University of Sussex

Empirical Research on Labour and Education Economics

Diego De la Fuente Stevens

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for the degree of Doctor of Philosophy

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To my family.

Declaration:

I hereby declare that this thesis has not been and will not be, submitted in whole or in part to another University for the award of any other degree. I certify that the thesis I have presented for examination for the PhD degree of the University of Sussex is solely my own work other than where I have clearly indicated that it is the work of others (in which case the extent of any work carried out jointly by me and any other person is clearly identified in it.) The copyright of this thesis rests with the author. Quotation from it is permitted, provided that full acknowledgement is made. This thesis may not me reproduced without my prior written consent. I warrant that this authorization des not, to the best of my belief, infringe the rights of any other party.

Statement of Conjoint Work:

I confirm that the chapter "Economics of Minority Languages: Employment Returns and Transmission of Indigenous Languages" was jointly co-authored with Panu Pelkonen.

Diego De la Fuente Stevens
(Signature)

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Preface

This is an economic research oriented towards understanding a series of socioeconomic relationships that arise in the context of Mexico. The study consists of three empirical chapters, of equal weight, each covering a different relationship and making individual contributions to the literature on the matter and to our general understanding of the social and economic structures that make-up the country.

The chapters can be read in separate, as each focus on a distinct subject. In fact, there is a great degree of independence between chapters, each with its own topic and strand of literature, employing different methods and data, and deriving its own conclusions. In this respect, each chapter is a research on its own. At the same time, these same chapters can be read together and understood as a volume of work devoted towards measuring a series of complex socioeconomic relationships that exist in the country. All chapters spin at the intersection between labour, development, and demographic economics.

Two of the chapters are single authored, the other has been co-written with Panu Pelkonen. In all, the titles are informative of the general theme of the research and are presented in the following order: Chapter 1: "The Impact of Remittances on Crime Levels", Chapter 2: "Intergenerational Persistence of Education: Trends, Causality and Geography", and Chapter 3: "Economics of Minority Groups: Employment and Transmission of Indigenous Languages".

*

Mexico is a large middle-income country that offers an interesting setting of study. With over 126 million inhabitants (2020) distributed along 1.97 million squared kilometres, it is also a setting with features that are important beyond its geography.

This is shown in multiple instances throughout the research: from the large flows of international remittances, to the presence of a significant number of native populations, or by the challenges the country has faced at providing educational opportunities for its large population. All topics studied in this research.

Many of the traits that characterise the country are shared, in some form, by many other countries, and Mexico offers an important case study to understand

them. In this respect, there is an expectation that the results identified in this research resonate to other contexts, at the time that they help bridge gaps in our general understanding of the relationships studied. As an empirical work, it ultimately seeks to provide a representation of some of the ways and degrees in which society and the economy are intertwined.

To another extent, there is also the expectation that some of this research can communicate with disciplines beyond economics. The frameworks used to analyse the data follow an economic formulation, but all chapters have a multidisciplinary component intrinsic to the topics studied. As this introduction proceeds, it describes some of the features that are most relevant of each chapter.

**

The first chapter of this research turns around the relationship between remittances and crime. This is a complex relationship. On the one hand, the idea that income from remittances can have an effect of crime levels is motivated by the notion that there exist individuals at the margin of engaging in crime. For them, it is expected that changes in welfare outside crime has the capacity to tip participation. Identifying this effect is difficult because remittances may also depend on crime. Directly, as quantities sent have been found to respond to crime cycles, and indirectly, because crime influences the decision to migrate, the prior of remittances.

Because crime and remittances are interlaced, correlations or slope coefficients, say nothing about causal effects, which is what this research is about. In this chapter, causal elasticity parameters are estimated using a singular feature of remittances, which is that these are direct income transfers from abroad. Therefore, its value depends on the exchange rate.

This is used in a decomposition of remittances that estimates the currency-driven component of its remittance value growth. The currency income shocks vary over time and space, as the data consists of a municipality level panel. Then, these income shocks are instrumented with a synthetic variable that simulates the nature of the currency movements.

The topics of remittances and crime, in the context studied, carry international preponderance. Remittances constitute a primary source of income to millions of families in Mexico, making them the world's third largest remittance flows.[1]

[1]Behind India's and China's, where aggregate flows are roughly double; but with a popula-

On crime, the setting also has particular dynamics. Over the past fifteen years, the country has been involved in process in which organised groups and the government have fought in violent ways to control key territories. Violence has been exercised at an unprecedented scale and over the period of analysis (January 2013 – December 2019) around a sixth of a million homicides have been perpetuated. This is over 60 daily violent deaths on average, and with evidence that three quarters of them are related to drug trafficking activities, organised groups must rely heavily on recruitment to maintain their operations. This is a tragic loss of life with costs that are difficult to quantify.

This is also different to most settings that study economics of crime, which focus primarily in property theft, a crime that is motivated directly by the value of the transferable good stolen. In this setting, many violent crimes are economically motivated as a by-product of the decision to engage in these criminal organisations. In connection to the discussion of existing literature, the research studies property crime as well, and provides income to crime elasticities for these. The results indicate that income transfers have a crime dissuading on homicides, car theft, home burglary and passer-by theft.

***

The second chapter, also single authored, focuses on studying intergenerational dynamics around education. The focus is on children aged 13-19, so most of them continue to live in their primary households. Specifically, this chapter looks at parent-child co-residing pairs captured in census data. This data is used to measure the strength of relationships between parental education and distinct outcomes of their children. The time span of this research is on pairs born between 1906 and 2007, bringing a historical perspective to the study of intergenerational mobility.

The study looks at intergenerational associations in various ways, providing a comprehensive view of intergenerational mobility in education in the country. The general focus is around three points: (1) long term trends, (2) geographical variation, and (3) causal effects.

The first two points are enabled because of the data. This is the microdata from the census, where the first sweep used was carried out in 1970, and the last one in 2020. In addition to the time horizon that these bring, these contain millions of

tion ten times larger. In this other sense, the Philippines (106 million inhabitants), the fourth largest receiver, is closer to Mexico.

parent-child observations, which allow for granular geographical estimates. This brings the possibility to study patterns that emerge between mobility and socioeconomic factors. Lastly, causal effects are disentangled using a policy reform that affected parental education as an exogenous source of parental education changes.

On intergenerational mobility parameters, one interest is on measuring the extent to which parental education is a predictor of children education and on the likelihood they work. Declining long-term trends are rendered. As with the previews chapter, correlations between parental and children outcomes are not necessarily causal. The idea is that the correlation that exists between parent and children variables (such as years of schooling), could be driven by many factors, like the economic position of the household. Therefore, it is not obvious ex-ante whether parental education has direct effects on the outcomes of children, or whether secondary relationships are driving the correlation.

Causal effects are identified with the focus of answering this question. To do so, the study narrows on the likelihood that children are enrolled to school and that they work, at the ages 13-15. The empirical strategy relies on exploiting a policy reform that increased mandatory minimum school leaving age and came into effect in 1993, increasing minimum school for those born after 1981. Then, the strategy measures the effect of parental schooling on children outcomes, for those parents that complied with the reform but would have left school before the age of 15 had the reform not taken place. This estimate shows that education has intergenerational spillovers on children outcomes. Ultimately, this is indicative of the strong ripple effects that education press in individuals and society.

****

The third chapter is the co-authored work with Panu Pelkonen. This is a research that studies indigenous groups, their employment and whether this is in connection to the survival of these cultures, measured here from the languages they speak. In the world, there are around two thousand minority languages, most are small and disappearing fast, and Mexico holds a good collection of them (66), with varying number of speakers, many holding several hundred thousand of them.

We first investigate whether there are economic benefits linked to the knowledge of these minority groups. The data comes from the census and allows to identify individuals by ethnicity and the language that they speak, bringing the possibility to use a detailed matching technique to estimate the employment and earnings

differentials between Indigenous who are able to speak the minority language (and Spanish), as opposed to Spanish only. This shows that for Indigenous men, learning to speak the Indigenous language comes with an increased likelihood of being employed and an expected increase in earnings. We then show that this is linked to their transmission, and ultimately their chances of survival.

In doing so, the research shows that the continuity of minority languages across generations is linked to concrete economic costs and benefits. Moreover, we also show that minority languages are able to survive in the absence of adequate support because of the high concentration of speakers located in tight geographical areas. This is consequential since and implies that languages are minoritarian from a national perspective, but dominant from the view of the local area in which the languages are natively spoken. This research contributes to the literature of minority groups, identity formation, skills and employment.

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Chapter 1

The Impact of Remittances on Crime Levels

Diego De la Fuente Stevens

Abstract

This research estimates the causal effects of remittances on the levels of four types of crime in Mexico. The empirical approach builds from the fact that the value of remittances is a function of the exchange rate. This allows for a decomposition of remittances that captures income attributable to currency fluctuations, which is then instrumented with a synthetic variable that mimics currency movements. The identification strategy recovers elasticity parameters for homicides and three types of property crimes, indicating that remittance transfers have a mostly crime reducing effect. The effects are particularly strong for violent crimes, including violent thefts, and in municipalities with high marginal remittance value.

Keywords: *Crime, Remittances, Income transfers, Exchange rates.*

1.1 Introduction

Research has shown that socioeconomic factors help explain crime participation. One line of study has found that environments with higher incomes and lower inequality reduce the likelihood that an individual is involved in criminal activities. Does this mean that income transfers can alter the incentives to engage in crime?

This research studies this question by focusing on remittances to Mexico. These are direct income transfers that result from migration, and are a major source of income to millions of people in Mexico and many other countries. Roughly 1 in 10 Mexican-born live abroad, most in the United States, making up the largest migration corridor in the world. With 13.58 million people in 2017, it was 3.5 times larger than the India-Bangladesh corridor -the second largest.[1] As a result of this migration, remittance flows to Mexico are significant and over the seven years covered in this study (2013-2019), these totalled 197.38bn US dollars. On the aggregate, only smaller than that of India and China, but larger when accounting for population size.[2]

From a relative angle, in 2017, remittances were 4.7 times the total government budget destined to health, 6.9 times the size of *Prospera*, the largest cash transfer programme of the country[3], and over twice the federal budget allocated to education, the biggest government spending bracket. In the same year, remittances were a bigger source of foreign direct income to Mexico than tourism and oil exports (being the 6th largest tourism destination and the 15th largest oil exporter), standing only behind car exports.[4]

As expected, research has shown that remittance transfers have welfare improving effects on different dimensions; from poverty and inequality to schooling and child labour.[5] Yet, little do we know about the potential effects that remittances can have in shaping crime participation.

This relationship can be motivated from the logic of the Beckerian framework

[1] Migration corridor decomposition: 12,683,066 from Mexico to US; 899,311 from US to Mexico. Net migration flows are stable around zero since before the period of study. A historical perspective of this migration in Hanson and McIntosh 2010.

[2] 2019 WB values: India 82.2 billion, China 70.3 bn, Mexico 38.8bn, Philippines 35.1 bn.

[3] A conditional cash transfer programme named Progresa (1997 - 2002) then Oportunidades (2002 - 2014) and later Prospera (2014 - current).

[4] Facts on tourism measured by number of arrivals, from UNWTO, Tourism Highlights 2017; fact on oil exports from CIA World Factbook.

[5] See Adams and Page 2005 and Acosta, Calderon and Fejnzylber 2008.

of crime participation (Becker 1968), in which engagement to crime responds to incentives, and then on the opportunity cost of working in crime. The question then becomes whether remittances shape incentives.

In one formulation of the model, this is expected to occur through two channels: a pure labour effect that is derived from the welfare improving capacity of remittances, and, for property crimes, also from a price substitution mechanism that results from direct effects of remittances on the returns to crime. Then, if remittances exert behavioural responses in criminal participation, these should be reflected in the levels of crime.

There is one research that looks at an angle of remittances and crime and that focus precisely on Mexico. Brito, Corbacho and Osorio 2014, study an extensive margin of remittances, and find a crime-reducing effect of remittances on homicides and street robbery (and no effect on burglary, car theft or extortions). Their measure of interest is the *share* of the remittance receiving population. To estimate causal effects, they use a distance-to-rail measure as instrumental variable to the remittance receiving population of 2010. This research makes a good effort to control for local characteristics, but one potential concern of this instrument is that it could be associated with crime. For example, if the rail is connected to crime through the local development effects of this infrastructure. This would bias the estimates because the study relies on a cross section data so local fixed effects cannot be included in the model. [6] [7]

The present research builds upon this and renders causal effects of remittance flows on crime levels. The remittance variable in this research comes from joining the quarterly flows of remittances with estimates of remittance receivers within municipalities, so it is effectively an intensive margin measure. The endogeneity problem is addressed by exploiting changes in the exchange rate. First, in a decomposition of remittance growth, then in the design of a variable that serves as

[6] For example, if railroad penetration is linked to urbanisation, trafficking routes, or other local dynamics, the railroad is associated to crime beyond remittances. The authors also use a panel of aggregate flows for states (32 states). This variable is closer to one used in this research but with differing geographical granularity (32 states vs. 2,456 municipalities).

[7] In another working paper, also using cross section data, Mahesh 2020 focus on India and use rainfall as instrument for remittances. The author finds a decreasing effect on violent crime and an inducing effect on non-violent crimes. In the study, it is not clear how rainfall meets the exclusion restriction, as rainfall is expected to affect remittances because of the initial effect of rainfall on incomes (through agriculture). The paper even argues that remittances respond to rainfall only because incomes are affected by rainfall, so "as an insurance" or "to compensate the fall of income". It is as if satisfying the relevance condition is what causes the violation of the exclusion restriction since the primal hypothesis is that socioeconomics shape crime participation. Unobserved heterogeneities are accounted for at a state level.

instrument.

A feature of remittances is that their *value* is subject to exchange rate fluctuations. These are sent in the host country currency, but used in domestic currency. Therefore, a depreciation of the exchange rate has a positive income effect on the remittance receiver (and the other way around). The empirical methodology builds from this, starting with the use of a decomposition of remittance growth that recovers changes in remittance value attributable to currency movements, each period (28 quarters), in each municipality (2,456 municipalities). This decomposition shows that currency fluctuations bring substantial income variation to households, with estimates indicating that these contributed with 37% of the aggregate growth in remittance value over the period covered.

Insofar the exchange rate pricing is exogenous to crime and remittances, so is the currency-driven changes in remittance value. This implies that even if remittances are intrinsically endogenous, the nature of the currency shock is not. With this, the model is first estimated with OLS, using the currency income as independent variable and crime levels as dependent variable.

The results show a negative relationship between the currency-driven income and all the crimes studied. The panel data enables for a municipality-level fixed effect estimation, which removes concerns of omitted variables driving the estimates. Nonetheless, the currency component identified by the decomposition depends also on a lagged remittance *level*, which could be endogenous.

The currency shock variable is instrumented with a synthetic variable that mirrors the nature of the quarterly movements in the exchange rate. The preferred estimates indicate that a 1% increase in remittance income leads to a reducing effect of 0.24% in the rate of homicides and violent car thefts, of 0.02-0.15% in passerby-thefts (depending on whether they were carried out with violence) and 0.03% in home burglary.

The results of this research show that remittances influence crime levels differently, and that larger effects are present in the lower end of the distribution of municipalities, when ordered by average remittance income. Sub-sample analysis also shows that remittance income may be capable of inducing some forms of crime, particularly property theft, and more so in their non-violent form. This is consistent with the idea of a pure labour effect driven by changes in welfare

outside crime as a baseline effect[8], with secondary price mechanisms for property theft. For these crimes, with potentially multiple channels, the identified parameters are interpreted as average causal effects, as the estimates capture all spillovers within municipalities.

The research proceeds as follows. In the next section, Section 2, the context and data of remittance and crime is described. Then, Section 3 elaborates on the empirical strategies, Section 4 presents the main results, and Section 5 provides concluding remarks.

1.2 Remittances and Crime

Mexico is geographically divided in 32 states and 2,456 municipalities. For these municipalities, this research constructs a 28-period panel dataset that puts together information from different sources. The period of study goes from January 2013 to December 2019 and is chosen to use a change in law requiring financial institutions to improve the granularity of their remittance reporting, now at a municipality level (rather than at a state level), to *Banco de México*, the central bank. The increase in the geographical identifier (by a factor of 76) is central to tighten controls that account for unobserved local heterogeneities, which is important for a country as large and diverse as Mexico.[9]

Data about crime comes from the *Secretariado Ejecutivo*, a branch dependent to the Ministry of Interior. In this data, crimes are classified across 10 types and 66 subtypes. Total crime occurrences are bunched in a given municipality, according to where the crime happened, and when the location of the actual crime is unknown, to where the crime is being investigated. This research focuses on four different crimes: homicides, car theft, home burglary and passerby theft. When the analysis is on property theft, broadly speaking, violent and non-violent modalities are studied separately.

In the raw data, homicides are classified in two categories depending on whether

[8]With violent crimes, remittances are expected to exert a mostly labour effect through the recruitment capabilities of organised criminal groups.

[9] Mexico is the 13^{th} largest territory with 1.96 million sq km. It is bounded by a 3,145 km border with the United States, 1,234 km with Guatemala and Belize and 9,330 km of coastline. It holds the 10^{th} world's largest population (126 million) and has dozens of distinct cultural groups, varied geography and development stages. In a robustness specification, potentially divergent local dynamics are controlled for with state specific time controls.

they were carried out with intention or by accident. Only the first are contemplated in this study, for this research rationalises homicides as the by-product of an economically motivated activity. As for the rest of crimes, *burglary* is understood as thefts committed while entering a building (or part of a building) as a trespasser; $thefts$ are classified between car thefts and thefts to people on foot while at a public space, the later referred to as *passerby* thefts.

It is a well known fact that crime is generally under-reported. Nonetheless, there is no reason to suspect reporting rates have changed over the period, so it is thought that this data provides an accurate picture of the growth in crime rates. Moreover, in addition to the saliency of homicide and car thefts (each year of 2013-2019 registered over 150 thousand car thefts), by their nature, these are relatively well measured types of crimes, and hence are useful benchmarks throughout this research.

1.2.1 Crime

From the causal direction of interest, remittances and crime are linked in the same way in which the decision to engage in criminal activities is associated with income. One approach to look at this relationship is through the lens of a rational decision maker who participates in crime if the expected benefits of doing so outweigh the opportunity cost of engaging in other activities. This notion can be formulated with an individual that participates in crime whenever $U(Y^{Crime}, X) - \pi S \succ U(Y^{Legal}, X)$. Where U denotes a utility that depends positively on income, and thus on the returns of the activity engaged in, denoted as $Y^{type=\{Crime,Legal\}}$.[10] The fact that crime is a risky activity is captured with parameter π, which stands for the probability associated with a potential costs of punishment associated with the crime, which are captured in S. Flexibility is given through X, which acts as a vector of all other relevant factors to the criminal engagement decision.

Then, the argument is on the existence of individuals at the margin of crime participation. This characterisation points that for an individual to participate in crime it has be that $Y^{Crime} \succ Y^{Legal}$ (insofar π and S are non-zero). This implies that for someone at the margin of participation. At the margin, expected criminal income must exceed non-criminal income to compensate for the poten-

[10] This simplifying assumption, on there being only to occupation tracks, is not central to any of the conclusions of the model discussed.

tial costs associated with criminal involvement (πS) to induce participation.[11]

Then, from concavity and additivity of income in the utility function, for someone at the margin, an increase in income, Y, should dissuade individuals from engaging in crime: $\frac{\partial U(Y^{crime},X)}{\partial Y} \prec \frac{\partial U(Y^{legal},X)}{\partial Y}$. This is the baseline effect expected from remittances, and occurs through mechanisms which have parallels with the channels exerted by wage subsidy policies (Xala i-Martin 1997), where a rise in income exerts a positive effect towards legitimate activities but also a negative effect on overall labour supply. Direct evidence, of a relationship between remittances and labour supply, is provided by Alcaraz, Chiquiar and Salcedo 2012, who study education and child labour in Mexico to show that remittances reduce labour participation by 12.3% in rural areas.[12]

It could be argued that because many crimes in Mexico are drug-related, that the individual-level Becker-type model of acquisitive crime used to explain criminal participation may be weakened by the role of peer group pressure in affected communities. The argument suggests that individuals may lose the possibility to bargain out of crime. While this has been documented to happen[13], this research focus is on individuals at the margin, which the logic of the Beckerian model of crime helps to understand as a rational choice. Insofar welfare outside crime is related to occupational choice and remittances affect welfare, these transfers are expected to have crime participation effects.[14]

Studying the relationship between transfers and crime has been difficult since few settings show enough income-transfer volume to expect spillovers on crime, and variation to identify them. Another challenge is that income transfers are most often endogenous. One line of research suggests that one cause of reverse causality is through the effects of crime on local (economic and non-economic)

[11] In the marginality condition: $U(Y^{Crime}, X) - \pi S = U(Y^{Legal}, X)$

[12] In rural areas. They also find an educational increasing effect of remittances. As remittances increase schooling, they could be consequential for crime from a long-term perspective. First, by increasing earnings and job prospects in the legal swaths of the economy; then, from the dynamic incapacitation effects of higher schooling. This later notion points that schooling reduces exposure to crime during a key period of life and thus prevents crime by protecting individuals from environments that would lead to criminal tracks later in life (Machin, Marie and Viujic 2011; Bell, Costa, Machin 2016, 2018). As the recovered estimates of this research capture the contemporaneous effect of remittance transfers, these type of long-term effects are not expected.

[13] Inter American Comission of Human Rights, Violence, Children and Organised Crime. 2016. ISBN 978-0-8270-6532-1

[14] If there are no individuals at the margin of participation, on welfare outside crime is not expected to shape criminal incentives, no effects should be detected in the estimations of this research.

conditions, which are central to the decision to migrate (Borjas 1994). Only in the economic direction, evidence for Mexico points that drug-related homicides have negative effects on economic growth (Enamorado, López, and Rodríguez 2014), unemployment (Coronado and Saucedo 2019), and property prices (Ajzenman, Galiani and Seira 2015)[15].

Another strand of literature focuses on contemporaneous responses of remittance senders to crime levels in the remittance receiving localities. In Meseguer, Ley and Ibarra 2017, the authors look at transfer sizes and show that when crime rises, remittance size falls -for those who are already remittance receivers. Studying Colombia, Vargas 2009 finds similar results. Both point that rises in crime deters remittance flows because of concerns about the safety of the money transfer and the investments to be carried out.

Addressing for the endogeneity of income has been a main focus in the literature and has taken various approaches. One approach narrows on policy changes. One research, by Chioda, De Mello and Soarez 2016, uses an expansion of a conditional cash transfer programme in Brazil and identify income reducing effects on crime. In another, studying the United Kingdom, d'Este and Harvey 2020 use a reform on universal credit, that increased the stringency of the conditions attached to the programme, and find strong evidence that this had property crime inducing effects. In a different context, Watson, Guettabi, and Reimer 2020 study universal income transfers from the Alaskan Permanent Fund Dividend and find income reducing effects on property crime. Another strand uses historical data, such as Halvor, Miguel and Torvik 2006[16] and Bignon, Caroli and Galbiati 2017, who study Bavaria and France respectively. Looking at shocks derived from agriculture, they also find evidence that crime is responsive to income shocks.

Related to this research, although their focus is on conflict, is a study by Dube and Vargas 2013, which looks at commodity-price induced income shocks in Colombia. Their research finds that *lower* coffee prices have a crime-inducing effect but so does *higher* oil prices. This dichotomy arises from the nature of commodities. For coffee, higher prices induce a strong labour effect because it is a labour-intensive crop. However, as the oil industry is capital-intensive, higher prices have its largest effect by increasing contestable resources in society, some

[15] Find that low income housing bears the majority of the pricing cost caused by drug-related homicides. Their analysis suggests that an increase in homicides of a magnitude of 1 standard deviation leads to a 3 percent fall in low-income housing prices.

[16] And later Traxler and Burhop 2010, who study the same setting and discuss effects found in violent crime.

of which is appropriated with violence. They call this a 'rapacity-effect', and is in connection to Borraz and Munyo 2020, who suggest that cash transfers in Uruguay improve the loot for crime and may induce it.

Literature showing that crime responds to prices and types of goods is varied and has been establishing rapidly. In one example, Galiani, Jaitman, and Weinschelbaum 2016 focus on durability as a trait of goods, and argue that if the life of a good determines its present value, it must also be related to its worth as a good that can be stolen. In another, the focus is on prices and causal effects, where using commodity prices as instrument for local prices, Draca, Koutmeridis and Machin 2019 find positive price elasticities; and so does Kirchmaier, Machin, Sandi and Witt 2020, who also look at metal prices in the UK. Among other things, this literature brings evidence showing that participation in crime is a function of the expected returns to the crime, which depend on traits such as the value, availability or even transferability (d'Este 2020) of existing goods in society.

In this sense, insofar the expected return of a crime is a function of income and then remittances, a crime inducing effect is expected to exist. When incomes vary across societies, so does the consumption of goods and assets, and thus the bundle of goods that can be stolen for profit. Thus, one can characterise potential criminal income to be a function of social wealth. This raises questions as to whether remittances have the potential to create channels that increase incentives to crime participation.

Most of the income from remittances to Mexico is used for consumption expenditures, often of durable goods. One survey shows that 73.7% of remittances to Mexico are spent in general consumption, 7.9% in vehicles and home improvements and most of the remaining in debt consolidation (15.5%)[17]. Another survey indicates that 20.9 to 23.2% of remittance recipients use remittance income 'primarily' to purchase a car.[18] Then, to the extent to which available goods in society depend on remittances, remittances can create opportunities for crime.

An extension of the baseline formulation of crime participation can articulate this channel. In particular, the view is that criminal income (Y^{Crime}) is a function of social wealth directly. Let $Y^{Crime} = F(Y_1, Y_2, ...Y_i)$, where individual incomes, Y_i, depend on remittance transfers, among other sources, as in $Y_i = Y_i^{transfer} + Y_i^{other}$,

[17] From Brito, Corbacho and Osorio 2014.

[18] Estimates from *Anuario de migración y remesas México*, 2017, BBVAA. Estimates do not quantify the actual amount spent on these.

so that rising transfers induce a positive price effect $\frac{\partial U(Y^{Crime},X)}{\partial Y^{transfer}} \succ 0$.

This is in tone to the rapacity effect found in Colombia, Uruguay and India (Mahesh 2020), and is a counteracting mechanism to the reducing effect derived from the welfare improving capacity of remittances.

The formulation of the Beckerian problem is flexible and allows to incorporate and understand distinct mechanisms through which international remittances may affect criminal activity. In the baseline framework, there is the pure welfare effect that is expected to exist in all the types of crime studied. This is the effect that results from a material improvement outside crime associated with remittances. The logic is that if crime comes with potential costs, improvements in welfare outside crime increase the opportunity cost of participation.

This labour substitution effect is crime reducing in nature because it enhances wellbeing outside crime. Additional narratives support the existence of secondary mechanisms for property crime. First, there is a price effect that results from the use of remittances in the acquisition of goods, which may happen to have the property of being transferable. This consideration suggests that an increase in incomes creates a better pool of stealable goods that may foster crime participation. This has echoes with a wide literature that has studied prices and the returns to property theft.

An additional effect is the expectation that remittances have distributional effects on income. The discussion of income dispersion has been looked at in the literature since at least since (Ehrlich 1973), where a rational agent model with heterogeneous agents is used to conclude that incentives for crime participation depend on the location of individuals in the distribution of earnings; an idea empirically explored by Enamorado, López-Calva and Rodríguez 2016 in Mexico, among others such as Demombynes and Özler 2005 in South Africa and Brush 2007 in the United States, who all find positive relationships between inequality and crime.

One empirical question that follows regards to the effect that remittances have on the distribution of incomes. The hypothesis is that, for their magnitude, remittances could have important income distribution consequences and that these change the incentives of crime participation. Following the logic of (Ehrlich 1973), if remittances reduce vertical inequality, a crime reducing mechanism could be expected and viceversa. With multiplicity of mechanisms, the expected effect of

remittances is ambiguous *ex-ante*, and the estimate captures the average effect.

In the settings where research has placed most of its focus, violent types crimes are rarely studied, since these are difficult to motivate from an economic logic (Draca and Machin 2015). In the Mexican setting, violent crimes, are largely driven by a confrontation between organised criminal groups, which relies on recruiting of individuals, a dynamic that provides an economic logic to many violent crimes.

Violent Crimes and the Mexican Context

Violent crimes became an increasing problem in Mexico as a result of a policy shift in how drug trafficking activities were dealt with. From January 2007 onwards, the government took a confrontational stance that disrupted existing organised trafficking equilibriums, with high violence both as means and consequence. Evidence on the violent consequences of disrupting trafficking routes is brought by Dell 2015, who shows how forced diversions of drug trafficking lines significantly increases violence along alternative routes. Only over the 7 years of study, 155,094 homicides were recorded (60.6 daily average), and estimates indicate that 74% are related to drug trafficking activities.[19] [20]

The largest proportion of homicides are not the immediate object of the crime, but a by-product of some other illicit activity. This is different to property crimes, but also to settings in which violent crimes are largely committed by acquaintances.[21] Given the high rates of homicides that arise from this confrontational dynamic, recruitment is at the core of criminal groups' opportunities for survival. Reports show that these recruits are mostly young individuals, often including young adolescents and even children.[22] [23]

[19] Estimates of proportion of homicides in Meseguer et. al. 2018. Number for total homicides is 146,655 when accounting only at the municipalities used in the regressions. Excluded municipalities based mostly in the state of Oaxaca, because of no matching with remittance data.

[20] From January 2007 to December 2019, an average of 54 daily homicides occurred, adding a total of 258,631, a 66.6% increase to the ten year average of the decade preceding the policy change. See right hand side of Figure 1.7, in the Appendix.

[21] For example, the UK National of Office Statistics estimates that 76.4% of all UK male homicides perpetuated where there is a suspect were committed by acquaintances, 35.4% by friends -different to their partner-. For females, 38% of homicides were committed just by their partner or ex partner.

[22] Inter American Comission of Human Rights, Violence, Children and Organised Crime. 2016. ISBN 978-0-8270-6532-1

[23] "Crime organizations are recruiting children as young as nine to act as lookouts and informants and to transport drugs. At 12, they are used to guard safe houses and at 16, they are forced to carry out more violent, often armed, crimes such as extortion, kidnapping

It is as if homicides, and other violent crimes, are complementary to trafficking activities, bound by the illegality of the activity and the force required to perform it (Grogger 2000).[24] These violent crimes, which directly non-pecuniary, are then bound to the labour and economic opportunities in which recruiting takes place. This is why the decision to become part of a criminal paying organisation, with violent crime as an activity but also a potential associated cost, connects remittances and violent crimes.

Bringing relevant evidence, Dell, Feigenberg and Teshima 2018 study the effect of worsening labour-market conditions (using changes induced by international trade policy) on violent crime in Mexico. They show that the changes in employment conditions induced trafficking participation and then homicides.[25] In a connected research, Dix-Carneiro, Soares and Ulyssea 2018 study an episode of trade liberalization in 1990's Brazil and also show that trade competition may affect local labour markets and induce crime.

1.2.2 Remittances

A release from the central bank reports that remittances contributed with 23.8% of national output growth in 2016. In some regions the contribution was even larger. In the state of Michoacán, the highest remittance recipient state, remittance growth added 2.29% absolute points to GDP growth (of a total of 4.39%).[26] [27]

Own estimates indicate that in the average municipality, 8.1% of the population count on remittances as a source of income[28] and received a quarterly mean remittance of $1,086.8 US dollars per person.[29] This is little over a third of the

and murder[...] Girls are usually forced to package and transport drugs and sexual abuse is commonplace." Insight Crime: Mexico Criminal Groups Increase Child Recruitment Tactics, July 17, 2019:

[24] Grogger 2000 studies of major urban conglomerates in the United States and finds that drug related activities spill into other forms of crime.

[25] The authors use increased competition to Mexican producers from China over the United States export market for their identification strategy.

[26] Multiplier estimates from central bank report: household income (1.05), production (2.67) and value added (1.06).

[27] There is abundant evidence that shows significant economic effects of remittances: from household expenditure on education and health (Tuirán 2002), to small firm investment (Woodruff and Zenteno 2007), or agricultural productivity (Taylor and López-Feldman 2010).

[28] Standard deviation 7.4%.

[29] Because remittances have grown, in 2020, these were equivalent to a per capita value of 6.4 thousand US Dollars, annualised.

average income per capita in the country. Moreover, data from the census shows there were 6.19 million remittance recipients in 2020 (up from 5.89 million in 2015), and that in *all* municipalities a share of the population has remittances as a source of income.

All municipalities in the country receive remittances, but large variation at both the extensive and intensive margin is observed. One variable used in this research is the proportion of households that receive remittances in each municipality. Municipalities in the highest decile from this perspective, which are areas with high levels of remittance dependence, consist of municipalities in which more than 20% of the population has remittances as a source of income. This measure is better represented in Figure 1.1 and in distributional form in the right hand side plot of Figure 1.5, in the Appendix.

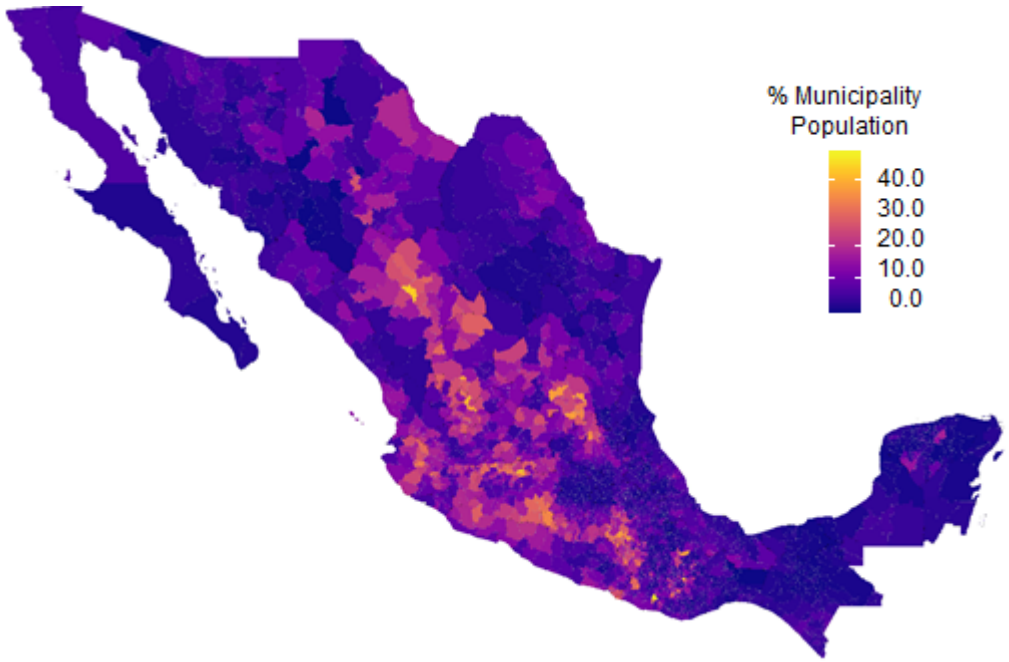


Figure 1.1: The Geography of Remittance Dependence: an Extensive Margin View (population share that receives remittances 2015).

According to the central bank over 97% of remittances are sent in the form of electronic transfers, with 'money orders' accounting for 0.6% of remittances, and cash and in-kind accounting for only 0.4% of them. As a result, measurement error in not a concern in this data.

To another extent, there is variation in the remittance size sent across municipalities. This is a different dimension in the way remittances vary. One depiction of this intensive margin is characterised by the average remittance, as portrayed

in Figure 1.2. This figure summarises the geographical distribution of the annual remittance, as if distributed along the whole population, in each municipality, in 2017. As this measure is relative to the entire population, it highlights the local economic significance of remittances by municipality.

A different characterisation of the intensive margin looks at the average remittance among remittance recipients only. This variable is closer to being an *effective* remittance per capita. A plot of the distribution of municipalities, by this other measure, is shown in the left hand side panel of Figure 1.5, in the Appendix.

