G1	Yes	Yes	Yes

Note: Robust standard errors in parentheses clustered by family. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. Education: Years of education (standardized). Restricted sample of grandparents in school age, or older, during *Cristero* war with grandchildren. Using both real minimum wage at adolescence and grand-parental education to instrument parental education. Each estimate represents the coefficient from a different regression.

## 6 The conditional effect of grandparental education on their grandchildren’s (G012)

This section refers to the theoretical model of Becker and Tomes (1979) and its predictions for the associations of outcomes across multiple generations. As described in section 2, this model predicts a small negative correlation coefficient for the grandparental education conditional on parental status. The empirical evidence from an emerging country may prove useful provided that the current evidence on multigenerational transmission of education stem mainly from countries in more advanced stages of development. Behrman and Taubman (1985) for instance found no empirical basis for this prediction based on survey data from the USA as the conditional OLS coefficient of grandparental education appears positive (around 0.007) but not statistically significant. They instrumented parental education with twins’ education and confirmed this result with a larger (around 0.04) but not statistically significant effect.<sup>24</sup>

More recently, Lindahl et al. (2014) used rich administrative records from four generations in the city of Malmö in Sweden. They instrumented the parental education with the education from previous generations (using the great-grandparental education). Their study documents a positive and statistically significant OLS estimate (0.08) and a positive but not statistically significant IV estimate of grandparental education on grandchildren’s education (around 0.05). Finally, with survey data Kroeger and Thompson (2016) examined the grandmother-granddaughter educative link in the USA and found a positive and strongly statistically significant OLS coefficient (around 0.09-0.12) however, no causal estimate was provided.<sup>25</sup>

With the two instruments at hand, the bivariate relationship described in Equation (2) is performed under multiequation approach as follows:

$$S_2 = \alpha_0 + \rho_1 \hat{S}_1 + \rho_2 \hat{S}_0 + \epsilon \quad (5)$$

where S is the educative outcome, and  $\hat{S}_\tau$  refer to the instrument for the first two generations,  $\tau = \{0, 1\}$ , described in sections 4 and 5 above.<sup>26</sup> The bivariate relationship in Eq. (5) is

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<sup>24</sup>They use the NAS-NRC sample composed by veterans born between 1917 and 1927 which appear very similar to the period examined here.

<sup>25</sup>Survey data from the National Longitudinal Survey of Youth (NLSY97).

<sup>26</sup>The estimation expression (5) with two independent instrumental variables was obtained by maximum likelihood seemingly unrelated regression described in Roodman (2011).

jointly estimated along with the first stage of parental and grandparental education described before. Once more, this specification includes the same set of exogenous covariates (gender, birth year, state fixed effects).

Table 6 shows both the OLS and IV estimates. Many interesting issues emerges from this table. Firstly, similarly to Lindahl et al. (2014) and Behrman and Taubman (1985), the OLS coefficient for the parental education is strongly significant, 0.40, whereas the grandparental estimate, 0.05, is only statistically significant at a 90 percent confidence. Interestingly the 95 percent confidence interval of the granfathers' estimate includes positive and negative values which does not allow rejecting the model's prediction. These standardized estimates are closer to those in Lindahl et al. whose (standardized) OLS estimates are 0.37 and 0.12 for parental and grandparental education respectively.<sup>27</sup>

Secondly, the point estimate of the instrumented coefficients suggest a stronger relationship than the one described by the OLS estimates. This time, the order of magnitude for the parental IV coefficient (0.44) is ten percent larger than the OLS estimate. However, the conditioned coefficient of grandparental schooling turned out not to be statistically significant. Once more the 95 percent confidence interval does not allow rejecting the models' prediction. These results bring about two important conclusions. Firstly, it is confirmed that accounting for endogeneity bias implies more persistence of parental origins (less mobility) than ignoring it. Secondly, that the effect of grandparental education, conditioned on parental education, become not statistically significant which implies less importance of indirect familiar background -than predicted by the OLS estimates.

All in all, results indicate that the influence of the grandparents' educative legacy do not remain further away from the first generation. No conditional effect can be inferred from grand-parental education on grandchildren education. Therefore, the persistence of some part of the current inequality in this emerging country can be traced back to the preceding generation only.

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<sup>27</sup>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 Mexico.

