Access to Secondary Schools Accelerating the Agricultural Transformation: Analysis of Panel Data from Rural Mexico *Draft*

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October 1, 2015

Abstract

The labor force from rural Mexico is currently transitioning out of agriculture, and I find that increasing access to secondary schools is a key factor in this transition. Using household survey data nationally representative of rural Mexico between 1980 and 2010, I find that access to secondary school reduces the probability of working in agriculture at age 20 by 5.4 percentage points and the magnitude of this impact grows with age. I use a differences-in-differences approach with a novel proxy for secondary school access based on sustained changes in school enrollment rates within villages. Field data from a selection of sample villages affirm this proxy, and regression results are robust to several alternative hypotheses. Understanding the impacts of secondary school access on labor outcomes has important policy implications since policy-makers can often influence school supply in rural developing areas directly. Economic theory maintains that the agricultural transformation is critical for economic development, increasing labor productivity, and raising incomes. My results show that policies to promote rural access to schools can simultaneously accelerate the agricultural transformation.

I. Introduction

Expanding job opportunities outside of the agricultural sector is critical to raising incomes and reducing poverty, and in many rural developing economies restricted access to schools is a limiting factor for obtaining non-farm work. Economic theory predicts that education is an essential element of economic growth (Nelson and Phelps, 1966; Mincer, 1984; Barro, 2001; Becker, Murphy and Tamura, 1994; Benhabib and Spiegel, 1994); yet there is little research to identify its role in the agricultural transformation, the stage of development when an economy's labor force shifts from being primarily agriculture to non-agriculture. This transformation raises incomes by allocating labor more efficiently across farm and non-farm sectors and by promoting capital investment to increase labor productivity (Lewis, 1954). This paper identifies the impacts of local secondary school access in rural Mexico on the probability of working in agriculture as the workforce transitions out of agriculture. Understanding the role of school access in the agricultural transformation provides policy direction to improve rural livelihoods and prepare an economy for a smooth transition of labor out of agriculture.

I find that local access to secondary school in rural Mexico reduces the probability of working in agriculture at age 20 by 5.4 percentage points, and the magnitude of the impact grows with age. I use unique panel data nationally representative of rural Mexico that record where all household members and children of either household head worked between 1980 and 2010 along with their education. The percentage of individuals age 20 to 30 working in agriculture in 1980 was 43.5 percent and in 2010 it was only 19.2 percent, demonstrating a substantial decline in the farm labor supply. Simultaneously, secondary education in rural Mexico is rapidly expanding. The mean education of individuals in their fifties in 2010 was only 5 years, and for those in their twenties, it was 9 years, or the completion of lower-secondary school. In this paper I find that access to secondary education in rural Mexico is a significant factor raising expected education and drawing individuals out of agricultural work. In 2007 the data indicate that 29 percent of rural Mexican villages still did not have a secondary school, suggesting that improvements in school supply will likely continue to support and even amplify the agricultural transition that is currently underway.

This paper has three distinguishing features. First, it uses rich panel data, nationally representative of rural Mexico to identify the impacts of secondary school access on education and the probability of working in agriculture. Second, it employs a novel proxy for secondary school access that is ground-truthed with field data from a select sample of villages. Finally, it finds suggestive evidence that the returns to secondary education are relatively higher for children from villages initially denied access to secondary school.

The length and scope of the data permit me to identify the impacts of secondary school access on the probability of working in agriculture using a differences-in-differences approach. I use variation within villages to identify the impacts of secondary school access on years of education and the probability of working in agriculture, controlling for village trends and state-year fixed effects. The year that a village gains access to a school is arguably exogenous to labor sector decisions. Similar to Duflo (2000), I exploit the fact that children who turn school-age before and after a school is built in their village differ from one another only according to their access to secondary education. Since villages cannot control or predict the year that a school is built (or school access improved) differences-in-differences regressions with village-specific trends and state-year fixed effects are expected to provide unbiased estimates of the impacts of local secondary school access on job sector selection. This paper makes a unique contribution to the economic literature because it uses nationally representative panel data to study impacts of school access on labor outcomes while the rural Mexican labor force is transitioning out of agriculture.

One of the central challenges and contributions of this paper is to estimate the year villages gain access to a secondary school when it cannot be directly observed. I create a proxy for secondary school access based on sustained changes in school enrollment rates of 12 year-old children. I validate this proxy using a range of data sources, including data collected in the field for a subset of villages. External sources indicate that the proxy performs well as a predictor of school construction. I then measure the impacts of having local access to a secondary school at age 12, the age when children typically begin secondary school, on years of education and the probability of working in agriculture as an adult. I first consider work outcomes at age 20 so that I observe work outcomes for each individual only once. I then repeat the analysis for ages 25 and 30 to test whether the effects of school access grow or diminish with age.

I further estimate the effects of an additional year of education on the probability of working in agriculture using access to secondary school as an instrument for education, and I find evidence that education is more impactful on the decision to leave agriculture for children from villages initially denied access to secondary school. A possible explanation for this finding is that children from more isolated villages lack comprehensive networks in the non-farm sector so they depend more heavily on education as a signal of ability to gain non-farm employment. Similarly, Card (2001) observes that the estimated returns to education are nearly always greater when instrumenting for education using school supply compared to the naíve OLS regression. He explains this phenomenon by suggesting that populations with initially high marginal cost of going to school have higher relative returns to education. In the context of this paper, the findings imply that initiatives to promote education have the strongest potential to accelerate the agricultural transformation when they prioritize villages initially isolated from schools because education is a more critical factor in the decision to work in agriculture for these children.

This paper contributes to two families of literature. The first pertains to the outcomes of education on labor outcomes and the other the transformation of rural developing labor forces out of agriculture. There is a large body of literature investigating the impacts of education on labor outcomes. While many studies find a positive correlation between education and employment in off-farm work (Zhang, Huang and Rozelle, 2002; Huffman, 1980; Janvry and Sadoulet, 2001), most of them do not account for the potential endogeneity of education in the labor choice model. School supply is often used as an instrument to estimate the impacts of education on labor force outcomes. Several studies indicate that improved access to education has positive impacts on years of school attendance (Duflo, 2000; Foster and Rosenzweig, 1996; Kane and Rouse, 1995; Card, 1993). Lavy (1996) observes that access to secondary education may affect primary schooling decisions as well, and Handa (2002) shows that effects of improved education persist across generations since more educated parents are likely to send their children to school for more years. Duflo (2000) and Foster and Rosenzweig (1996) use school construction as an instrument to identify the impacts of education on income. They find significant, positive effects, but they do not distinguish between farm and non-farm labor. One study measures the impacts of education on farm and non-farm wages, but it examines self-selected education only and does not investigate how changes in the supply of education affect labor allocation (Joliffe, 2004). Allocation of labor across sectors is a critical element of economic development, and the role of schools in this allocation is potentially very important.