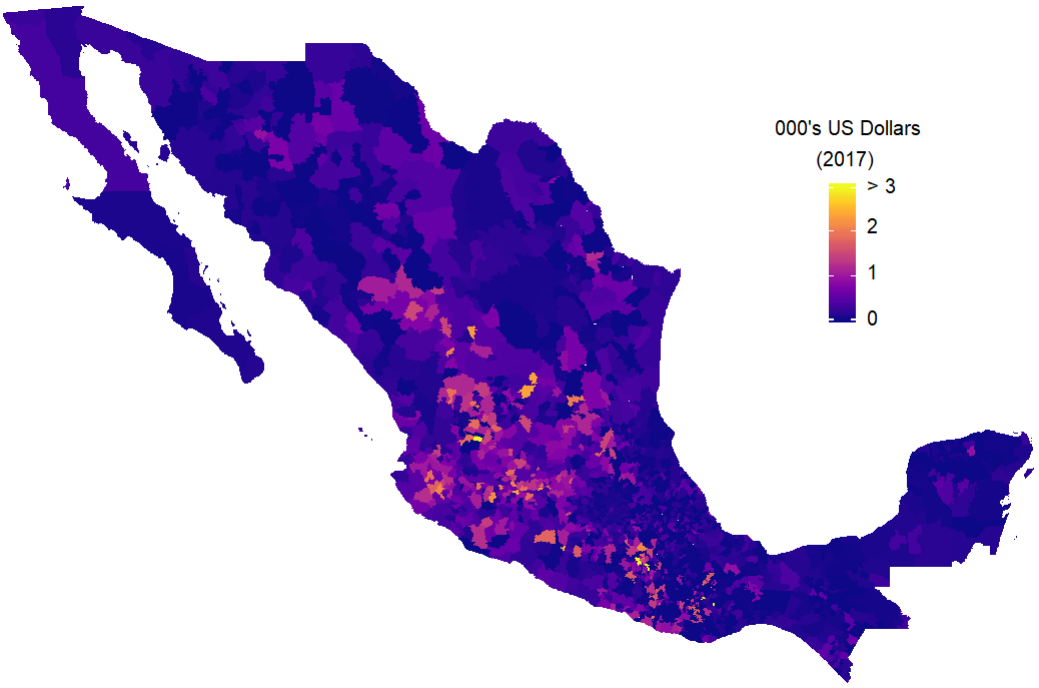


Figure 1.2: Intensive Margin: Remittance per capita: Municipality Level 2017

A supplementing table of the extensive and intensive margin is provided in Table 1.3, where municipalities are partitioned by population size into six groups. This table shows that households living in more rural municipalities are much more likely to be remittance recipients but also more likely to receive smaller remittances.[30]

In addition to the relevance of remittances in the economic life of Mexico, these have grown over the period of study. The left of Figure 1.3 shows the national

[30] Specifically, municipalities in the smallest population-bracket are 3 times more likely to be remittance recipients than households coming from the two largest brackets. With remittance size, the average remittance of the smallest municipalities is a third compared to large population sets. This is consistent with the notion that migration is a function of the relative opportunities in the origin and host localities.

trend of remittance flows relative to levels of January 2013. This shows that there has been a very sharp increase in international remittances over the period of analysis, doubling in size when measured in US Dollars. The Figure overlaps remittance flows in domestic and foreign exchange, to show the currency effect, which is particularly visible from the 7^{th} quarter onwards. This currency effect is relevant to the empirical strategy.

The right hand of this Figure side provides actual remittance flows and shows that, despite the seasonal patterns (observable in the (US dollar) trend in the left panel), year-on-year variation is positive for all years. A further exploration of the data shows that this is explained by an increase in the number of transfers rather than by changes in the size of the actual transfer. According to the data, there were 5.6 million remittance transfers made in December of 2013, and up to 10.7 million in the same month of 2020. More research needs to be done to understand the extent to which the excess of remittance transactions is due to an increase in the frequency of remittance sending or an increase in the number of senders. Mexican census provides evidence in support of the first hypothesis, for the growth in remittances has not been matched with a proportionate growth in remittance receivers over the period of study.

One hypothesis is that one factor behind the increase in remittance transfers (and thus aggregate flows) is the improving performance of the labour market conditions in the United States, where most remittances stem from. Remittances and employment are both tied because remittances constitute a share of disposable income, and because improvement in the destination country incentivises migration flows. During the period of analysis, the US economy was immersed in a prolonged phase of economic expansion, with the unemployment rate going from 10% in October 2010 to 3.5% in February 2020.

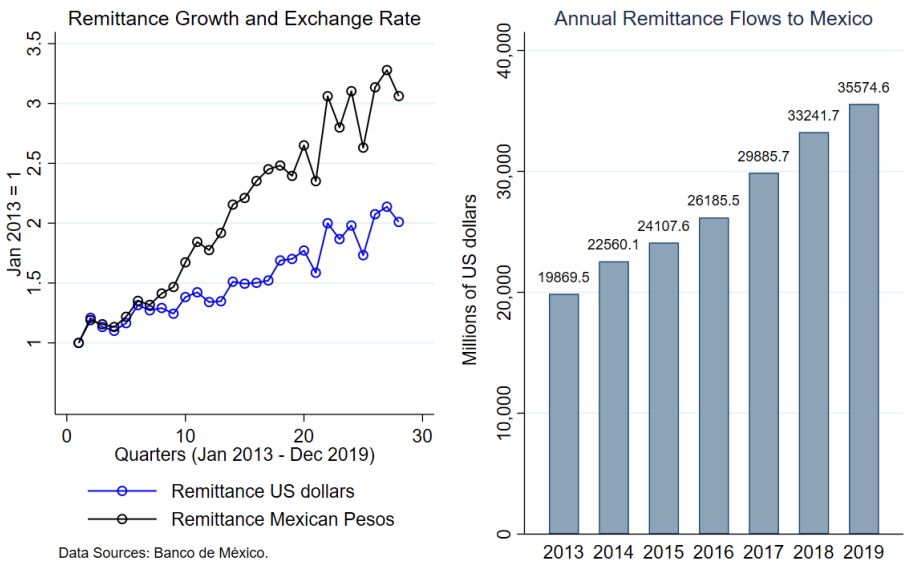


Figure 1.3: Aggregate Remittance Flow Trends and Currency Fluctuations

Internal remittances are not included in this study for various reasons. These income transfers carry differing considerations. First, these are likely to differ in the degree to which they are permanent or temporal in nature, these are also likely to differ in size, on who the remittance sender is, and the extent to which they are registered. The analysis of internal remittances faces challenges for the lack of accurate measurements and a clear categorisation that classifies internal remittances. Yet, these transfers are meaningful and expected to have a series of spillovers that deserve study. This research places its attention only on international remittances and controls for levels of internal remittances with the inclusion of municipality fixed effects and quarterly time controls. With this, it addresses for the time invariant level of internal remittances and potential trends.

1.3 Empirical Approach

The main empirical approach spins around a decomposition of remittance growth that recovers the exchange-rate driven growth, in combination with an instrumental variable model. The decomposition has echoes with the literature on productivity decomposition (Bartelsman, Haltiwanger & Scarpetta 2009), with a formulation adapted so that changes in prices are given by the currency changes.

Using this decomposition allows to obtain three different sources of remittance growth: one that depends on changes in the exchange rate (ΔER_t), another that depends on changes in remittance sending quantities ($\Delta R^F_{t,m}$) and a crossed-term, as in equation 1.1. In this equation, R denotes remittances and superscripts MX

and F stand for domestic and foreign currency values.

$$R_t^{MX} = R_{t-1}^{MX} + \overbrace{R_t^{MX} - R_{t-1}^{MX}}^{\Delta R_t^{MX}} \text{, where:}$$

$$\Delta R_t^{MX} = \overbrace{\sum_{m=1}^{n} R_{t-1,m}^{F} \Delta ER_t}^{\text{Currency}} + \overbrace{\sum_{m=1}^{n} \Delta R_{t,m}^{F} ER_{t-1}}^{\text{Quantity}} + \overbrace{\sum_{m=1}^{n} \Delta R_{t,m}^{F} \Delta ER_t}^{\text{Crossed}} \tag{1.1}$$

The focus of this decomposition is on the *Currency* component in equation 1.1 because we are interested in exploiting the direction of the currency shock, which depends on the nature of the currency fluctuation, which is treated as exogenous. The right of Figure 1.4 provides a visual representation of this component, by plotting the national value of the term at a quarterly periodicity. The sums of the term, over municipalities and across periods, show that 36.9% of remittance value growth -over the seven years of study- was driven by currency movements.[31] The left hand side panel plots the exchange rate of Mexican Pesos to US Dollars, showcasing strong currency swings. Notice that the two variables plotted are correlated by construction.[32]

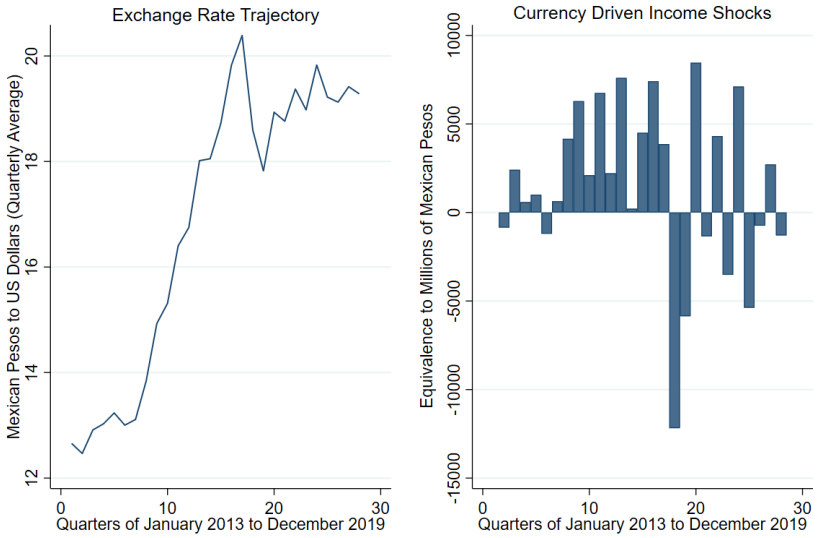


Figure 1.4: Exchange Rate Volatility and Currency Income Shocks.

The remittance variable, from which the currency income term comes, is constructed from joining the remittance flow data with the proportion of households

[31] Largest fraction stem from intensive margin changes (61.9%).

[32] It is worth noting that the Mexican Peso is one of the world's most traded currencies, so, despite the size of remittances, these are marginal to total financial trades of the currency. As such, remittances are unlikely to have any noticeable effect on the exchange rate.

receiving remittances. The proportion of the remittance receiving population is the extensive margin measure plotted in map in Figure 1.1. Then, the remittance variable captures the average remittance sent to each municipality among remittance recipients. Figure 1.5 presents the distributions of the main remittance variables (average remittance received and the proportion of remittance recipients within municipalities).

The effective average remittance lays the foundation from which the currency driven term comes from. This is the main explanatory variable, which is $R_{m,t}$ in equation 1.2. It corresponds to the product of exchange rate movements and lagged remittance values. The exchange rate change is key for it provides an exogenous variation on both the direction and size of the shock, but so is the lagged remittance value, which provides the weighting to the currency income shock. As this weighting depends on lagged values, it also addresses concerns of endogeneity from contemporaneous responses of crime to remittances.

The main empirical results come from a model that includes municipality fixed effects, so the overall levels of remittances are well controlled for, and we can be sure that the estimate is not driven by an eventual association between *levels* of remittances and crime.

The dependent variable, $C^{j}_{m,t}$, is the crime rate of type j, in municipality m, and at time t. The focus is split between property thefts and homicide crimes. Aggregate crime is averaged by municipality population, with a time varying population variable, so these are population-adjusted crime rates. Both the crime and remittance variables are transformed into logs so the parameter, ϕ, is an elasticity measure and there is one crime specific parameter, ϕ_j, to be estimated.

To contextualise the growth trajectory and dispersion of crime rates across the country, Figure 1.6 is provided in the Appendix. In the left hand side, the figure presents crime levels over time, relative to the first analysed quarter. This shows stable national crime rates, with the exception to homicides, where there is a reversal of a slight declining trend observed during the first 9, of the 28, quarters of study. The right hand side of this figure conveys the distribution of municipalities by crime rate, showing important variation in levels of criminality across geographical areas.[33]

[33] In 746 municipalities there were no violent car thefts over the whole period and 636 saw zero non-violent car thefts. One way to see this is through the distributions of Figure 1.6

Figure 1.7, also in the Appendix, presents crime trajectories for a longer than studied horizon (which is highlighted in the shaded area in the plot), placing in perspective the lapse studied. This shows, first, the effect of the policy change on the homicides rate (four years prior to the start of the period of analysis), motivating the focus of homicides as a by-product of organised-crime related conflict. Second, that the levels of homicide during the period of analysis fall within the 'normal' parameters of the post 2007 crime environment. Lastly, that trajectories across some crime levels follow similar paths, indicating a possible overlap of criminal activities. Summary statistics of the crimes studied are also presented in Table 1.2.[34]

From the panel structure of the data, it is possible to include municipality fixed effects to the model, and thus control for the general level of remittances, crime, and local conditions tightly. As such, the preferred specification of the model includes municipality fixed effects. Other specifications control in differing ways, with the inclusion of demographic, geographic and trend variables.[35] With fixed effects, there is confidence that the estimates are not driven by omitted variables, an empirical advancement compared to the existing research on remittances and crime. A specification that includes quarterly dummies for time trends render comparable estimates.

$$C^{j}_{m,t} = \phi_j \overbrace{R_{m,t}}^{(R^{F}_{t-1}, \Delta ER_t)} + \alpha_m + \delta t + \varepsilon^{j}_{m,t} \tag{1.2}$$

The currency term is naturally correlated with exchange rate fluctuations, for it is one of its components. Working from this, the empirical strategy designs a syn-

[34] The homicide rate per 100,000 people rose from 9.3 to 22.5 between 2007 and 2017. From a Latin American perspective, a region characterised with high rates of violence, the rate is not atypically high. Yet, as is visible in the distribution plots of Figure 1.7, the national rate hides significant geographical variation. For instance, in 19.9% of municipalities no homicides occurred over the whole period of study. Similarly, the homicide rate of the bottom third municipalities, when ordered by crime, is below the United States average (5.3 per 100,000) and for 85% of municipalities it is below the Brazilian national average (29.5). However, some municipalities hold high crime rates; for instance, two municipalities -Tijuana and Acapulco- contributed with 9.1% of accumulated homicides despite accounting for only 2% of the population. Other international homicide rate comparisons: El Salvador (60), South Africa (34.3), Brazil (29.7), Costa Rica (11.7), Uruguay (8.7), United States (5.3).

[35] Annual population estimates from *Conapo*, the *National Population Council*. This population data consist of government population forecasts made in 2010; the discrepancy between this population measure and actual population (census) is used to control for unexpected population flows. This variable is similar to that built by Rios 2014 as a measure of unexpected migration. Other data sources are the municipality-level Gini coefficient for inequality from *Coneval*, a government dependent institute that measures social policy in Mexico; geographic controls such as US-Border identifiers are included in specifications of the model.

thetic instrumental variable. This is done because the independent variable could be correlated with the error term if the exchange rate has immediate spillovers in other sectors of the economy that affect participation. On the other hand, the level variable is lagged, so channels of reverse causality would only be present if future crime prospects help inform current remittance senders. To address these two type of concerns, in a second step, the currency term is instrumented.

The constructed variable is a *binary* variable that codes positive (= 1) and negative income shocks. This is a mechanical indicator of the nature of the currency movement that loses information regarding the size of currency fluctuation. Even with the loss of information, the instrument is strongly correlated with the currency shock variable, as is observable in the test statistics of the first stage regression presented in Table 1.1. Insofar the magnitude of the shock is the cause of concerns of endogeneity, the binary variable is uncorrelated with the error term in the second stage. Under the assumption that the variable is uncorrelated with crime for reasons beyond its effect on the currency term of the decomposition, the estimates of this model capture the average causal effect of remittance income on crime.

The baseline results, includes municipality fixed effects and the are summarised in Table 1.1. These are estimates of the equation characterised in equation 1.2, where the model use the currency-driven income from remittances as independent variable. The focus is on homicide and three distinct types of property theft, in both violent and non violent forms. In the first set of estimates, the parameter corresponds to the OLS estimates. The second are the set of results from the model with the binary synthetic instrumental variable.

Results from the binary model indicate that a one percent increase in this remittance income leads to a 0.24% fall in the homicide rate. In specifications that account for other controls, such as regional spillovers of remittances, time effects or non-linear marginal effects, the estimates are fairly similar and range between 0.24-0.35%, as is shown in Table 1.4, in the Appendix. Estimates for the rest of the crimes read alike, as elasticities. Specifically, a one percentage point increase in this remittance income leads to a 0.24% fall in the rate of violent car theft, of 0.02-0.15% in passerby theft, depending on the mode of crime, and 0.03% in non-violent home burglaries. For all crimes with statistically significant results, the causal effect in the binary model is net negative.

Table 1.1: Regression Estimates of Currency Income Shock on Crime (all crimes)

	(1) Homicide	(2) CarV	(3) CarNV	(4) HomeV	(5) HomeNV	(6) PasserbyV	(7) PasserbyNV
OLS Income Shock (all crimes)							
Currency	-0.0454***	-0.0268***	0.0351***	-0.0214***	-0.0317***	-0.0416***	-0.00700
	(0.00658)	(0.00777)	(0.00779)	(0.00615)	(0.00775)	(0.00747)	(0.00691)
N	26188	26188	26188	26188	26188	26188	26188
adj. R^2	0.525	0.751	0.716	0.464	0.698	0.810	0.709
F	490.1	599.8	23.37	133.6	117.3	44.88	2.215
IV Income Shock (IV: Synthetic Binary) (all crimes)							
Currency	-0.243***	-0.238***	-0.00202	-0.0130	-0.0332**	-0.150***	-0.0222*
	(0.0124)	(0.0147)	(0.0143)	(0.0113)	(0.0142)	(0.0137)	(0.0126)
N	26188	26188	26188	26188	26188	26188	26188
adj. R^2	-0.066	-0.061	-0.039	-0.039	-0.039	-0.046	-0.039
F	382.9	261.9	0.0201	1.328	5.429	119.1	3.075
First Stage. Instrument: Binary (currency nature)							
Currency term			0.134***		F = 7390.48		
			(0.001)		R-squared = 0.2829		
					Observations = 40,161		

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.001$

The estimates capture average effects around the mean. Assuming linearity, calculations indicate that a ten percent increase in this income stream leads to a 2.43 percent fall in homicides. This is 1.47 fewer homicides a day, or 537 per year. In a similar manner, an increase of remittance income of the same magnitude is expected to reduce the average number car thefts by 1,356 a year, from an average of 56,993 annual thefts recorded in the period of study. These effects are economically significant but the magnitude of the crime problem in the country overcast their significance.

The approach taken could be related to simulated and synthetic instrumental variables developed first to study endogenous local development by Bartik 1991 and Blanchard and Katz 1992.

The potential to use synthetic instruments to find causal effects is visible in the distinct contexts in which they are applied, as Boustan et al 2013, Enamorado, et al 2016 and others have shown.[36] The use of these estimation method had relied largely on exploiting initial conditions of the variable of interest, which can be an issue for identification in the presence of a relationship between the initial conditions and the dependent variable (Goldsmith-Pinkham, Sorkin and Swift 2018), as is shown forward.

[36] Boustan et. al 2013 and study inequality and public finance dynamics in the US, while Enamorado et. al. 2016 focus on inequality and homicides.

1.3.1 Sub-Specifications and Robustness Checks

A series of specifications of the model are estimated. The first concern is that seasonal patterns are driving part of the results. Therefore, in the top row of Table 1.4 the regression includes quarterly dummies for time controls. The results are very similar to the baseline estimates, stronger if anything.

Then, there is an argument that remittance senders could respond to exchange rate movements when sending their remittances. This is, currency movements could shift intertemporal preferences and thus choices. To test for this, in one alternative specification of the independent variable, the lagged level of the remittance (R^F_{t-1}) is replaced with the average remittance, so that the independent variable becomes: $R_{m,t} = \left(\frac{1}{n}\sum_{t=1}^{n} R^F_{m,t} * \Delta ER_t\right)$. This transformation of the independent variable ensures that the estimates are not driven by responses to current exchange rate fluctuations. Modifying the remittance level variable in this way goes largely undetected by the estimates, which supports the view that remittance senders are cash-constrained and thus cannot respond, when sending remittances, to short term changes in the exchange rate (Bleaney and Tian 2019). As municipality fixed effects are added, including controls such as state remittance spillovers also make little difference to the estimates.

In the subsequent rows, the regression controls for regional remittance spillovers from remittances, by including a time varying state level variable of remittance flows. Then, the fourth row includes a second order polynomial of the currency shock variable that show evidence of non-linear effects. Lastly, it provides the estimates of the model in which in addition to municipality level fixed effects, state specific time trends are incorporated. As expected, given the stringency of the controls, the explanatory power of the independent variable falls; yet, continues to be statistically significant for homicides and home burglary.

Further, in the series of estimates presented in Table 1.5, municipalities are split in three groups by ordering of their remittance. This shows that elasticities are larger for the smaller remittance municipalities. For these, estimates are negative and statistically significant for all seven modalities of crime studied, a finding that resonates with the existence of decreasing marginal effects of income and the non linear effects reported in the fourth row in Table 1.4.[37] Another interesting finding from this partition of municipalities is that, for the middle group of

[37] A specification of the model incorporates the square of the currency shock as independent variable (shown in Table 1.4) and finds that the effect of this income is non linear.

municipalities, remittances exerts crime inducing effects for home burglaries and non-violent passerby theft. This distributional ambivalence of effects explains the non-significant parameter estimated when using the entire sample of municipalities.

Shift-Share Synthetic Instrument

In an alternative specification of the model, the average remittance per capita is the main independent variable. Then, it is instrumented with an synthetic variable that depends on initial conditions and a predicted remittance growth pattern for each municipality.

The model continues to be as in equation 1.2, and the parameters recovered continue to be elasticities. In sum, the first change is in the independent variable; the second, in the type of synthetic instrumental variable followed.

The instrument is a sequence of remittances that is predicted by interacting the remittance growth of municipality groups with the initial average remittance within the municipality. The growth rate is built as a composite measure of remittance growth of municipality groups (ranked by average remittance). As the variable grows with the remittance growth of other municipalities, it is independent of changes in the remittance receiving municipality. This is one of the main reasons why this method is employed.

For this variable, the relevance condition is satisfied because the instrumental variable is a predicted measure of the actual remittance value (a scatter of actual remittance and the predicted remittance is plotted in Figure 1.8). One central assumption for the exclusion restriction to be satisfied is that the instrumental variable is indeed independent of municipality-level *changes*.

The logic is that the predicted remittance value is constructed using the composite growth rate of remittances of a group of municipalities. The group is formed from municipalities located in different parts of the country. The groupings are chosen so that similar municipalities (in remittance terms) are bunched and no municipality weights more than 5 percent of aggregate remittance flows of the group. This is done with to ensure that the groups' remittance growth is not driven by conditions occuring in any one municipality.

Regarding the initial remittance level, the starting point for each sequence, the method relies on an independence assumption between crime levels and remittance levels. One issue with this approach is that even if the predicted remittance values are uncorrelated to changes in the local area, the level of remittances might be endogenous. This is why the preferred set of estimates emerge from the currency shock and the binary synthetic variable.

Results from this model are summarised in Table 1.8. Now the independent variable is the effective per capita flow of remittance. These estimates are the OLS in the first row, and the estimates from instrumental variables in the proceeding rows. In the second row, the instrumental variable is the predicted remittance flow. In the third row, the instrument is the binary synthetic instrument used in the currency shock model. The first two rows correspond to estimates from a model with full set of controls and state specific time trends.The last row control for municipality level fixed effects.[38]

1.4 Discussion

There is consistency across violent and non-violent types of crime in the direction of the estimates. This is not obvious ex-ante, since violent and non-violent crimes are distinct types of crime, likely to be committed by different types of individuals. This is a narrative of heterogeneous criminal agents, in which distinct types individuals respond differently to changes in non-criminal income.

The magnitudes of the estimated effects vary somewhat across violent and non-violent forms of property crimes. One interpretation involves explaining some fraction of violent crimes as intentionally non-violent acts of crime gone wrong. This interpretation focuses on the heterogeneity intrinsic to crime opportunities, rather than on heterogeneous criminal actors. From this view, different levels of riskiness are associated with differing likelihoods of violence. Then, a stronger reduction in violent property crimes, *vis-a-vis* their non-violent form, results from the fact that perceived risk informs the search rule of thefts: crimes more likely

[38] All the estimated parameters are elasticities, but the fact that the dependent variable varies from models, makes these estimates incomparable amongst them. Particularly considering heterogeneous effects. To place the estimates of this second model in perspective, where there to be linear effects, a one standard deviation of remittances (4.5 thousand US dollars) around the mean (3.9 thousand US dollars), which is a significant increase (115%), would be associated with an expected fall of 34.80% in homicides and of 37.27% in non-violent home burglaries. With the inclusion of lagged effects to the model, the estimates also detect a violent car theft reducing effect.

to lead to violence are discouraged first over crimes that are deemed to be less risky.

With the municipality data, the estimates capture all local-level spillovers on crime. As a result, these measure the net effects across all mechanisms. When a single mechanism is expected, the measure captures the strength of that channel. Such is the case of homicide crime, where remittances are associated to this crime through behavioural responses to welfare changes that shape recruitment and criminal group participation. As for property crime, where multiple mechanism may arise, results show that if a price inducing mechanism is to exist, this is dominated by the welfare improving effect of remittances.

The inducing effect of remittances, which would be present under increased availability of transferable goods, is undetectable in all national level estimates. This suggests that either it is either absent or not strong enough to dominate the other effects. The discussion of establishing the channels through which remittances influence crime participation remains open to more research. Research on the role of remittances on shaping transferable goods, inequality and welfare provide routes to follow.

The estimates of this study imply that thousands of homicides, car thefts and other various types of crime are adverted each year because of remittances. This has direct policy implications because it indicates that transfers of economic nature can change crime participation incentives and thus crime levels.

Rather than suggest the use of remittances or income transfers as means to reduce crime participation. The research intends to point how the economic environment is a significant determinant of crime participation. From the same logic that motivated how income from remittances would be able to tip participation in crime, labour, social and economic prospects should also be considered.

International remittances are a particular kind of income transfer, but similar principles should apply to other types of transfers. From an income transfer perspective, examples of these can be found on conditional income transfers, unemployment benefits, wage subsidies or universal income policies. Each policy has its own consideration, which span beyond this research. Yet, one should consider the possibility that income transfers have spillovers in various realms of life, including crime participation. These externalities should be accounted for when measuring the potential effects of a policy change.

In sum, the estimates provide a cautionary tale, for income transfers alone are unlikely to be the most efficient way of tackling crime on their own. While crime responds to remittance changes, the magnitude of income needed to reduce crime substantially is relatively high. Given the context studied, in which individuals are expected to face a choice (in which the environment matters) and these transfers are expected to dissuade or push individuals at the margin; targeted policies and strategies that improve welfare and material opportunities outside illegality should be designed.

The study measures contemporaneous effects of remittances on crime, which imply that the effects captured are responses to changes in circumstances. Yet, remittances are likely to have long-term effects on local development and thus on crime that are not captured in the effects estimated. Long term effects should be studied. Nothing is discussed about the strategy of security involving the judicial for it is beyond the scope of this research. Nevertheless, it is to be highlighted that social and economic policies should be an integral part of the security strategy.

1.5 Conclusions

Remittances to Mexico are a primary source of income. For their size and spread, they have been shown to cause intended and non-intended effects in vast areas of society and the economy. This article has looked at whether these income transfers shape crime levels, a relationship of which we know little of. Using a detailed quarterly (28 quarters) and municipality level (2,456 municipalities) dataset, the empirical strategy recovers causal elasticity parameters.

The estimates are identified with a synthetic instrumental variable model, and the paper in motivated with a Beckerian criminal agent narrative. To estimate the causal relationships, the research exploits the exchange rate fluctuations affecting remittances value as a source of exogenous income. Doing this shows that positive income shocks have a violent-crime reducing effect, a pattern found for homicides and different forms of violent thefts.

The context is unique since a significant proportion of crimes are the by-product of organised criminal activities. This allows to extend the focus beyond prop-

erty crimes, and study crimes that are complementary to these organised groups' criminal activities. Attention is extended to homicides, a crime that few settings allow to motivate from an economic logic. Property thefts have been more widely studied in the literature and the estimates of this paper point to the same direction of the literature: crime increases when socioeconomic conditions worsen.

The identified parameters are economically significant and resonate with the idea that socioeconomic conditions are partly behind crime dynamics in Mexico. Policy lessons can be learnt from this given the wide use of income transfer policies employed by governments (such as conditional income transfers, unemployment benefits, wage subsidies or universal income policies) and other social policies that shape welfare outside crime.

1.6 Appendix: Tables and Figures

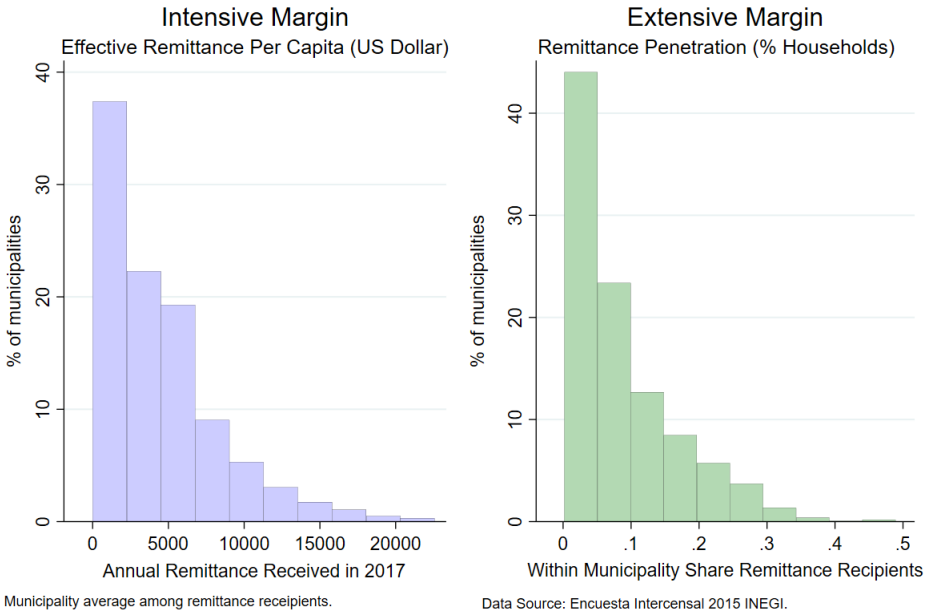


Figure 1.5: Distribution of municipalities by remittance characteristics.

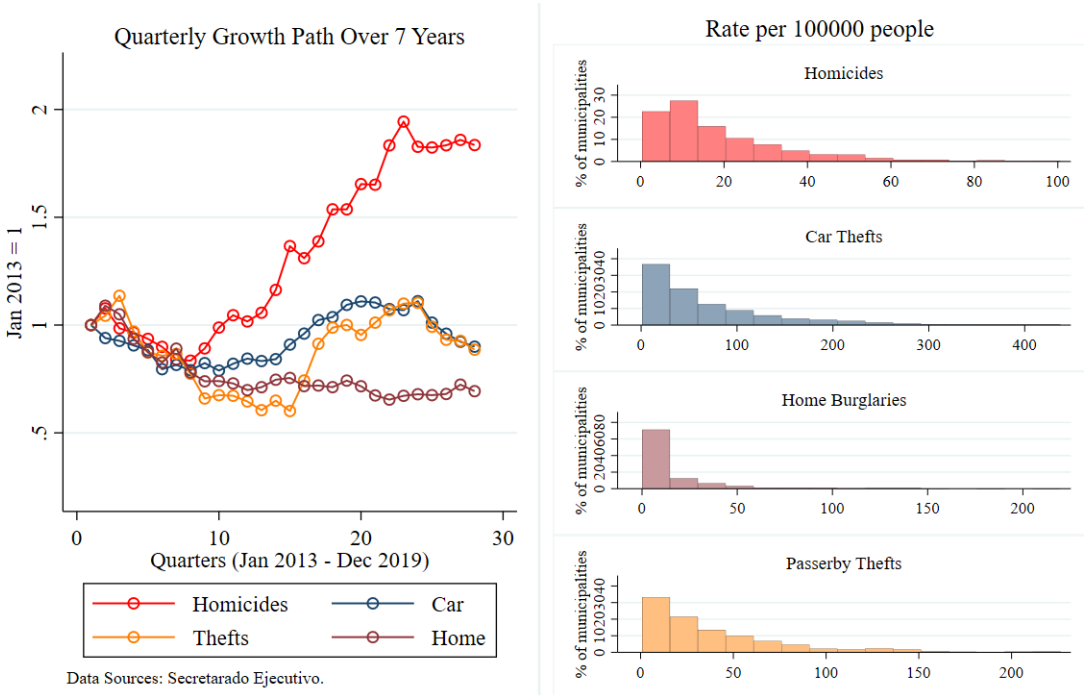


Figure 1.6: National Trend of Crimes and Municipality Distribution by Crime Rates

Figure 1.7: Crime in Numbers and Long Term Trend

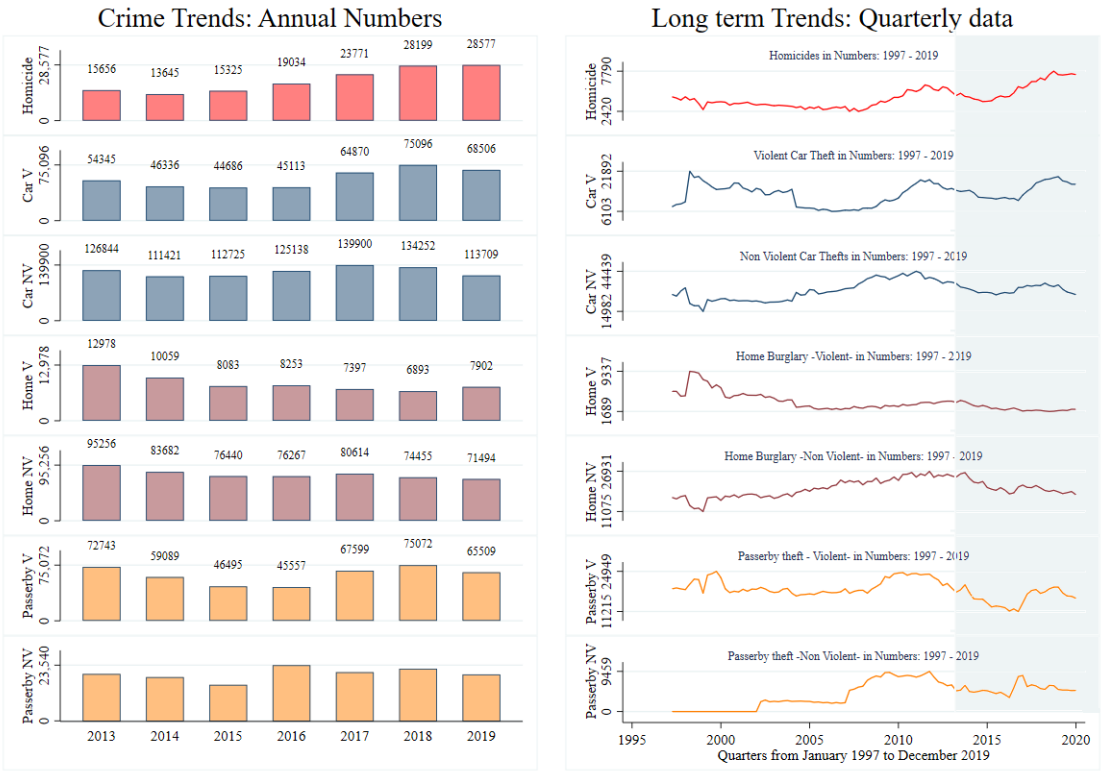


Figure 1.8: First stage: Actual and Predicted Remittance Per capita.