Table 6: **OLS and IV regression of children's education on parent's and grandfathers' education**

Dep. Var:	(1)	(2)
Grandchildren education (G2)	OLS	IV
<b>Reduced form</b>		
Parental education (G1)	0.400*** (0.035)	0.444*** (0.053)
Grandfather education (G0)	0.055* (0.030)	0.121 (0.166)
Observations	1912	1912
Adj. R-squared	0.237	0.222
<b>First stage, G1</b>		
Minimum wage	-	0.171*** (0.009)
Adj. R-squared	-	0.557
F-stat	-	62.39
<b>First stage, G0</b>		
CRT1	-	-1.402** (0.560)
Adj. R-squared	-	0.1292
F-stat	-	7.59

Note: Robust standard errors in parentheses clustered by family dynasty. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. Education: Years of education (standardized). Sample of grandparents in school age, or older, during *Cristero* war (with grandchildren). Controlling for sex (G1, G2), birthyear (G0, G1, G2), number of children (G0, G1) and state fixed effects. See tables 3 and 5 below for endogenous tests. Instrument for G1: Real minimum wage at adolescence by state. Instrument for G0: Regional exposition to *Cristero* conflict (CRT1). First stage include 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.

## 7 Conclusions

This paper examined the transmission of human capital across three generations in Mexico. A natural experimental set up from a regional war that occurred at the beginning of the twentieth century was exploited to instrument years of schooling of the “grand-father” generation whereas the minimum wage at adolescence served as instrument for the “parents” education. These are the two main identification strategies that enabled us estimating an AR(2) model without resorting to lagged variables from previous generations, like in Lindhal et al. 2014, nor to data from close relatives like in Behrman and Taubman (1985). Retrospective survey data and this unified framework provided empirical estimates on the evolution of education across multiple generations as well as the conditional effect of grandparental education on their grandchildren education.

Results provide long-run trends of the inequality transmission of human capital from a developing country that belongs to the region with the lowest levels of educative mobility worldwide. Findings with the two pairs of parent-children links at hand show that the causal estimates unveil a much larger importance of direct familiar background than what is obtained by traditional OLS estimates. This conclusion holds for any of the two contiguous pairs of parent-children links. The IV estimates also suggest a larger persistence of the family background in the older generations (the grandparent-parent link), than in the younger generations (the parent-child link) which implies an upward trend of educative mobility across generations. In other words, the most direct family background seems to play a lesser role in successive generations.

Many interesting issues also emerged when jointly instrumenting both parental and grandparental education to estimate its causal effect on the grandchildren education. The IV coefficient for parental education (0.44) confirms a stronger relationship than what is traditionally observed by OLS, whereas the grandfather estimate (0.12) on the grandchildren education turned out not to be statistically significant. The 95% confidence interval of this coefficient contains both positive and negative values which do not allow rejecting the well-known Becker and Tomes (1979) model’s prediction. These results suggest that a substantial part of the current inequality in Mexico can be traced back to the preceding generation only.

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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 (Art. 3).<sup>28</sup> 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* war, 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* war 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

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<sup>28</sup>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.

Catholic hierarchy.

## A.2 The effect of the conflict on the grandparents' generation, G0

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 war 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). 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.<sup>29</sup> 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 war.

The objective here 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.<sup>30</sup> Following Imbens & Wooldridge (2007) the empirical implementation is as follows:

$$S_0 = \alpha + \beta_1 \text{Cristero} * \text{Cohort} * \text{Rural} + \beta_2 \text{Cristero} + \beta_3 \text{Rural} + \beta_4 \text{Cohort} + \beta_5 \text{Cristero} * \text{Cohort} + \beta_6 \text{Cristero} * \text{Rural} + \beta_7 \text{Cristero} * \text{Rural} + \epsilon \quad (\text{A1})$$

where 'Cristero' is a dummy variable for individuals in Cristero region (comprised by a set of states engaged in conflict as described above), 'rural' is a dummy for individuals living

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<sup>29</sup>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.

<sup>30</sup>Under a similar objective and following a triple difference approach Singh and Shmyyakina (2016) found a substantial and statistically significant negative effect of localized insurgencies on children's educational attainment.

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 1 shows descriptive statistics for these groups and variables. The outcome variable is grandparents’ education, S0.