The second body of literature relates the agricultural transformation to development and improved livelihoods. Economic theory shows that transitioning labor away from farm work into the non-farm sector is a necessary catalyst for economic growth and capital investment so that wages can rise above subsistence levels (Lewis, 1954; Timmer, 1988). Lewis (1954) shows that in an economy with an abundant supply of farm labor, many workers are employed in agricultural work at subsistence earnings. Employers in the non-farm sector can continuously pull workers from the agricultural sector at subsistence wages since the labor supply from agriculture is plentiful and initially, almost infinitely elastic. However, as capital rents and investment rise in the non-farm sector and more workers are drawn off of the farm, the marginal product of labor in agriculture eventually rises above subsistence. In response, wages in both the farm and non-farm sectors rise. As the farm labor supply is reduced, the industrial sector invests capital in agriculture to make farms and farm workers more productive, so that food production can keep pace with the food demands of workers in the non-farm sector (Timmer, 1988). The agricultural transformation, as it is known, is one stage on the process of economic development, and empirical studies also show that access to non-farm work is associated with higher incomes and less income variability (Huffman, 1980; Janvry and Sadoulet, 2001; Zhang, Huang and Rozelle, 2002). The role of education in this process is little understood. Showing that access to local secondary schools advances the agricultural transformation would indicate a critical avenue by which government policies directed towards school expansion may improve the welfare of farm and non-farm workers in a developing economy.

The impacts of constructing a secondary school where children previously did not have school access is of particular interest from a policy perspective because of the implications they have for public investment in education. I use a unique proxy for secondary school access, because the locations of secondary schools and years of construction are not observed directly. I validate this proxy by visiting more than 25 percent of the sample villages and asking residents when schools were constructed. These data collected in the field affirm that the enrollment rate proxy performs well. One potential concern with the empirical design is that secondary school enrollment rates may be correlated with improved access to roads, factories, or other non-farm employment. However, I find no evidence of this as the results are robust to several tests for alternative explanations. This paper shows that improving secondary school access in rural Mexico significantly reduces the probability that children grow up to work in agriculture. By promoting the agricultural transformation, school supply may have long-lasting impacts on income, standard of living, and economic growth.

II. The Workforce and Access to Education in Rural Mexico

Rural Mexico has entered a stage of development when the workforce is transitioning out of agriculture and non-farm production is growing. The farm workforce from rural Mexico fell by 2 million, or 25 percent, between 1995 and 2010 (Charlton and Taylor, 2013). A decade or more prior to this, rural communities began to see the effects of recent federal efforts to expand rural education. Mexico's constitution requires that basic education (currently grades 1-9) must be publicly available, free of charge, and non-religious, but many children do not have access to these services.

Empirical analysis shows that the probability that rural Mexicans work in agriculture is decreasing over time, and rising education is a significant factor contributing to this decline. Charlton and Taylor (2015) show that the farm labor supply from rural Mexico declined by an average of 0.97 percentage points annually between 1980 and 2010. Scaling by the rural population of Mexico in 2010, this amounts to over 150,000 persons leaving agriculture each year. The study finds that Mexico's expanding non-farm economy, declining birthrates in rural Mexico, and rising rural education all contribute significantly to the negative trend; however, their analysis regresses the probability of working in agriculture directly on own education, and does not investigate the impacts of exogenous shocks to education.

During the same period that Mexico's rural labor force is observed moving out of agriculture the federal government was also investing in new school infrastructure. This naturally leads to the question of whether and to what extent rural school supply may have contributed to the agricultural transformation. Public spending on education in Mexico rose from 2.9 percent of the GNP in 1980 to 5.1 percent in 2010.[1] There were accompanying policy changes with these expenditures as well. In 1992, the federal government increased mandatory education from the completion of primary school (grade 6) to the completion of lower-secondary school (grade 9)[2] (Rolwing, 2006). Although federally required education changed in 1992, the mandate was not effectively enforced, particularly in rural areas where secondary schools did not exist. Consequently, the mandate did not generate an exogenous change in expected eduction across rural communities as one might expect. Rather gains in education were more gradual and differed across locations.

Conversations with village authorities and school teachers in rural Mexico indicate that villages have little influence in determining if and when a school is constructed. School funding is highly centralized, so communities have little power to initiate a school-building project. The central government agency Secretaría de Educación Pública (SEP) is the largest source of school funding. In 1992 the education system was decentralized to the 32 states, but most reports contend that the decentralization was mostly administrative. Since the decentralization, states gained greater authority in school placement, but state governments still rely heavily on SEP for funding. In 2005 the national govern-

[1] http://databank.worldbank.org/data/home.aspx

[2] I refer to lower-secondary schools as "secondary" schools in the remainder of the paper

ment provided about 85 percent of educational funding (Santibañes, Vernez and Razquin, 2005), retaining much of the decision-making authority at the national level. Village authorities say that the federal government prioritizes building schools in communities located farthest from existing schools and in communities with the highest poverty rates, yet field visits reveal that many villages are still lacking.

One of the major constraints for remote villages is finding teachers who are willing to live and work in the location. Limited supply of teachers and school infrastructure has been resolved in part by multi-shifting schools (providing morning, afternoon, and evening sessions) so that more students can attend school even where additional buildings and multiple teachers do not exist. A system of telesecundarias, or distance learning, was implemented in the 1990s. In telesecundarias, one teacher is hired to teach all of the subjects and students watch their lessons on satellite television. Telesecundarias are most prevalent in poorer, highly rural states, and many of the villages in this paper have access to no more than telesecundaria education. Although multi-shifting schools and establishing telesecundarias reduces some of the physical constraints necessary for providing school access, schools still require state or federal resources for operation. Villages and municipalities rarely have the funding to establish schools independently of the state or federal government. Furthermore, teachers and community residents say that education completed at schools not registered with the federal government are often unrecognized by employers or schools of higher education. Consequently, demands for education in isolated villages must be met by supplies from higher government authorities.

The opportunity cost of time is another significant constraint to attending school for poorer households, though this is partly overcome by government programs that subsidize school attendance from poor families. For example, Prospera, the well-known anti-poverty program (formerly called Oportunidades and Progresa), gives cash transfers to families conditional on children's school attendance and regular health check-ups. Progresa, as the program was originally named, began in 1997. It was initially offered only to households in randomly selected villages, and then it was rolled out at the national level for qualified households. Since Prospera is a welfare program to fight poverty, qualification is targeted to the poor. However, Bobonis and Finan (2009) and Lalive and Cattaneo (2009) find that Prospera recipients in Mexico positively affect the school attendance of children in communities ineligible for conditional cash transfers through peer effects. The program was implemented using a randomized roll-out design, and studies indicate that the program was effective at both targeting the poorest families and at increasing school attainment (Skoufias, Davis and De La Vega, 2001; Schultz, 2004). Since Prospera was rolled out randomly across villages and quickly became universal, the program's potential impacts on school attendance should not confound the results in this paper.

III. The Model

I illustrate the decision to work in agriculture using a two-period model, in which individuals maximize net discounted income over their lifetime. Net earnings in period 1 depend on how much time individual i allocates to work and how much time he allocates to school. Individual i is endowed with $\bar{T}_1$ units of time for work and school. When not in school individuals work in the agricultural sector at baseline wage W_{1A}, where A indicates the agricultural sector. Each unit of school, s_{1i}, costs $Z_i = z(km_i)$ in terms of lost wages, where km_i is the distance from i's home to the nearest secondary school. Assume $\frac{dz}{dkm_i} > 0$. That is, the time and cost of traveling to school each year is increasing in the distance traveled to school. Consequently, there is an opportunity cost of attending school in period 1 equal to forgone wages.