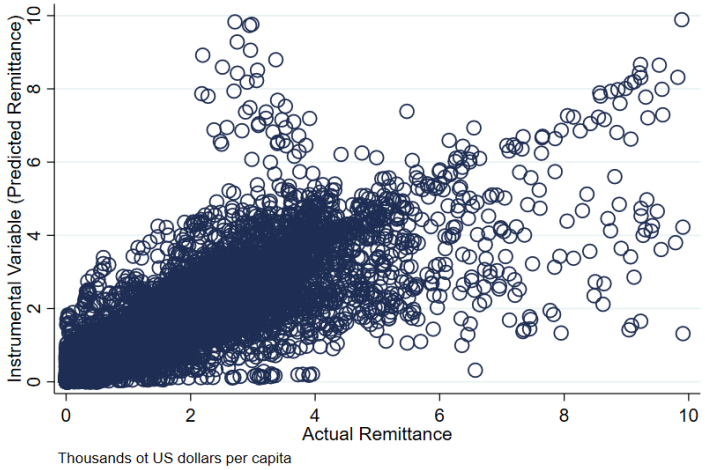


Table 1.2: Municipality Level Descriptive Statistics: Selected Variables

	Mean	Std. Dev.	Percentiles	Percentile stat. value
Population Size	75,119	168,897	25	11,760
			50	24,743
			75	57,147
			99	878,931
Average Age	31.3	3.0	25	29.3
			50	31.0
			75	33.0
			99	39.5
Remittance intensity (US dollars)	3,901	4,549	25	1,214
			50	2,822
			75	5,021
			99	1,9991
Remittance dependency (Population Share)	8.8%	7.8%	25	2.7%
			50	6.3%
			75	12.7%
			99	31.7%
Homicides (Rate 100,000)	13.4	19.2	25	0
			50	7.5
			75	17.3
			99	96.15
Car Theft (Violence) (Rate 100,000)	15.9	33.9	25	0
			50	3.7
			75	16.7
			99	179.1
Car Theft (No Violence) (Rate 100,000)	35.3	56.4	25	0
			50	13.5
			75	46.4
			99	266.4
Larceny (Violent) (Rate 100,000)	55.5	88.9	25	0
			50	22.7
			75	67.5
			99	429.9
Burglary (Home) (Rate 100,000)	38.8	60.9	25	0
			50	16.8
			75	51.9
			99	308.9

Remittance intensity is the average remittance received by remittance recipients whereas Remittance dependency corresponds to proportion of households receiving remittances in 2015, both within municipality. Crime statistics correspond to rate per 100,000 inhabitants. Data source for remittance statistics: Banco de México; data for crime: Secretariado Ejecutivo.

Table 1.3: Intensive and Extensive Margin of Remittances by Type of Locality (Population size of in 2015)

Municipality Population (thousands)	Extensive Margin	Intensive Margin
$pop < 15$	.0894	1.87
$15 < pop < 50$	.0770	3.58
$50 < pop < 100$	.0598	5.20
$100 < pop < 250$	.0467	4.93
$250 < pop < 500$	.0316	5.64
$500 < pop$	.0319	4.52

Intensive Margin: using 2017 levels of remittance flows, measures average remittance in 000 s of US dollars. Extensive Margin: Share of households receiving remittances, 2015 census.

Robustness Checks and Sub-specifications

Table 1.4: Currency Income Shock (IV: Synthetic Binary). Robustness checks: (i) time controls, (ii) extensive margin gains, (iii) remittance spillovers from surrounding area, and (iv) control for increasing/decreasing effects.

	(1) Homicide	(2) CarV	(3) CarNV	(4) HomeV	(5) HomeNV	(6) PasserbyV	(7) PasserbyNV
Time Controls (quarters)							
Currency	-0.283***	-0.300***	-0.0111	-0.0122	-0.0371**	-0.171***	-0.0118
	(0.0136)	(0.0161)	(0.0156)	(0.0124)	(0.0155)	(0.0150)	(0.0138)
N	26188	26188	26188	26188	26188	26188	26188
adj. R^2	-0.077	-0.072	-0.040	-0.039	-0.039	-0.049	-0.040
F	431.0	344.6	0.506	0.977	5.686	129.7	0.733
Average remittance shock							
$\text{Currency}_{average}$	-0.260***	-0.254***	-0.00914	-0.0141	-0.0242*	-0.153***	-0.0255**
	(0.0124)	(0.0146)	(0.0142)	(0.0113)	(0.0142)	(0.0137)	(0.0126)
N	26247	26247	26247	26247	26247	26247	26247
adj. R^2	-0.056	-0.055	-0.039	-0.039	-0.039	-0.042	-0.039
F	441.0	300.6	0.412	1.556	2.906	125.3	4.097
Spillovers from state remittances							
Currency	-0.235***	-0.223***	0.00354	-0.0180	-0.0351**	-0.145***	-0.0213*
	(0.0124)	(0.0146)	(0.0142)	(0.0113)	(0.0142)	(0.0137)	(0.0126)
N	26188	26188	26188	26188	26188	26188	26188
adj. R^2	-0.062	-0.053	-0.038	-0.038	-0.039	-0.045	-0.039
F	205.8	177.4	8.920	12.55	4.117	63.38	1.752
Marginal effects							
Currency	-0.352***	-0.377***	-0.0279	-0.0118	-0.0286	-0.205***	-0.0120
	(0.0168)	(0.0198)	(0.0192)	(0.0152)	(0.0191)	(0.0185)	(0.0170)
Currency sq	0.0232***	0.0263***	0.00569***	-0.000147	-0.00285*	0.0113***	0.0000676
	(0.00140)	(0.00166)	(0.00160)	(0.00127)	(0.00160)	(0.00155)	(0.00142)
N	26188	26188	26188	26188	26188	26188	26188
adj. R^2	-0.073	-0.068	-0.040	-0.039	-0.039	-0.049	-0.040
F	220.6	181.1	9.302	1.117	14.37	65.22	0.659
IV Income Shock (IV: Exchange Rates) (all crimes)							
Currency	-0.103***	-0.0995***	0.0250*	-0.0598***	-0.0893***	-0.142***	-0.0281**
	(0.0111)	(0.0131)	(0.0131)	(0.0103)	(0.0130)	(0.0126)	(0.0116)
N	26188	26188	26188	26188	26188	26188	26188
adj. R^2	-0.003	0.004	-0.038	-0.030	-0.032	-0.043	-0.040
F	508.1	620.7	15.04	144.1	132.2	92.99	4.635
Time Controls (state specific year trend). Fixed effects + exchange rate							
Currency	-0.0533***	-0.00298	-0.0223	0.0184	-0.0318*	0.0105	-0.00171
	(0.0162)	(0.0172)	(0.0179)	(0.0144)	(0.0184)	(0.0161)	(0.0151)
N	26188	26188	26188	26188	26188	26188	26188
adj. R^2	-0.049	-0.045	-0.047	-0.047	-0.048	-0.047	-0.046
F	6.269	22.20	9.670	5.257	1.122	5.772	8.646

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.001$

Table 1.5: Currency Income Shock (IV: Synthetic Binary). Regressions by Initial Remittance Percentile

	(1) Homicide	(2) CarV	(3) CarNV	(4) HomeV	(5) HomeNV	(6) PasserbyV	(7) PasserbyNV
Remittance Percentiles 0 - 33%							
Currency	-1.153***	-1.779***	-1.094***	-0.275**	-0.265**	-0.844***	-0.369***
	(0.130)	(0.144)	(0.145)	(0.0906)	(0.132)	(0.104)	(0.0852)
N	8035	8035	8035	8035	8035	8035	8035
adj. R^2	-0.086	-0.120	-0.072	-0.041	-0.040	-0.036	-0.038
F	78.35	152.8	57.16	9.189	4.061	65.22	18.76
Remittance Percentiles 34-66%							
Currency	-0.251***	-0.299***	0.0221	0.0770***	0.116***	-0.0458**	0.0703***
	(0.0205)	(0.0248)	(0.0236)	(0.0193)	(0.0235)	(0.0215)	(0.0213)
N	9101	9101	9101	9101	9101	9101	9101
adj. R^2	-0.077	-0.075	-0.039	-0.043	-0.046	-0.041	-0.042
F	149.9	146.0	0.876	15.89	24.42	4.547	10.90
Remittance Percentiles 67-100%							
Currency	-0.259***	-0.214***	0.0238	-0.0709***	-0.152***	-0.236***	-0.0599**
	(0.0193)	(0.0232)	(0.0223)	(0.0186)	(0.0231)	(0.0246)	(0.0219)
N	9052	9052	9052	9052	9052	9052	9052
adj. R^2	-0.075	-0.061	-0.039	-0.040	-0.046	-0.057	-0.042
F	181.0	85.23	1.147	14.45	43.30	91.91	7.465

Standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.001$

Table 1.6: Lagged effects: Remittance per capita. (OLS). Inclusion of past five quarters of average remittance flows to the specification of the model.

	(1) Homicide	(2) CarV	(3) CarNV	(4) HomeV	(5) HomeNV	(6) PasserbyV	(7) PasserbyNV
	OLS (all crimes). Lags for 5 quarters						
Remittance	-0.161***	-0.119**	-0.0217	0.0279	0.0345	-0.0791**	-0.0153
	(0.0340)	(0.0415)	(0.0363)	(0.0266)	(0.0372)	(0.0340)	(0.0285)
Remittance1	-0.0197	-0.0613	-0.00430	-0.0415	0.0344	-0.0406	-0.00939
	(0.0419)	(0.0512)	(0.0448)	(0.0328)	(0.0458)	(0.0419)	(0.0351)
Remittance2	0.0148	-0.0325	-0.0178	0.0281	-0.0507	-0.0109	0.00302
	(0.0402)	(0.0491)	(0.0430)	(0.0315)	(0.0440)	(0.0402)	(0.0337)
Remittance3	0.0248	-0.000661	0.00815	-0.0414	-0.0246	0.0157	0.0329
	(0.0390)	(0.0477)	(0.0418)	(0.0306)	(0.0427)	(0.0391)	(0.0328)
Remittance4	0.0382	0.0552	0.123**	0.0694**	0.0236	0.0206	-0.0248
	(0.0384)	(0.0469)	(0.0411)	(0.0301)	(0.0420)	(0.0384)	(0.0322)
Remittance5	0.0891**	0.120**	0.0477	-0.0492**	0.0238	0.0914**	0.0496*
	(0.0307)	(0.0375)	(0.0328)	(0.0240)	(0.0336)	(0.0307)	(0.0257)
N	22448	22448	22448	22448	22448	22448	22448
adj. R^2	0.430	0.653	0.700	0.486	0.673	0.782	0.730
F	100.6	522.7	1374.6	400.5	631.6	1111.9	537.5

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.001$

Table 1.7: Lagged effects: Remittance per capita. (IV: Binary Synthetic Variable (nature of currency shock). Inclusion of past five quarters of average remittance flows to the specification of the model.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Homicide	CarV	CarNV	HomeV	HomeNV	PasserbyV	PasserbyNV
	Synthetic IV (all crimes). Lags for 5 quarters						
Remittance	-0.219**	-0.198*	0.0825	0.0573	-0.0613	0.0832	0.261**
	(0.0985)	(0.104)	(0.107)	(0.0874)	(0.110)	(0.0962)	(0.0917)
Remittance1	0.0829	0.0829	-0.00930	-0.0229	0.0353	-0.0617	-0.103*
	(0.0621)	(0.0658)	(0.0672)	(0.0551)	(0.0695)	(0.0607)	(0.0578)
Remittance2	-0.0522*	-0.0583**	-0.117***	0.000957	-0.0820**	-0.0402	0.0400
	(0.0279)	(0.0296)	(0.0302)	(0.0248)	(0.0313)	(0.0273)	(0.0260)
Remittance3	0.0440	0.0338	0.106***	-0.0265	0.0770**	0.0877**	0.0787**
	(0.0282)	(0.0299)	(0.0306)	(0.0251)	(0.0316)	(0.0276)	(0.0263)
Remittance4	-0.00237	-0.00836	-0.0283	0.0639**	-0.0467	-0.0992***	-0.115***
	(0.0295)	(0.0313)	(0.0319)	(0.0262)	(0.0330)	(0.0288)	(0.0275)
Remittance5	0.0415*	0.0318	-0.00538	-0.0524**	-0.00955	0.0575**	0.0242
	(0.0239)	(0.0253)	(0.0259)	(0.0212)	(0.0267)	(0.0233)	(0.0223)
N	22770	22770	22770	22770	22770	22770	22770
adj. R^2	-0.054	-0.055	-0.053	-0.053	-0.053	-0.053	-0.057
F	3.943	3.341	3.736	2.010	2.888	3.337	11.21

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.001$

Table 1.8: Regression Estimates with Remittance per capita to Crime Levels. OLS and IV

	(1) Homicide	(2) CarV	(3) CarNV	(4) HomeV	(5) HomeNV	(6) PasserbyV	(7) PasserbyNV
OLS Benchmark specification (all crimes)							
Remittance pc	-0.0763***	-0.158***	0.0134	0.000559	0.0278**	-0.0955***	0.00844
	(0.0122)	(0.0149)	(0.0133)	(0.00978)	(0.0136)	(0.0125)	(0.0105)
N	27328	27328	27328	27328	27328	27328	27328
adj. R^2	0.432	0.664	0.701	0.519	0.666	0.780	0.724
F	158.0	820.4	2143.4	631.3	1007.2	1751.4	834.4
Instrumental Variables Synthetic Instrumental specification (all crimes)							
Remittance pc	-0.0787*	-0.172**	0.336***	0.0501	0.293***	0.0177	0.351***
	(0.0426)	(0.0525)	(0.0475)	(0.0346)	(0.0484)	(0.0441)	(0.0377)
N	27328	27328	27328	27328	27328	27328	27328
adj. R^2	0.048	0.279	0.505	0.224	0.316	0.462	0.253
F	174.2	813.1	2100.3	630.8	995.2	1741.8	807.9
Instrumental Variables Binary Synthetic specification (all crimes)							
Remittance pc	-0.345**	0.277	0.149	-0.0439	-0.323*	0.0743	0.0860
	(0.165)	(0.176)	(0.180)	(0.145)	(0.186)	(0.162)	(0.152)
N	27720	27720	27720	27720	27720	27720	27720
adj. R^2	-0.067	-0.060	-0.047	-0.046	-0.061	-0.044	-0.043
F	4.370	2.467	0.686	0.0914	3.018	0.209	0.320

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.001$

Chapter 2

Intergenerational Persistence of Education: Trends, Causality and Geography

Diego De la Fuente Stevens

Abstract

How persistent are individual outcomes across generations? This research looks at this question through the lens of education, focusing on relationships between co-resident parent-child pairs born between 1906 and 2007 in Mexico. The data comes from a collection of censuses and allows implementing various types of methods, which together provide a comprehensive picture of intergenerational dynamics in Mexico. A component of the research provides a descriptive analysis of mobility, with the estimation of long term trends, geographical patterns and spatial correlations. For this, it measures intergenerational distribution functions and the extent to which parental education influences the likelihood that: (i) their children are enrolled to school, and (ii) that they work while teenagers. The second component of this research identifies causal effects. For this, it uses a policy reform that increased mandatory-school leaving age, for those born around 1981, as an exogenous source of education variation. This part of the research shows that parental education permeates directly into the schooling and employment outcomes of subsequent generations.

Keywords: *intergenerational mobility, education, household economics*

2.1 Introduction

Education shapes the lives of individuals, but does it also shape the lives of future generations? This research engages in this question by exploiting information from millions of parent-children pairs born between 1906 and 2007 in Mexico. The data comes from seven census sweeps and is comprehensive enough to enable a study of intergenerational dynamics from a long-term, spatial and causal perspective.

The study of intergenerational mobility looks at the extent and nature of the relationships that exist between the outcomes (or status) of the parents and those of their children. In developing countries, focusing at early stages in the formation of children is of interest because there is large variation in attainment of outcomes from early in life.

The study centres around cohabiting intergenerational links because at the age at which children are looked at (between 13-15 and 16-18 years), most family pairs co-reside and continue to live in their primary household. At the same time, at this age, children are expected to have attained several educational outcomes, and the most elementary ones, such as literacy or completion of primary school, are today achieved by most in Mexico.[1]

As one looks at higher levels of education, more variation is observed. Even as early as 2020, a tenth of the 13-year olds had left school, a proportion that increases rapidly thereafter, with over a fifth of the 15-year olds and 45 percent of the 18-year olds having dropped out of the school.[2] Thus, household level data brings the possibility to study intergenerational patterns behind the observed social disparities, making censuses a unique source of information.

Formal schooling is focused around developing skills, disseminating knowledge, and fostering ideas, so the access and quality of education is expected to have wide-ranging effects. At an individual level, mounting evidence shows that education is at the core of setting a number of cognitive and non-cognitive skills that resonate throughout the lives of individuals; in areas ranging from earnings (Card 1999) and labour performance (Card 2019), to health, household stability,

[1] As a result, for recent cohorts, parental education has little explicative power over attainment of these type of early educational outcomes.

[2] The 2020 census sweep was carried out in March 2020, so should not reflect the conditions derived from Covid19. For its timing, it brings a comprehensive snapshot of society immediately before the pandemic.

employment, smoking (Oreopoulos and Salvanes 2011), up to crime participation (Machin, Marie, Vujić 2011, or Bell, Costa and Machin 2018), or fertility (Cygan-Rehm and Maeder (2013)). Then, because society is the working of its parts, this is all reflected on differences in general levels of well-being, demographics and economic performance (Hanushek and Wößmann 2010).

The educational years studied are important because they set foundational building blocks in the lives of individuals. In the hierarchical structure in the educational formation process, which derives from the verticality of the skill formation process, this also matters. Exclusion from early stages of education eject individuals from the possibility of future education and skill formation. Exclusion of early education is a policy that is costly to overcome Heckman 2006. In this respect, measuring the intergenerational determinants behind school drop-out children is a central component for comprehending the dynamics leading to heterogeneous outcomes later in life.[3]

To study this, multiple censuses are used (1970, 1990, 1995, 2000, 2010, 2015, 2020), permitting to examine mobility from a long-term angle. This shows that parental education has progressively become a weaker predictor of school attainment in Mexico. This is first shown with estimates of persistence parameters, that measure the expected change in the likelihood of observing: (a) a teenager dropping out of school and (b) participating in the labour force, upon a one-year change in parental schooling. Trends are also examined through the lens of conditional distributions, which are transition matrices measuring the likelihood of observing each educational level for children, conditional on parental schooling level.

Long term trends reveal that the dominant force behind the rise in mobility (or fall in persistence) are level improvements occurring at the bottom of the educational distribution. This shows that, while the distribution of education continues to exhibit significant inequalities, educational qualifications in Mexico are rising faster for those with lower education. This is explained by the gradual expansion in access to early education that occurred over the twentieth century, and its effects are shown across all levels of education studied.

Causal effects are identified for some of the cohorts. This is of interest because

[3] When there is a strong relationship between outcomes, whole families are likely to remain close in the social distribution of these, which comes at a cost for society and the economy for it leads to a waste of talent and effort, all in detriment of the development process of society.

intergenerational associations can be driven by multiple factors, such as family income. Given the ages and stages of the educational formation process studied, it is unlikely that ability or similar factors are driving the relationship, as could be the case in higher levels of education. This idea is supported by the fact that many of those who leave school early enter the workforce early too, indicating that socioeconomic factors are likely to be determinant. In 2020, conditional on having left school at age 17, the likelihood of being part of the labour force was 45.3 percent, in contrast to the group that continues in education, for which the estimate is 9.3 percent.

This research identifies causal effects of education using a policy reform that increased mandatory school leaving age. This exogenous episode of variation in education (for parents born after 1981) is exploited in a triangular model that captures the average effect of parental schooling on children, for the group of parents who would have dropped out of school had the reform not taken place. This is the local average treatment effect (LATE), and indicates that: (i) a one-year increase in parental schooling leads to a 2.2-4.7 percentage point rise in the likelihood that their children are enrolled in school, and (ii) to a 1.1-3.9 percentage point fall in the likelihood that they work.

The estimates also show that least squares, which provide population-level averages, give an underestimate of the causal effect of education for the complier group.

One explanation for this is heterogeneous effects. With a heterogeneous population, there is a whole distribution of treatment effects, and the average reform effect among the treated is different from the average population effect (Blundell and Dias 2009). As compliers are those that would have dropped out of school before the age of 15 without the reform, this is a population group with low socioeconomic indicators and below the median in the educational distribution, who would in turn exhibit potentially larger returns from schooling.

The approach exploits a policy reforms to disentangle causal intergenerational effects in the line of Black, Devereux, and Salvanes 2005[4], and builds a comprehensive picture of intergenerational mobility for an emerging country (Torche 2019). Showing the extent to which education permeates into the lives of subsequent generations, it demonstrates the strength of education as a tool to structurally

[4] Examples with parallels to this research are Chevalier (2004) and Black, Devereux, and Salvanes (2005) who study the cases of Britain and Norway respectively.

shape individuals and society.

One of the strands in the literature of intergenerational mobility in Latin America focuses cross-country comparisons. In a pioneering study for the region, Behrman, Gaviria, Székely, Birdsall, & Galiani. (2001) use retrospective question surveys to estimate education mobility in Brazil, Colombia, Mexico, Peru and the United States. They find similar mobility levels across the Latin American countries, but that mobility is low when compared to the United States (. With a focus on education also, Hertz et al. (2007) studies 42 countries and finds that Latin America ranks highest in the world in terms of schooling persistence, even after important gains in mobility have been achieved over the past fifty years.

Subsequent efforts to compare social mobility have caught up to the point that comparable national level trends for eighteen countries have been estimated. A research by Neidhöfer, Serrano and Gasparini 2018 shows that in all of the countries studied, children are expected to have more schooling and see more mobility than their parents. They show that for those born in the 1940, an additional year of parental education is associated with an average increase of 0.6 years of children schooling, a number that drops to 0.4 for those born in the 1980s.

Another strand of the literature for the region focuses on within-country analysis and narrows on providing subnational level estimates. Research for Mexico by Urbina (2018) provides income-percentile mobility trends, and studies mobility during an episode of educational expansion of basic education, showing improvements at the bottom of the distribution. Then, Campos-Vazquez & Medina-Cortina (2019) presents disaggregated demographics analysis, showing non-causal skin-tone heterogeneities; whereas Corak & Monroy-Gómez-Franco (2019) split the country into five regions and provide insights of the disparities that exist, particularly in detriment of the south part of the country.

There is also research for other Latin American countries, such as Brazil, where Leone (2017) recover gender specific estimates, and finds higher mobility and educational attainment for daughters than for sons; also, Leone (2019) studies geographical variation in mobility across 27 federative units, showing evidence of an association between mobility and income inequality. Any thinner partition of the population, or estimates of causal effects is absent in the body of literature for the region.

Interesting papers are emerging on the topic for developing countries. Perhaps closest to this research is the work by Alesina, Hohmann, Michalopoulos and Papaioannou (2021), which uses large data from the census to provide spatial variation of intergenerational persistence levels. The study provides a thin geographical analysis of intergenerational persistence for a number of African nations and studies correlations that emerge from it. The authors looked at primary education and studied the likelihood that children finish primary school, conditional on whether their parents completed it. They call these the upward and downward mobility measures, depending on whether the parent had completed primary schooling.[5] Another related work is Geng 2020, who also use census data to study intergenerational mobility in China for the cohorts born between 1950-77. The author looks at co-residents, narrowing to children at least 23 years old, and looks at them in connection to a historical institution process of examinations.[6] There is also the work on India by Asher, Novosad and Rafkin (2018)

In high income countries there has been more research on the gepgraphy of mobility. In the United States, income mobility has been shown to display large regional and sub-group disparities (Card, Domnisoru and Taylor 2018) which are associated with residential segregation, income inequality, school quality (Chetty, Hendren, Kline and Saez 2014), school exclusion (Chetty, Friedman, Saez, Turner and Yagan 2020), among others. Research by Bell, Blundell, Machin (2018), for the United Kingdom, look at wages, home ownership and education mobility, and studies their correlation with industrial performance, voting record and housing. Other countries have also received attention, such as Italy, where Güell, Pellizzari, Pica and Rodríguez-Mora (2018) provide a regional characterisation of mobility and find correlations with economic activity, inequality and social capital. Similarly, Acciari, Polo and Violante (2019) who focus on showing regional disparities in Italy, Heidrich (2017) in Sweden, and Deutscher and Bhashkar (2020) in Australia.

This stream of research has paid attention overwhelmingly to a sample of high income countries largely because of data constraints. The fact is that this research has been propelled by the use of administrative records and linkable data, which are largely unavailable in much of the developing country context. Yet, in all settings that have explored the geography of mobility, research has shed light to

[5] They estimate these probabilities at a thin geographical level and explore correlations that emerge, which range from geographical attributes to measures of colonial ties.

[6] The age of 'children' studied in this research draws concerns of selection driven by endogenous household attrition that the author seeks to address in various ways.

wide regional differences and multiple socio-economic associations with mobility.

While there is growing interest in the topic of inequality, opportunities and social mobility in the Latin American, there is no similar work for the region. In this respect, mapping of the persistence at a municipality level provides a new set of estimates to the studies on the spatial patterns of mobility. This part of the research reveals that some regions of Mexico currently experience persistence levels that are over twice the national average and are slightly above the twenty-year lagged national estimate. For instance, the South Pacific region has intergenerational persistence parameters which are 2-3 times higher to those in the northern border region, where mobility is highest on average (see top-left map in Figure 2.7, in the Appendix, for a mapping of persistence).

A partition of the country by locality type also shows a rural and urban divide, with stronger intergenerational relationships in rural areas in general. However, deep heterogeneities are also detected within urban areas, which is documented in a series of metropolitan area maps of mobility in the Appendix. These show the variation of persistence levels across the municipalities that make each urban area (relative to the national value).

With this, the research proceeds to examine geographical patterns and provides a series of correlations. Contextualising intergenerational parameters to outcomes that are meaningful to the setting is at the centre of the geographical section of this research. While the discussion revolves around non-causal associations, these provide insights that could help us understand more about the causes and consequences of the levels of inequality that developing countries experience. The focus is on correlations with poverty, fertility, migration, demographics and child health.

As this research provides multiple measures and scopes of mobility in a unified framework, the estimates can be compared. This is important because estimates of mobility that come from different studies are difficult to compare for distinct reasons. To start, because the outcome and independent variables vary across studies, but also because the time frame, sample characteristics (such as age or gender), and the context differs. In this respect, the present research provides a series of statistics that allows to look at intergenerational dynamics in education from a comprehensive perspective, and contribute to our understanding of these dynamics in Mexico and developing countries in general.

In what follows, Section 2 elaborates on the data and the educational reform used to identify causal effects. This is continued with the empirical strategies in Section 3 where, with a combination of least squares, instrumental variables, transition matrices and geographic analysis, intergenerational mobility is studied. Section 4 discusses the results and Section 5 presents concluding remarks.

2.2 Intergenerational Linkages and Data

The gap in what we know about social mobility across countries results largely from data constraints. First, the administrative tax records, that powered the expansion of the research on social mobility in higher income countries, are largely unavailable for most developing countries. Second, because of the high rates of labour informality, even if the data were to be available, these contain a subsample of the population. This is a concern because employment choices are endogenous, and then so is tax compliance and the individuals contained in the sample.[7] In Mexico, the threat to the validity of administrative tax records as a representative source of information is no exception, with recent estimates indicating that informality absorbs 3/5 of the working population and up to 4/5 in some states of the country.[8]

In the absence of representative (and intergenerationally linkable) earnings data, specially designed surveys are often used. Longitudinal surveys tracking households are absent in emerging economies also, but retrospective questions help collect information of the parents from their children. This approach has made important contributions to the advancement of the research on mobility in developing countries, but also faces limitations.

Perhaps the most serious is the fact that information of the parents is based on recollection from the children. This is likely to lead to recollection errors, which poses problems to the credibility of the data.[9] The issue may be acute when the

[7] "Most people can agree on many of the features of what is known as the shadow economy. Agreeing a more precise definition is more difficult. A variety of different terms are used in addition to 'shadow economy'. These include 'underground economy', 'non-observed economy', 'hidden economy", 'cash economy', 'informal economy' and so on. There is no universal agreement on what exactly is covered by those terms or how they differ." OECD 2017

[8] *Encuesta Nacional de Ocupación y Empleo* (ENOE), from INEGI.

[9] In general, setups with measurement errors such as transitory shocks in the variable measured, observing children and parents at non-comparable stages in their life-cycle, not taking into account age effects, or using survey data in which the variance of the variables is smaller than that of the true population will lead to underestimates of the true mobility parameter. This attenuates the effect identified in the estimates, but if measurement errors also arise from

focus is on variables such as earnings, which fluctuates over the lifecycle and could be subject to cognitive and recollection biases. This is less of a challenge with retrospective questions of stable outcomes such as home ownership, education, or occupation of the parents. While there exist well implemented surveys and where these concerns are minimised[10], the problem is intrinsic to the nature of the recollection exercise.

Because the focus of this research is on outcomes attained while individuals are co-residing with their parents, household level data from the census provides a wealth of largely unused intergenerational information. Moreover, censuses cover a long period of contemporary Mexican history. These will allow the estimation of geographical variation of intergenerational mobility in detail. The focus on education, important on its own, also bring advantages from a methodological scope. One is stability, which makes for more accurate measurements. Another is that, upon certain constraints, comparing individuals of different ages is not an issue.

Outcomes in which variation happens before selection from household attrition occurs, sets aside the need for longitudinal data and retrospective surveys that has prevented the emergence of mobility research for a larger set of countries. This is relevant for two reasons. First, since the large body of the literature on mobility has focused on high-income countries, environments in which early educational outcomes are most often universally attained, little do we know about intergenerational determinants of early-in-life outcomes. Then, census and other household data can be used to push the research on this and help close the gap in what we know of intergenerational mobility across contexts.[11]

The main data sources are the national censuses, carried out by national statistics office of Mexico, INEGI, and homologated by IPUMS International.[12] Because of size, censuses allow for a more granular and precise analysis compared to the existing research on mobility for Mexico, which is built largely on smaller sample

cognitive biases, such as when misreporting is a function of the location of individuals in the socioeconomic distribution, other biases arise. All this poses threats to the credibility of estimates using this data (see Solon (1989) and a discussion in Dearden, Machin and Reed (1997)).

[10] Such as survey ESRU – EMOVI 2017, for Mexico does an excellent task at collecting information from interviews to 17,665 individuals aged 25 to 64. Estimates are representative at a national level, for Mexico city, and for five regions of the country.

[11] It is expected that correlations with other types of mobility are present. Already there is evidence that shows cross-country associations between education and earnings mobility (Blanden 2013).

[12] Minnesota Population Center. Integrated Public Use Microdata Series, International: Version 7.3 [dataset]. Minneapolis, MN: IPUMS, 2020. https://doi.org/10.18128/D020.V7.3

surveys. With census data, millions of parents and children born over a century long period are retrieved. Specifically, cohorts matched are born between 1906-1984 (parents) and 1952-2007 (children), and we then observe particular outcomes at a point of interest in their lives.

Different sub-samples are constructed with this data, depending on the empirical strategy at hand. This is something that needs to be borne in mind throughout the article. In the part of the research which displays the intergenerational distributions of education, the focus is 18-19 year-old children of parents aged 36-64.

For the regression analysis, the age group of children varies with the outcome variable. Specifically, when computing point estimates: (1) for enrolment to secondary school and youth employment as outcome variables, the age group of children is 13-15, (2) when studying completion of secondary school, children age is 16-18. As for parents, when 'enrolment' or 'employment' are outcome variables, parental age is between 31 and 42, and when the outcome variable is 'completion', the age ranges wider and is between 31 and 64. At these ages, there are no systematic changes in the composition of households because of household attrition from children.[13]

An analysis of the population shows that education has risen over time, but has done so differently across levels. The estimates of Table 2.4, in the Appendix, provide the distribution of parents according to their completed years of schooling. This table shows how education attainment has changed for parents over time. A distinctive change in the distributions come from the fall in non-schooled individuals, a proportion that goes from 28.7 and 39.7 percent for male and female parents born between 1932-1942, to 3.2 and 4.6 percent for those born along 1977-1987.[14]

A related set of results for children are in Table 2.5, which provides the percentage of children enrolled at school by age and time of observation. In line with previews results, primary school enrolment has become close to universal: whereas 71 to

[13] Looking at the literacy rate helps to see this. Plotting the literacy rate of children living in households by age for different cohorts shows: (1) a steady increase in the literacy rate across cohorts (2) the rate remains relatively stable until the late teenage years. As literacy is a stock, fluctuations in the literacy rate can only be explained by compositional changes in households. This is why, to recover population estimates, focusing on household begin attrition occurs is important.

[14] The trend is also present when looking at higher levels of schooling which shows that 32 percent of parents born between 1977-87 completed nine years of schooling (before dropping school altogether), a number up from 1.1-1.7 percent for those born between 1932-1942.

74 percent of children born in 1958 were in school (age 12 in 1970), the number is 96.5 percent for those born in 2003 (age 12 in 2015). Another structural change observed is that schooling begins at an earlier stage for more recent cohorts, since only 30.2-30.7 percent of 6-year-old children in 1970 attended school, while 97.2-97.4 percent of them did in 2015.

Convergence in attainment to higher levels of schooling is observed. For example, the proportion of those aged eighteen that remain in school increases between 2.45 and 3.66 times between the first and last census. Despite these dramatic improvements in basic and intermediate levels of education, inequalities continue to exist, and one can begin to notice increasing heterogeneity in enrolment around ages 13-15, and sharp drops in enrolment thereafter. These compositional variations in school attendance is one factor motivating the study of outcomes around this age.[15]

Summary statistics of the sample in the regressions are displayed in Table 2.3, in the Appendix. The table conveys education, demographic and socioeconomic information for parents and children in the different regression samples. The top section corresponds to information of the parents, whereas the bottom half of the table displays information for the children of these parents. The table depicts the increasing education, decreasing child-labour participation and stable demographics (as characterised by the indigenous composition, age, rural-urban location, household size and migration rates).

2.3 Empirical Methods and Results

The empirical strategy has two main components. The first consists in the construction of the joint parent-child distribution functions. Unconditional distributions display the educational layout and the population shifts happening over the course of the period studied. Conditional distributions provide the empirical probability of observing the transition to each educational level from one generation to another. This is followed by the use of econometric methods to identify point parameters of persistence that measure the extent to which an additional parental schooling year is associated with a change in the empirical probability of

[15] For reference purposes, ages 13-15 are marked in bold as these denote the years for which the reform in 1993 is effective to. Age of completion of primary school if no repeats: 12. This is not the sample of the regression but population level statistics. In the regression sample, roughly 1 in 10 of those born in 2001 did not complete secondary school.

a given outcome; first defined as enrolment, then completion of secondary school and extended to look at the employment status of children. Causal estimates are identified in this part of the research.

2.3.1 Distribution Functions

Unconditional and conditional distributions are identified first. These describe the intergenerational education structure. First, unconditional distributions are built from estimating the proportion of the population in each parent-child educational pair, so that the collection of these probability points provide the intergenerational density mapping. The estimates of interest are the empirical probabilities of observing the realisation of $Schooling_i^{child}$ and $Schooling_i^{parent}$ together, as in equation 2.1.