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

Variable	Obs	Mean	Std. Dev.
<b>Grandfathers</b>			
Dummy cristero region (C)	786	0.240	0.428
Dummy rural area (R)	786	0.822	0.383
Dummy affected cohort (T)	786	0.762	0.426
Cristero*cohort (CT)	786	0.170	0.376
Rural*cohort (RT)	786	0.622	0.485
Crister*rural (CR)	786	0.218	0.413
Cristero*rural*cohort (CRT)	786	0.154	0.361
<b>Grandmothers</b>			
Dummy cristero region (C)	616	0.247	0.431
Dummy rural area (R)	616	0.812	0.391
Dummy affected cohort (T)	616	0.810	0.393
Cristero*cohort (CT)	616	0.130	0.336
Rural*cohort (RT)	616	0.472	0.500
Crister*rural (CR)	616	0.216	0.412
Cristero*rural*cohort (CRT)	616	0.175	0.381

Sources: Cristero fighters from Meyer (1973c) and Meyer (2014). Rural population from 1910 Census (INEGI). Rural population refers to areas outside the state capital.

Table 2 presents 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)	-1.172** (0.470)	0.00571 (0.210)
Dummy <i>Cristero</i> region (C)	-0.876*** (0.253)	-0.875*** (0.268)
Dummy rural area (R)	-0.512** (0.260)	-0.809*** (0.188)
Dummy affected cohort (T)	0.457 (0.291)	0.255* (0.138)
<i>Cristero</i> *cohort (CT)	0.767* (0.434)	-0.000305 (0.192)
Rural*cohort (RT)	-0.214 (0.302)	-0.0722 (0.122)
<i>Cristero</i> *rural (CR)	1.070*** (0.299)	0.817*** (0.291)
Observations	772	510
Adj. R-squared	0.082	0.092

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.<sup>31</sup> Table 3 reports the interacted term of interest (CRT) that confirms a negative effect on the grandfathers' years of schooling. These results control for age, ethnicity condition and includes state fixed effects. Estimates suggest no effect on fertility or in the future wealth 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. The identification strategy to assess the effect of grandparents' education on their offspring builds on these results.

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

Variables	Grand-Father (G0)			Grand-Mother (G0)		
	(1)	(2)	(3)	(1)	(2)	(3)
	Schooling	Children	Wealth	Schooling	Children	Wealth
<i>Cristero</i> *rural*cohort	-1.068** (0.470)	0.305 (1.976)	0.269 (1.978)	0.0055 (0.219)	-0.655 (0.908)	-0.009 (0.727)
Interaction & main Eff.	Yes	Yes	Yes	Yes	Yes	Yes
Birhtyear	Yes	Yes	Yes	Yes	Yes	Yes
Ethnicity	Yes	Yes	Yes	Yes	Yes	Yes
State fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	772	786	774	510	616	607
Adj. R-squared	0.091	0.044	0.150	0.116	0.068	0.154

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.

<sup>31</sup>Wealth holdings were computed by Principal Component Analysis, PCA, from the rich set of the assets reported by the survey respondent when he or she was at age 14. Wealth variable refers to rank decil.

## B The clergy as education provider

Table 4 **Schools managed by the government or by the clergy, by state, Mexico 1895**

No. of schools by type of management					No. of schools by type of management				
State	(A) Gov.	(B) Clergy	(C) Total	Clergy percent	State	(A) Gov.	(B) Clergy	(C) Total	Clergy percent
Ags.	46	31	77	40.3%	Puebla	1091	79	1170	6.8%
Campeche	80	6	86	7.0%	Qro.	158	47	205	22.9%
Coahuila	99	33	132	25.0%	S.L.P.	355	312	667	46.8%
Colima	45	24	69	34.8%	Sinaloa	335	14	349	4.0%
Chiapas	126	29	155	18.7%	Sonora	176	2	178	1.1%
Chih.	98	26	124	21.0%	Tabasco	130	36	166	21.7%
Durango	133	87	220	39.5%	Tamps.	193	37	230	16.1%
Gto.	274	344	618	55.7%	Tlaxcala	248	18	266	6.8%
Guerrero	382	19	401	4.7%	Veracruz	694	125	819	15.3%
Hidalgo	594	84	678	12.4%	Yucatán	342	10	352	2.8%
Jalisco	446	365	811	45.0%	Zac.	400	70	470	14.9%
Edomex	1031	89	1120	7.9%	D.F.	354	191	545	35.0%
Mich.	300	254	554	45.8%	BCN.	94	38	132	28.8%
Morelos	234	31	265	11.7%	BCS.	11	0	11	0.0%
N. León	316	88	404	21.8%	Nayarit	32	24	56	42.9%
Oaxaca	688	94	782	12.0%					

Source: *Cuadro sinóptico y estadístico de la República Mexicana* in Peñafiel (1900). Notes: Public schools includes three levels of government (federal, state, municipality). Federal administration only. The modern state of Quintana Roo was part of Yucatan state back in nineteenth century.