In the second period, the individual has the option to work in the agricultural or the non-agricultural sector. This paper focuses on the impacts of school access on farm labor supply, so let $D_i = 1$ if individual i works in the agricultural sector (A) in period 2, and $D_i = 0$ if he works in the non-agricultural sector (N). Second period earnings depend on the sector of work and years of education attained in period 1. Individuals are endowed with $\bar{T}_2$ units of time for work in period 2. Let wages in sector $j \in \{A, N\}$ be given by the concave function $W_{2ji} = w_{2j}(s_{1i})$, where $\frac{dw_{2j}}{ds_{1i}} > 0$ and $\frac{d^2w_{2j}}{ds_{1i}^2} < 0$. That is, wages in period 2 are increasing in years of education and there are diminishing returns to school. Assume further that $\frac{dw_{2N}}{ds_{1i}} > \frac{dw_{2A}}{ds_{1i}}$ for any $s_{1i} > 0$, that is that the returns to education are greater in the non-agricultural sector than in the agricultural sector.

The individual maximizes the sum of net earnings from each period by selecting how long to attend school in period 1 and whether to work in the agricultural sector in period 2. The optimization problem can then be written

$$\max_{s_{1i}, D_i} \quad W_{1A}[\bar{T}_1 - s_{1i}z(km_i)] + \delta[D_i w_{2A}(s_{1i})\bar{T}_2 + (1 - D_i)w_{2N}(s_{1i})\bar{T}_2] \tag{1}$$

III - I Solving for Optimal Years of Education

Since D_i is a dichotomous variable, I solve the optimization problem recursively. There are two possible outcomes, one where individual i chooses to work in the agricultural sector ($D_i = 1$) and one where he chooses to work in the non-agricultural sector ($D_i = 0$), and there is an optimal amount of school associated with each outcome. I find the income-maximizing quantity of school that an individual would select for the agricultural and non-agricultural sectors separately. Define the optimal selection of school s^*_{1ji}, for individual i working in sector $j \in \{A, N\}$. Optimal education is implicitly defined by the first order condition

$$\delta\bar{T}_2 \frac{dw_{2j}}{ds_{1i}}\bigg|_{s^*_{1ji}} = W_{1A}z(km_i) \tag{2}$$

where the left-hand side of equation (2) represents the discounted marginal benefit of school for an individual in sector j, and the right-hand side represents the marginal cost of school in terms of lost wages and effort in period 1. It follows that $s^*_{1Ni} > s^*_{1Ai}$ since $\frac{dw_{2N}}{ds_{1i}} > \frac{dw_{2A}}{ds_{1i}}$ for any given s_{1i}, and there are diminishing marginal returns to education.

The effect of constructing a new school in an individual's village is to decrease km_i, that is, to decrease the distance to school. This, in turn, decreases the marginal opportunity cost of attending school. Applying the Implicit Function Theorem, distance to school affects the optimal years of education according to the expression

$$\frac{\partial s^*_{1ji}}{\partial km_i} = \frac{W_{1A}\frac{dz}{dkm_i}}{\delta \bar{T}_2 \frac{d^2 w_{2j}}{ds^2_{1i}}\Big|_{s_{1i}=s^*_{1ji}}} \tag{3}$$

This shows that years of optimal schooling are decreasing in distance to school. Consequently, when a school is constructed in i's village, he will attend more years of school regardless of whether he works in the agricultural or non-agricultural sector. It is unclear whether optimal years of school increase more for the individual planning to work in the agricultural sector or for the individual planning to work in the non-agricultural sector. This depends on how quickly the returns to education are decreasing in each sector at the optimal years of education.

III - II Solving for the Probability of Working in Agriculture

Now, I look at whether an individual will work in the agricultural or non-agricultural sector given the optimal years of school for each sector. Individual i works in the agricultural sector if his net earnings from working in the agricultural sector are greater than his net earnings from working in the non-agricultural sector. The probability of working in the agricultural sector can then be expressed

$$Pr(D_i = 1) = Pr[W_{1A} z(km_i)(s^*_{1Ni} - s^*_{1Ai}) > \delta \bar{T}_2 (w_{2N}(s^*_{1Ni}) - w_{2A}(s^*_{1Ai}))] \tag{4}$$

That is, the probability of working in the agricultural sector is equal to the probability that the additional cost incurred from attending the optimal years of school for the non-agricultural sector is greater than the gain in earnings from working in the non-agricultural sector in period 2. Individuals that highly discount future earnings are more likely to work in agriculture in the second period because the cost of attending more school in period 1 is large compared to the discounted benefit of working in the non-farm sector in period 2. Likewise, when the base wage in period 1 or the optimal amount of school required for the non-agricultural sector is large, individuals are more likely to work in the agricultural sector.

To find the effects of building a school inside the village on the probability of working in agriculture I take the partial derivative of expression (4) with respect to distance to school:

$$
\begin{aligned}
\frac{\partial Pr(D_i = 1)}{\partial km_i} = Pr[W_{1A}\frac{dz}{dkm_i}(s^*_{1Ni} - s^*_{1Ai}) + W_{1A}z(km_i)\Big(\frac{\partial s^*_{1Ni}}{\partial km_i} - \frac{\partial s^*_{1Ai}}{\partial km_i}\Big) \\
-\delta\Big(\frac{dw_{2N}}{ds_{1i}}\Big|_{s_{1i}=s^*_{1Ni}}\frac{\partial s^*_{1Ni}}{\partial km_i} - \frac{dw_{2A}}{ds_{1i}}\Big|_{s_{1i}=s^*_{1Ai}}\frac{\partial s^*_{1Ai}}{\partial km_i}\Big)\bar{T}_2 > 0]
\end{aligned} \tag{5}
$$

Combining the above expression with the first order condition for optimal education in expression (2), the last two terms drop out of expression (5). The effects of distance on the probability of working in agriculture is then

$$
\frac{\partial Pr(D_i = 1)}{\partial km_i} = Pr[W_{1A}\frac{dz}{dkm_i}(s^*_{1Ni} - s^*_{1Ai})] \tag{6}
$$

This shows that the probability of working in agriculture is increasing in distance to school since $s^*_{1Ni} > s^*_{1Ai}$. Consequently, building a school in a child's village reduces the probability of working in agriculture by decreasing the relative cost of traveling to and from school for the non-farm sector.

This model implies that improving rural school supply reduces the probability of working in agriculture under the following conditions: (1) the returns to education are greater in the non-agricultural sector compared to the agricultural sector, (2) there are diminishing marginal returns to education in both sectors, and (3) there is an opportunity cost to traveling to and from school. The last two conditions are standard assumptions in economic theory, and I show suggestive evidence for the first condition in the appendix using income and labor data from rural Mexico.

IV. Empirical Approach

The objective of this analysis is to measure the impacts of school access on the probability of working in agriculture from rural Mexico. The model implies that school access impacts the decision to work in agriculture by decreasing the opportunity costs of attending school, leading children to select more years of education and pursue work in the non-farm sector. Construction of secondary schools provides an exogenous shock to education within villages. Similar to Duflo (2000)'s identification strategy, in this analysis children who are secondary school age before the school is constructed do not benefit from local school access while younger children from the same village do benefit. Children from the same village who turn 12 before and after a secondary school is constructed are not expected to systematically differ from one another except through their access to secondary school. Consequently, children who turn 12 before a secondary school is constructed constitute the control group, and children from the same village who turn 12 after the school is constructed are the treatment.