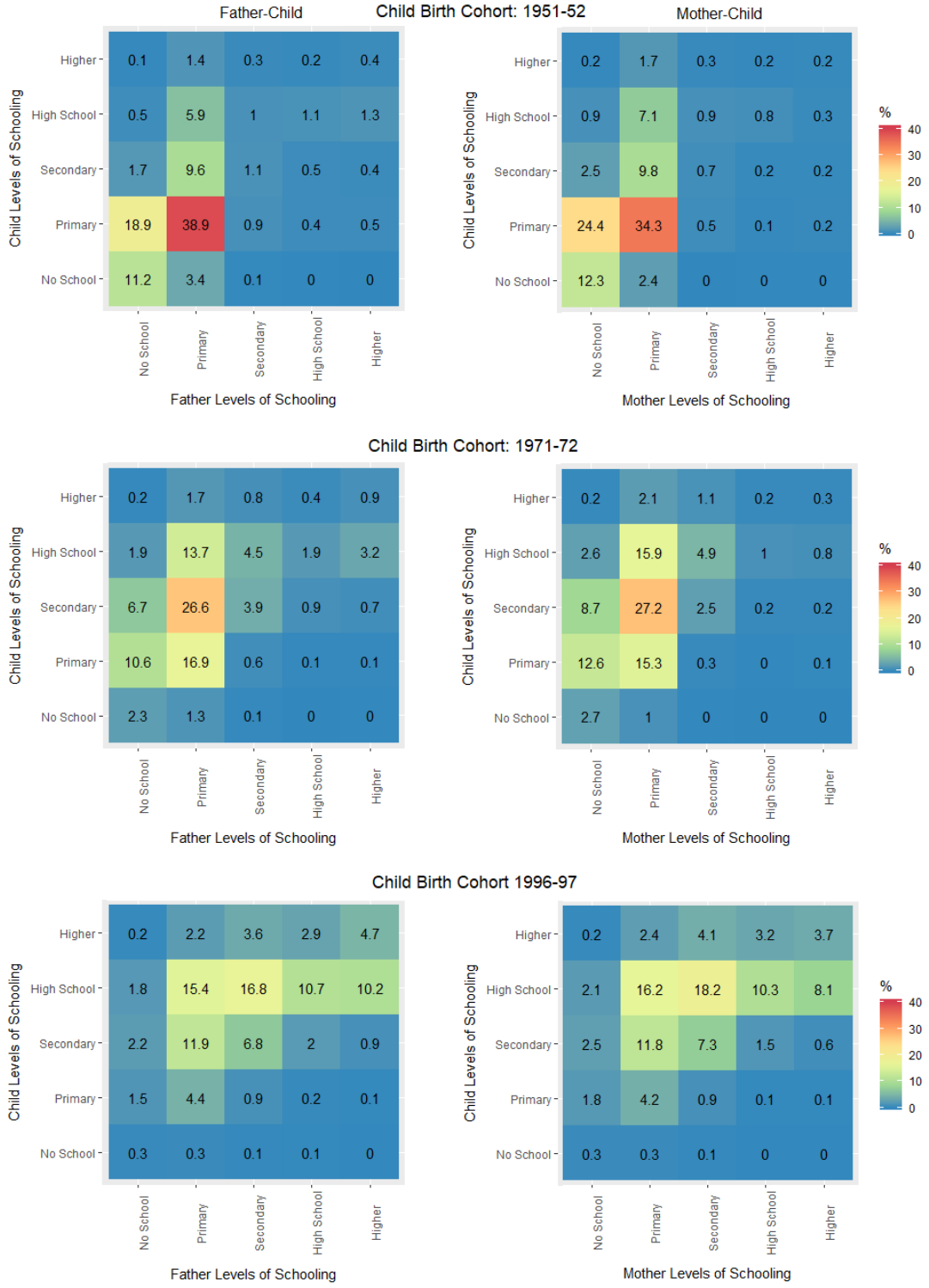
$$\mathbf{P}[Schooling_i^{child}, Schooling_i^{parent}|X_i] \tag{2.1}$$

Where, $Schooling_i^{type}$ denotes attained educational *level* and is aggregated into five categories: No schooling (0 yrs), Primary (1-6 yrs), Secondary (6-9 yrs), High School (9-12 yrs), Higher (+ 12). The distributions are conditional only on a set of standard demographic variables such as gender and age, which are captured in X_i. We observe density shifts over time, which sheds light to the magnitude and location of education changes.

These are plotted in Figure 2.1 which portray intergenerational distributions over time, for mother and father separately. There are some difference in magnitudes across parents, but parallels dominate the picture. The cohorts depicted are children born between 1951-52 to parents born between 1906-1936, up to children born between 1996-97 to parents born between 1951-78. In each of the distributions portrayed, by construction, the sum of all education-cell adds to the total representation of the population (100).

In this display of distribution functions, a large density shift occurs. This is observable from the lowest education brackets in the first cohort and from the upward diagonal trajectory.

Figure 2.1: Unconditional Distribution of Parent-Child Educational Pairs (Evolution)



Children aged 18-19 with parents age 36-64.

For the cohort of children born in 1951-52, between 11.2 and 12.3 percent of pairs had no schooling at all, 34.3 to 38.9 percent had both primary school as their highest educational qualification. This is in contrast to more recent times, in

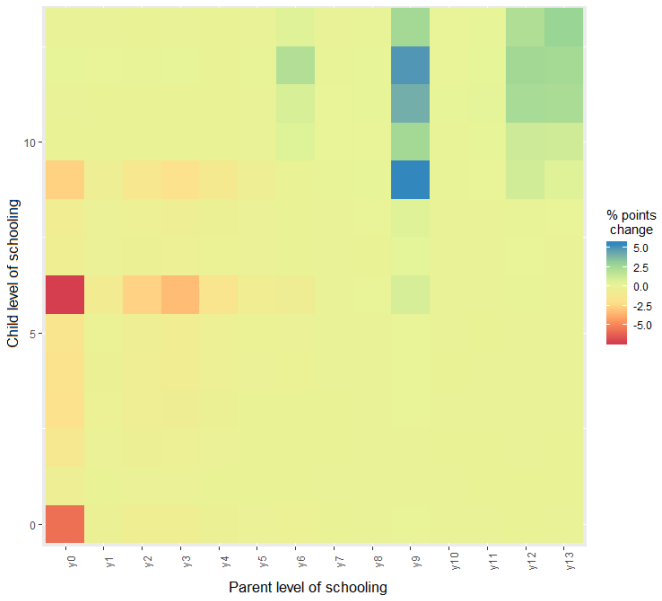
which around 0.3 percent of pairs have no education (children born in 1997-99).[16]

Population density gains are also observed at high levels in the educational ladder. While their weight in the total population is smaller, high-school parent-child pairs have increased their representation in the population by a factor greater than 10 over the period (for both mother and father pairs).

Completion of higher education is not observed in these distributions because of the age of children, which is 18-19, and is chosen to avoid selection because of attrition from primary household. In terms of education above high school, estimates show that children of highly educated households are more likely to be engaged in higher education than those coming from low educated households.

When disaggregating levels into schooling years, the largest density gains happen at key school periods: 9, 12 and 12+ years, which corresponds to secondary and high school diploma years. This can be seen in Figure 2.2, which displays the density changes in the parent-child distribution between the first and last cohort studied (percent – population - change).

Figure 2.2: Changes in the Unconditional Distribution of Parent-Child Pairs



Horizontal: highest schooling level of the parent. Vertical: Highest schooling level of child. The sum of all cells add to 0.

Next, the empirical strategy splits the sample of children by parental education.

[16] Each row measures the total proportion of children in each education level, whereas each column adds the total proportion of parents in each level.

Now, the focus is on recovering conditional distributions. These provide a mapping of the empirical probability of transitioning, over the course of a generation, from one educational level to another. As such, these are mobility representations they dissect the likelihood of children outcomes, when accounting for parental background. The focus is on the probability points of equation 2.2, which denote the likelihood of observing $Schooling_i^{child}$ conditional on parental schooling $Schooling_i^{parent}$.

$$\mathbf{P}[Schooling_i^{child}|Schooling_i^{parent}, X_i] \tag{2.2}$$

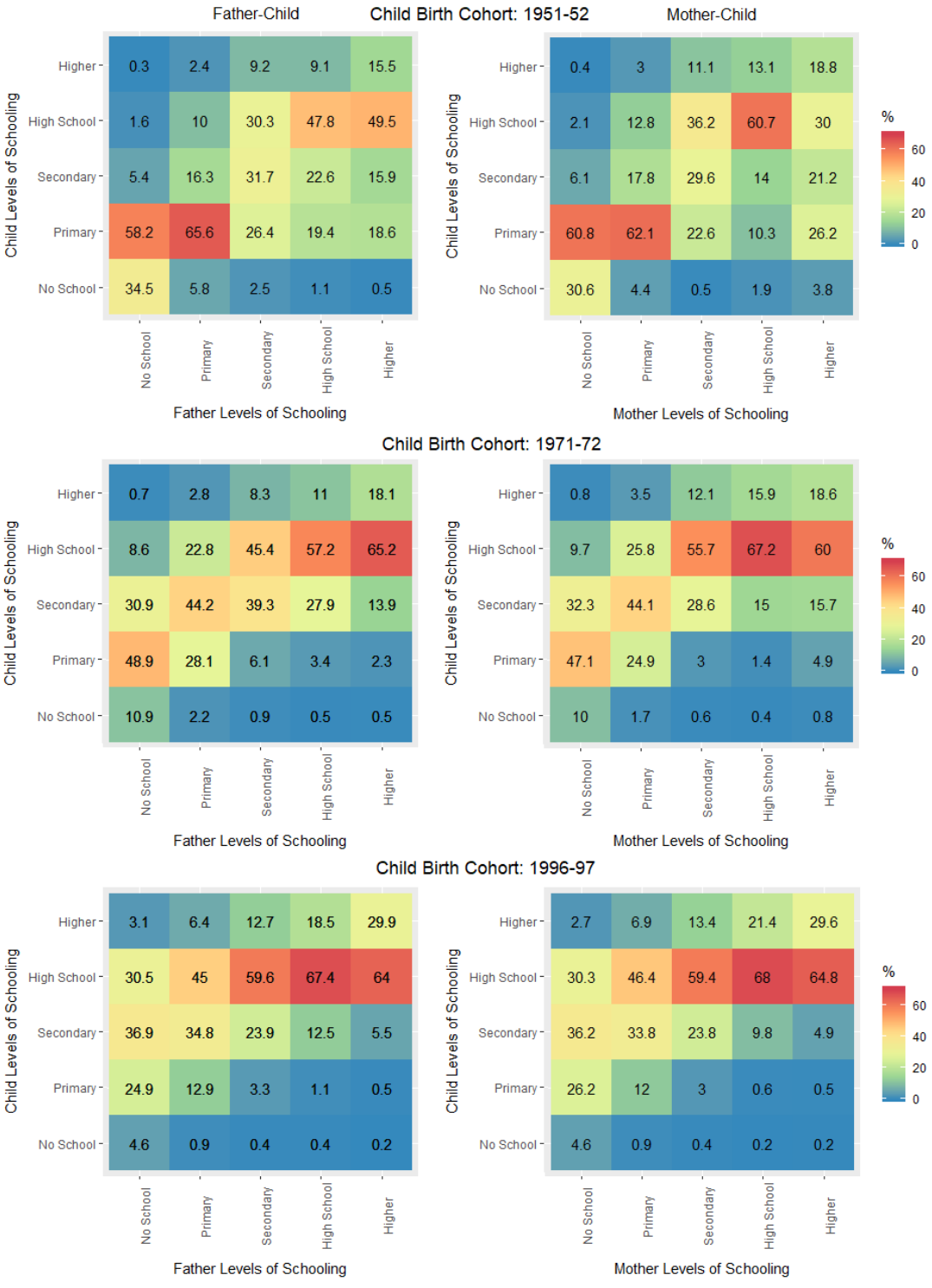
These likelihoods are displayed in the transition matrices in Figure 2.3. Now, each column in the distribution measures the layout of children coming from each household background (so that each column adds to 100). From a conceptual standpoint, where there to be no mobility whatsoever, the entire population would be located along the diagonal, showcasing that children and parental education are the same (as in Figure 2.4, in the Appendix, which displays the hypothetical visualisation of extreme outcomes).

Observe in the left hand side panel of Figure 2.3 that those born in 1951-52 to parents in the low end of the educational distribution were highly likely to remain at the bottom. For this cohort, conditional on having a father with no schooling, the likelihood that a child did not attain any school either was 30.6 - 34 percent (and of achieving up to primary schooling of 58.2 - 60.8 percent). Similarly, two thirds of the children with primary school educated parents did not progress beyond primary school themselves.

Compared to these values, there has been progress in attainment of low education levels. For the most recent cohort, the likelihood of observing a zero schooled children, conditional of having a father with no school either, is of 4.6 percent. This is over seven times lower than the estimate for the first cohort.

Two related phenomena can also be observed at higher levels of the distribution. As intergenerational improvements have become more likely, there are relatively more individuals engaging in higher levels of education than the immediate previews generation. Also, downward movements have become less common over time; altogether showing that attainment wise educational ceilings have been breaking and the educational floors solidifying.

Figure 2.3: Distribution of Children Education (Conditional on Parent's Education).



Horizontal: highest schooling level by the parent. Vertical: Highest schooling level of child.

2.3.2 Point Persistence Estimates

The next component of the empirical strategy looks to synthesise the information observed in the distribution functions into a unified statistic that summarises the degree of association between parental education and the outcomes of their children. The first characteristic recovered from the intergenerational structure is the derivative of equation 2.3 with respect to $Schooling_i^{parent}$. In this section, parental *years of schooling* acts as independent variable, and we let the dependent variable take three different outcomes.

$$Outcome_i^{child} = \alpha_0 + \Psi Schooling_i^{parent} + \Theta X_i + \epsilon_i \tag{2.3}$$

Specifically, $Schooling_i^{parent}$ corresponds to the highest achieved school $year = \{0, 1, .., 18\}$ of the parent. The dependent variable $Outcome_i^{child}$ takes two values of school participation of children and one of labour participation. Educational outcomes are denoted $Enrolment_i^{child}$ ($= \mathbb{1}$ if enrolled in school at age 13-15) and $Completion_i^{child}$ ($= \mathbb{1}$ if completed secondary school at age 16 to 18).

For these, the persistence parameter (Ψ) is interpreted as the expected point change in the conditional likelihood of observing enrolment and completion of secondary school, upon a given change in parental years of schooling. The higher the value of the persistence parameter, the lower mobility is.

School and work become time competing activities at this point in life, so interest on whether parental schooling affects children employment arises too. The estimated equation is extended to allow the outcome variable to denote whether the child works (now, $Outcome_i^{child} = Work_i^{child} = \mathbb{1}$ if the child (13-15) works), so that the parameter reflects on the association between parental education and work status of their children.

National level regressions are calculated for seven cohorts, with least squares, starting from the generation of children born in the early 1950's. Causal estimates are recovered for two child birth groups, the cohort of children born between 2000-02, and the one of 2005-07 (for outcome variables $Enrolment$ and $Work$).

Least square estimates are presented for all cohorts studied in Table 2.1. These estimates provide a measure of strength of the intergenerational association between parental and children outcomes. In tone with the distribution functions, one thing the table shows is that the relationship between parental education and

children outcomes is weakening over time, at least from the perspective of early drop-out rates and child work.

Whereas for the cohorts of children born in the 1950's, an additional year of schooling of the parent was associated with an increase of (i) 4.8-5.2 percentage points more likely to be enrolled in secondary school, (ii) 4.7-5.3 percentage points more likely to complete secondary school, and (iii) 1.6 percentage points lower likelihood of work. For those born early in the 21st century the corresponding changes in likelihoods are: 2.1-2.2 points for enrolment, 1.8-2.1 for completion, and a reduction of 0.9 points for work.

This downward trend showcases the extent to which early and intermediate steps in the education formation process of individuals has become independent from parental background. Ultimately, these statistics provide a measure of the degree to which the education replicates across generations.

Parental education continues to be a statistically significant predictor of secondary school enrolment even in the latest cohort, but estimates of persistence should mechanically go to zero were mandatory school be fully provisioned and enforced. This is the result of a gradual expansion of the educational system that the country has undergone since the second half of the century (Urbina 2018), and show that the extent to which acquisition of early education is shaped by parental characteristics is dependent, among other things, to the availability of public educational services: in the absence of these services, the education of children depends to a larger extent on parental factors.[17] [18] [19] This result indicates that secondary school continues to be underprovisioned in the country.[20]

In a separate analysis that focuses on completion of *primary* school as an outcome

[17] So that their education, earnings and time availability are at the core of explaining children educational differences. See (Solon 1999, 2002, Becker, Kominers, Murphy and Spenkuch 2018)

[18] Education and socioeconomic wellbeing are entwined. When education is seen as a form of capital (with all this embodies) it places itself at the centre of determining the quality and productivity of time use (Nicholson 1891, Schultz 1961) and as a result ends up explaining many of the existing differences in employment, earnings and other economic outcomes. In this dynamic, cross-country associations also show that education and earnings mobility are highly correlated (Blanden 2013).

[19] Intergenerational mobility affects local economic conditions by shaping social capital. This relationship arises from the fact that when opportunities to fulfil individual potential are unevenly distributed, a suboptimal use of social resources arises. Indeed, research has found that a high conditioning of the materialization of individual potential to parental education leads to growing inequality (Corak 2013) and a slowing down of economic growth (Marrero and Rodríguez 2013).

[20] First stage estimates of the instrumental variable model are statistically significant.

variable, this is exactly what the analysis shows. Whereas parental education has a strong explicative power on attainment of this level of schooling for the earlier cohorts, as the distribution functions showed, it quickly ceases to be significant for the later ones. For children born between 1952-54, an additional year of parental schooling is associated with a 6.4 percentage point higher likelihood of completing primary school, whereas for those born between 2002-05, the expected likelihood increase is only 0.03 percentage points, virtually zero.

Compared to the mobility matrices, the regression estimates shed light to the strength of the association between parental and children outcomes, but abstract the nature behind the observed trend in mobility. Ultimately, a hypothetical fall in education of children coming from high educated parents would also drive a fall in the persistence parameters. This is one dimension showing how conditional distributions directly provide complementary information; by showing the changes in educational distribution by segments, these demonstrate that the persistence estimates are in decline because children of low schooled households are increasingly attaining higher qualifications than their parents.

As the study covers a long period of study, the educational characteristics of the population have gradually changed. This is something which can be seen in school attainment statistics, such as the transition matrices presented in the previous section. The distributions of parental education are changing over time which has implications for the interpretation of the inter-generational mobility results. This is consequential for the intertemporal comparability of estimates.

The discussion has parallels to the one of non-linear effects of education. This is connected because the logic of non-linearity implies that different educational attainment qualifications carry different effects. One view would look at this from the scope of education as a form of capital with varying marginal effects.

In line, there is the view that key cut-off years embody particular value, an argument that finds support in empirical evidence that shows a great degree of bunching of individuals at level limit educational levels, indicating that the majority of individuals choose to complete multi-year *levels* before dropping out (Figure 2.2). Therefore, efforts of extrapolation should be done with care, for the recoveredestimates are effects around the mean.

These measurements are not yet causal because many other factors may feed into the relationship between parental education and children outcomes. To show

whether the effects of parental education are causal, the research studies a policy reform. The educational reform increased mandatory school leaving age, to include secondary schooling in addition to primary school. This reform provides a discontinuous variation in education for those parents born around twelve years prior to the reform. As the reform came into effect the 5th of March of 1993, we then observe the children of the generation of parents born in the years adjacent to 1981, in the both the 2015 and 2020 census.

The age group of the parents is contained to the minimal possible distance to assume away secular trends unrelated to the one-off change in the law drive the estimates.[21] The primal assumption is that the overturn in school enrolment observed in Figure 2.5, in the Appendix, results from the educational reform. The figure plots the number of students enrolled in secondary school in the pre and post reform period, where one can see that total secondary school students fell during the three years prior to the reform (and there were fewer enrolled students to secondary school in 1992 than in 1985). By the end of the 1990s decade, secondary school enrolment rates were 27.3 percent above the corresponding rate to the 1992-1993 schooling cycle.

This exogenous source of educational variation of the parents is used to identify causal effects by instrumenting parental years of schooling with the policy shock. The first stage equation is as in equation 2.4, in which $Reform1993$ is a cohort specific indicator for parents affected by the policy. Results of this first stage are at the bottom of Table 2.1.[22]

$$Schooling_i^{parent} = \alpha_1 + \lambda Reform1993 + \Gamma X_i + \eta_i \tag{2.4}$$

Causal effects are estimated for both enrolment to school and work likelihood as outcome variables. The estimates that result from this are interpreted as local effects that measure the average intergenerational impact of parental education on the children of the complier group. Differences in school-enrolment and employment on the children are attributed to the increase in parental schooling brought

[21] Parents aged 31-38 in 2015, and 36-43 in 2020 (so born between 1977-84). Results robust to shorter specifications. Later educational reforms happened in 2002 (pre-school) and 2006 (higher secondary). These are too recent to be analysed for the extent to which intergenerational mobility is the interest.

[22] The reform used to disentangle causality looks at an exogenous increase in the extensive margin of education. Understanding whether intensive margin adjustments -such as changes in curricula or the like- have intergenerational spillovers is a body literature that is largely missing, specially for developing economies. Knowing more on this would bring answers about long-standing questions of why and how education shapes the dynamics of social and economic life.

by the reform.

Instrumental variable estimates, which are presented in the IV columns of Table 2.1 next to their least squares counterparts, show that the association between parental education and children outcomes is causal. That is, the correlation between parental and children outcomes not only results from positive links between factors that are correlated with education or teenage work such as family income, access to school, effort or ability.

This occurs distinct mechanisms such as parental education affecting directly the quality of the endowments that children have. In this line of reasoning, Currie and Moretti (2003) document a positive relationship between maternal education and children's birth weight, a predictor of future health and later performance. In a parallel argument, parental education may have incidence in the choice of other inputs or may indirectly facilitate a higher quantity and quality of other inputs through its effect on household income.

By construction of the sample, the compliers of the reform are the same in both the child-work and child-enrolment analysis, so the estimations capture two distinct spillovers effects for the same subpopulation. In this sense, the instrumented estimates indicate that parental education has spillovers across generations and may happen over multiple realms in the lives of their children. Specifically, an increase in a parental year of schooling led to an average 1.5 - 4.7 percentage point increase in secondary school enrolment and a 1.1 - 3.9 point decline in the likelihood of work. This is for the children of those who would have not stayed in school had the reform not taken place. Only one of the causal estimates is not statistically significant, which is for maternal education and enrolment to secondary school in the 2020 census.

Notice that the instrumented estimates are stronger that their least squares counterparts, particularly the estimates for the father. This is explained by the fact that least squares identify population averages, whereas the instrumented estimates provide local effects of parental education on children. With heterogeneous population there is a whole distribution of treatment effects and the average reform effect among the treated is different from the average population effect (Angrist and Krueger 2001 and Blundell and Dias 2009), and as the reform increased mandatory leaving age from 12 to 15, those affected by the reform are individuals who would have completed primary school or less had the reform not taken place, so these are individuals situated low in the educational distribution.

In relation to the idea of heterogeneous population, because this is a policy reform that happens at a fixed point in time, in the IV estimates, the age of parents change depending on the sweep of the census.

Table 2.1: Intergenerational Persistence or Outcomes (13-15 yr olds).

Birth Cohort		Father		Mother	
Parent	Child	OLS	IV	OLS	IV
Independent Variable: Parental Years of Schooling					
Outcome Variable: Child Enrolment to Secondary School					
1932-42	1954-57	.0486	-	.0518	-
		(.0021)		(.0017)	
1952-62	1974-77	.0341	-	.0386	-
		(.0003)		(.0003)	
1957-67	1979-82	.0281	-	.0306	-
		(.0017)		(.0015)	
1962-72	1984-87	.0269	-	.0268	-
		(.0003)		(.0002)	
1972-82	1994-97	.0185	-	.0189	-
		(.0004)		(.0003)	
1977-84	2000-02	.0159	.0473	.0169	.0248
		(.0003)	(.0107)	(.0003)	(.0064)
1977-84	2005-07	.0219	.0227	.0211	-.0147
		(.0004)	(.0067)	(.0002)	(.0296)
Outcome Variable: Child Works					
1932-42	1954-57	-0.016	-	-0.016	-
		(0.001)		(0.001)	
1952-62	1974-77	-0.013	-	-0.015	-
		(0.000)		(0.000)	
1962-72	1984-87	-0.013	-	-0.013	-
		(0.000)		(0.000)	
1972-82	1994-97	-0.009	-	-0.009	-
		(0.000)		(0.000)	
1977-84	2000-02	-0.007	-0.023	-0.007	-0.011
		(0.000)	(0.007)	(0.000)	(0.004)
1977-84	2005-07	-0.009	-.0225	-0.009	-0.039
		(.0003)	(.0049)	(.0002)	(.0013)
Outcome Variable: Child Completion of Secondary School					
1906-36	1952-54	.0473	-	.0525	-
		(.0010)		(.0013)	
1926-56	1972-74	.0477	-	.0584	-
		(.0002)		(.0002)	
1931-61	1977-79	.0433	-	.0529	-
		(.0010)		(.0014)	
1936-66	1982-84	.0398	-	.0456	-
		(.0002)		(.0001)	
1946-76	1992-94	.0269	-	.0297	-
		(.0002)		(.0003)	
1951-81	1997-99	.0211	-	.0232	-
		(.0002)		(.0002)	
1956-86	2002-05	.0186		.0206	
		(.0001)		(.0001)	

First Stage

Independent Variable: =1 for those born after 1981

Outcome Variable: Years of Schooling of the Parent

	Father	Mother
λ	1.176	1.574
se	(.025)	(.019)
F	2146.2	6472.2
N	792,122	1,284,578

Standard error in parenthesis. Main Independent Variable: Years of schooling of parent. Mother and Father Regressions Separately

In particular, for children born between 2000 and 2002, the age of parents is rel-

atively low. These are individuals that were 18-22 years old when they became parents of the child and we then observe in 2015. For these, the causal effects on education is stronger than for the older parents (who are also more educated on average). When the focus is on children born between 2005 and 2007, parents are 23-27 years old at the time of birth.

As parenting age differs, household are thought to be structurally different and the IV estimates may not be fully comparable (between cohorts). There is a great degree of consistency in the estimates however, which suggests that the causal effect is not exclusive of a particular population group.

2.3.3 Geography of Mobility

Instrumental variable estimates are recovered at a national level; yet least square are identified also at a state (32 states) and municipality (2,456 municipalities) level. As we move from focusing on national level estimates to smaller estimation units: (1) regional heterogeneities and patterns of association are revealed, and (2) a process of geographical convergence is detected.

One way to display municipality level estimates is by showing how persistence parameters are distributed. This is what Figure 2.6a does, for four different cohorts. From children born between 1982-84 (1990 census) to the cohort of 1997-99 (2015 census). Overlapping the distributions shows a general shift towards lower persistence values (a shift to the left), and a reduction in the variance of mobility estimates.

The fall in dispersion indicates that municipalities with initially higher values of persistence are more likely to have made larger gains over the period.[23] Figure 2.6b shows this by plotting the educational persistence level, relative to the national level, against the absolute change in persistence between 2000 and 2015 (and 2010 to 2015 in the right hand side panel). Negative values in the vertical axis correspond to municipalities where persistence has fallen (or mobility has improved).

The downward relationship indicates that insofar the discussion spins around intergenerational mobility in education, lagged places are gradually catching up.

[23] These are the distribution for the cohorts of children that were 16-18 and 13-15 at the time of the census.

Mobility Correlates

This last section studies the relationship between mobility and different features of the social structuring. Municipality level parameters, for the most recent cohort, with completion of secondary schooling as an outcome variable are mapped in the top left panel of Figure 2.7. Then, in Figure 2.8, for a series of metropolitan areas, presenting the anatomy of mobility within urban areas.[24] The persistence parameters are normalised with respect to the national level ($\frac{\Psi_{Mun}}{\Psi_{Nat}}$)[25], for ease of interpretation.

The geographical variation observed pushes the question about existing linkages between intergenerational mobility and the social and economic structure. This is the spirit of the research on the geography of mobility.

Expanding this literature to developing countries matters because features that might be over-looked in one context might be relevant in another, just as Alesina et. al 2021 shows while studying correlations of mobility with colonial investments in Africa. Considering context is central to formulate associations that are relevant and, while non-causal, provide coherent connections with evidence and theories.

The relationships studied are captured in various ways, one is through the parameter χ from equation 2.5. In this equation, the independent variable is the normalized municipality level persistence parameter, so a one unit increase in the ratio represents a doubling of intergenerational persistence, relative to the national average. On the other hand, the dependent variable is allowed to take different variables and hence the interpretation of the coefficient varies together with the variable. The estimated parameters are summarized in Table 2.2 and analysed next.

$$Social_{Mun} = \alpha + \chi * \overbrace{\left(\frac{\Psi_{Mun}}{\Psi_{Nat}}\right)}^{Persistence_{Mun}} + \varepsilon_{Mun} \tag{2.5}$$

Where:

[24] This has parallels to research for the UK that finds differentiated patterns of mobility in London to the rest of the country (Bell, Blundell and Machin 2019)

[25] Municipality level parameters for the cohort of children born around 1999. Outcome variable: Completion of secondary school.

$$Social_{Mun} = \begin{cases} \text{Poverty} \\ \text{Fertility (number of children, child mortality, teenage pregnancy)} \\ \text{Internal Migration} \\ \text{Ethnic Composition} \end{cases}$$

Table 2.2: Correlates of Intergenerational Persistence or Outcomes (13-15 yr olds).

	Correlates	
	χ	SE
Internal Migration	-0.093	(0.023)
Fertility	1.28	(0.081)
Teenage Pregnancy	0.037	(0.005)
Child Mortality$^{\diamond}$	0.027	(0.002)
Poverty*	0.251	(0.019)
Extreme Poverty*	0.145	(0.013)

Interpretation of correlates: *:$\beta * 100$ and $^{\diamond}$: $\beta * 1000$. χ from eq. 2.5.

Poverty: A measure of multidimensional poverty that considers seven dimensions. Following official poverty accounting, a person is considered *poor* whenever it has an income below a poverty threshold and lacks at least one (but any) of the remaining 6 dimensions: food security, health and education services, housing, social security and certain public services.[26] A person is considered *extreme poor* if, in addition of being income deprived, the person lacks 3 or more of the other 6 dimensions.

In the analysis both measures of poverty provide the share of the population, in each municipality, living under these conceptions of poverty (the variable is distributed between $[0, 1]$).

As pointed in Table 2.2, persistence of educational outcomes and poverty are strongly intertwined, with a ten percent increase of the persistence ratio is associated with a 2.5 percentage point increase in the poverty rate and a 1.45 point rise in the extreme poverty rate. The relationship between persistence of early educational outcomes and poverty could make echo to frameworks that study poverty circles (Balboni, Bandiera, Burgess, Ghatak, & Heil 2020).

[26] Accounting by CONEVAL. Income thresholds as of November 2019: 81.4 US dollars per person a month in urban areas and 56.6 in rural areas. Basic services are: Access to running water, electricity, garbage collection, drainage and so on.

Fertility: This is looked at from three different angles. First, measuring average number of living children per woman; then, the share of women $[0, 1]$ that had a child during the ages of 15-19; lastly, from the perspective of chances of survival for children (with a life to death child ratio). These distinct measures provide information about the circumstances in which children are born in each area.

Existing research has provided evidence and theoretical grounds to expect a relationship between fertility and family planning with intergenerational mobility. One initial premise is on the existence of a trade-off between number of children and the resources that parents can give to their children; a situation that arises because both, time and material inputs, are finite. As in Becker (1991), where the individual is not seen in isolation but as part of a family whose members span several generations and thus choices are made to maximize the well-being of the family-line.

Similar conclusions are reached in other disciplines through different approaches. For instance, Van Bavel 2006 points that a large body of sociology understands that "the decline of fertility [...] is the consequence of the emergence of a child-oriented society. In such a society, parents' main investment consists of helping their children to get ahead. -The fewer the children, the more time and care could be devoted to each and the better the results." In a similar note, a parallel body of research shows that the timing of parenthood affects parenting decisions and family earnings with long term consequences (Carneiro, López García, Salvanes and Tominey (2015))[27].

The estimates of this study show that a ten percent rise in the intergenerational persistence parameter is associated with: (i) an average increase of 0.13 children per woman, where the national fertility rate for the sample is 2.76 children; (ii) when the focus is the share of women who are 15 to 19 years old and have had children[28], the recovered parameter points to a 0.37 percentage point increase in likelihood of observing a teenage mother; (iii) lastly, when looking at child mortality, defined as the ratio of dead to living children within households, a same increase in persistence is associated with 2.7 additional child deaths per 1000 born. These are strong associations that shine attention to the fact that places in which there is low education mobility are also places more likely to have

[27] Looks at Norwegian administrative data to show how timing of parental income affects children outcomes all the way into adulthood

[28] This subsample corresponds to the cohort of children studied in the regression analysis.

low chances for child survival, higher teenage pregnancy and female fertility rates.

Migration: Measured as the share of the population coming from a different state to the one in which current municipality is located.[29] As such, it is a measure of out-of-state, internal migration. Here the focus is the population aged 20 to 40 years.

A priori, one expects that the decision to migrate is linked to the relative opportunities of both the place of origin and destination. Areas in which parental background is a stronger predictor of early in life success are places with more unequal distribution of opportunities, so the expectation is that high persistence municipalities are less likely to attract migrants.

In this direction, estimates point that a ten percent increase of the persistence parameter is associated a 0.93 percentage points fewer migrants as a share of the total population. This is substantial in relative terms as the share of the national percentage of people who migrate every 5 years spins around 3 and 5 percent (see Table 2.4).

Ethnicity: This part of the research looks at ethnicity, using a self-identification variable from the census. The dependent variable corresponds to the share [0,1] of the population within each municipality that 'identifies' with an indigenous group, regardless of whether they speak the language. To some extent the discussion has parallels with that of Chetty et al 2014 and Card et al 2018 for racial disparities and mobility in the United States. At the same time, the discussion has large differences too. One is the large number of native civilizations to Mexico; another, the fact that some of these groups have a special legal right to follow unique social norms.

These populations live in tightly formed clusters, as observed in the top right panel of Figure 2.7. These happen to also be low mobility regions. The estimated relationship points that a 2.09 percentage point increase in minority group representation is associated with a ten percent increase in the intergenerational persistence level with respect to the national level.

In 2015, 21 percent of population identified as indigenous (6.6 percent speak an indigenous language). Historical exclusion and complexities of the societal

[29] The census allows to recover place of birth and of residence prior to the census.

system, with land tenure at its centre, could be underlying blocks of the relationship found. This motivates a branching research that explores labour aspects of Indigenous groups and intergenerational language transmission (De la Fuente Stevens and Pelkonen).

2.4 Conclusion

This research provides a comprehensive study of intergenerational persistence of education in Mexico. The research is based on a series of censuses and looks at co-residents born between 1906 and 2002, rendering millions of parent-child pairs and the possibility to study mobility at a thin geographical level and from a long time horizon.

This paper exploits data from seven Mexican censuses (1970, 1990, 1995, 2000, 2010, 2015 and 2020) to investigate the extent of persistence in educational attainment across generations of co-residing parents and children. The seven cohorts spanned those children born between 1951-52 to parents born from 1906 to 1936 up to those children born between 2005-07 to parents born from 1978-86.

There are three empirical phases to the analysis. The first is descriptive and estimates persistence parameters for different cohorts. In this part, the focus is on child schooling and labour market outcomes, and concludes that intergenerational relationships are weakening over time. The second uses an educational policy reform in Mexico to causally estimate the persistence parameters using an instrumental variable for the final two (of the original) cohorts and finds that these are statistically significant. This shows that the intergenerational association is not only driven by differences in social position of the parents but that education has the capacity to permeate multiple generations. For one cohort this research also finds that the relevant persistent effects are larger in magnitude compared to the comparable OLS estimates. The third and final phase exploits municipal level data to empirically examine the relationship between a variety of socio-economic and demographic outcomes and municipal level persistence. It focuses on migration, ethnicity, poverty, fertility and child health. The key finding for this final part of the analysis is that adverse outcomes are weakest in those municipalities where persistence (and hence a lack of generational mobility) is strong. A process of convergence is observed, mobility levels are geographical

persistent and important disparities continue to exist.[30]

Research on intergenerational mobility looks at the degree and mechanisms through which the structure of families, and thus societies, replicate across generations. Because education builds cumulatively, and schooling sets the framework in which a series of skills develop, initial stages in the educational formation has long term implications over the lives of individuals. In this light, conceptualising access to education from a household dynamic perspective can help explain how initial inequalities replicate across generations and help policymakers design policies that contemplate the ripple effects of their policies.

Another key takeaway from this research is that where there is variation in attainment of outcomes early in life, census data holds a wealth of intergenerational information for contexts that do not have longitudinal data or linkable administrative records to study intergenerational mobility.

[30]Municipality-level cross time correlations of persistence levels are between 0.52 and 0.6 between censuses.

2.5 Appendix: Tables and Figures

Figure 2.4: Upward or Downward mobility? Hypothetical Settings: No Mobility, Full Upward Mobility, Full Downward Mobility

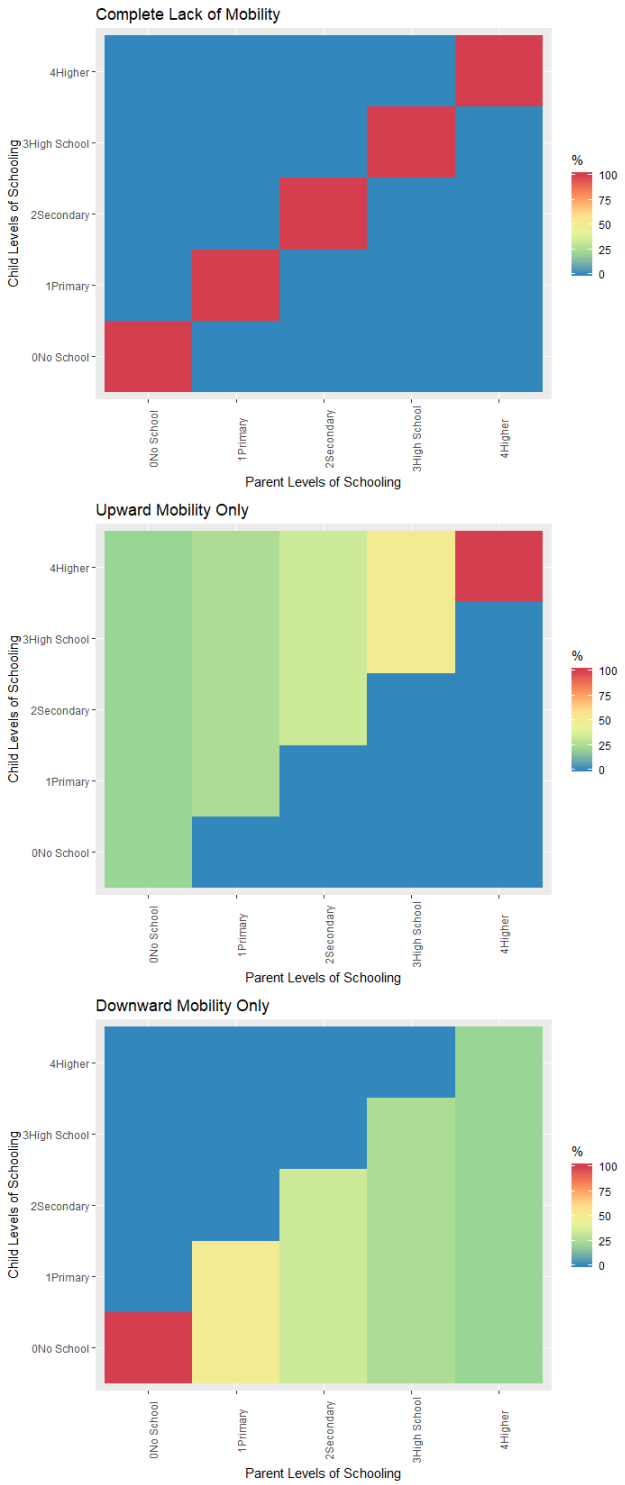


Figure 2.5: Education Reform and Enrolment to Secondary School (National Level)

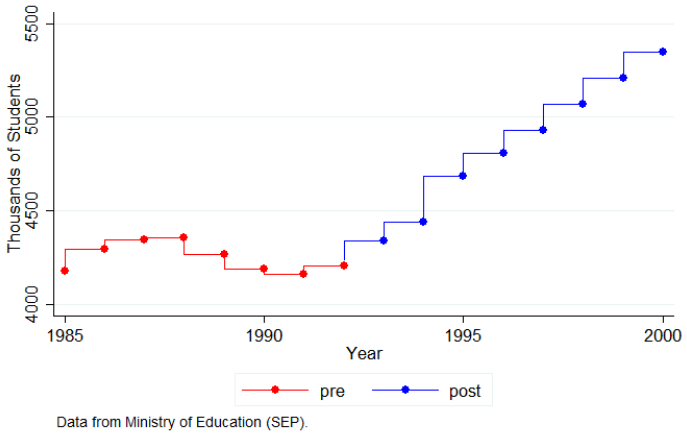
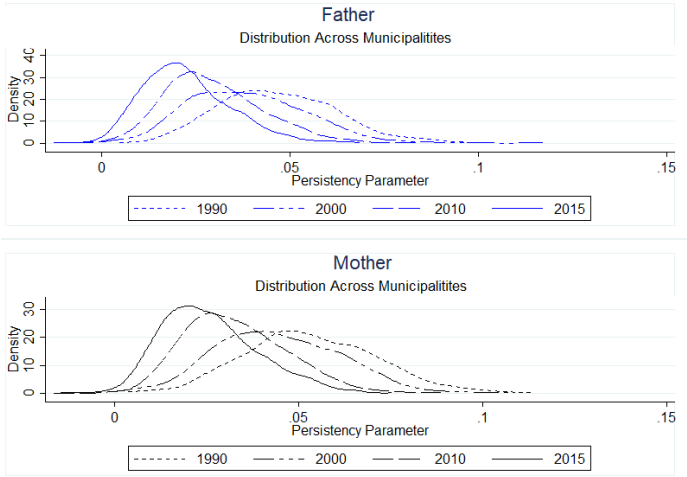


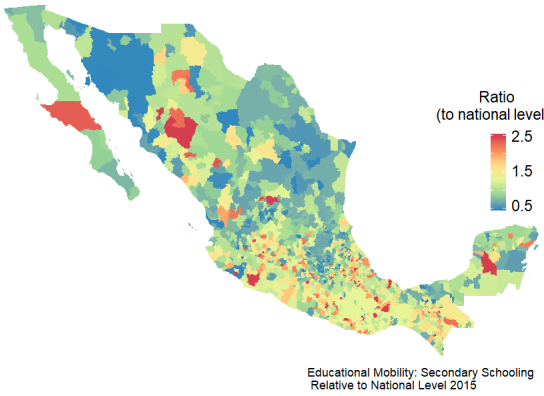
Figure 2.6: Convergence of Intergenerational Mobility

(a) Parameter distributional shift

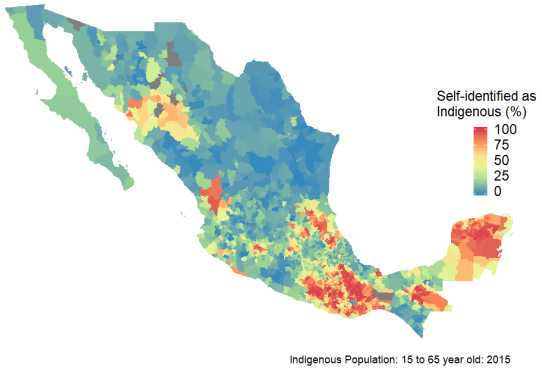


(b) Mobility changes and its level

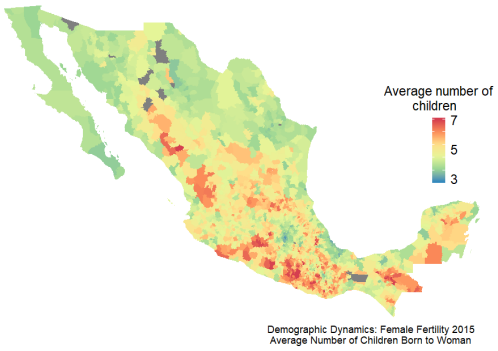
Figure 2.7: Intergenerational Mobility and its Correlates 2015



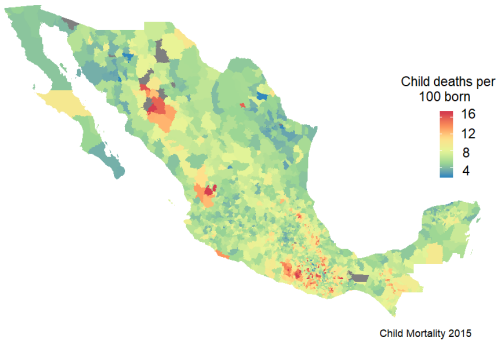
(a) Intergenerational persistence



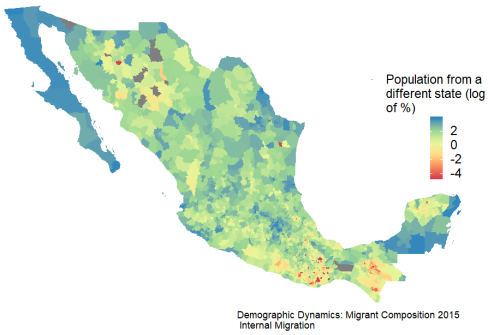
(b) Indigenous population



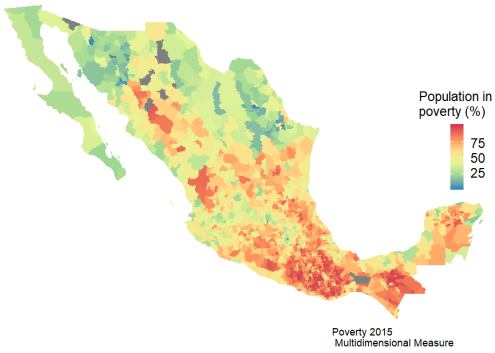
(c) Female fertility (per woman)



(d) Child Mortality (death to life ratio)

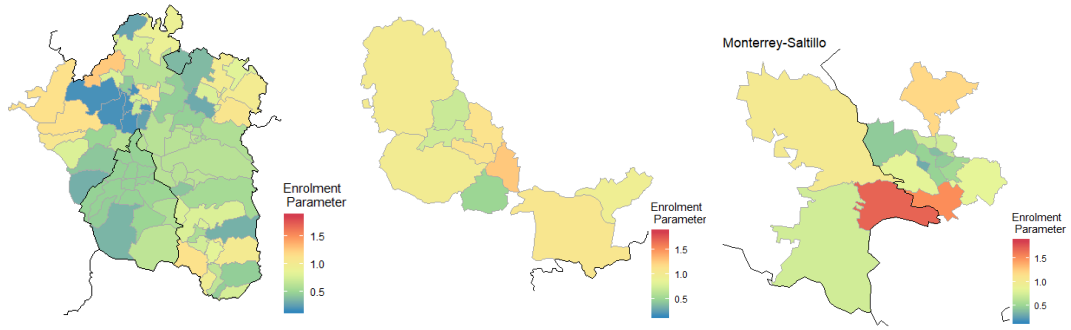


(e) Proportion of internal migrants



(f) Multidimensional poverty index

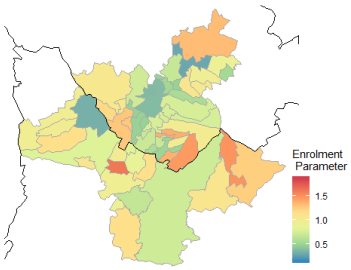
Figure 2.8: Intergenerational Persistence of Educational Outcomes in Metropolitan Areas of Mexico (values relative to national average, for 2015).



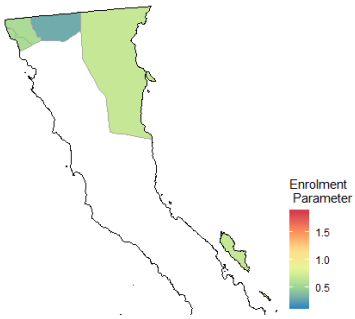
(a) Mexico City

(b) Guadalajara

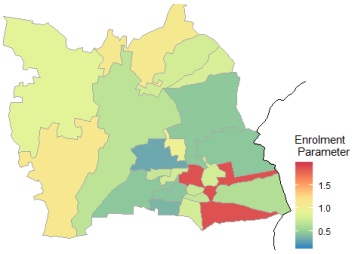
(c) Monterrey-Saltillo



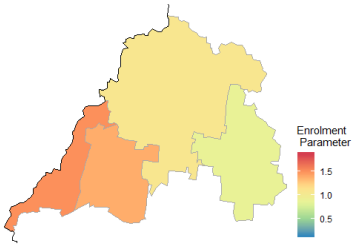
(d) Puebla-Tlaxcala



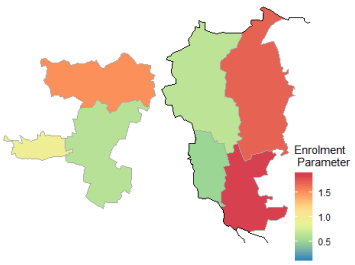
(e) Tijuana-Mexicali



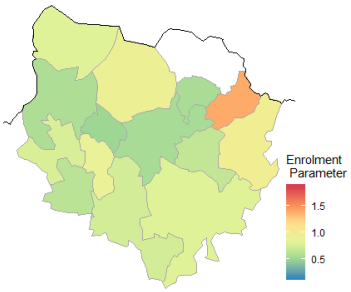
(f) Toluca



(g) León - San Francisco del R.

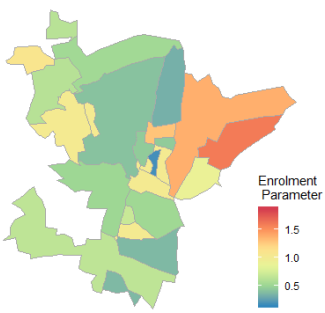


(h) Querétaro-Celaya.

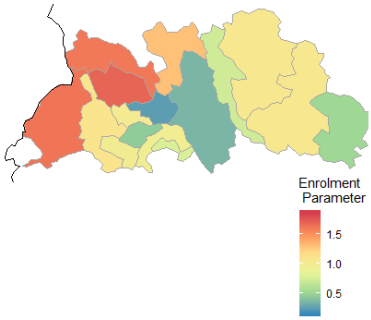


(i) Cuernavaca-Cuautla

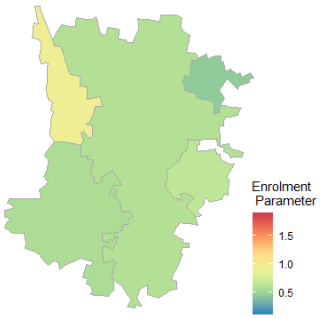
Figure 5 (part 2) Intergenerational Persistence of Educational Outcomes in Metropolitan Areas of Mexico (values relative to national average, for 2015).



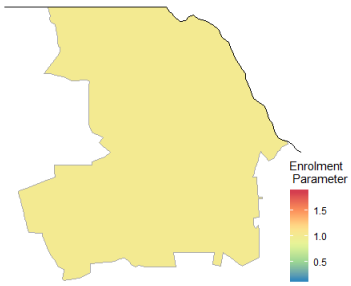
(a) City of Oaxaca



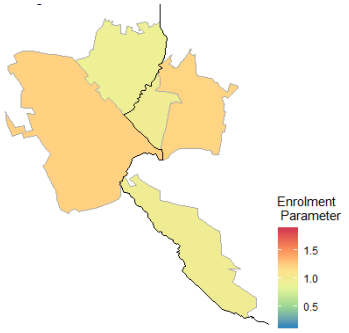
(b) Córdoba - Orizaba



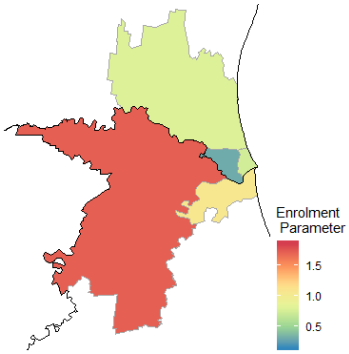
(c) Mérida



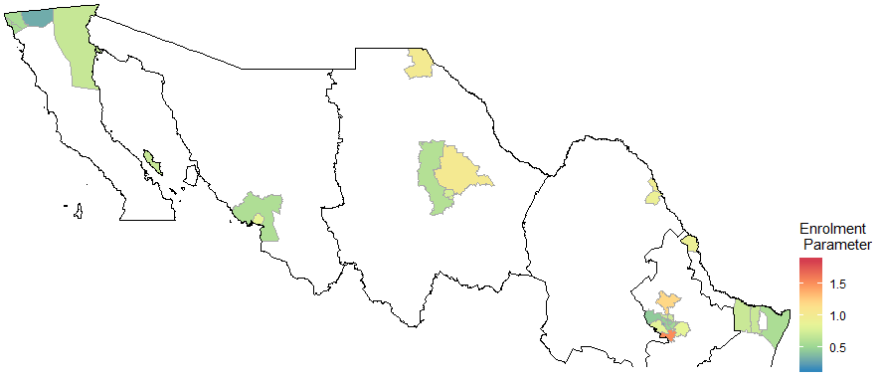
(d) Ciudad Juárez



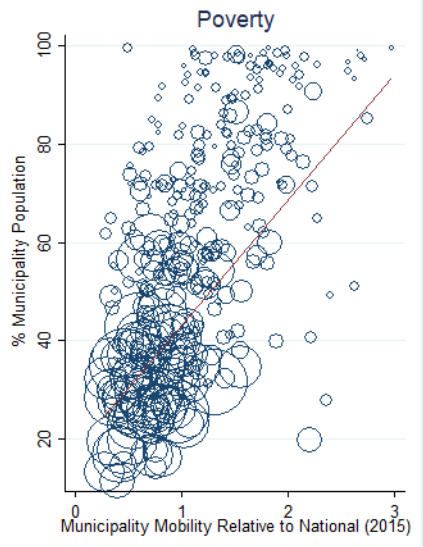
(e) La Laguna

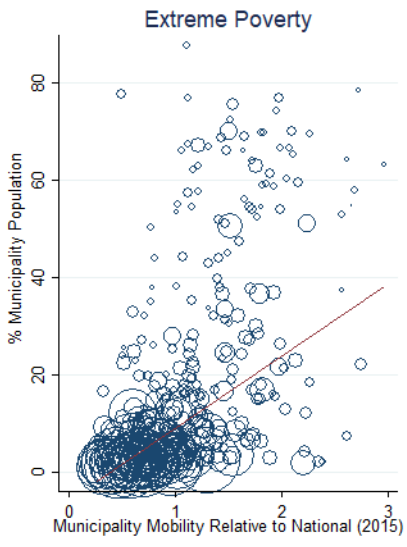


(f) Tampico

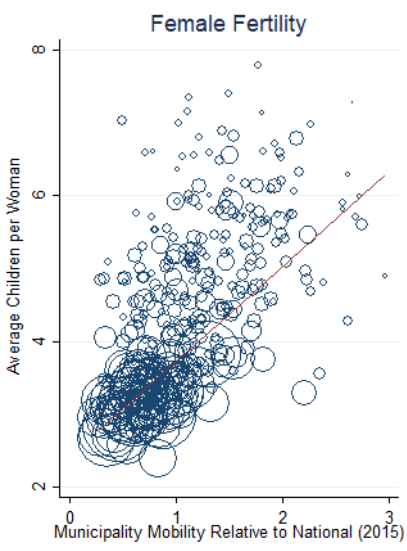


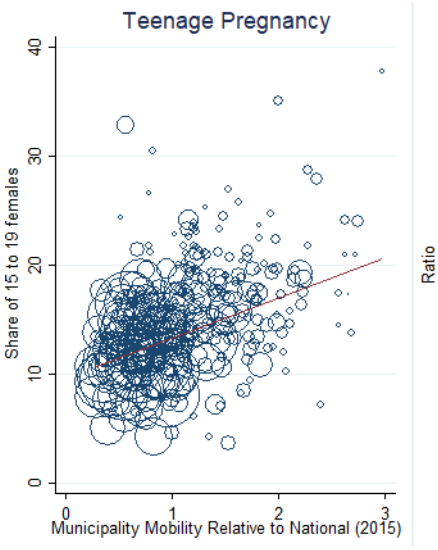
(g) Number of cities in US border states

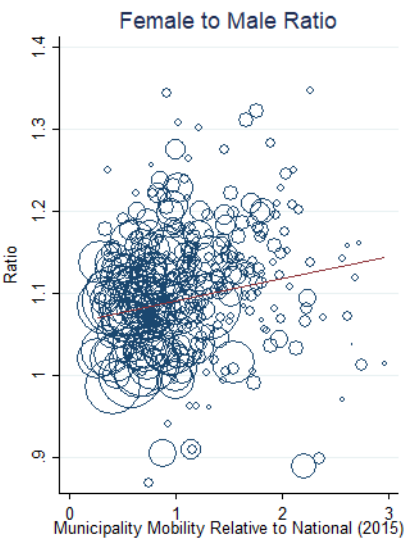

Poverty
% Municipality Population
20
40
60
80
100
0
1
2
3
Municipality Mobility Relative to National (2015)

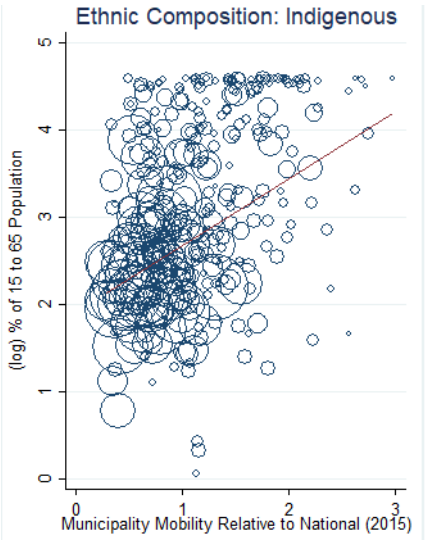

Extreme Poverty
% Municipality Population
0
20
40
60
80
0
1
2
3
Municipality Mobility Relative to National (2015)

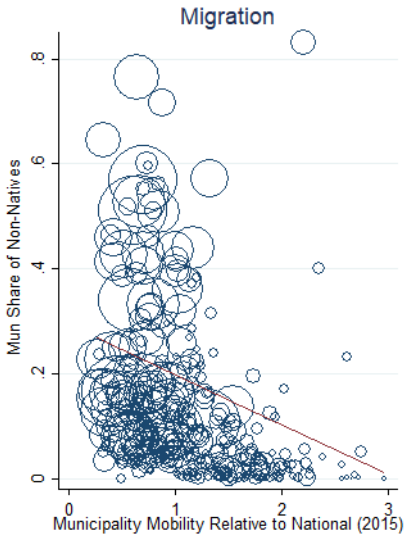

Child Mortality
Death to Life Ratio
0
.05
.1
.15
.2
0
1
2
3
Municipality Mobility Relative to National (2015)

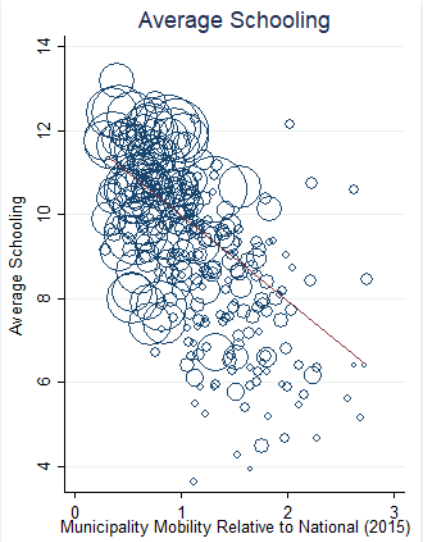

Female Fertility
Average Children per Woman
2
4
6
8
0
1
2
3
Municipality Mobility Relative to National (2015)


Teenage Pregnancy
Share of 15 to 19 females
0
10
20
30
40
0
1
2
3
Municipality Mobility Relative to National (2015)


Female to Male Ratio
Ratio
.9
1
1.1
1.2
1.3
1.4
0
1
2
3
Municipality Mobility Relative to National (2015)


Ethnic Composition: Indigenous
(log) % of 15 to 65 Population
0
1
2
3
4
5
0
1
2
3
Municipality Mobility Relative to National (2015)


Migration
Mun Share of Non-Natives
0
.2
.4
.6
.8
0
1
2
3
Municipality Mobility Relative to National (2015)


Average Schooling
Average Schooling
4
6
8
10
12
14
0
1
2
3
Municipality Mobility Relative to National (2015)

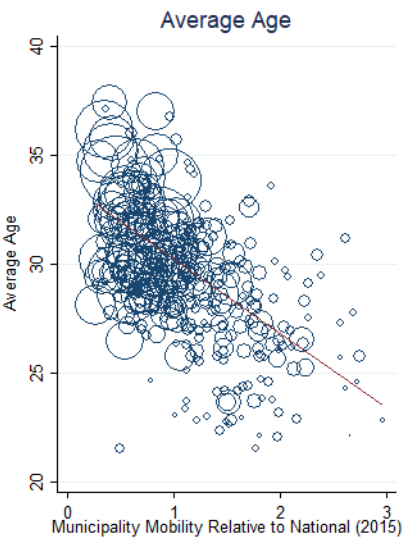

Average Age
Average Age
20
25
30
35
40
0
1
2
3
Municipality Mobility Relative to National (2015)

Table 2.3: Descriptive Statistics: Parents (28-38)

Summary statistics of the parents

Enrolment to Secondary School

Year	Child	Age	School	Illit.	Sec.	Uni.	Indig.	Obs.	Child	Age	School	Illit.	Sec.	Uni.	Indig.	Obs.
Mother									Father							
1932-42	3.85	35.3	2.48	31.27	3.26	.43	7.98	9532	3.46	35.84	2.81	22.33	4.14	1.07	10.17	4755
1952-62	3.4	35.2	4.52	15.65	14.56	1.54	7.95	188289	3.16	35.78	5.44	9.28	21.55	4	9.61	102961
1957-67	3.12	35.24	5.67	13.91	25.2	3.44	-	8090	2.95	35.76	6.52	7.83	31.82	6.4	-	4751
1962-72	2.86	35.23	6.4	9.61	33.47	3.67	8.43	210287	2.71	35.72	7.01	6.04	39.59	5.54	9.79	118912
1972-82	2.66	35.29	7.67	6.29	51.18	5.43	9.86	239788	2.6	35.75	7.82	4.52	52.67	5.72	11.28	144096
1977-84	2.56	35.22	8.15	5.12	58.42	6.33	10.13	214953	2.51	35.68	8.22	4.1	58.56	6.63	11.36	129334

Completion of Secondary School

Obs.	Child	Age	School	Illit.	Sec.	Uni.	Indig.	Obs.								
Mother									Father							
1910-42	4.79	43.16	2.36	34.39	3.46	.44	7.31	17450	4.83	47.61	2.98	23.44	6.14	1.91	7.81	16988
1930-62	4.31	43.7	3.73	22.54	10.43	1.26	7.92	372346	4.34	47.42	4.55	13.72	16.17	4.52	8.36	366617
1935-67	3.81	43.05	4.5	21.34	16.17	2.77	-	14861	3.82	46.41	5.56	12.91	24.25	7.76	-	14629
1940-72	3.42	42.73	5.59	14.45	25.73	4.13	8.76	376019	3.44	46.06	6.43	8.96	32.13	9.45	9.56	372897
1950-82	2.96	42.97	7.3	10.37	45.32	8.51	10.43	480161	2.96	45.93	7.89	6.78	49.15	12.66	10.94	477483
1955-84	2.75	43.02	8.13	7.27	55.71	10.37	9.94	389580	2.76	45.87	8.57	4.94	57.57	13.86	10.34	394324

Summary statistics of children: Enrolment to Secondary School

Mother to Child Sample									Father to Child Sample							
Year	Age	Illit.	Enrolled	Indig.	Migr.	Works	Rural	Obs.	Age	Illit.	Enrolled	Indig.	Migr.	Works	Rural	Obs.
1955-57	13.85	12.4	55.85	6.26	-	16.08	-	9532	13.79	13.75	54.63	7.78	-	16.29	-	4755
1975-77	13.88	3.02	74.07	5.35	4.62	10.45	28.19	188289	13.81	3.19	74.87	6.47	4.65	9.86	28.04	102961
1980-82	13.87	2.34	79.19	-	4.68	16.48	27.82	8090	13.83	2.79	79.56	-	4.72	16.75	27.34	4751
1985-87	13.88	1.45	81.14	5.24	3.89	12.91	26.91	210287	13.83	1.5	81.41	5.74	4.04	12.66	26.43	118912
1990-92	13.92	.84	87.6	6.26	3.48	8.22	27.88	239788	13.88	.87	87.7	6.98	3.54	8.06	28.14	144096
2000-02	13.9	.59	90.03	6.57	3.32	5.25	28.34	214953	13.86	.58	90.47	7.3	3.1	5.00	29.08	129334

Summary statistics of children: Completion of Secondary School

Mother to Child Sample									Father to Child Sample							
Year	Age	Illit.	Enrolled	Indig.	Migr.	Works	Rural	Obs.	Age	Illit.	Enrolled	Indig.	Migr.	Works	Rural	Obs.
1952-54	16.95	11.91	28.74	5.45	-	40.12	-	19053	16.94	12	28.96	5.55	-	38.97	-	16988
1972-74	16.96	2.99	44.48	4.86	3.36	33.52	26.87	418434	16.96	3.02	44.44	5.15	3.21	32.96	28.03	366617
1977-79	16.99	3.13	45.1	-	3.13	43.15	26.83	16628	16.98	3.05	45.47	-	2.94	42.49	28.33	14629
1982-84	16.96	1.98	51.32	5.04	2.92	37.31	24.76	428731	16.96	1.96	51.56	5.37	2.76	36.57	25.79	372897
1992-94	16.98	1.03	61.2	5.92	2.4	28.01	26.53	555044	16.97	1.01	61.67	6.31	2.25	27.27	27.53	477483
1997-99	16.99	.74	68.09	5.81	2.49	21.94	24.87	461070	16.99	.71	68.5	6.16	2.38	21.2	26.03	394324

Child: Average number of children (same parent) in household. Age: Average age. School: Average years of schooling of the parent. Illit: Illiteracy rate ('cannot read or write a message'). Sec: % Parents that completed secondary school ($\geq$ 9 years of schooling). Uni: % parents with years of schooling $\geq$ 15. Indig: % Population that speaks indigenous language. Migration: % in which state of residence 5 years prior census differs from current state. House: Home ownership status is 'owned and paid'. Obs: Number of observations in regression sample. Enrolled: % Children that attend school. Migration: % for which the state of residence 5 years prior to the census differs from current state. Works: % of children that are employed. Rural: % of population living in towns with less than 2,500 inhabitants. Remaining variables, as with parents.

Table 2.4: Schooling of parents over time (28-38 year old).

Distribution of parental education over time (28-38 year old)

Years	Father						Mother					
	Year of birth											
	1932-42	1952-62	1957-67	1962-72	1972-82	1977-1987	1932-42	1952-62	1957-67	1962-72	1972-82	1977-1987
None	.287	.123	.072	.052	.038	.032	.397	.214	.128	.094	.052	.046
1	.081	.026	.026	.021	.010	.007	.065	.031	.041	.028	.011	.009
2	.143	.071	.054	.044	.025	.018	.130	.086	.056	.059	.027	.021
3	.150	.107	.081	.068	.048	.037	.133	.126	.109	.085	.046	.037
4	.075	.060	.047	.037	.024	.018	.071	.068	.057	.049	.026	.021
5	.038	.041	.035	.030	.023	.019	.031	.043	.046	.035	.025	.020
6	.135	.259	.242	.224	.200	.182	.124	.253	.270	.247	.224	.200
7	.010	.017	.021	.021	.016	.012	.005	.009	.009	.013	.012	.010
8	.016	.029	.036	.038	.032	.026	.005	.013	.017	.025	.026	.022
9	.017	.124	.167	.216	.305	.328	.011	.102	.133	.153	.281	.320
10	.003	.010	.018	.021	.018	.016	.001	.003	.004	.010	.012	.011
11	.007	.019	.020	.026	.025	.024	.003	.007	.008	.021	.025	.019
12	.007	.035	.059	.097	.117	.145	.007	.012	.035	.083	.113	.126
13	.001	.003	.014	.011	.005	.008	.003	.001	.019	.019	.006	.007
14	.001	.006	.007	.007	.008	.009	.001	.002	.003	.005	.007	.007
15	.003	.007	.008	.011	.020	.020	.000	.004	.008	.008	.024	.022
16	.003	.015	.037	.033	.035	.041	.002	.006	.027	.033	.038	.045
17	.000	.023	.032	.029	.031	.034	.000	.005	.016	.019	.026	.033
18+	.013	.016	.012	.004	.010	.015	.002	.007	.006	.003	.009	.014

Table 2.5: Schooling of children over time (6-18 year old).

Distribution of likelihoods: % of children (ages 6 to 18) enrolled in school.

	Year of Census: birth year ranges from 1952-2009											
	1970	1990	1995	2000	2010	2015	1970	1990	1995	2000	2010	2015
Age	Males						Females					
6	30.2	79.1	92.4	91.2	94.5	97.2	30.7	79.6	92.4	91.2	94.6	97.4
7	58.9	88.8	96.7	96.0	96.2	97.9	59.6	88.9	96.1	96.2	96.6	98.3
8	71.7	91.7	96.9	96.8	96.9	98.3	72.0	91.6	97.7	97.0	97.1	98.3
9	78.8	93.1	97.5	97.2	97.0	98.4	77.4	93.1	97.6	97.3	97.4	98.4
10	78.9	92.5	96.8	96.8	96.8	98.1	78.8	92.4	97.3	97.0	97.1	98.5
11	80.6	92.2	96.2	96.6	96.5	98.0	78.7	91.6	95.8	96.7	96.8	98.3
12	74.4	88.1	93.6	93.7	95.5	96.5	71.3	85.6	89.3	92.5	95.2	96.5
13	**69.8**	**82.1**	**87.0**	**88.6**	**91.9**	**93.9**	**61.5**	**77.3**	**82.7**	**86.4**	**92.2**	**94.4**
14	**57.0**	**71.9**	**79.3**	**80.9**	**87.0**	**90.0**	**47.7**	**68.3**	**76.6**	**80.0**	**88.9**	**92.1**
15	**45.4**	**61.2**	**63.4**	**68.7**	**78.8**	**82.2**	**37.3**	**60.2**	**61.2**	**69.0**	**82.5**	**85.2**
16	36.2	49.7	54.1	56.7	65.1	72.9	32.0	51.6	54.0	60.3	71.5	78.3
17	29.9	41.0	43.3	48.9	58.0	66.3	24.7	45.8	47.5	53.9	66.0	74.1
18	22.9	33.7	32.3	38.8	47.4	54.0	18.7	38.0	36.2	43.6	56.0	60.6

Table 2.6: Intergenerational Persistence: Enrolment to Secondary School. State Level Trends. Father-Child Links.

	Birth Cohort (Child)					
	1954-57	1974-77	1979-82	1984-87	1994-97	1999-02
State	Intergenerational Persistency: Father-Child $\Delta\mathbb{P}(school^{CH}\|X)$.					
Michoacán	.046	.042	.035	.036	.029	.021
Chiapas		.04	.025	.029	.022	.021
Coahuila	.023	.027	.013	.025	.022	.02
Colima	.049	.034	.029	.012	.021	.019
Campeche	.07	.043	.034	.018	.008	.019
Durango		.041	.034	.033	.021	.018
Puebla	.049	.042	.037	.034	.019	.018
Chihuahua	.05	.032		.026	.017	.018
Aguascalientes		.033	.015	.029	.02	.017
Baja California		.02	.032	.023	.008	.017
Jalisco	.042	.034	.036	.031	.021	.017
Oaxaca		.035	.035	.024	.018	.016
Tlaxcala		.029	.036	.026	.015	.016
Nayarit	.082	.023	.021	.019	.015	.015
Zacatecas	.056	.037	.032	.035	.014	.015
Veracruz	.051	.04	.03	.025	.02	.015
Sonora	.08	.021	.023	.013	.017	.014
Guanajuato	.057	.043	.046	.034	.017	.014
México	.048	.022	.018	.021	.017	.013
Querétaro		.036	.03	.034	.018	.013
Guerrero	.059	.034	.027	.02	.017	.013
Tamaulipas	.028	.024	.012	.022	.014	.013
Yucatán	.067	.037	.034	.023	.013	.012
Tabasco	.042	.03	.01	.02	.02	.011
Quintana Roo		.028	.022	.018		.011
Nuevo León	.039	.018	.02	.021	.02	.011
Morelos		.022	.025	.024	.013	.011
Baja California Sur	.076	.019	.013	.013	.021	.01
Distrito Federal	.027	.009	.013	.013	.011	.01
Hidalgo	.054	.034	.029	.022	.012	.01
San Luis Potosí	.047	.034	.026	.023	.014	.009
Sinaloa	.068	.028	.023	.023	.011	.007

Outcome Variable: Enrolment of Secondary School (13-15 yr olds.). Main Independent Variable: Years of schooling of parent. Mother and Father Regressions Separately, (Age: 28-38).

Table 2.7: Intergenerational Persistence: Enrolment to Secondary School. State Level Trends. Mother-Child Links.