This is a differences-in-differences estimator (DD) that measures the variation in probability of working in agriculture within villages across individuals with and without access to a local secondary school. The key assumption for DD is that school access and trends in sector choice would be the same across all villages absent of treatment. However, this does not seem like a realistic assumption since some villages may be located closer to urban development, where non-farm employment is growing more quickly. If urban development increases the demand for secondary education and this is also correlated with gaining a secondary school, then the estimated coefficient in the DD estimator will be biased downward (away from zero). I address this by controlling for village-specific trends and state-year fixed effects. The village trends remove any trends within the village that correlate with both demands for education and local supply of non-farm jobs. The state-year fixed effects control for any state-wide shocks, such as passage of a state education or employment policy.

To begin, I look at the first-stage effects of secondary school access on years of education. Let edu_i be the dependent variable, the number of years that individual i attends school, and let sec_i be the explanatory variable, a dummy variable equal to 1 if individual i's village had a secondary school when i was 12 years old and zero otherwise. Let X_i be a vector of individual and household characteristics likely to affect labor sector choice, including gender, how many children and adults lived in i's household when he was school-age, and how much agricultural land i's household inherited. I control for unobserved, time-invariant village characteristics by including village fixed effects, λ_v. I further control for village-specific trends, $\gamma_v * t$, and simultaneous statewide shocks using state-year fixed effects, $\phi_{s,t}$. The first-stage regression is then expressed

$$edu_i = \alpha + \beta sec_i + \eta X_i + \lambda_v + \gamma_v * t + \phi_{s,t} + \epsilon_{i,v,t} \tag{7}$$

where $\epsilon_{i,v,t}$ is the error term.

I expect the coefficient β on secondary school access to be greater than zero since gaining access to secondary school reduces the cost of attending school. If the returns to education are greater in the non-agricultural sector than in the agricultural sector, then access to secondary school will subsequently affect whether individuals work in agriculture when they grow up.

Let $Y_{i,v,t}$ be the next outcome of interest, a dummy variable for working in agriculture. To begin, let $Y_{i,v,t}$ equal 1 if individual i from village v works in agriculture in year t, when he is 20 years old, and zero otherwise. In the analysis I will repeat this regression with i's labor choices at ages 25 and 30 to see if impacts grow or diminish with age. The main equation of interest, which I refer to as the reduced form regression, is

$$Y_{i,v,t} = \alpha + \beta sec_i + \eta X_i + \lambda_v + \gamma_v * t + \phi_{s,t} + \epsilon_{i,v,t} \tag{8}$$

After estimating the impact of school access on the probability of working in agriculture, I next investigate the impact of an additional year of education. The naíve OLS estimator regresses the probability of working in agriculture directly on own education.

$$Y_{i,v,t} = \alpha + \beta edu_i + \eta X_i + \lambda_v + \phi_{s,t} + \gamma_v * t + \epsilon_{i,v,t} \tag{9}$$

However, omitted variables correlated with education and labor sector choice are likely to bias the estimates of causal impact. An alternative strategy, often used in the labor literature, is to use access to school as an instrument for education, which measures the local average treatment effect of an additional year of education for children from villages that were initially denied access to a secondary school.

V. Data

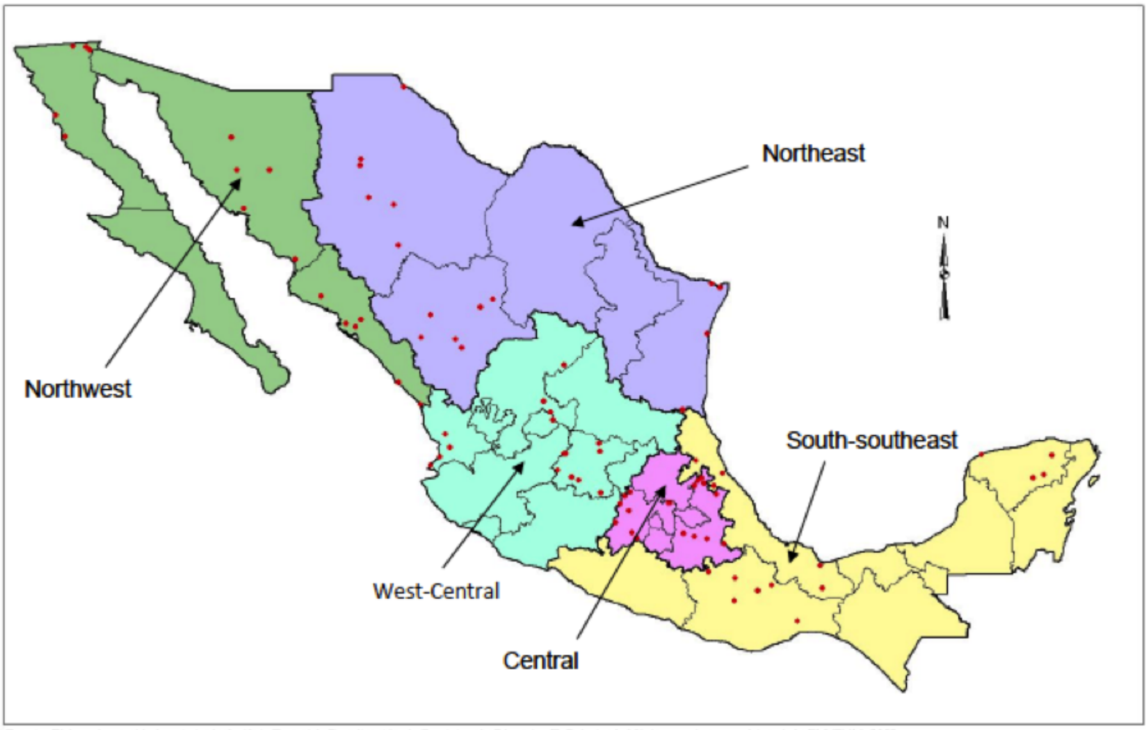
I use data from a nationally representative sample of rural Mexican households. The Mexico National Rural Household Survey (Spanish acronym *ENHRUM*[3]) is unique in providing retrospective panel data on individual migration from rural Mexico to both the United States and destinations within Mexico in 1980-2010.

The map in Figure 1 shows Mexico divided into five representative regions and the locations of the original ENHRUM surveys. [4]

The panel data come from three survey rounds: 2002, 2007, and 2010. Each round collects detailed information on migration destinations, whether migrants worked in the agricultural or non-agricultural sector, and employment status (wage-earner or self-employed) for family members, including the household head, his/her spouse, all others living in the household, and children of the household head and spouse living outside the household. Work histories were gathered as far back as 1980 for a randomly selected group of household members and back to 1990 for all household members. Since those who do not have a work history from 1980-1990 are a random sample, the exclusion of these individuals in the earliest decade of the analysis should have no bearing on the results. Some households were dropped from the survey in 2010 due to budget constraints and increased violence in their communities. The method of dropping communities from the survey in 2010 maintains a nationally representative sample of rural Mexico apart from the communities

[3] *Encuesta Nacional a Hogares Rurales de México*; Spanish acronym ENHRUM

[4] The surveys in the Northeast region were dropped from the 2010 survey, so I do not have data for households in this region for years 2008-2010. Some of the original localities shown in the map were dropped in the final survey round due to budget constraints or violence. The remaining sample was randomly selected to retain the integrity of national representation.