	Birth Cohort (Child)					
	1954-57	1974-77	1979-82	1984-87	1994-97	1999-02
State	Intergenerational Persistency: Mother-Child $\Delta\mathbb{P}(school^{CH}\|X)$					
Aguascalientes	.077	.043	.028	.03	.019	.028
Durango	.057	.045	.026	.035	.021	.024
Chihuahua	.035	.036	.042	.031	.025	.023
Chiapas	.071	.045	.03	.031	.023	.023
Jalisco	.04	.043	.031	.034	.024	.022
Tamaulipas	.046	.031	.018	.022	.013	.022
Colima	.062	.033	.03	.023	.023	.022
Campeche		.042	.028	.016	.013	.02
Michoacán	.037	.043	.04	.035	.029	.02
Coahuila	.053	.029	.024	.026	.018	.02
Guanajuato	.047	.047	.065	.035	.022	.019
Querétaro	.046	.043	.03	.027	.018	.018
Puebla	.065	.049	.045	.031	.02	.017
Nayarit	.072	.036	.042	.02	.017	.017
Tlaxcala	.054	.033	.032	.027	.017	.017
Zacatecas	.076	.041	.052	.035	.02	.017
Morelos	.087	.033	.014	.027	.02	.017
Veracruz	.051	.04	.044	.026	.02	.015
Oaxaca	.031	.039	.039	.024	.017	.015
Quintana Roo	.083	.03	.034	.016	.011	.015
Tabasco	.031	.033	.023	.023	.011	.014
México	.041	.024	.013	.022	.017	.013
Sinaloa	.059	.037	.024	.024	.016	.013
San Luis Potosí	.044	.036	.035	.02	.013	.013
Guerrero	.07	.037	.024	.021	.016	.013
Yucatán	.06	.046	.032	.022	.013	.012
Nuevo León	.033	.023	.019	.019	.02	.012
Distrito Federal	.028	.012	.014	.015	.015	.012
Baja California	.025	.03	.023	.022	.016	.012
Hidalgo	.036	.036	.03	.02	.013	.012
Sonora	.058	.03	.019	.018	.019	.011
Baja California Sur	.064	.032	.025	.025	.023	.007

Outcome Variable: Enrolment of Secondary School (13-15 yr olds.). Main Independent Variable: Years of schooling of parent. Mother and Father Regressions Separately, (Age: 28-38).

Table 2.8: Intergenerational Persistence: Completion of Secondary School. State Level Trends. Father-Child Links.

	Birth Cohort (Child)					
	1952-54	1972-74	1977-79	1982-84	1992-94	1997-99
State	Intergenerational Persistency: Father-Child $\Delta\mathbb{P}(Secondary^{CH}\|X)$					
Chiapas	0.046	0.058	0.047	0.048	0.033	0.031
Guerrero	0.033	0.054	0.056	0.044	0.033	0.029
Oaxaca	0.047	0.059	0.057	0.048	0.033	0.027
Michoacán	0.04	0.05	0.047	0.046	0.031	0.025
Veracruz	0.053	0.054	0.05	0.043	0.03	0.024
Campeche	0.028	0.047	0.046	0.033	0.026	0.024
Puebla	0.043	0.055	0.047	0.046	0.029	0.023
Querétaro	0.05	0.051	0.044	0.037	0.026	0.022
Chihuahua	0.045	0.047	0.054	0.04	0.03	0.022
Guanajuato	0.041	0.052	0.042	0.047	0.028	0.021
Baja California Sur	0.042	0.04	0.037	0.027	0.03	0.021
Jalisco	0.046	0.048	0.043	0.041	0.028	0.021
Yucatán	0.053	0.056	0.045	0.041	0.027	0.02
Durango	0.035	0.055	0.052	0.043	0.023	0.019
Tlaxcala	0.06	0.042	0.035	0.035	0.023	0.017
Morelos	0.031	0.033	0.034	0.031	0.014	0.016
Nayarit	0.047	0.04	0.038	0.031	0.022	0.016
Aguascalientes	0.07	0.048	0.041	0.036	0.021	0.016
Sinaloa	0.056	0.038	0.034	0.03	0.019	0.015
México	0.034	0.035	0.03	0.03	0.021	0.015
Baja California	0.037	0.033	0.027	0.032	0.018	0.015
San Luis Potosí	0.039	0.05	0.04	0.04	0.022	0.015
Quintana Roo	0.034	0.049	0.044	0.032	0.02	0.015
Coahuila	0.054	0.04	0.033	0.029	0.015	0.014
Hidalgo	0.029	0.056	0.037	0.04	0.02	0.014
Tamaulipas	0.057	0.039	0.034	0.03	0.019	0.014
Zacatecas	0.031	0.052	0.058	0.043	0.021	0.013
Tabasco	0.041	0.044	0.037	0.036	0.017	0.012
Sonora	0.046	0.037	0.035	0.024	0.018	0.011
Nuevo León	0.055	0.029	0.023	0.022	0.016	0.011
Distrito Federal	0.04	0.021	0.019	0.018	0.015	0.009
Colima	0.039	0.047	0.042	0.036	0.02	0.009

Outcome Variable: Completion of Secondary School (16-18 yr olds.). Main Independent Variable: Years of schooling of parent. Mother and Father Regressions Separately, (Age: 34-64).

Table 2.9: Intergenerational Persistence: Completion of Secondary School. State Level Trends. Mother-Child Links

	Birth Cohort (Child)					
	1952-54	1972-74	1977-79	1982-84	1992-94	1997-99
State	Intergenerational Persistency: Mother-Child $\Delta\mathbb{P}(Secondary^{CH}\|X)$					
Chiapas	0.056	0.075	0.069	0.056	0.038	0.033
Michoacán	0.046	0.058	0.063	0.055	0.036	0.03
Guerrero	0.038	0.061	0.062	0.051	0.036	0.029
Chihuahua	0.044	0.058	0.065	0.049	0.033	0.029
Oaxaca	0.041	0.07	0.067	0.052	0.035	0.027
Campeche	0.026	0.052	0.061	0.038	0.027	0.026
Jalisco	0.044	0.061	0.046	0.048	0.034	0.025
Veracruz	0.058	0.064	0.062	0.051	0.034	0.025
Baja California Sur	0.051	0.044	0.045	0.031	0.03	0.024
Puebla	0.05	0.063	0.059	0.051	0.029	0.024
Guanajuato	0.034	0.063	0.053	0.051	0.031	0.024
Querétaro	0.083	0.063	0.055	0.04	0.029	0.022
Durango	0.034	0.069	0.071	0.051	0.028	0.022
Yucatán	0.059	0.068	0.064	0.047	0.028	0.021
Morelos	0.079	0.04	0.047	0.035	0.015	0.021
Sinaloa	0.061	0.05	0.044	0.039	0.025	0.019
Nayarit	0.074	0.051	0.05	0.033	0.027	0.019
Colima	0.049	0.056	0.058	0.046	0.025	0.018
San Luis Potosí	0.04	0.058	0.058	0.045	0.024	0.018
Tlaxcala	0.046	0.048	0.037	0.04	0.024	0.018
Hidalgo	0.058	0.064	0.069	0.046	0.022	0.017
Coahuila	0.049	0.05	0.035	0.032	0.018	0.017
Aguascalientes	0.021	0.055	0.059	0.039	0.024	0.016
Tamaulipas	0.048	0.048	0.047	0.035	0.02	0.016
México	0.046	0.043	0.041	0.033	0.022	0.016
Zacatecas	0.034	0.065	0.073	0.05	0.026	0.016
Baja California	0.039	0.043	0.042	0.038	0.024	0.016
Tabasco	0.046	0.059	0.042	0.043	0.02	0.016
Sonora	0.032	0.047	0.041	0.033	0.022	0.014
Quintana Roo	0.079	0.054	0.059	0.038	0.02	0.013
Nuevo León	0.065	0.036	0.023	0.024	0.018	0.013
Distrito Federal	0.048	0.027	0.018	0.02	0.017	0.01

Outcome Variable: Completion of Secondary School (16-18 yr olds.). Main Independent Variable: Years of schooling of parent. Mother and Father Regressions Separately, (Age: 34-64).

Chapter 3

Economics of Minority Languages: Labour Market Returns and Transmission of Indigenous Languages

Diego De la Fuente Stevens and Panu Pelkonen[1]

Abstract

This study demonstrates a series of links between minority language skills, their economic return and their transmission across generations. Using a detailed matching procedure and different data sources, we estimate the likelihood of being employed for bilingual versus monolingual men for a large number of Mexican Indigenous groups. We find that for Indigenous groups, retaining the minority language along with Spanish increases employment opportunities. Furthermore, we show that the languages that are associated with larger labour market benefits are more likely to be passed on from parents to children, controlling for other factors. Overall, this study shows that the continuity of minority languages across generations is linked to concrete economic benefits, labour market specialisation, and insurance value, along with the usual social factors within the family and the community.

Keywords: Intergenerational transmission, language skills, bilingualism, return to skills, minority languages.

[1]Panu Pelkonen is Lecturer in Economics at the Department of Economics at the University of Sussex.

3.1 Introduction

Many developing countries are characterised by a dominant official language[2] and one or many minority languages that have varying numbers of speakers and differing levels of official status. In the developed world, smaller languages are often beneficiaries of substantial legal protection and educational infrastructure that shield them from an erosion of speakers. This is typically not the case in developing and emerging economies where, in the absence of supportive state institutions, languages either sustain themselves in various networks, or don't and face extinction.

Current trends in linguistic diversity around the world suggest that minority languages are disappearing fast, and that 90% of the world's languages are expected to disappear in the next 100 years (Nettle and Romaine, 2002). For Mexico, the most important reasons for the loss of native languages in the past has been a 'forced language shift', an official policy favouring Spanish; but, in current times, increasingly also a 'voluntary language shift', an abandonment of the language even in the absence of its suppression. This raises questions as to why some languages survive while others fade to exist.

In families where at least one parent speaks an indigenous language, parents weigh the options on what languages to teach to children. In a typical case, parents face a choice of raising bilingual children (who speak both the minority and the majority language), or monolingual children (the majority language only). In the common case where the school system supports only the majority language, parents must make an active effort to maintain the minority language at home.

In this study, we examine the intergenerational transmission of language and the economic rationale of language choice by breaking the family decision to raise bilingual children to different effects. Namely, the strength of social networks and the expected economic return to knowing a minority language. The main social networks are the family and the local area. For the expected economic benefits, we estimate the effect of minority language bilingualism on employment likelihood and earnings.

The study focuses on Mexico, which is one of a handful of large countries which has a rich tapestry of minority languages (66 currently spoken). In the setting, languages remain geographically clustered, which makes it unique to look

[2]Such as English, Spanish or French.

at language variation and compare employment returns, transmission rates, their varying characteristics and conditions. As the Mexican censuses and income surveys distinguish individuals by both ethnicity and language, these may also be unique in allowing for a good documentation of the transmission of languages and their employment effects.

Firstly, we show that indigenous men who are bilingual have, on average, a 2-4 percentage points higher likelihood of being employed, and receive 4.9 percentage higher earnings, as opposed to observationally equivalent indigenous men who can only speak Spanish. These estimates are based on a combination of matching and least squares regression using censuses for employment returns, and the income and expenditure survey (ENIGH) for the earnings estimates. Importantly, the results between OLS and matching differ, suggesting that OLS fails to adequately account for the omitted variable bias due to socioeconomic status.

The large number of observations inherent to the censuses allows us to recover language specific employment returns and intergenerational transmission rates. With this, we show that the estimated employment return varies by language but remains positive for all language groups for which the estimate is statistically different to zero. We present evidence showing that this employment effect derives partly from a larger likelihood of the speakers of indigenous languages to work in agriculture. Results also point that language returns are increasing with the intensity of the local language network and is highest amongst those with least education.

In the second part of the study, we rationalise and estimate a model of language transmission within families. We show that only about two-thirds of children with at least one parent who speaks an Indigenous language, learns to speak it. This proves that a large share of indigenous families in Mexico are at 'the margin' of the decision of whether to teach or not to teach the native language to their offspring.

The results show that the key social determinants of language transmission are the number of parents and other adults in the household that can speak the minority language, as well as the share of people in the municipality who can speak the language. Heterogeneous parents will face difficulties transmitting the minority language because the ability of a parent to diffuse the language depends on whether the partner acts as a barrier for transmission or as a facilitator.[3]

[3] It is as in the model of marriage and cultural transmission in Bisin and Verdier (2000), in which transmission of culture is modelled as the result of interactions inside the family and

Language transmission matrices show that in households in which both parents know how to speak the Indigenous language, 72.9 percent of their children speak it, and 55.3 percent for single mothers. This number drops to 7.9 percent in two parent households in which only the mother is Indigenous bilingual to 4.7 percent when the father is the single bilingual parent.

The empirical model of intergenerational language transmission includes parental characteristics such as education level, municipality and regional characteristics. Once the model is extended to include the estimated employment benefits, which are specific to each indigenous language, we find that larger employment benefits are associated with higher transmission of the language, particularly in rural areas. The strong effect in the rural areas is consistent with the fact that a disproportionate share of indigenous people in Mexico live in rural areas and work in traditional occupations such as agriculture or crafts. Across groups, the average proportion of the indigenous population working in agriculture is 47.6%.

Overall, the results suggest that among the numerous indigenous populations of Mexico, knowing the Indigenous language allows for broader job opportunities in occupations that the Indigenous populations specialise in. As such, learning the indigenous language can be thought of as an 'insurance' against the possibility of an unsuccessful integration to the mainstream job market, where the Spanish language dominates.

The economic literature on language skills is not broad. Particular attention has been paid to the return on language skills of migrants in the developed countries, and the generic, and reasonably well identified conclusion is that immigrants have a high return on fluency in a dominant language (Dustmann 1994, Chiswick and Miller 1995, Dustmann and Fabri 2003, Bleakley and Chin 2004, Miranda and Zhu, 2013). These studies find that immigrants who are proficient in English in the UK, the US or Australia earn 5-36% more, depending on the estimation method (OLS and various instrumental variables). Dustmann and Fabri also report a positive effect on employment in the UK. The study on German fluency in Germany by Dustmann (1994) suggests a wage return of 7-15% using OLS with Heckman selection. On the other hand, Yao and van Ours (2015) find only modest wage effects for immigrant women and none for men in the Netherlands with respect to fluency in Dutch.

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society, where the ability of a parent to transmit his/her cultural traits crucially depends on the choice of partner which is a function of ethnic representation.

In the developing or emerging countries, a particularly well documented relationship is the economic benefit of knowing English in India, where a substantial positive return has been reported at least by Azam et al (2013) and Chakraborty and Bakshi (2016). A somewhat different angle to the same question is provided by Shastry (2012) who shows that economic areas in India that have had a lower threshold for learning English, have grown faster due to opportunities provided by globalisation and information technology.

One study that explicitly estimates employment and wage returns to bilingualism in native language and Spanish, is Chiswick, Patrinos and Hurst (2000), who find that bilingualism is a disadvantage in contrast to speaking only Spanish in Bolivia. Their study is based on an OLS estimate that does not control for ethnicity or a more precise matching of characteristics. As language and ethnicity are highly correlated, it is possible that the negative effects of bilingualism estimated in the paper are being driven by unobserved ethnicity, and the relative economic disadvantage of indigenous groups.

For our work, another relevant and interesting study is one by Munshi and Rosenzweig (2006) which shows that the choice of language of schooling in India has long-run implications for the labour market specialisation of the pupils as they grow up. In the study, they show that working class boys are disproportionately channelled to indigenous language schools which typically lead to traditional occupations, despite high returns to English language education. The suggested reason is that traditional occupations, which depend on local job networks, provide (or are perceived to provide) economic security. The results in our study can be interpreted in a similar framework: teaching the indigenous language to children may provide 'backup' job market opportunities in the traditional sector.

Another line of literature that this study contributes to is the study of ethnic enclaves. Our results resonate for example with work by Edin, Frederiksson and Åslund (2003) and Damm (2009) who find that in Sweden and Denmark, respectively, the labour market outcomes of ethnic minorities are better if they live within their own enclaves. Neither Edin et al. or Damm explicitly study language, but it is likely that the use of a minority language among recent immigrants is one of the key factors in creating mutual understanding, job referral networks or other valuable information that affects labour outcomes.

Compared with the existing literature, one of the main contributions of this study is to show that the logic of economic returns may also apply to minority

languages. Studying this issue is difficult for two reasons. Firstly, since most minority languages are in relative decline, the ex-ante view tends to be that these languages are associated with little economic benefits. Secondly, only few countries have a large enough number of minority languages for which the relevant data on language skills can be found. In this study, the census and income surveys bring the possibility to control tightly for ethnicity and overcome a negative bias that emerges from the high correlation between bilingualism and ethnicity. Further, with census data, we can estimate economic returns to minority language bilingualism for a total of 34 languages, which makes it possible to study their relationship to language transmission, another key contribution of this research.[4]

The article is structured as follows. Section 2 gives an overview of indigenous languages in Mexico. In Section 3, we present an analysis of the employment return to bilingualism, for all indigenous languages together, and separately for each language. In Section 4 we present a basic model of language choice and transmission and continue with its empirical implementation in Section 5. Section 6 concludes. The data is introduced within sections 2, 3 and 5 as appropriate.

3.2 Indigenous Populations of Mexico

Mexico is integrated by a rich mixture of native cultures which results in dozens of local languages that are currently spoken. These language systems stem from 11 independent language roots and were spoken by 7.36 million people in 2020.[5] While there is heterogeneity in size and geographical variation in their location, all share being concentrated in tight areas which form language clusters. Our evidence supports the view that these clusters form local language and economic networks which are central to the survival of minority languages.

In 2015, little over 1 in 20 Mexicans spoke an indigenous language, yet over 1 in 5 identified as indigenous. Figures 1 and 2 provide a snapshot of the distribution of indigenous people and languages in Mexico. Based on census data, Figure 1 shows the proportion of municipal population that 'self-identifies' as indigenous. The second map, in Figure 2, shows the proportion of people who actually 'speak' an Indigenous Mexican language. There is a clear overlap between speakers and

[4] By separating language from the culture and estimating life outcomes of bilinguals, the recovered estimates overcome the difficulty to measure culture and its features, something that has slowed the development of economic research of culture. In this sense, core contributions of this research rest on exploiting the inclusion of the cultural identification question to the census from the year 2000 onwards in addition to the language question.

[5] Language classification from Instituto Nacional de Lenguas Indígenas.

self-identified indigenous, but also a fading of speakers at the outline of the regions where most self-identified indigenous live.

Over time there has been an important decline in the representation of minority language speakers. Estimates of 1820 suggest that 60% of the population spoke a native language, by 1889 the figure was down to 38%, to 16% in 1930 and to 5.8% in 2020. When accounting for population growth, the speaking population has remained relatively constant, at least since the beginning of the twentieth century; yet, because the tightness of the language network determines the frequency of language-specific interactions, languages depend on population representation to survive. There are fears that in the absence of institutional support, especially indigenous-language schooling, an important part of the cultural heritage of these cultures can soon be forever lost.

Minority languages are concentrated to the point that where they are mostly spoken these language clusters account for an absolute majority of the local population. This changes the interpretation of minority languages, for they are nationally minoritarian but locally dominant. Across all language groups, this bimodal distribution is a recurrent feature, as displayed in the maps in the Appendix which shows the proportion of language speakers within municipalities. [6]

Table 1 best summarizes geographical information about language groups by providing four different measures of language concentration. The language groups in the table all have more than 10 thousand speakers, and ten have a quarter of a million speakers or more. In the table, the languages (column 1) have been ordered by the total number of speakers (column 2). The two most spoken indigenous languages are Náhuatl and Maya, which together account for 36% of the minority language population (23.8% and 11.9% respectively). The third column, provides the proportion of the language population with respect to the total population. This measure shows that languages are small in relative terms as Náhuatl and Maya account for only 1.44% and 0.72% of the total population.

[6] The emergence of well-defined clusters is remarkable and draws parallels with minority languages such as Basque of Catalan in Spain, where speakers are also highly concentrated and the economic returns appear to be local (Rendon 2007 finds a 2-6 percentage increase likelihood of employment from Catalan knowledge.)

Figure 3.1: Population share that identifies as 'indigenous Mexican' by municipality, 2015.

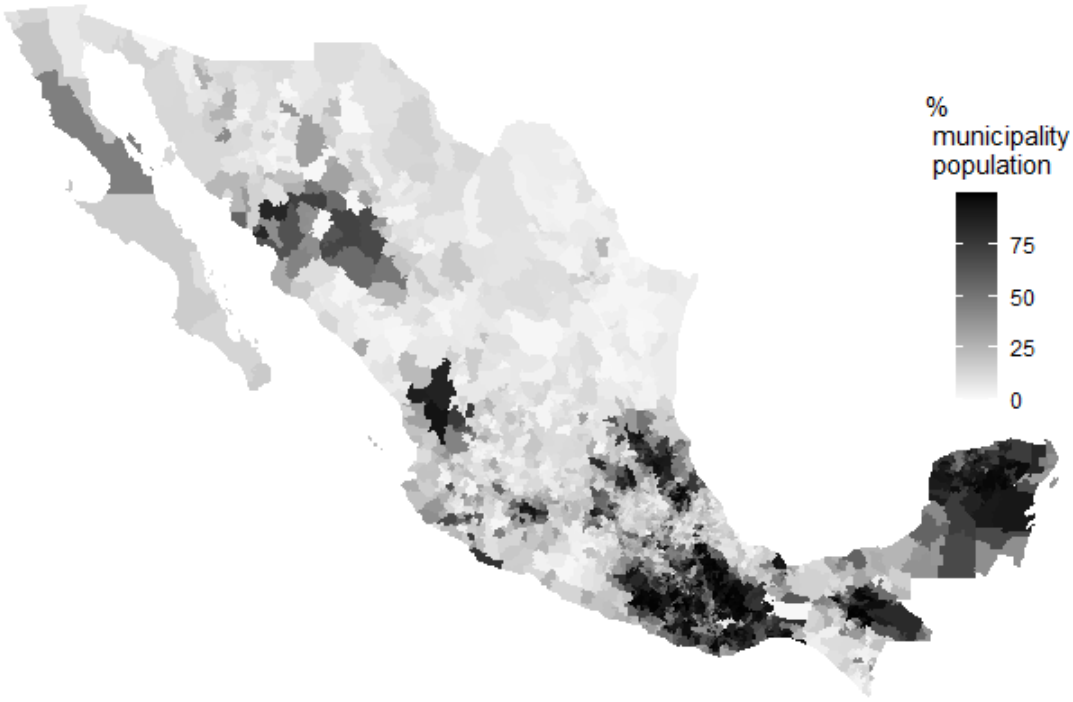


Figure 3.2: Population share that speaks an Indigenous Language, by municipality, 2015.

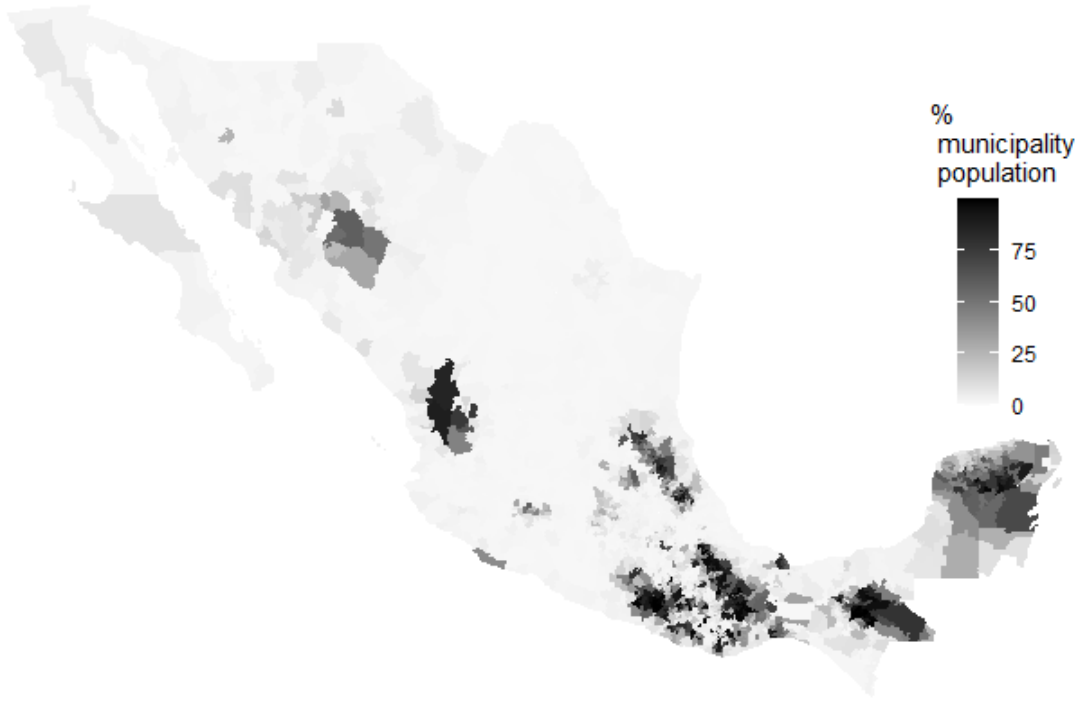


Figure 3.1 and Figure 3.2 based on own calculations from Mexican Census 2015.

The fourth and fifth column bring a local dimension to these languages. The first of these provide the total number of speakers that live in a 'cluster-municipality', defined as a municipality in which either: i. over 30% of the population speak a particular language; ii. over 10% of the national language population is concentrated in that municipality, or iii. more than 10,000 same-language speakers live in the municipality.[7] Cluster municipalities are effectively municipalities with a high density of speakers and/or relatively large aggregate numbers of them. Each language has its own cluster(s) and there is little between-group mixing, although some examples of territorial overlap are discussed. At an aggregate level, of the total native speaking population, 78.22% live in areas that meet the criteria for cluster municipalities.

The fourth column gives the share of the cluster-municipalities' population that speak the minority language. This is an 'intensive-margin' measure that shows the extent of local language representation. Most language groups account for a considerable share of the local population. For example, of the 1.72 million Náhuatl speakers in 2015, 1.32 million lived in cluster-municipalities, and made up for 19.9% of these municipalities' population. For several languages, the density of speakers in the local area, measured by their proportional representation, is even much higher; such is the case of the Mixe language that, while spoken by 134 thousand, 0.11% of the national population, makes up for 68.57% of its corresponding cluster population.[8]

The Cluster Intensity column of Table 1 provides a measure of within-language concentration. The statistic provided is a the percentage of the overall language population that lives in its cluster area. Effectively, it corresponds to the total cluster population (column 4) over total speaking population (column 2) and shows that most of the speaking population live in their own cluster areas. So, while column 5 shows a measure of density of each language network, column 6 shows the extent to which these cluster areas represent the existence of language speakers in the country.

The last two columns of this table count the number of municipalities that make up each language cluster and the total number of municipalities in which each language is spoken. Out of the large languages, we see that Mazateco, spoken by 240 thousand people, and thus making 0.2% of the national population, is spo-

[7] 33 spoken languages with a total population of 73,316 have no identified cluster.

[8] With few exceptions, language groups make up single digit representations of the aggregate cluster population Smaller languages such as Chontal de Tabasco, Mayo, Huichol and Yaqui.

ken in 533 municipalities, but only 28 of these are cluster municipalities, which account for 71.64% of the overall Mazateco language speakers, who themselves represent 61.78% of the cluster population.[9]

Table 3.1: Indigenous Language Clusters: Descriptive Measures of Language Concentration

Language	National		Cluster		Cluster	# Municipalities	
	Total	%	Total	%	Intensity %	Cluster	Language
Nahuatl	1,724,800	1.44	1,324,762	19.99	76.8	136	1484
Maya	861,238	0.72	824,120	21.54	95.69	113	499
Tzeltal	561,224	0.46	501,256	45.72	89.31	17	330
Mixteco	508,050	0.42	388,706	28.3	76.5	124	1016
Tzotzil	494,738	0.41	431,302	43.56	87.17	30	303
Zapoteco	464,224	0.38	332,936	50.34	71.71	141	996
Otomi	309,344	0.25	205,382	12.79	66.39	24	612
Totocana	267,868	0.22	205,218	41.9	76.61	32	578
Chol	251,942	0.2	220,394	32.31	87.47	10	240
Mazateco	240,518	0.2	172,320	61.78	71.64	28	533
Huasteco	174,434	0.14	136,172	31.01	78.06	10	307
Mazahua	151,790	0.12	103,464	16.87	68.16	7	356
Purepecha	143,360	0.11	111,860	17.26	78.02	12	297
Tlapaneco	134,592	0.11	107,364	44.57	79.76	9	233
Chinanteco	134,504	0.11	107,292	31.46	79.76	20	392
Mixe	134,404	0.11	99,142	68.57	73.76	23	495
Tarahumara	75,944	0.06	52,166	30	68.69	8	179
Zoque	67,342	0.05	44,752	33.82	66.45	10	178
Amuzgo	57,124	0.04	50,820	38.97	88.96	5	130
Tojolabal	54,316	0.04	48,170	31.59	88.68	2	66
Huichol	52,318	0.04	39,054	7.71	74.64	5	177
Chatino	51,864	0.04	46,346	57.78	89.36	9	147
Popoluca	48,974	0.03	42,178	33.02	86.12	4	118
Tepehuano	46,820	0.03	36,864	34.21	78.73	3	69
Mayo	42,270	0.03	33,442	3.97	79.11	5	71
Cora	28,472	0.02	22,618	52.88	79.43	1	50
Chontal de Tabasco	28,060	0.02	26,498	2.4	94.43	4	17
Triqui	27,490	0.02	20,390	3.67	74.17	5	135
Huave	19,924	0.01	16,894	59.77	84.79	3	93
Yaqui	19,478	0.01	11,820	7.42	60.68	1	61
Popoloca	18,012	0.01	10,924	20.83	60.64	1	65
Cuicateco	13,318	0.01	9,030	55.35	67.8	6	116
Pame	11,842	0.01	9,674	23.21	81.69	2	36
All	7,220,598	6.02	5,793,330	32.26*	78.22*		

∗ Arithmetic average across languages.

As languages are distributed in well-defined geographical, their social and eco-

[9] Likewise, Mixe is spoken in 495 municipalities (of 2,456); 73.76% live in 23 of these municipalities, which are the language cluster. The remaining 26.24% Mixe speakers are in the remaining 472 municipalities.

nomic effects must be coming almost entirely from local effects. The majority of the language groups are located at the centre and south of the country and the networks that emerge from their grouping could to be central for understanding the survival of minority languages and their varying effects.

3.2.1 Institutional and Education Policies for Indigenous Populations in Mexico

Mexican society is a collection of groups with profoundly diverse backgrounds. One manifestation of this is the mosaic of languages that exist. While a significant number of languages have been lost through policies of cultural homogenization that began during colonial times and persisted into the second half of the twentieth century, as of 2015, there were 66 Mexican languages written and spoken in different parts of the country (7.4 million people).

From the end of the 19th century and much of the 20th century, educational policies for indigenous groups in Mexico were viewed as tools for crafting a homogeneous national identity around the idea of mestizaje.[10] Public institutions aimed for the cultural assimilation of these population groups through schooling and teaching of Spanish language. Indigenous cultures during the time were relegated and, common to the times, approached as if inferior to European ones (Stavenhagen, 1988, Salmerón and Porras 2010).

Indigenous language speaking populations tend to be concentrated in tight geographical areas, a pattern that appears to be fundamental for the transmission of language, one of the core points studied in this research. Organizations of native language speaking populations appeared after the revolution (1910-1917). Many of them originated in the 1930s but they only gained strength in the early 1970s. It was in this later decade in which public education shifted to adopt a multicultural and multilingual approach. Federal resources destined for the National Indigenous Institute grew more than tenfold between 1971 and 1976 (Sarmiento 1985) and in 1975 the first National Congress of Indigenous Populations was held.[11] The congress was the catalysing event for the creation of the National Council of Indigenous Populations[12] where, for the first time, representatives of

[10]The term “Mestizo” is a racial categorization from colonial times used to refer to a descent of a combined Spanish and American. This concept ignored the fact that within each region of the continent, now Latin America, independent cultures and civilization prevail.

[11]Occurred in Pátzcuaro, Michoacán.

[12]CNPI Spanish acronym.

indigenous groups would work together in a national political organization (Recondo 2007).

The creation of this national indigenous council, together with the debate about multiculturalism and education of the time, led a series of institutional changes. In particular, bilingual education became a goal in itself rather than a vehicle for cultural homogeneity (García Segura 2004, Jiménez and Mendoza 2015, Jiménez-Naranjo and Mendoza-Zuany 2016).[13]

In 1978, a reform established that education would be imparted in the mother tongue of the child at least during the first years of primary school. The new focus on education would initially look only at the linguistic component as a differentiator, relegating the cultural element. Implementation of the reform took time due to technical difficulties but in 1984 textbooks, programs, guides, learning material and general books in over 20 indigenous languages were produced for the first time (Salmerón and Porras 2010). This material was created for pre-schooling and the first four years of primary school.

The next set of reforms occurred as a result of political pressure during the 1990s, a period that also saw the EZLN uprising (an ideological and armed movement led by Indigenous of Chiapas in southern Mexico in 1994), a reform in Jan 1992 (Art 4)[14] recognising the constitutional right of indigenous communities to self-determination. The reform aimed to guarantee the right of these groups to preserve and enrich their languages, knowledge and culture. This reform would have important governance and administrative changes for indigenous communities long after.

In January 2001 the Federal Government created a national institute to coordinate bilingual and intercultural education (https://eib.sep.gob.mx/). This institute is in charge of developing educational curricula to attend cultural diversity, forming teachers, producing learning material, and pertinent school models. The Law of Linguistic Rights (2003), grants students of basic education the right to receive their education in their mother tongue, regardless of their location, a legal upgrade to the 1978 reform outlined above (Schmelkes 2006).

[13] This shift was driven by organizations such as the National Alliance of Bilingual Indigenous Professionals which was founded in 1977.

[14] In current Mexican Constitution, as a result of another constitutional reform in 2001, the changes of Article 4 in 1992 have been shifted to belong to Article 2.

The institutional framework for the protection of indigenous languages is has gradually evolved, but continues to face important limitations. Formal mechanisms for the protection of cultural identity need to be accompanied with resources for them to be effective. There is a lack of policies accompanied with resources for the promotion of Indigenous education and culture. This has been relegated been informal mechanisms and language transmission greatly relies on the type household and the society in which individuals live.

The composition of the household and the characteristics of society are central in explaining the transmission of language. The role that each of these networks play is to some extent distinct. The easiness of learning a language will be a function of how the household is composed, that is of how many other indigenous language speakers there are in the household. This is the idea that social networks are at the core of language transmission. From an individual perspective, the value of a language is an increasing function of the number and type of speakers. This is a spillover effects that is consistent with the existence of indigenous language clusters.

3.3 Labour Market benefits of bilingualism

In this section we estimate the employment effects of attaining indigenous bilingualism conditional on being of indigenous origin. The analysis is based on two different data sources: Mexican Censuses (from 2000, 2010 and 2015) and the National Household Income and Expenditure Survey (ENIGH, from 2014, 2016 and 2018). The latter data is a more detailed employment and income survey at the cost of a smaller sample size.

We estimate labour returns to languages in two steps. Firstly, we use all the six datasets above to estimate the wage and employment likelihood return, to both indigenous languages and Spanish. The comparison groups are the matched monolinguals; in the first case the Spanish-only speaking Indigenous people and in the latter case the Indigenous-only monolinguals. Earnings returns are estimated with the survey since censuses are ridden with non-response to wages; estimates of employment returns from the census are corroborated with the income survey. Secondly, we estimate the economic returns to each indigenous language separately. This can only be done with the Census, since the ENIGH data is not large enough to capture separate returns.

The datasets contain information about ethnic group and knowledge of ethnic language. Distinguishing between ethnic group and knowledge of language is only possible from the 2000 census onwards (2010, 2015) and is central to the matching estimator that we construct. All individual variables in our analysis (gender, birthplace, employment, schooling, household composition and age), as well as locality and municipality level characteristics, such as rural-urban status, are constructed from these sources. Summary statistics for the censuses are presented in Appendix Table 6, and the corresponding summary statistics for the ENIGH data are in Appendix Table 7.

Disentangling the effect of minority language bilingualism from other socio-economic factors is based on a combination of matching and OLS estimation. In the first step, we restrict the sample tightly to only indigenous working age men who live in families in which there is at least one indigenous speaker, in a way that the indigenous language corresponds to the main indigenous language within the municipality. Because the sample is restricted to indigenous men that live in a household that speaks the dominant language of the place of residence, this matching guarantees that the control group has a minimal social distance to the treatment group. In this data we observe state of birth and residence 5 years prior to the census interview, a desirable feature because our estimates then capture the effects of bilingualism of long-term indigenous residents.

The baseline specification is summarised in the diagram below and consists of: males who are 25 to 64 years old, long term residents, self-identify indigenous, live in an indigenous speaking household and the language spoken in the household matches the dominant language in the municipality of residence. This group is then divided into treatment depending on whether they are Indigenous bilingual or control for when they are monolingual Spanish speakers. After the inclusion of all the restrictions on the data, we are left with a sample of 358,347 individuals for our estimates for 2015, 419,964 for 2010 and 136,416 for 2000. Using similar restriction in the ENIGH data, we are left with 12,188 observations from pooling the three surveys.

The empirical methodology adopted uses a matching approach that is based on conditioning the sample with respect to a tight set of characteristics. The approach theorises a set of linguistic and demographic constraints which seeks to guarantee that individuals are observationally equivalent in the relevant aspects. This is the core of the independence assumption which rests of ensuring that

differences on the treatment are not explained by the observable identifying variables.[15] Thus, there is no selection on the unobservable term that is captured in the error term. Then, matching is a process of building a counterfactual in a way that reproduces the treatment group among the non-treated, in a way that mimics experimental conditions in a non-experimental setting.

Under certain assumptions, the matching method constructs the correct sample counterpart for the missing information on the treated outcomes had they not been treated, by pairing each participant with members of non-treated group. Satisfying the matching assumptions ensures that the difference between the two groups is treatment, in this setting minority language skills.

The choice of the appropriate matching variables is a delicate issue. In this research, we trimmed the sample to match tightly upon observable linguistic, demographic and geographic variables. The specific matching technique[16] is chosen because it enables the model to control for geography in a way in which we compare individuals that live in the same municipalities. With highly heterogenous groups living in tight linguistic clusters, observationally equivalent individuals may differ widely from geographical effects which are expected to be large. Unobservable heterogeneity due to geography is expected from the diversity and size of Mexico, and not accounting for it would expectedly bias the estimates.

The method of matching used guarantees that the individuals are compared within the same municipality, not only within linguistic family, household structure, schooling, and other observable variables such as demographics and migration status.

$$d_i = 1 \begin{cases} \text{sex} = \text{male} \\ \text{age} = (25 - 64) \\ \text{long term resident} = 1 \\ \text{indigenous belonging} = 1 \\ \text{indigenous speaking family} = 1 \\ \text{family language} = \text{mun language} \\ \text{Language: Spanish \& Indigenous} \end{cases} \qquad d_i = 0 \begin{cases} \text{sex} = \text{male} \\ \text{age} = (25 - 64) \\ \text{long term resident} = 1 \\ \text{indigenous belonging} = 1 \\ \text{indigenous speaking family} = 1 \\ \text{family language} = \text{mun language} \\ \text{Language: Spanish only} \end{cases}$$

To recover subgroup effects, this matching sample is further tightened with the

[15] Conditional on a set of observables, the non-treated outcomes are independent of the participation status.

[16] Over other statistical methods such as propensity score matching or inverse probability weighting.

inclusion of years of schooling and language specific indicators.

$$+ \begin{cases} \text{years of schooling (0-18)} \\ \text{language (33 languages)} \end{cases}$$

In the second step, we estimate the likelihood of employment with a linear probability model summarized as:

$$employment_i = \gamma_0 + \lambda * d_i + \Lambda X_i + \varepsilon_i \tag{3.1}$$

$$wage_i = \gamma_1 + \mu * d_i + \Omega X_i + \epsilon_i \tag{3.2}$$

In these equations, $employment_i$ is a binary variable indicating whether the person is employed (=1) or unemployed (=0) and $wage_i$ corresponds to the log of wages for those who are currently employed and receiving a positive wage. In the equations, d_i is the matching identifier between the treatment group (bilingual) and the non-treated (monolingual); X_i corresponds to a fourth-order polynomial of age, linear years of schooling, locality size controls and municipality level fixed effects.

The inclusion of municipality fixed effects together with the matching in the first step guarantees that the employment comparison between mono- and bilinguals is done within the same geographic area. The parameters λ and μ are the estimates of interest and measure the percentage point difference in the likelihood of employment for bilingual working age men and their expected earnings differential in comparison to the control of Spanish monolinguals.

As we present the results, we display them with and without the 1st step matching to show its effect on the estimates. A priori, there's a reasonable expectation that without the 1st step matching, the control group of monolinguals would include Spanish speakers who have larger social distance to the treatment group, who are also more likely to have higher socioeconomic status. This would produce a negative bias on the estimates that the matching estimator corrects.

The employment variables used in this study reflect some features of the economic opportunity that individuals face, motivating the choice of variables used. There is of course limitation about the extent to which the chosen variables measure the totality of economic prospects, opportunity and wellbeing. In this respect, other measures of employment such as occupation, job type or contractual differences

may provide valuable information, which is why a descriptive analysis on the sectoral distribution and occupation of individuals by language type is produced.[17]

Results of equations 1 and 3.2 using Census data for 2000, 2010 and 2015 and ENIGH 2014, 2016 and 2018 are summarized in Table 2. These are the set of estimates with full set of controls which include age (linear and non-linear effects), locality size controls, schooling years and municipality fixed effects. The first four columns correspond to the employment returns of the census data; the fifth and sixth column to the pooled estimates for earnings and employment from the income and expenditure surveys.

The first row of results corresponds to the returns without the 1st step matching. Notice that employment returns from this estimation are all non-negative, but with earnings as a dependent variable the estimate for minority language bilingualism is largely negative (-9.2% lower earnings).

The second row of the table corresponds to the 2-step estimates. Now, the estimates capture the difference in the probability of employment conditional on the matching constraints, in addition to the full set of demographic controls and the municipality fixed effects. Closing the distance between groups leads to an increased employment return vis-à-vis the fixed effects estimates (2.2% increase in likelihood of employment in the pooled census matching estimate, against 0.5% with fixed effects). This is consistently observed across all estimation years with the census. The matching estimator for employment returns with the income survey is 2.1%, which is very similar to the pooled census estimates. The estimate for earnings with the matching estimator provides a major upward correction with respect to the fixed effects estimates. With the matching constraints, we find minority language bilingualism to be associated with an expected 4.9 percent increase in earnings.

The last row in Table 2 summarizes the employment returns from knowing Spanish. These estimates are subject to a similar indigenous matching process. They differ in that the treatment group are now Spanish and Indigenous language

[17] A thorough statistical analysis of employment is provided through Tables 3.8, 3.9 and 3.10. These are all occupational representation matrices, first by contractual differences, then, by schooling and sectoral choice, and last from a within industry, sub-occupation, perspective. All these show interesting and important characteristics with the hope that they can motivate further research. These provide evidence as much as questions about the clear role of agriculture with questions about land tenure, also specialisation patters and specific labour markets, or the role that entrepreneurial activities play.

bilinguals whereas the control group are Indigenous language monolinguals (as opposed to Spanish only monolinguals). Notice that these estimates are more in tone to the existing literature of returns to language skills that focuses on returns to migrants' knowledge of the dominant language.

Table 3.2: Employment Returns to Bilingualism: Increase in likelihood of Employment.

λ: employment likelihood difference.

μ: percentage earnings increase.

	λ_{2000}^{Census}	λ_{2010}^{Census}	λ_{2015}^{Census}	$\lambda_{pooled}^{Census}$	μ_{pooled}^{ENIGH}	λ_{pooled}^{ENIGH}
			Indigenous Bilingual: Fixed Effects			
Indigenous	0.017**	0.015**	0.002	0.005**	-0.0922**	0.0136**
	[0.003]	[0.001]	[0.001]	[0.001]	(0.0126)	(0.00286)
N	157,991	634,627	762,538	1,555,156	44230	49323
adj. R^2	0.120	0.085	0.114	0.090	0.357	0.057
F	157.5	763.2	2146.6	3898.2	429.8	114.2
			Indigenous Bilingual: Matching			
Indigenous	0.0354**	0.0302**	0.020**	0.022**	0.0497^{+}	0.0209**
	[0.005]	[0.002]	[0.002]	[0.002]	(0.0272)	(0.00552)
N	136,416	419,964	358,347	914,727	9836	11559
adj. R^2	0.122	0.099	0.136	0.108	0.385	0.048
F	121.8	319.9	511.4	2262.5	76.74	17.08
			Spanish Bilingual: Matching			
Spanish	0.015**	0.014**	.034**	.017**	0.273*	0.0294*
	[0.003]	[0.002]	[0.003]	[0.001]	(0.0902)	(0.0133)
N	147,439	449,784	350,617	947,840	8409	10047
adj. R^2	0.125	0.105	0.145	0.115	0.397	0.055
F	136.9	317.4	496.6	2585.17	68.76	14.71

Standard errors in parentheses. $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.001$

Matched estimates account for municipality level fixed effects.

The results show employment estimates for Spanish to be between 1.4 and 2.9 percent which is a range comparable in magnitude to the minority language return. When using the income survey, the employment probability differential estimate (2.94%) also within the range of the census estimates, which spanned between 1.4 and 3.4%, depending on the cohort studied. We found however that earnings returns to Spanish are considerable (28.9% expected earnings increase), which is consistent with the notion that dominant, official languages untap larger networks and may yield higher benefits.

The period of study is relatively short to analyse long term trajectories but there appears to be a slight downward trend in returns to Indigenous bilingualism and an upward trend in returns for Spanish. Even though censuses and income survey sweeps were conducted in different years, estimates coming from either dataset are robustly similar.

Next, this chapter documents how the returns to bilingualism vary by native group, and level of education. We also document how bilingualism features in occupational choice. Table 3 presents the employment returns to each indigenous language, ordered by magnitude of the estimated effect. Effectively, these estimates correspond to the matching estimator with full set of controls but tightened so that each language group is identified separately. In the prior estimates, employment comparisons for individuals were within language and demographic group, family type and municipality, but the estimates were interpreted as an average effect across languages. Now, we gain insight to the anatomy of the heterogeneous relationships that exist between language and employment. We estimate the employment return to 33 indigenous languages, which is the maximal number of languages we can include if we require that both the treatment and the control group must have more than 60 observations in the 2nd step estimation. Figures 5 and 6 in the Appendix show an upward relationship between language returns and the proportion of indigenous language speakers working in agriculture (last column in Table 3).

Table 3.3: Employment Returns to Bilingualism by Language (pooled estimates)

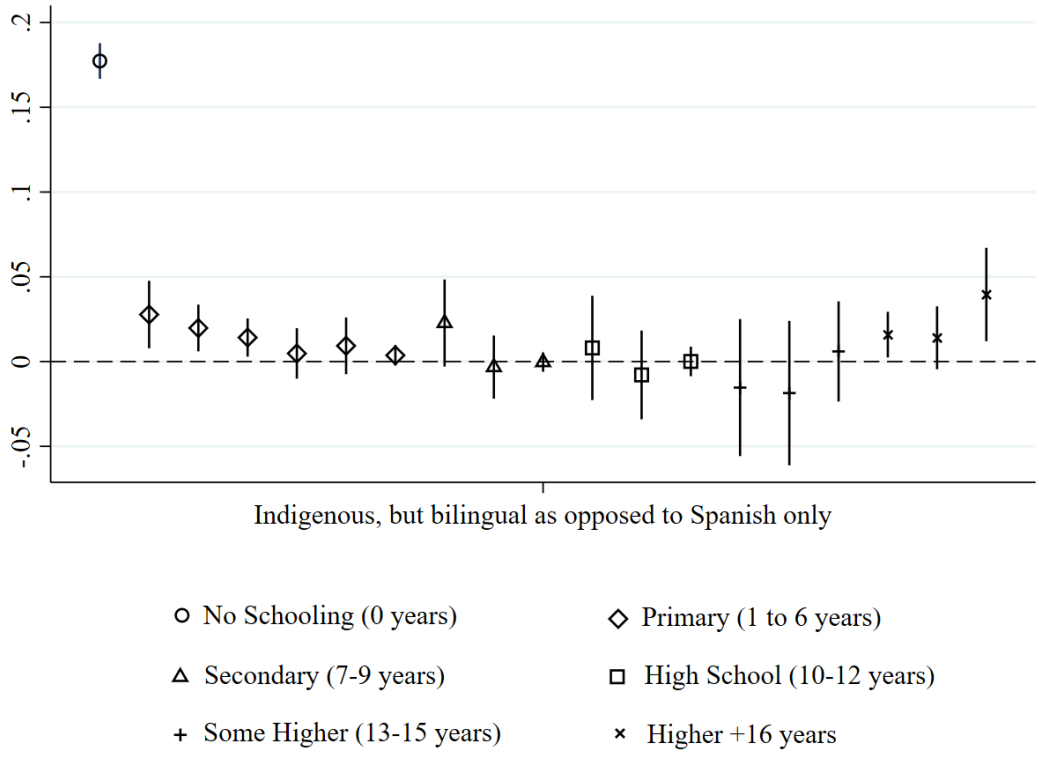
Population: 25-64 Year Old Non-Migrant Males.						
Language	λ	SE	Obs	School	Age	Agro
Maya**	0.033	0.005	139547	6.15	42.7	0.24
Zapoteco**	0.039	0.007	104327	6.51	43.0	0.33
Nahuatl**	0.020	0.005	218763	5.47	42.0	0.34
Chol**	0.078	0.020	27404	5.39	40.3	0.73
Huave**	0.119	0.038	3794	5.30	41.5	0.54
Huasteco**	0.047	0.017	18074	5.65	42.3	0.24
Mixe**	0.069	0.027	26492	5.32	41.5	0.47
Mazateco*	0.059	0.025	44340	4.62	41.1	0.48
Tzotzil*	0.058	0.024	79846	4.22	39.2	0.62
Mazahua*	0.033	0.015	9913	5.10	43.6	0.22
Chontal de Oaxaca*	0.079	0.037	1189	5.50	47.7	0.66
Huichol*	0.255	0.128	7768	5.51	39.4	0.31
Mayo+	0.037	0.019	2887	6.47	45.8	0.37
Zoque+	0.035	0.018	14319	4.44	41.6	0.65
Purepecha+	0.034	0.018	11451	6.23	41.8	0.29
Pame+	0.093	0.056	1061	3.80	41.9	0.55
Chinanteco	0.031	0.019	22346	5.39	41.8	0.64
Tojolabal	0.091	0.060	3344	3.91	39.6	0.82
Tlapaneco	0.060	0.040	25928	5.69	40.0	0.56
Popoluca	0.049	0.034	8572	4.04	41.1	0.67
Popoloca	0.070	0.055	1515	3.93	41.2	0.35
Otomi	0.012	0.011	32536	5.67	43.4	0.25
Cuicateco	0.023	0.024	5285	4.49	44.0	0.70
Tzeltal	0.018	0.019	66095	4.95	39.4	0.73
Mame	0.040	0.053	737	3.82	45.6	0.60
Cora	0.021	0.055	5361	4.42	40.7	0.48
Yaqui	0.013	0.040	1047	7.23	43.6	0.26
Chocho	0.006	0.082	197	8.40	48.2	0.46
Totocana	0.001	0.021	47017	4.99	42.7	0.49
Mixteco	-0.001	0.009	95892	5.09	42.1	0.41
Amuzgo	-0.007	0.028	11847	3.77	39.9	0.58
Chontal de Tabasco	-0.016	0.026	2140	7.63	42.4	0.27
Tarahumara	-0.017	0.026	10828	4.18	41.6	0.36
Chatino	-0.016	0.020	11584	3.59	41.6	0.60
Pop 25-64				9.8	41.3	0.10

Pop 25-64: corresponds to all non-migrant males (indigenous and non-indigenous).
Notes: ** P<0.001, * P<0.05, + P<0.1 Agro Share: share of the population working in the agricultural sector. Average School: average years of schooling.

In a further tightening of the matching estimator, the sample is partitioned by education. The employment returns for the 18 school year groups is depicted in Figure 3.3, where it becomes clear that the employment benefit from Indigenous bilingualism is substantially larger for those with least schooling. A close examination shows that returns are positive for individuals with less than half of primary school completed, but also for individuals at the top end of the education distribution. One potential explanation for the returns to non-schooled individu-

als is that for illiterates, communication is constrained to oral forms which makes languages a central asset in the social and economic life. A robustness check in which the matching sample is restricted by literacy status support this hypothesis (available on request). A robustness check in which the matching sample is restricted by literacy status support this hypothesis (available on request).

Figure 3.3: Indigenous language employment returns by school attainment (pooled matching 2010-2015)



Occupational statistics summarised in Tables 10, 11 and 12 in the Appendix, are connected. The first two of these tables provide statistics for both the treatment and control group.Table 10 describes the general framework of employment at a national level and tells that bilinguals are a couple of percentage points more likely to be employed but twice as likely to be independent workers, have multiple jobs, be informal workers and work without any kind of a contract.

Table 11 provides the percentage of individuals from each educational level in each occupation category; this describes the occupational distribution of men within schooling group. It becomes apparent that the ability to speak native languages comes with an increased likelihood of working in agriculture. The table effectively provides the expected occupation and shows Indigenous bilingual

men are disproportionally represented in the agricultural sector across all schooling levels, and more so for the lower educated (whereas, for the whole sample, 43.1% of the Indigenous bilinguals worked in agriculture -and 15.6% of the Spanish monolinguals-, the number jumps to 60.4% for bilinguals with no schooling). "Technicians and associate professionals" is another sector that responds to education, while accounting for 3.2% of the overall indigenous language population, it absorbs over 35% of the highest educated ones.

A closer examination of occupation statistics is in Table 12 which provides occupational representation differentials across the sectors analysed in Table 11. The third and fourth column measure the proportion of jobs within each sector (column 1) taken by different occupations (column 2) for both the treatment and control group. The last column provides a ratio of these measures.

As has been documented in the previews statistics, agricultural workers (and also forestry and fishing related activities) are occupations in which the bilinguals are heavily represented. Observe also that Indigenous bilingual men are overrepresented in niche traditional occupations such as "Weavers" and "Artisans" where, conditional on sectoral choice, they are up to five times more likely to participate than their monolingual counterparts. Also, some occupations of political nature, such as "Government Officials" or "Directors of Political, Union and Civil Organizations" where, from this measure of representation, 6.3 and 2.3 times larger respectively. Perhaps in connection to the positive employment returns found for the highly schooled individuals, overrepresentation is present for workers of the educational sector. This evidence of representation is in line with the idea that language-specific labour market opportunities exist and that these networks help explain employment returns to minority languages.

3.4 Transmission of language

When an individual remains monolingual, direct communication links are limited to other monolingual or bilingual speakers who share the language. A native speaker of a particular language should choose to learn another language if the utility gain derived from increasing communication links outweigh the costs of learning (a simple model of bilingualism, but not fully applicable to our study, is provided by Church and King, 1993).

In bilingual or multilingual environments and families, roughly the same idea applies to the efforts of parents to teach their children a particular language. Parents may master a menu of languages, and associate languages with different expected long term social, cultural and economic benefits. The costs of teaching a particular language to children may also vary greatly depending on the availability of speakers in the household and the exposure of the children to the language in the local environment. If the utility derived from knowing a language is increasing in the number of speakers and the costs of learning the language decrease with higher exposure to the language, cost-reducing and benefit-enlarging externalities make the efforts to learn a language an increasing function of the number of potential speakers.

Suppose that parents maximise the expected net utility of their children, and that language choice is the feature to be considered. Denote this utility as $u(language, X)$, where X accounts for the rest of the relevant things to language, the individual and the setting. Expressed as $u(language, X) = v_{lang}(network, X) - c_{lang}(network, X)$, where the utility, v, and costs, c, of learning the language depend on language network and X.[18] Let $network$ be an increasing function of the proportion of speakers in the local area, denoted by p, so that $\partial network/\partial p > 0$. then $\partial u(language, X)/\partial p > 0$, both because $\partial v(network, X)/\partial p > 0$ and $\partial c(network, X)/\partial p < 0$.

This formulation implies three possible outcomes. If $v > c$, $\forall$ p, parents make an effort to pass their own language even in the absence of speakers in the local area. The second equilibrium happens when $c > v$ $\forall$ p, and is then opposite; it implies that even with large number of speakers in the area, the language is not transmitted. Lastly, when there are individuals at the margin of transmitting the language, the skill is passed-on whenever the language is spoken by a sufficiently large proportion of the population, say p^*.[19] Because of network effects on c and v, insofar the actual language proportion exceeds threshold p^*, all else constant, the benefits exceed the costs of learning ($v > c$). As transmission is a function of p, this formulation places language clusters at the centre of the survival of minority languages. Notice that this results from pure externalities of language networks.

In the Mexican setting, as in most countries with minority cultures, languages

[18] When the costs and benefits of learning a language are separable. This simplifying assumption is not instrumental for the argument.

[19] At $p = p^*, u(network, X) = v(network, X) - c(network, X) = 0$

lack proper institutional infrastructure and bilingual school education is underdeveloped. Institutional support and infrastructure can be incorporated to the framework under the idea that these reduce the cost of language acquisition, and hence the network threshold, p^*, lowers.

Acknowledging the role that networks play in the transmission of the languages leads to the discussion of what are the relevant features of language networks and whether different networks exist. So far, the discussion has centred around the local area network, where the density of the network, as viewed from the proportion of minority language speakers, has incidence on the likelihood of transmission. The focus next is on the family and employment, where a similar logic apply.

In the family network the core idea is that the costs of teaching a language to a child declines with more adults in the household who are able to speak it. Furthermore, the existence of relatives who speak an indigenous language also increase the social benefits of knowing the language. In the estimates below, we show that the transmission is higher when both parents can speak the minority language, than in mixed couples where only one of the parents can speak it. Additional extended family members in the household who speak the minority language also increase the likelihood of transmission.

Commanding an additional language is a skill, with a potential positive economic return. In the context of Mexico, the economic benefits from native languages are likely to exist due to employment networks in certain professions, such as in agriculture, traditional industries and professionals in education. Our main hypothesis is that the decision to pass the language is partly informed by the perceived economic opportunities that the language skill may provide to their children. One can assume them to be informed by the existing economic returns that the parents' generation has enjoyed. Overall, we build a simple model of intergenerational language transmission as a function of the language networks and the economic benefits. In the formulation of the problem, the network of the language speaker is a function of the family language structure and local area language characteristics, as in $network(family, local, economic)$

$$P_i(\text{Language Passed}|X) = F(\underbrace{network}_{Family,Local,Economic}, \underbrace{Z}_{Controls}) + \epsilon_i \tag{3.3}$$

Specifically, $Family$ correspond to language resources in the family; $Local$ to language resources in the local community, $Economic$ to the employment return to the language and Z to controls of the family, language and municipality.

The study focuses on families with both parents present. In such cases, the language resource in the family will be measured with variables that consist primarily on whether both or only one of the parents can speak the native language. We also take into account whether there are other adults in the household who can speak the language (such as grandparents). We assume (and test) that each additional adult who can speak a native language in the household, generally increases the likelihood that the language is passed down to the next generation.

For local elements, the main focus is on the strength of the language in the local area, for which we compute the proportion of people in the municipality who speak the same minority language as the household does. In practice, this measures the potential interactions that can be made using the minority language in the local area. In our data of bilingual families, the average family is located in a municipality where 52% of the local population can speak the same language as the family. This confirms that the typical bilingual family lives in a 'core' of the minority languages. On the other hand, this measure has a large variation, showing that the strength of the local language network cannot in general be taken for granted, and it is important to control for it.

The focus of this part of the research is disentangling whether the perceived economic benefits are associated with the transmission of the languages. This is important because it is the first paper to examine whether minority language benefits are associated with the transmission of the language. The survival of languages is clearly a complex set of dynamics and which depend profoundly on the family and social fabrics. In the transmission estimates we have included variables regarding the type of linguistic household in which individuals live, such as which of the parents speak the language, about household size and other family members speaking the language, municipality fixed effects, and several demographics. In the transmission of languages, the social and family network are dominant predictors of transmission.

Some of these control variables, such as partner choice are endogenous in the sense that perhaps individuals that are more likely to partner with another language speaker may also be more prone to passing on the language on their own. While the evidence shows a high degree of matching between language speakers, the matching pattern that exists is likely to be mostly driven by the high concentration of speakers in geographic language clusters, which makes matches frequent.

Language transmission Table 3.12 presents statistics of language transmission by parental structure. This table shows the rate of transmission of each of the languages studied for households in which (i) both parents speak the language, (ii) single mother speaks the language, (iii) mother speaks the language, but not the father, and (iv) father speaks the language, but not the mother. One thing this table shows is that heterogeneous speaking households indeed have lower transmission rates. Yet, we also observe that single mother households have relatively high transmission rates, almost as large as two parent speaking households. This is indicative that the difference in transmission between heterogeneous speaking parents is likely to be because of the existing barrier of communication that exists between heterogeneous parents.

3.4.1 Data and sample

The data is based on the Mexican Census of 2015. The sample is limited to the household respondent and his/her spouse and children. Families which speak only Spanish are excluded, so that at least one of the parents states that they can speak a native Mexican language. To simplify analysis, single-parent families and families where parents speak two different native languages are excluded. As such, each bilingual nuclear family is categorised to belonging to one of the native Mexican language groups. Further, the age of the mother has been restricted to range 25-54.

Table 13 in the Appendix presents the summary statistics on the 2015 sample of households. Within the sample, 64.5 percent of parents have passed the minority language to their children.[20] In 9 percent of the families, only mother can speak the native language, and in 12 percent, only father. This implies that in 79 percent of the families, both parents state that they can speak a native language. We have not documented the Spanish skills, since it is increasingly rare that people in Mexico can't speak any Spanish. All children are exposed to Spanish by the school system.

A noteworthy fact is that only about two-thirds of children with indigenous-speaking parents learn the indigenous language (Table 6). This goes to show that a large fraction of families is likely to be 'at the margin' of deciding whether to pass the indigenous language to the next generation.

[20] In 93% of the families, either all or none of the children learn the minority language. Therefore we have rounded the share of children who speak the language to either 0 or 1. The language skills of children under 4 years are not defined

Table 13 also lists a number of key household variables that may affect the transmission of language within the household. The table includes variables at the native language group level and the municipality level. At language group level, the main variable of interest is the group-specific employment return to bilingualism, or the estimated increase in likelihood of employment from being able to speak the native language in addition to Spanish. Other variables that proxy the economic importance of the group are the group size, as well as the average wealth and education in the group. All of these variables have substantial variation across the 34 groups covered by the sample.

3.4.2 Results

Table 4 shows results on a number of estimations for the determination of language transmission, using family and municipality characteristics, and the economic return to languages.

The first column is the benchmark model for language transmission, and it uses only the household characteristics, as well as regional fixed effects. The first important result is that if either mother or father can't speak the native language, it is much more likely that the language is not transmitted to children. If father doesn't speak the language, the likelihood of transmission falls by 44 percentage points. Mother's ability to speak the minority language is estimated to be somewhat more important than father's (47 percentage points), which is consistent with mothers spending more time with their children than the father.

Additional adults in the household that can speak the minority language increase the likelihood of language transmission by about 4.5 percentage points per person. While the effect is statistically quite significant, the size of the effect on children is only about 1/10 of the effect of a parent's language.

With regards to the local network of minority language speakers, the first column of Table 4 suggests that if the local proportion of minority language speakers increases by 10 percentage points, the likelihood of transmitting the language in the household increases by 4.4 percentage points, which is not far from the effect that one additional adult speaker in the household has. This is a variable that has substantial variability across households, with a standard deviation of 0.3. This implies that moving a bilingual family to a municipality with 1 SD larger

share of minority speakers would imply a 13.2 percentage points (0.3*0.44) larger likelihood that the language is passed to the next generation.

Parental education, age and household wealth (based on an index of items) all have a negative and significant association on the likelihood of language transmission. Of these, it is worth noting that each year of maternal education reduces the likelihood of the language transmission by about 0.7 percentage points, and one standard deviation of household wealth by about 5 percentage points. An explanation for these effects could be that further study, typically conducted in Spanish, gears the parents to overlook the potential value of the minority languages. The effect of wealth and education suggest that in general the indigenous languages are strongly associated with lower socio-economic status in Mexico.

Columns 2 adds the employment return of the language-specific bilingualism into the model. The effect of the economic return in itself suggests a positive and statistically significant effect. Here it is important to note that since this variable varies by the 34 native groups, the standard errors are clustered by these groups. Column 3 further adds controls for the municipal level of economic deprivation. Since there are nearly 2000 municipalities covered by the sample, adding these controls allows us to address for sources of potential omitted variable bias in the model. Other variables included are indices for educational, health, housing and food deprivation. Remarkably, these have very little effect on the results of interest, suggesting that local levels of economic development are well controlled for and do not bias the results.[21]

[21] An alternative to municipal multidimensional deprivation would be to use municipal fixed effects. The problem with this approach is that since the native groups are highly regional (see the appendix maps), municipal fixed effects would not have sufficient variation in most of the country, but would instead be based on the largest cities which host multiple indigenous groups, but with few, and very selected individuals. This would not give the representative estimates we are looking for.

Table 3.4: Factors behind language transmission: a focus on the family, locality and employment returns.

Dependent variable: Children can speak native language				
	1	2	3	4
Employment Return		.364**	.368**	.432**
		[.124]	[.125]	[.122]
Urban*Employment Return				-0.373
				[.303]
Urban				-.0401*
				[.0156]
Only mother speaks native	-.443**	-.442**	-.442**	-.439**
	[.0326]	[.0325]	[.0323]	[.0331]
Only father speaks native	-.474**	-.473**	-.472**	-.47**
	[.0341]	[.034]	[.034]	[.0349]
# Other adults speak native	.0449**	.0455**	.0455**	.046**
	[.00541]	[.00528]	[.00526]	[.00539]
% municipality share HH lang	.436**	.436**	.444**	.442**
	[.0434]	[.0433]	[.0425]	[.0428]
Mother's years of educ	-.00722**	-.00727**	-.00747**	-.00776**
	[.000689]	[.000682]	[.000714]	[.00071]
Father's years of educ	-.004**	-.00407**	-.00433**	-.00431**
	[.00059]	[.000599]	[.000642]	[.000627]
Mother's age	0.000396	0.000395	0.000363	0.000372
	[.000321]	[.000324]	[.000326]	[.000351]
Father's age	-.000594**	-.000603**	-.000638**	-.000718**
	[.000201]	[.000199]	[.000194]	[.000183]
Normalised HH wealth	-.0519**	-.0515**	-.051**	-.0422**
	[.00489]	[.0047]	[.00441]	[.00345]
Municipal controls:				
Educational deprivation			-.00141*	-.00165**
			[.000564]	[.000593]
Health deprivation			-0.0000531	0.000218
			[.000651]	[.000563]
Housing deprivation			0.000402	0.000392
			[.000324]	[.00031]
Food deprivation			.000564**	.000617**
			[.000197]	[.000211]
Constant	.581**	.571**	.59**	.611**
	[.0414]	[.0426]	[.0405]	[.0411]
Observations	227,076	227,076	227,076	227,076
R-squared	0.524	0.524	0.525	0.527

Notes: Linear probability. If at least 50% of children speak native, the family is coded as 1 in the dependent variable. Standard errors clustered at language group level, ** p<0.01, * p<0.05, + p<0.1. Employment return: corresponds to language specific increase likelihood of employment estimate. All models include regional fixed effects.

The fact that a very large proportion of the indigenous males work in agriculture suggests that the employment return to the native languages must be partly driven by employment dynamics in this sector. If that is the case, it is possible that the families in rural areas respond to this economic benefit more than in urban areas, by making sure their children learn the indigenous language. Infor-

mation from the language transmission matrices in Table 16 and 17 indicate so.[22]

This is why, in the final column of Table 4, we have interacted the employment return with urban location. The results show that in rural areas, the higher employment return is associated with an increased likelihood to pass the language, at 5% statistical significance level, whereas in the urban areas, the effect is very close to zero. In rural areas, the size of the effect is not trivial: If the employment return to bilingualism increases by 2 standard deviations (2*.033), the likelihood of passing the language increases by 3 percentage points (2*.033*.432 = .0304).

3.4.3 Robustness checks

An obvious concern that arises from the estimates of Table 4 is that the result on the employment return observed could in fact be reflecting the generic socioeconomic status of the language. It may be that estimates of the return to bilingualism are not actually returns on skills per se, but that they are signals of the relative prestige of the language: Workers who belong to a higher status group, are more likely to find work (leading to the variability in employment return across groups) and also more likely to pass the language to their offspring as a 'signal' of the group membership.

Due to this concern, in Table 5 we report estimates with the inclusion of other variables that capture whether the status of the group change the estimates. If the generic group status is a source of omitted variable bias, inclusion of these variables should reduce the estimate on how much the return to bilingualism affects language transmission. The columns 1-3 of the table include, consecutively, (1) the size of the group as measured by the logarithm of the number of households in Mexico where the language is spoken, (2) The average wealth index of the households of the group and (3) the average education of the households in this group. Further, in column 4, all of these variables are included at the same time.

Remarkably, the results show that the effect of employment return on the language transmission appears to be fairly orthogonal to these variables. From this,

[22] These tables arrange households by the language-composition of parents (and occupation) and provide the share of children who are bilingual in each of household groups. Estimates of Table 16 show that in bilingual households, in which the 'head' of the household works in agriculture, 84.1% of children are minority language bilingual too, a transmission rate well above that of any other sector. Table 17 corroborates this by showing that across the ten largest spoken languages, language transmission rates are consistently higher in agriculture households.

we can conclude that the relative socioeconomic status of the languages is not driving the main result in Table 4.[23]

Table 3.5: Robustness check: Language group status

Dependent: Children can speak native language				
	[1]	[2]	[3]	[4]
Employment Return	.301*	.364**	.433**	.335*
	[.13]	[.131]	[.117]	[.127]
Ln Group Size	-.0098*			-.00827+
	[.00447]			[.00408]
Group avg wealth		-0.0259		-0.00341
		[.0165]		[.0231]
Group avg education			-0.0148	-0.00543
			[.00925]	[.0127]
Municipality controls	yes	yes	yes	yes
Household controls	yes	yes	yes	yes
Region fixed effects	yes	yes	yes	yes
Observations	227,076	227,076	227,076	227,076
R-squared	0.525	0.525	0.525	0.525

Notes: All models include the same controls as in column 3 of Table 4. Standard errors clustered at language group level, ** p<0.01, * p<0.05, + p<0.1.

3.5 Conclusions

This study demonstrates two linked results on the economics of language skills, that are new to the existing literature. The study is based on data from Mexican Censuses and the National Household Income and Expenditure Survey.

Firstly, we estimate the economic return to being bilingual for 34 indigenous Mexican languages. We show that on average, observationally identical indigenous Mexican males are more likely to be employed if they can speak both the indigenous language and Spanish as opposed to Spanish only. The employment benefit varies by language and can be explained by the domination of agriculture by the indigenous groups. The result can be demonstrated with two different data sets, and emerges as we take the analysis from an OLS with municipality fixed effects to a detailed matching estimator, suggesting that unobserved omitted factors relating to socioeconomic circumstances are likely to bias the return to indigenous languages downwards in the OLS. Economic benefits of minority languages

[23] An additional measure of group status we used is whether some parts of the municipality has autonomous indigenous governance that allows for native language schooling. This had only a minor effect on the estimates, and the own effect of this variable was positive but not statistically significant.

have not been shown in the literature to this extent before due to data limitations.

Secondly, we show that the employment returns to a language affect the likelihood that parents transmit the language skills to their children. We build a detailed picture of bilingual households in Mexico, and control for all key factors in the family and the local environment that affect the transmission of indigenous languages either by reducing the cost or increasing the benefits of knowing them. The result is driven by rural areas where indigenous populations dominate niche sectors such as agriculture. This result contributes to literatures on intergenerational transmission, identity formation and ethnic enclaves. For example, the results suggest that the economic benefits of migrant enclaves observed in other literature are likely to be mediated by a common language. The study also provides a unique systematic documentation on how economic factors can affect the continuation and survival of minority languages that lack the support of official institutions in developing countries. It is furthermore apparent from the results that additional language skills can be thought of as forms of insurance that allow the speakers to access niche labour markets, resonating with early results such as Munshi and Rosenzweig (2006).

These findings point to a number possibilities for future research on the economic returns of minority languages in other countries and contexts, and how policies and institutions interact with this relationship. A precondition for such research is that the censuses or household surveys document the languages spoken by individuals, and that the country in question has rich variability in minority languages. Institutional changes in language policies and labour markets can aide the identification of the effects of interest. In our study period for Mexico, there were no significant changes in the institutional setting and the formal support for the minority languages was weak.