Fuente: Elaborado en el Laboratorio de Análisis Espacial, Coordinación de Servicios de Cómputo, El Colegio de México con base en datos de la ENHRUM, 2003.

Figure 1: Map of ENHRUM Villages

dropped due to violence.

The ENHRUM data are summarized in Table 1. The first panel of Table 1 summarizes the dependent variable of interest, whether individuals work in agriculture. I summarize the probability of working in agriculture at ages 20, 25, and 30, the ages I use in the analysis. The first three rows of Table 1 show that a little less than one-third of 20, 25, and 30 year-olds work in agriculture throughout the sample period. However, the share of individuals working in agriculture is not constant over time. In 1980, 44 percent of all individuals age 20 to 30 worked in agriculture; by 2010, only 19 percent worked in agriculture.

The second panel summarizes individual and household characteristics that may be correlated with the probability of doing agricultural work, including years of education, sex, the number of children (age 14 and under) and the number of working-age adults (ages 15 to 65) living in the individual's household when 12 years old, whether the head of the household speaks an indigenous language, and how much land the household inherited as of 2002. The mean educational attainment in the full sample is 7.69. However, years of education differ substantially across generations, the younger generations being more highly educated than the older generations on average.

The third panel of Table 1 shows the educational attainment by age in 2010. Individuals in their twenties have expected education of 9 years while those in their fifties have expected education of only 5 years. This is an impressive rise in education in a short period of time, reflective of the expansion of secondary schools throughout rural Mexico between 1970 and 2000.

The ENHRUM data also contain community surveys that record the public infrastructure existing in the villages in 2002 and 2007, including schools. The fourth panel records the number of villages where the highest school level located in the village is primary, lower-secondary (grades 7-9), and upper-secondary school (grades 10-12 or 13) in 2002 and 2007. These data show that many villages did not have lower-secondary schools in the early 2000s, and very few had upper-secondary schools.

VI. Constructing a Proxy for School Access

In this paper, I identify the impact of local secondary school access on the probability of working in agriculture. One of the empirical challenges of this paper is that I do not directly observe when secondary schools are built in each village. The federal government's education division, la Secretaría de Educación Pública (SEP), shared its school records indicating the most advanced school located in each village every year from 1990 through 2012. However, field visits to a few of these villages revealed that schools were actually built many years prior to the year indicated by the SEP records. Consequently, this paper develops a different strategy for approximating the year of school construction in each village.

I construct a proxy for local secondary school access using annual village-level enrollment rates of 12 year-old children from the ENHRUM survey. This is the age when children typically begin secondary school. I use sustained increases in the school enrollment rates in a village as an indicator that the village acquired access to a secondary school, likely through school construction. Since education is traditionally low in rural

Table 1. Summary of ENHRUM Data

VARIABLE	Mean	SD	Min	Max	Obs
Share Working in Agriculture					
Agriculture if Age 20 (1980-2010)	0.290	0.454	0	1	5,138
Agriculture if Age 25 (1980-2010)	0.279	0.449	0	1	4,762
Agriculture if Age 30 (1980-2010)	0.290	0.454	0	1	4,238
Agriculture if Age 20-30 (1980)	0.435	0.496	0	1	800
Agriculture if Age 20-30 (2010)	0.192	0.394	0	1	1,434
Characteristics of Individuals, Age 20					
Years of Education	7.69	3.65	0	16	6,527
Female	.454	.498	0	1	5,138
Children in HH (when age 12)	5.25	2.84	1	23	6,527
Adults in HH (when age 12)	3.28	2.68	0	15	6,527
Indigenous Language (hh head)	.139	.346	0	1	4,694
Inherited Land (hundreds of ha)	.017	.176	0	5.07	5,138
Educational Attainment by Age in 2010					
Education if Age 20-29 (2010)	8.94	3.42	0	17	1,320
Education if Age 30-39 (2010)	7.74	3.67	0	21	1,314
Education if Age 40-49 (2010)	6.58	3.96	0	18	996
Education if Age 50-59 (2010)	5.04	3.65	0	19	614

ENHRUM Community Survey
Highest Level of School in Village in 2002 and 2007

	2002	2007
Primary	24	23
Lower-Secondary	47	45
Upper-Secondary	9	12

villages, qualified teachers are unlikely to come from within the village, which reduces the probability of endogenous selection based on hiring teachers from within the villages to meet the local demands for education.

School enrollment rates are calculated by the percentage of 12 year-old children who enroll in secondary school each year. When, for 4 consecutive years, at least 50 percent of children age 12 attend school, then I assume that the village gained access to secondary school in the first of the 4 years.[5] In some village-years there are no 12 year-old children

[5] I experimented with different proxy constructions, increasing and decreasing the number of consec-

in the sample (or the education of the 12 year-old children is missing). Therefore, I allow for up to 2 missing values within the stretch of 4 consecutive years. If I do not observe a change in school enrollment rates for a village, then I assume that the village did not receive access to a secondary school before 2010. Between 1970 and 2010, I observe 2.5 children at age 12 per village-year on average with a range from 0 to 11. Figure 2 plots the number of villages where I observe changes in access to secondary schools each year using this proxy. I can observe the individual work choices at age 20 of individuals with access to secondary school if their village gained school access no later than 2002.

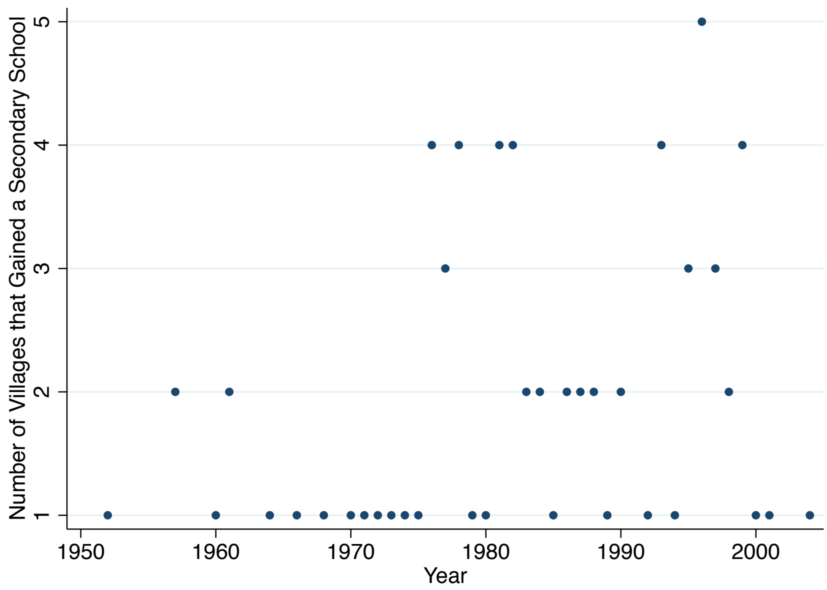


Figure 2: Number of Villages that Gained Secondary School Access

VI - I Validating the Proxy

I conduct 4 checks to test the validity of this proxy. First, I plot the mean enrollment rates before and after the proxy turns one to see whether the proxy picks up distinct and sustained increases in school enrollment rates, as it is intended to. Second, I compare the proxy with the 2 years ENHRUM village infrastructure data that record the number and type of schools located in each village. Third, I compare the proxy with SEP records.

utive years and enrollment rates. Requiring fewer consecutive years generally did not capture sustained increases in school enrollment rates. Requiring more consecutive years generally appeared to miss the initial jump in enrollment rates within the village. Regression results using other proxies did not show a significant impact of "school access" on the probability of working in agriculture once I included all of the controls described in the empirical section.