3.6 Appendix Tables and Figures

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Table 3.6: Summary Statistics Census 2015 by population groups

Indigenous	Speaks Indigenous	Average Age	Illiteracy Rate	School Years	Work Status	Sample Size
All non-migrant male, 25-64						
0.21	0.07	41.4	0.04	9.60	0.85	2,352,008
All non-migrant male, 25-64 Identified with ethnic/indigenous group.						
1	0.28	41.6	0.07	8.03	0.83	799,977
All non-migrant male, 25-64 Identified with ethnic/indigenous group Speaks Indigenous Language.						
1	1	42.3	0.16	6.02	0.80	357,369

* Estimates for three different samples. Non explicit variables as follow: Indigenous: Share of population that self-identifies as indigenous; Schooling: Average years of schooling; Illiteracy Rate: share that "does not know how to read or write a message"; Work Status: share of the population working

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Table 3.7: Summary Statistics ENIGH 2016, by population groups

Indigenous	Speaks Indigenous	Average Age	Illiteracy Rate	Post Primary	Work Status	Sample Size
All non-migrant male, 25-64						
0.30	0.06	41.9	0.04	0.29	0.91	56,217
All non-migrant male, 25-64 Identified with ethnic/indigenous group.						
1	0.20	42.1	0.07	0.39	0.92	17,776
All non-migrant male, 25-64 Identified with ethnic/indigenous group Speaks Indigenous Language.						
1	1	42.9	0.15	0.60	0.94	3,968

* Estimates for three different samples. Non explicit variables as follow:
Indigenous: Share of population that self-identifies as indigenous; Schooling: Average years of schooling; Illiteracy Rate: share that "does not know how to read or write a message"; Work Status: share of the population working

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Table 3.8: Employment Statistics for Indigenous Populations (Matching Sample)

	Employment Statistics	
	Indigenous Bilingual	Spanish Monolingual
Employed	.943	.917
Independent Workers	.447	.244
Multiple Jobs	.201	.103
Formal workers[1]	.159	.344
Contract[2]	.156	.318
Weekly Hours of Work	45.3	48.9

[1] Defined by whether they have access to social security and health (IMSS, ISSTE, Pemex, Military)

[2] Working under a contract. ENIGH 2016, matching estimator sample.

Table 3.9: Occupation choice by bilingualism, percentages by level of education

Industry Occupation for Indigenous by Bilingual Status (and Schooling Years).
Spanish monolinguals (d=0), Indigenous bilinguals (d=1).

	Schooling					
	0	1-6	7-9	10-12	12+	All
	d=0					
Industry-Occupation						
Legislators, senior officials and managers	0.1	0.3	0.7	2.5	8.5	2.2
Professionals	0.3	0.5	0.7	1.2	30.5	5.7
Technicians and associate professionals	0.4	0.5	1.4	5.4	14.1	4
Clerks	0.4	0.8	2.3	6.4	7.5	3.4
Service workers and shop and market sales	8.7	10.8	18.1	25.5	15.2	16.5
Skilled agricultural and fishery workers	40	28.6	13.2	6.3	2.2	15.6
Crafts and related trades workers	23.8	28.4	27	22.5	11.7	23.9
Plant and machine operators and assemblers	5.4	11.6	20.1	18.1	6.6	14.5
Elementary occupations	21.3	18.9	16.5	11.8	3.9	14.4
Armed forces	0.1	0.1	0.5	0.9	0.3	0.4

	Schooling					
	0	1-6	7-9	10-12	12+	All
	d=1					
Industry-Occupation						
Legislators, senior officials and managers	0.1	0.2	0.4	1.2	5.4	0.6
Professionals	0.2	0.3	0.6	0.9	21.5	1.7
Technicians and associate professionals	0.2	0.4	1	6.4	35.1	3.2
Clerks	0.1	0.3	1.1	4.1	5.7	1.2
Service workers and shop and market sales	4.7	6.9	14.8	21.6	9.4	10.1
Skilled agricultural and fishery workers	60.4	51.7	34.8	23.2	6.6	43.1
Crafts and related trades workers	14.3	17.9	20.2	16.6	7.8	17.3
Plant and machine operators and assemblers	2.2	4.4	8.5	11.2	4	5.7
Elementary occupations	18.2	18.3	18.7	14.1	4.7	17.1
Armed forces	0.0	0.1	0.6	1.3	0.3	0.3

Note: Males 25-64 by ethnicity and language domain. Observations
with non-identified professions excluded when computing this set of statistics.

Table 3.10: Occupation within Industry: Differentials of Ethnic Indigenous by Language Status

Industry	Occupation within industry	Within Industry Share d=0	Within Industry Share d=1	Relative difference
Legislators, senior officials and managers	Directors and managers in health, educational, and social services	9.8	14.7	1.52
	Coordinators in health, educational, and social services, and grading judges[1]	7.6	11.6	1.52
	Directors and managers of museums, cinemas, and other establishments	1.8	3.3	1.85
	Directors of political, union, and civil organizations	1.1	2.4	2.26
	Officials, legislators and government officials	1.9	11.8	6.29
Professionals	General practitioners and specialists	9.7	9.7	1.01
	Fashion, industrial, and graphic designers, and interior decorators	3.2	3.2	1.02
	Other health specialists	2.9	3.2	1.11
	Specialists in agronomic sciences	3.6	4.3	1.19
	Broadcasters, entertainers, and clowns	1.6	1.9	1.22
	Professors, higher education instructors, and upper secondary teachers	10.2	13.9	1.37
	Other teachers and specialists in teaching, not elsewhere classified	2.4	4.8	2.02
	Performing artists	6.2	12.8	2.1
	Researchers and specialists in human sciences	2.8	5.8	2.12
	Educational supervisors and specialists in educational sciences	1	4.3	4.4
Technicians and associate professionals	Education aids and technicians, instructors and trainers	13.9	14.6	1.05
	Primay and secondary/middle school teachers	38.5	61.7	1.61
Clerks	Files workers and workers in control of stores and warehouses	27	30.7	1.14
	Supervisors of workers who provide and manage information	1.4	2.3	1.65
	Enumerators and encoders	2.4	8.3	3.53
Service workers and shop and market sales	Workers in the care of people	0.2	0.2	1.04
	Traders in stores	20	23	1.15
	Hairdressers, stylists, and related workers	1.1	1.3	1.22
	Gardeners	4.6	6.2	1.37
	Workers in the preparation and serving of food and drinks in establishments	12.9	17.6	1.38
Skilled agricultural and fishery workers	Workers in silvicultural and forestry activities	3.4	3.8	1.11
	Workers in agriculture	78.8	90.6	1.15
Crafts and related trades workers	Workers in the production and processing of food, beverages, and tobacco	6.8	8.1	1.21
	Artisans and workers in the manufacture of ceramics, glass, tile, and related	2.5	3.1	1.24
	Bricklayers and other workers in building construction	35.1	52.5	1.5
	Artisans and workers in the production of textile products	1.9	2.9	1.54
	Other craft workers, not elsewhere classified	0.9	1.4	1.58
	Artisans and workers in the production of wood products	5.6	9.7	1.73
	Weavers and workers in the preparation of textile fibers	0.3	1.3	5.2
Plant and machine operators and assemblers	Drivers of motorized land transport	57.2	63.6	1.12
	Operators of machinery for extraction in mines, quarries, and pits	2	2.3	1.16
	Operators of agricultural and forestry machinery	1.6	2.2	1.42
	Operators of machinery in the production of textiles, leather, and fur	5.7	9.5	1.69
Elementary occupations	Support workers in forestry, fishing, and hunting activities	20.3	23.7	1.17
	Assistant gardeners	0.2	0.3	1.25
	Support workers in forestry, fishing, and hunting activities	1	1.6	1.71
	Drivers of cycling transportation vehicles and animal-powered transports	0.6	1.3	2.17
	Support workers in agricultural activities	12.8	28.1	2.21
Armed forces	Workers in the army	98.1	99.6	1.02

[1] Coordinators and department heads in health, educational, and social services, and grading judges.

[2] Operators of machinery and equipment for extraction in mines, quarries, and pits.

[3] Operators of machinery and equipment in the production of textiles, leather, and fur.

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Table 3.11: Summary Statistics

Variable	Obs	Mean	SD	Min	Max
Household variables:					
Children speak native	225,183	0.646	0.478	0	1
Only mother speaks native	225,183	0.093	0.290	0	1
Only father speaks native	225,183	0.120	0.325	0	1
# Other HH adults speak native	225,183	0.145	0.445	0	11
% municipality share HH lang.	225,183	0.521	0.314	0.0000015	.97
Mother's years of educ.	225,183	4.822	3.879	0	18
Father's years of educ.	225,183	5.468	3.917	0	18
Mother's age	225,183	38.751	8.009	25	54
Father's age	225,183	42.527	9.751	12	100
Normalised HH wealth	225,183	0.042	1.009	-1.481	3.483
Urban household	225,183	0.311	0.463	0	1
Language group variables (n=33):					
Employment return	225,183	0.028	0.033	-0.048	0.104
Group size (# of households)	225,183	236002	209959	2362	596636
Average wealth in group	225,183	0.314	0.439	-0.538	1.151
Average yrs. of education in group	225,183	4.960	0.659	3.131	7.261
Municipality variables (n=1962):					
Educational deprivation index	225,183	33.062	10.633	5.1	60.6
Health deprivation index	225,183	13.752	6.722	0.9	77.4
Housing deprivation index	225,183	32.188	16.935	1.3	82.7
Food deprivation index	225,183	27.960	12.311	0.5	85.7

Table 3.12: Language Transmission by Family Structure.

Language	Both parents Bilingual	Single Mother Bilingual	Mother Bilingual Father Spanish	Mother Spanish Father Bilingual	Parent-Child Pop
Nahuatl	.684	.512	.082	.048	367,488
Maya	.494	.31	.053	.025	129,570
Tzeltal	.937	.784	.161	.151	207,892
Tzotzil	.945	.835	.135	.11	175,270
Mixteco	.75	.624	.071	.045	122,274
Zapoteco	.688	.524	.074	.038	85,842
Chol	.923	.742	.113	.098	79,222
Totocana	.731	.54	.065	.037	57,926
Mazateco	.747	.466	.051	.057	55,072
Huasteco	.818	.602	.059	.071	46,506
Tlapaneco	.897	.763	.155	.099	44,256
Otomi	.427	.33	.043	.035	43,132
Purepecha	.735	.637	.169	.072	32,370
Chinanteco	.805	.534	.074	.06	31,234
Mixe	.797	.595	.095	.037	30,162
Tarahumara	.851	.566	.195	.05	18,384
Amuzgo	.921	.789	.11	.095	18,172
Zoque	.781	.566	.105	.04	17,880
Mazahua	.26	.213	.049	.026	17,206
Tepehuano	.96	.789	.214	.318	16,664
Huichol	.947	.783	.136	.064	16,474
Chatino	.901	.832	.075	.076	16,318
Tojolabal	.863	.804	.043	.07	15,954
Popoluca	.818	.637	.057	.053	13,210
Cora	.968	.875	.378	.092	8,838
Triqui	.811	.794	.072	.08	8,570
Huave	.871	.745	.074	.059	5,740
Chontal ∵	.494	.4	.045	.069	5,054
Popoloca	.702	.529	.071	.008	4,444
Pame	.901	.875	.197	.05	3,666
Yaqui	.927	.652	.257	.064	3,478
Mayo	.284	.117	.107	.037	2,844
Cuicateco	.625	.358	.102	.026	2,502
All	.729	.553	.079	.047	3,052,206

Share of children from each parental linguistic arrangement that learnt native language of the parents.

∵ Chontal de Tabasco. Data: Households (that identify as indigenous) and in which an indigenous language is spoken by either of the household parents. Mothers are 25-55 years, children under 5 excluded. Census 2015. Parent-Child Pop: differs from number of observations because of weighting in sample.

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This table shows a decomposition of households by years of schooling and language structure of the parents. The measure given is the transmission rate of the language within households. The rates (range: 0-1) of transmission decrease with the education of the parent.

Table 3.13: Language Transmission by Family Structure and Parental Education.

Years of schooling (Father)	Both parents bilingual	Mother bilingual father Spanish	Mother Spanish father bilingual	Parent-Child population
None*	0.845	0.154	0.065	403,942
1 year	0.754	0.107	0.049	81,154
2 years	0.779	0.085	0.049	182,264
3 years	0.755	0.092	0.058	260,452
4 years	0.773	0.074	0.054	139,114
5 years	0.754	0.082	0.046	114,034
6 years	0.741	0.085	0.045	703,016
7 years	0.689	0.09	0.046	22,326
8 years	0.647	0.052	0.049	43,380
9 years	0.601	0.056	0.045	478,978
10 years	0.567	0.031	0.057	12,644
11 years	0.519	0.042	0.057	14,204
12 years	0.486	0.075	0.039	125,030
13 years	0.64	0.044	0.024	5,598
14 years	0.349	0.044	0.015	4,272
15 years	0.441	0.059	0.044	11,724
16 years	0.441	0.08	0.063	4,2974
17 years	0.419	0.084	0.032	19,944
18 years or more	0.431	0.142	0.018	13,792

Share of children from each parental linguistic arrangement that learnt native language of the parents. Mothers are 25-55 years, children under 5 excluded. Census 2015. Parent-Child Pop: differs from number of observations because of weighting in sample. * Labelled as 'Non or preschool'.

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Table 3.14: Language Transmission by Family Structure and Occupation of the Father.

Occupation of Father	Both parents Bilingual	Mother Bilingual Father Spanish	Mother Spanish Father Bilingual	Parent-Child Pop
Agriculture*	0.841	0.117	0.082	1127698
Construction	0.57	0.07	0.033	325154
Wholesale and retail	0.452	0.045	0.026	190340
Manufacturing	0.58	0.088	0.028	165222
Transportation$^{\diamond}$	0.49	0.062	0.046	74766
Hotels and restaurants	0.357	0.048	0.021	63160
Education	0.498	0.072	0.059	58378
Public administration *	0.447	0.068	0.023	52452
Other services	0.393	0.047	0.034	50852
Business services$^{\bullet}$	0.312	0.054	0.022	37992
Health and social work	0.369	0.064	0.018	8628
Private house services	0.406	0.067	0.032	8274
Mining and extraction	0.618	0.028	0.073	4216
Electricity, gas, water$^{\odot}$	0.527	0.054	0.006	4164
Financial services	0.223	0.022	0.01	1962

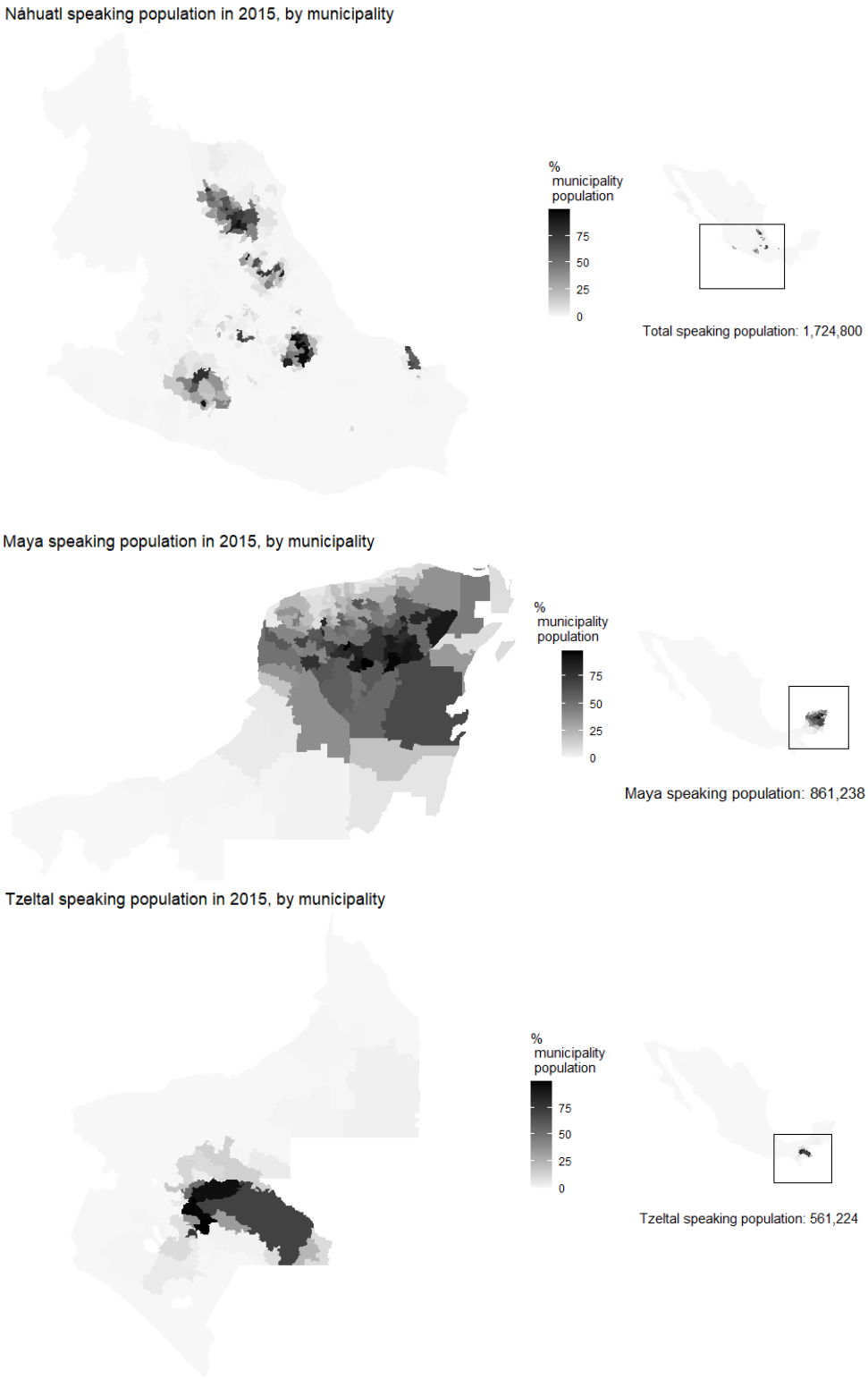
Share of children from each parental linguistic arrangement that learnt native language of the parents. * Agriculture, fishing, and forestry. $^{\diamond}$ Transportation, storage, and communications. * Public administration and defense. $^{\odot}$ Electricity, gas, water and waste management.$^{\bullet}$ Business services and real estate. Mothers are 25-55 years, children under 5 are excluded. Census 2015. Parent-Child Pop: differs from number of observations because of weighting in sample.

Table 3.15: Language Transmission by Family Structure and Occupation of the Father.

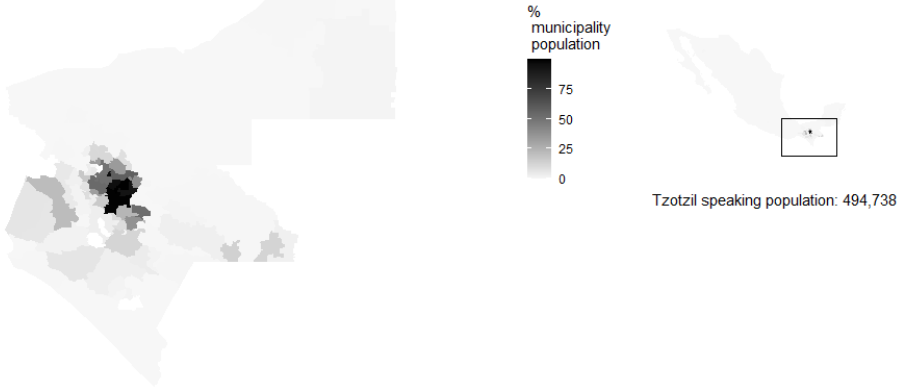
Language Group	Both parents Bilingual	Mother Bilingual Father Spanish	Mother Spanish Father Bilingual	Parent-Child Pop
Agricultural workers (industry code: 10)				
Nahuatl	0.767	0.105	0.07	153452
Tzeltal	0.97	0.225	0.221	146580
Tzotzil	0.962	0.191	0.137	102774
Chol	0.952	0.17	0.162	60512
Maya	0.684	0.092	0.04	59024
Mixteco	0.83	0.112	0.071	40474
Totocana	0.85	0.138	0.071	31018
Mazateco	0.903	0.141	0.148	30996
Zapoteco	0.775	0.09	0.055	30988
Tlapaneco	0.953	0.127	0.22	19664
Construction sector workers (industry code: 50)				
Nahuatl	0.581	0.078	0.037	35048
Maya	0.461	0.068	0.027	21068
Tzotzil	0.888	0.107	0.086	11108
Zapoteco	0.672	0.082	0.029	9482
Mixteco	0.57	0.064	0.045	7302
Tzeltal	0.691	0.061	0.108	5578
Otomi	0.375	0.037	0.024	5424
Totocana	0.517	0.042	0.031	4444
Mazahua	0.259	0.014	0.019	3296
Huasteco	0.733	0.061	0.105	3270
Crafts and related trade workers (occupation code: 7)				
Nahuatl	0.599	0.085	0.032	41282
Maya	0.395	0.044	0.023	20592
Zapoteco	0.619	0.061	0.027	9798
Tzotzil	0.912	0.087	0.034	8838
Purepecha	0.761	0.265	0.053	8474
Mixteco	0.544	0.05	0.032	6670
Otomi	0.383	0.028	0.029	6200
Tzeltal	0.68	0.029	0.105	5602
Huasteco	0.705	0.04	0.064	3914
Totocana	0.499	0.03	0.019	3908

Share of children from each parental linguistic arrangement that learnt native language of the parents. Mothers are 25-55 years, children under 5 are excluded. Census 2015. Parent-Child Pop: differs from number of observations because of weighting in sample.

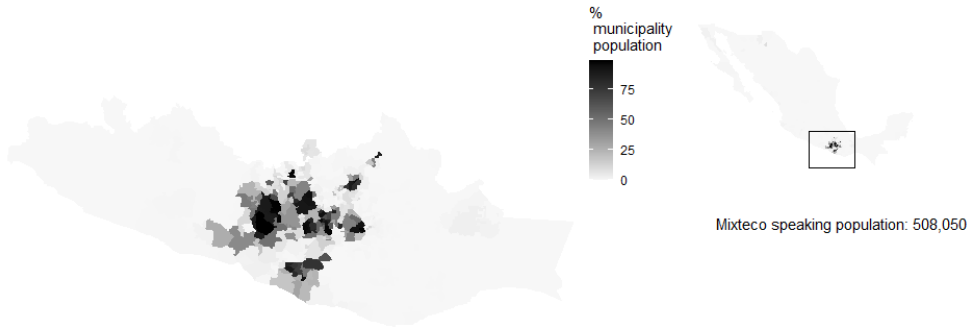
Figure 3.4: Anatomy of the Geographical Distribution of Indigenous Language Speakers



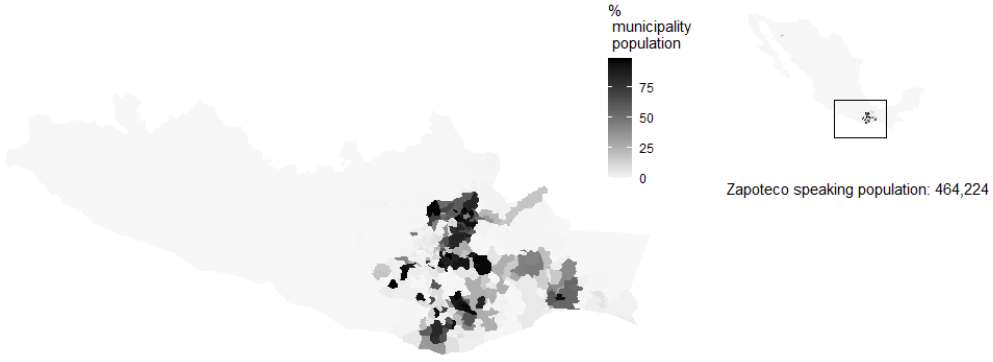
Tzotzil speaking population in 2015, by municipality



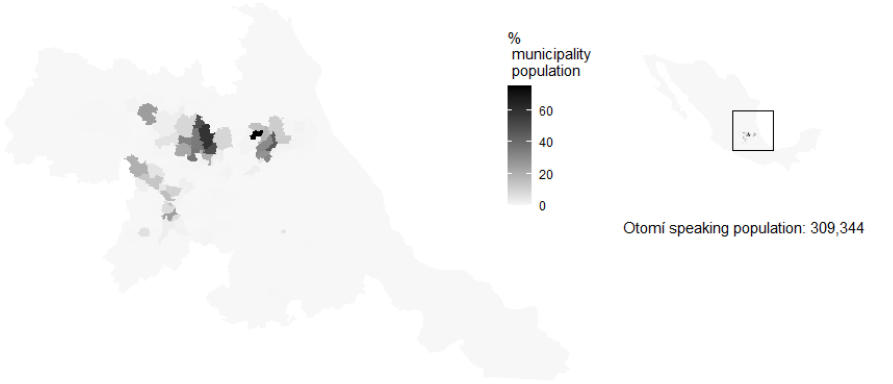
Mixteco speaking population in 2015, by municipality



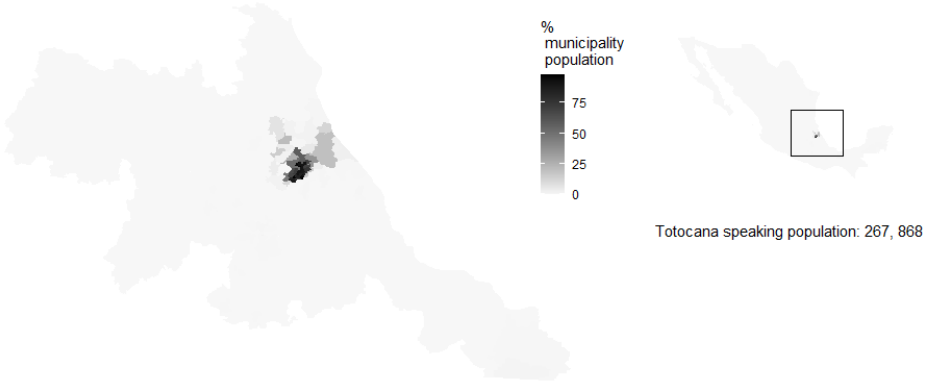
Zapoteco speaking population in 2015, by municipality



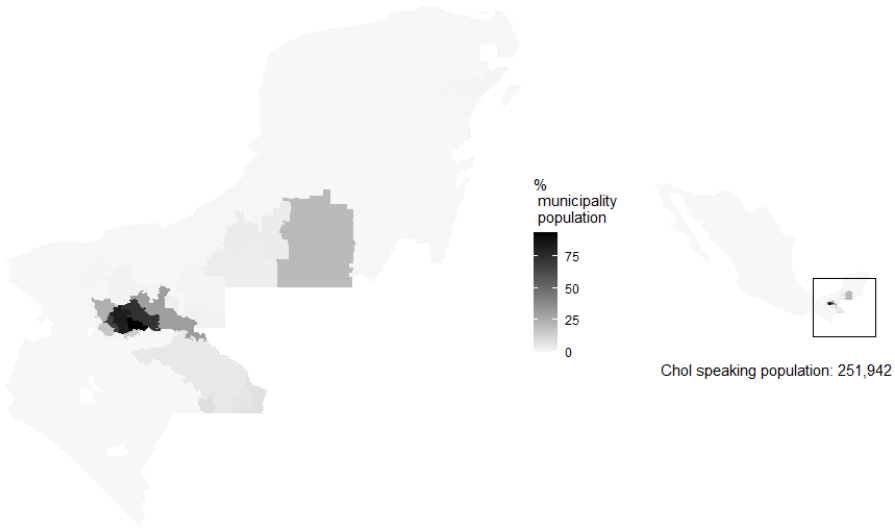
Otomi speaking population in 2015, by municipality



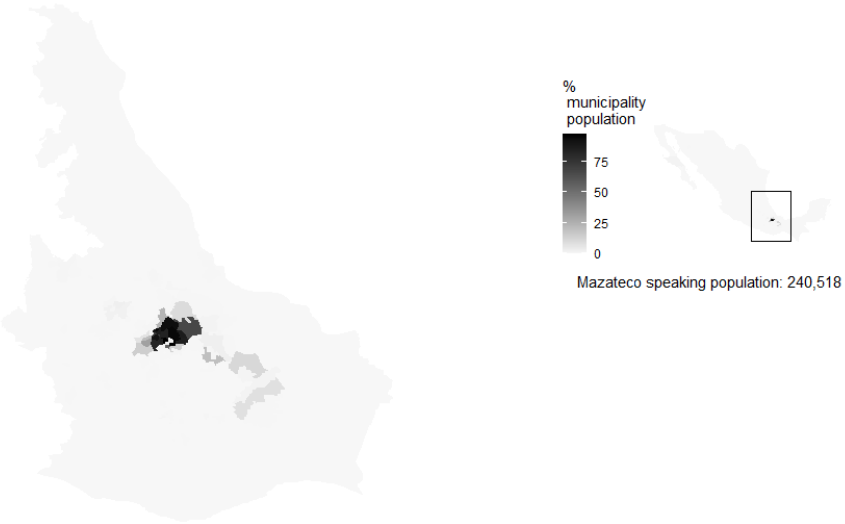
Totocana speaking population in 2015, by municipality



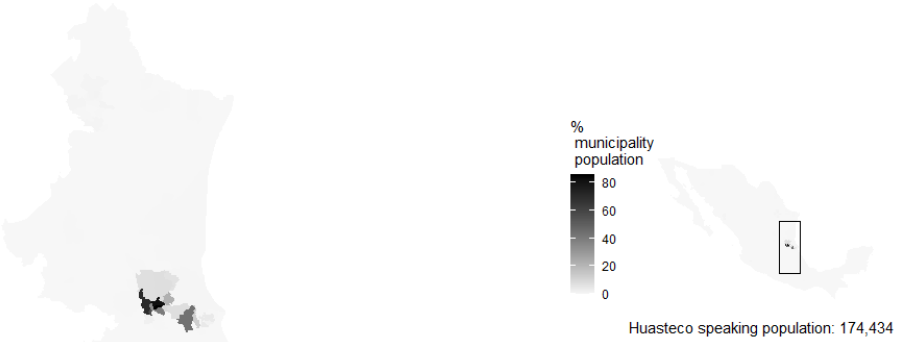
Chol speaking population in 2015, by municipality



Mazateco speaking population in 2015, by municipality



Huasteco speaking population in 2015, by municipality



Mazahua speaking population in 2015, by municipality

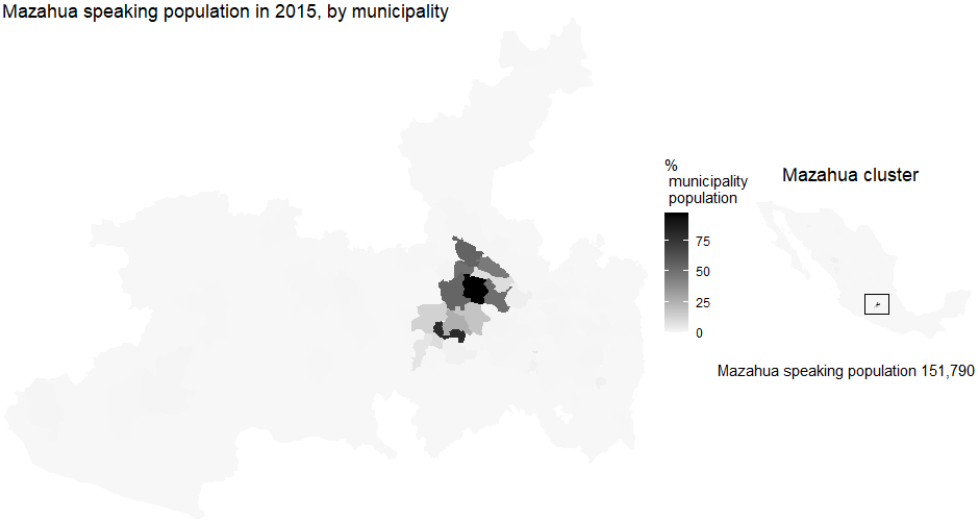


Figure 3.5: Employment Returns and Agricultural Work Shares, by Language (languages with statistically significant employment returns)

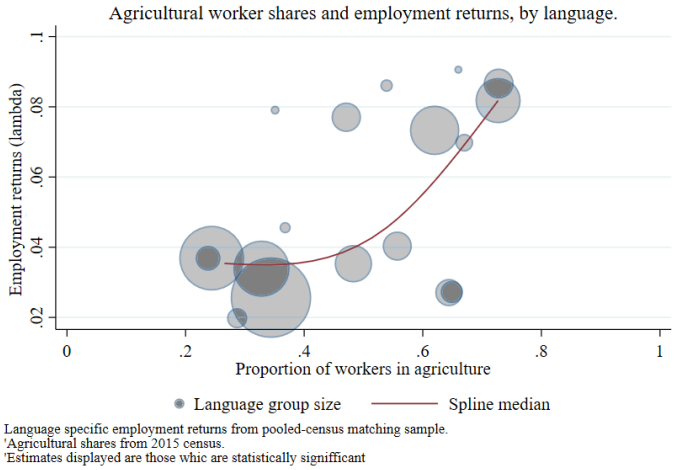
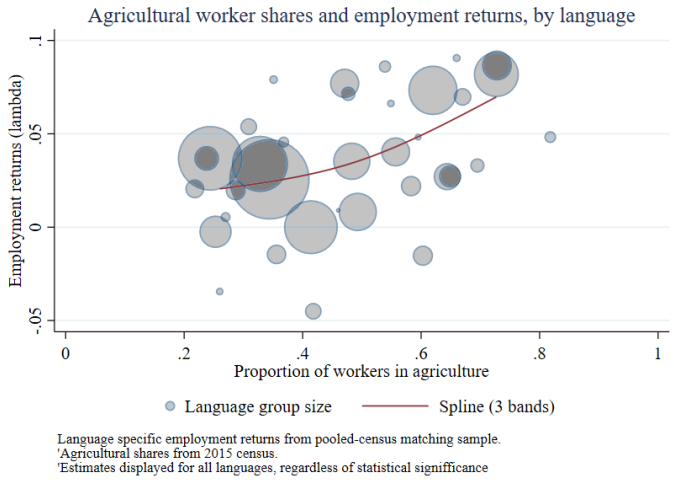


Figure 3.6: Employment Returns and Agricultural Work Shares, by Language (all languages)



Chapter 4

Concluding Remarks

This thesis studies three topics of the Mexican socioeconomic reality from an economic perspective. The results that emerge in each of the topics show a glimpse of how complex human relations and economic interactions are, and this research hopes to contribute to our general understanding of these. The thesis touches on varies topics with an empirical lens and combination of datasets and seeks to provide new results to the general literature of the matter in which they are in.

The topics studied are distinctively different, yet some parallels should not be overlooked. For instance, all chapters centre around a question of employment; be it early employment, labour benefits to minority language, or an approach to crime participation. Similarly, there is closeness in how the topics are studied. This is evident from more than one angle. For example, one chapter studies patterns of intergenerational persistence of education across generations, whereas another studies intergenerational transmission of the minority language. Similarly, while the thesis uses an entire repertoire of empirical methods, there is some overlap. For instance, two of these chapters rely on instrumental variable methods to recover causal effects. There is also crossing in some of the data sources, and a general interest in the focus on unintended effects and the display of geographical patterns.

The features studied in each of the chapters are socioeconomic relationships in which Mexico stands out from one perspective to another. With this, this research hopes to contribute to the general literatures of empirical labour, education and demographic economics. Outside economics, it hopes to connect with disciplines that study intergenerational mobility such as sociology, where vast work exists; or anthropology, in the study of Indigenous groups, where a profound quantitative analysis of indigenous language transmission and employment of this groups is

offered; perhaps as wide as criminology, law enforcement and policing.

In a similar note, results that have emerged from this thesis convey information with policy implications. There is perhaps one key policy message in each on the chapters: (1) The fact that income transfers causally affect crime levels shows that socioeconomic factors are a determinant of crime participation. The effect of income transfers is meaningful, but income transfers alone are not a solution to crime. (2) Causal intergenerational spillovers of parental education show how powerful education is as a tool of transformation, not only individuals but entire lines of families, and then society. Schooling has significant ripple effects that, over time, determine the development level that each society can achieve. (3) Preservation of minority cultures in Mexico has happened because these groups have formed tight population clusters. Demographic conditions are changing and without institutional support, much of these cultures and their knowledge will be forever lost.

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