Lastly, I compare the proxy with new field data from 22 of the ENHRUM villages located in Southern Mexico.

If observed changes in enrollment rates are a good proxy for gaining a secondary school, then there should be sustained improvements in school enrollment rates in all years after the proxy turns one. Figure 3 shows the mean secondary school enrollment rates in the years leading up to and following the years that villages gain access to a secondary school. As expected, there is a jump in enrollment rates the year that the proxy turns one. The enrollment rates remain high after the proxy switches, indicating a sustained increase.

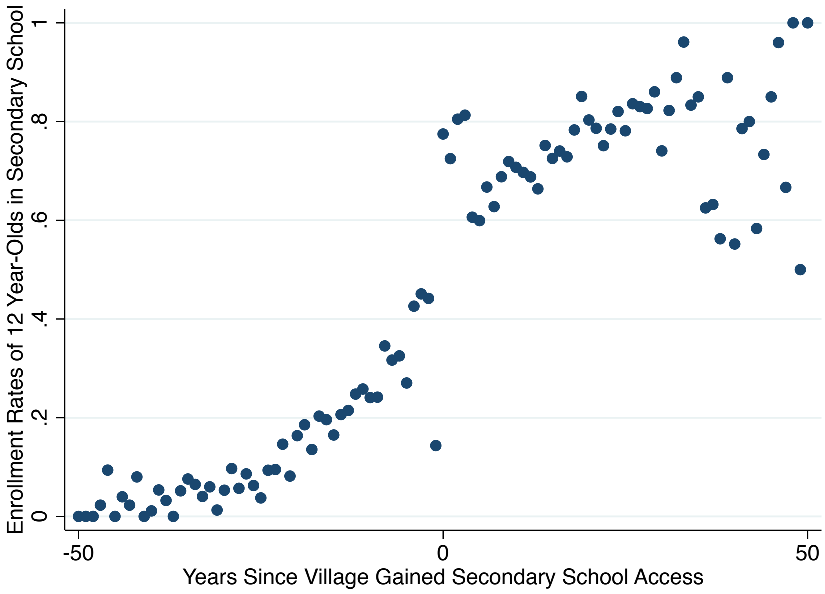


Figure 3: Mean Secondary School Enrollment Rate Before and After Villages Gained Access to Secondary School

I further find that the proxy is a good predictor of education. Figure 4 illustrates the correlation between school access and mean years of education. The x-axis in Figure 4 indicates how many years after the village gains access to a secondary school that the individual turns school age. Negative numbers indicate that the individual is too old to benefit from the school. The figure shows that individuals who were 12 years old 20 years before their village gained a secondary school have an expected education of 5-6 years of school, a little less than completion of primary school (completion of primary school is 6 years). Expected years of education rise slightly in subsequent years leading to the establishment of a secondary school. For children that turn 12 the year that a secondary school is established (according to the school enrollment rate proxy), expected school attainment jumps to 9 years, or the completion of lower-secondary school, and expected education remains around 9 years for children who turn 12 in the following years. These figures provide suggestive evidence that the proxy identifies the year that a secondary school is established in a village.

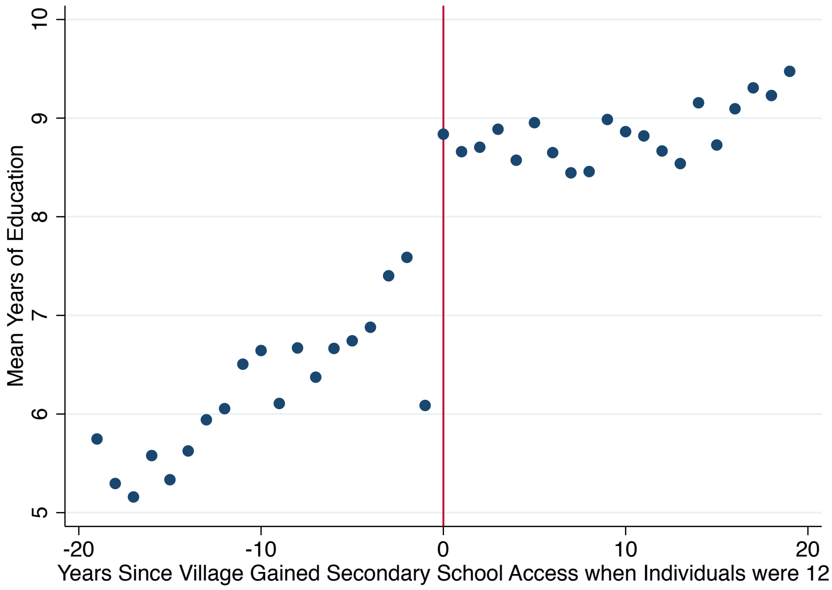


Figure 4: Mean Years of Education for Individuals who Turned 12 Before and After their Village Gained Access to Secondary School

ENHRUM includes surveys of community infrastructure in 2002 and 2007, though it does not record the year that schools and other infrastructure were built. As support for the validity of this proxy, I compare the proxy for school access to the actual school access recorded in ENHRUM in 2002 and 2007. Table 2 records the number of observations where the proxy and ENHRUM match regarding secondary school access. It also records the number of observations in which the proxy indicates that a village has access to a secondary school while the ENHRUM community data indicate that a secondary school is not located in the village. Since children in some villages can easily attend school in a neighboring village, it is not surprising to find observations in which secondary school enrollment rates are high and there is no secondary school located in the village. These children may still have good access to secondary school even though the school is not in their village. It is harder to understand why the proxy would not detect access to a secondary school when a school does in fact exist inside the village. This occurs twice in 2007. Possibly the quality of teaching is low, and families choose not to send their children to school in these villages so enrollment rates remain low. Other explanations may exist.

Table 2. Matches Between Proxy and ENHRUM Community Survey Regarding Access to Secondary School

	2002	2007
Proxy and ENHRUM: Yes Secondary School Access	54	55
Proxy and ENHRUM: No Secondary School Access	3	2
(Proxy: Yes) and (ENHRUM: No)	21	21
(Proxy: No) and (ENHRUM: Yes)	2	2
Observations	80	80

Finally, I verify the enrollment rate proxy using new field data that ask residents from 22 villages in Southern Mexico when a secondary school was first established in or near the village. I visited villages in Estado de México, Veracruz, Puebla, Yucatán, and Oaxaca to collect these data.

The years when villages gained secondary school access according to each data source, including SEP, the enrollment rate proxy, and new field data, are summarized in Table 3. The field data indicate when a secondary school was constructed within 10 minutes of the village by bus or shared auto. How remote villages are varies substantially. Some villages are located near highways and some are located on long stretches of dirt roads. Villages located near paved highways sometimes have access to secondary schools in a neighboring village. Children from more remote villages may walk to school in a neighboring villages, but it is usually more difficult.

As reported in Table 3, SEP records indicate gains in school access several years after school enrollment rates rise and after residents say that a secondary school was constructed in their village. The first row of Table 3 indicates the number and percentage of villages that gained access to a secondary school before 1990. Official SEP government records indicate that only 31 percent of the villages in the ENHRUM dataset had a secondary school by 1990. The enrollment rate proxy indicates that 60 percent of the ENHRUM villages had access to a secondary school by 1990. The field data indicate that 57 percent of the villages in the subsample had access to a secondary school by 1990. SEP records indicate that a greater percentage of villages gained access between 1990 and 2010 than do the enrollment rate proxy or the field data, and in 2010, SEP indicates that 24 percent of the villages still did not have access to a secondary school while the enrollment rate proxy shows only 5 percent of villages without a secondary school and the field data show only 9 percent of villages without secondary school access.

The lower half of Table 3 shows the difference between the years that each data source indicates a village gained access to a secondary school. The SEP data indicate that villages gained secondary school access 15.2 years later than the enrollment rate proxy on average. The field data indicate that villages gained secondary schools 6.23 years earlier than the enrollment rate proxy and 20.79 years earlier than SEP. The enrollment rate proxy that I use in the analysis typically predicts gains in secondary school access somewhere between the years that field data indicate and that SEP records indicate. The enrollment rate proxy seems to be closer to the field data on average. This verification with field data lends support that the enrollment rate proxy does provide a good estimate for the years that villages gained access to secondary schools.[6]

VI - II Balance Tests

I regress several pre-determined variables on the proxy for secondary school access, controlling for village fixed effects, village trends, and state-year fixed effects. These regressions provide a test for whether access to secondary schools is indicative of other changes in the population. Table 4 reports the results. I find no evidence that access to secondary school is correlated with systematic changes in the village population. Inclusion of these

[6]I did repeat the main analysis using the SEP data and the field data. Results using the SEP data were similar to those found with the proxy. They were significant when I controlled for village fixed effects, but they were not significantly different from zero when I additionally controlled for village trends and state-year fixed effects. Results using the field data were not significantly different from zero when I controlled for village fixed effects.

Table 3. Comparison of Potential Proxies for Secondary School Access

	Official Government Records		Constructed Proxy Rise in Secondary School Enrollment Rates		Field Conversations with Residents Secondary School within 10 min	
	Number	Percentage	Number	Percentage	Number	Percentage
Villages with Secondary School before 1990	25	31%	48	60%	13	57%
Villages with Secondary Construction 1990-2010	36	45%	28	35%	8	35%
Villages with no Secondary in 2010	19	24%	4	5%	2	9%
Total Villages	80	100%	80	100%	23	100%
	Difference	Observations	Difference	Observations	Difference	Observations
Mean (Reported Year − Enrollment Year) if Year Reported	15.2	35			-6.23	22
Mean (Reported Year − Government Year) if Year Reported			-15.2	35	-20.79	14

Note: There are no government records of school locations prior to 1990

controls in the equations of interest are expected to add efficiency to the estimates, and the absence of significant impacts in Table 4 supports the identification strategy that uses school access as an exogenous shock.

Table 4. Balance Tests

	(1)	(2)	(3)	(4)
VARIABLES	Children in HH When 12 Years Old	Adults in HH When 12 Years Old	HH Head Speaks Indigenous Language	Household's Inherited Land
Secondary School Access	-0.229	0.091	-0.012	0.004
	(0.161)	(0.155)	(0.018)	(0.005)
Observations	6,527	6,527	4,694	5,138
R-squared	0.252	0.190	0.790	0.070

All specifications include village FE, village-specific trends, and state*year FE.
The sample is limited to individuals age 20.
Robust standard errors in parentheses, clustered at the village level
*** p<0.01, ** p<0.05, * p<0.1

VII. Results

VII - I Impact of Secondary School Access on Education and Labor Outcomes

The model predicts that gaining local access to a secondary school leads to more years of education, and consequently a reduced probability of working in agriculture. As a first stage I measure the impact of local secondary school access on expected education. The results are recorded in Table 5. Column (1) limits the sample to 20 year-olds, column (2) to 25 year-olds, and column (3) to 30 year-olds. All specifications include village fixed effects, village trends, and state-year fixed effects. Since individuals from rural Mexico usually finish school before age 20, I expect little change in the coefficients across specifications. However, the samples are slightly different for each age group.

The coefficient on access to secondary schools is highly significant in all specifications, and the coefficients are similar in magnitude, lending support to the model and sample. The results indicate that access to secondary school at age 12 increases the expected years of education by 1.2 to 1.3 years. Since secondary school is 3 years, these findings show that either take-up is not complete or some children attend school in years prior to gaining local access, reducing the impact of gaining local school access.

Table 6 reports the impacts of secondary school access on the probability of working in agriculture at ages 20, 25, and 30. The coefficient on secondary school is significantly less than zero in all specifications. The results indicate that access to secondary school reduces the probability of working in agriculture at age 20 by 5.4 percentage points. The magnitude of the impact grows with age to 7.3 percentage points at age 25 and 12.4 percentage points at age 30. The magnitude of the results might grow as individuals age if there are costs and time associated with searching for a job in the non-agricultural sector. Individuals may work in the agricultural sector while they search for a non-agricultural job.

Table 5. Effects of Secondary School Access on Years of Education OLS

VARIABLES	(1) Age 20 Education	(2) Age 25 Education	(3) Age 30 Education
Secondary School Access	1.291	1.184	1.178
	(0.260)***	(0.286)***	(0.366)***
Female	0.115	-0.003	-0.034
	(0.099)	(0.112)	(0.129)
Children in HH	-0.147	-0.120	-0.115
	(0.032)***	(0.030)***	(0.030)***
Adults in HH	-0.013	0.008	0.035
	(0.030)	(0.033)	(0.033)
Inherited Land	0.580	0.303	0.446
(100s of ha)	(0.258)**	(0.198)	(0.253)*
Observations	5,138	4,763	4,238
R-squared	0.309	0.321	0.343

All specifications include village FE, village-specific trends, and state*year FE.
Robust standard errors in parentheses, clustered at the village level
*** p<0.01, ** p<0.05, * p<0.1

VII - II Comparing naíve OLS to Two-Stage Least Squares

Next I compare the naíve OLS results to the IV results. The odd columns in Table 7 show the results from the naíve OLS regression and the even columns show the IV results. The IV estimates are larger in magnitude for all age specifications. I test for endogeneity of education using the Durbin-Wu-Hausman test, which allows for heteroskedastic errors. In the age 20 specification I cannot reject the null hypothesis that the IV results are different from the naíve OLS results at the ten percentage level, but I can reject it at the 12 percentage level. The IV measures the Local Average Treatment Effect (LATE) of education on the probability of working in agriculture for individuals from villages that gained secondary school access between 1972 and 2002 (the years when 20 year-olds in this sample could have been affected by a change in school access). One potential reason that the IV results are larger in magnitude than the naíve OLS results is that education is a more important factor in determining whether children leave the agricultural sector

Table 6. Effects of Secondary School Access on the Probability of Working in Agriculture
Linear Probability Model

VARIABLES	(1) Age 20 Agriculture	(2) Age 25 Agriculture	(3) Age 30 Agriculture
Secondary School Access	-0.054	-0.073	-0.124
	(0.025)**	(0.030)**	(0.028)***
Female	-0.248	-0.235	-0.227
	(0.019)***	(0.019)***	(0.019)***
Children in HH	0.007	0.003	0.001
	(0.003)**	(0.003)	(0.003)
Adults in HH	-0.004	-0.006	-0.012
	(0.003)	(0.003)*	(0.003)***
Inherited Land	0.064	0.036	0.099
(100s of ha)	(0.052)	(0.019)*	(0.042)**
Observations	5,138	4,762	4,238
R-squared	0.316	0.306	0.317

All specifications include village FE, village-specific trends, and state*year FE.
Robust standard errors in parentheses, clustered at the village level
*** p<0.01, ** p<0.05, * p<0.1

in villages initially denied access to secondary education. Perhaps children from these villages have weaker networks of friends and relatives working in in the non-farm sector so they depend more heavily on secondary school education as a signal of their ability when applying for a non-farm job.

An alternative explanation for the large coefficients on education in the IV regressions is that access to secondary school is a weak instrument, which causes estimates to be biased. However, I do not find evidence to support this explanation. Stock and Yogo's test for instrument strength reveals that school access is a strong instrument for education. The naíve OLS and the IV results show that education reduces the probability of working in agriculture, and the IV results provide an upper-bound on the magnitude of the impact since the IV model appears to isolate villages where education is a more critical factor for individuals to leave agricultural work.

Table 7. Comparing OLS with IV
Estimated Effects of Education on Probability Agriculture

	Age 20		Age 25		Age 30	
	(1)	(2)	(3)	(4)	(5)	(6)
	naíve OLS	IV	naíve OLS	IV	naíve OLS	IV
VARIABLES	Agriculture	Agriculture	Agriculture	Agriculture	Agriculture	Agriculture
Education	-0.013	-0.042	-0.016	-0.061	-0.015	-0.105
	(0.002)***	(0.017)**	(0.002)***	(0.024)**	(0.002)***	(0.033)***
Female	-0.246	-0.243	-0.235	-0.235	-0.228	-0.231
	(0.019)***	(0.017)***	(0.019)***	(0.017)***	(0.018)***	(0.018)***
Children in HH	0.006	0.001	0.002	-0.004	-0.000	-0.011
	(0.003)*	(0.004)	(0.003)	(0.004)	(0.003)	(0.005)**
Adults in HH	-0.004	-0.005	-0.006	-0.005	-0.012	-0.009
	(0.003)	(0.003)*	(0.003)**	(0.003)*	(0.003)***	(0.004)**
Inherited Land	0.071	0.088	0.041	0.055	0.106	0.145
(100s of ha)	(0.052)	(0.053)*	(0.019)**	(0.022)**	(0.042)**	(0.050)***
Observations	5,138	5,138	4,762	4,762	4,238	4,238
R-squared	0.323	0.286	0.319	0.211	0.327	
Durbin-Wu-Hausman Test for endogeneity of education (with heteroskedastic errors). H_0: education is exogenous						
F(1,79)		2.494		3.540*		15.607***
First-stage F-stats. H_0: secondary=0 using robust standard errors						
F(1,79)		24.598***		17.249***		10.366***
Stock and Yogo's Test for weak instruments. H_0: instrument is weak						
(The critical value for 2SLS of nominal 5% Wald test rejection of the null at 10% is 16.38)						
min eigenvalue stat		34.329		20.932		13.261

All specifications include village FE, village-specific trends, and state*year FE.
Robust standard errors in parentheses, clustered at the village level
*** p<0.01, ** p<0.05, * p<0.1

VIII. Robustness Checks

The above analysis identifies the impacts of secondary school access on years of education and the probability of working in agriculture by using a unique proxy for school construction. I isolate the impacts of other confounding factors on labor outcomes by controlling for village fixed effects, village trends, and state-year fixed effects. However, there may still be concern that omitted variables correlated with school access and access to non-agricultural employment drive the results. I perform three robustness checks to test alternative hypotheses: (1) I control for whether there was a secondary school in the village when individuals were 20 years old since gains in school access could be correlated with village-wide gains in non-agricultural employment, (2) I control for the education of the household head to see whether household characteristics drive the results, and (3) I control for peer networks working in the non-agricultural sector since networks could precipitate a multiplier effect in non-agricultural employment.

VIII - I Robustness Check 1: Control for Village School Access at Age 20

Secondary school access at age 12 will not be as good as randomly assigned if improved access to school is correlated with improved access to urban areas, factories, or non-farm employment. Presumably, those who were older than age 12 when the village gained access to the secondary school did not benefit from school access. However, if school access is correlated with access to non-farm employment (through road construction or a new bus route connecting the village to an urban area), then older individuals may shift out of the farm sector for reasons other than education. Table 8 tests whether improved access to secondary education in a village is correlated with a reduction in the farm labor supply the year that education access improved. I control for individuals who had access to a secondary school at age 20 (too old to go to secondary school) and individuals who had access to secondary school at age 12 (since individuals who had access to secondary school at age 12 also had access to secondary school at age 20).

Column (1) shows the impacts of secondary school access at age 12 on expected education. The coefficient on village school access at age 20 is significantly greater than zero. That is, mean years of education within a village appear to rise before the proxy for school construction detects a rise in secondary school enrollment rates. Nevertheless, there is little change in the coefficient on secondary school access at age 12 after controlling for school access at age 20. Column (2) shows the impact of school access on the probability of working in agriculture, and the results are similar to those found before controlling for whether the village has a secondary school when the individual is age 20. The coefficient on village school access when age 20 is not significantly different from zero, suggesting that there is not significant correlation between a village gaining access to schools and local non-farm work opportunities. Controlling for whether the village had a secondary school when age 20 helps isolate the impact of education apart from potential changes in the demand for education or other unobserved village-level changes that occur the year that the village gains secondary school access, but it has little impact on the results.

Table 8
Control for Secondary School in Village at Age 20

VARIABLES	(1) Education	(2) Agriculture
Secondary School Access (age 12)	1.365	-0.050
	(0.248)***	(0.027)*
Secondary School in Village (age 20)	0.549	0.033
	(0.277)*	(0.036)
Female	0.117	-0.248
	(0.099)	(0.019)***
Children in HH	-0.147	0.007
	(0.032)***	(0.003)**
Adults in HH	-0.014	-0.004
	(0.030)	(0.003)
Inherited Land	0.584	0.064
(100s of ha)	(0.258)**	(0.052)
Observations	5,138	5,138
R-squared	0.309	0.316

All specifications include village FE, village-specific trends, and state*year FE.
Robust standard errors in parentheses, clustered at the village level
*** p<0.01, ** p<0.05, * p<0.1

VIII - II Robustness Check 2: Control for Education of the Household Head

Table 9 controls for the education of the household head and drops all household heads from the analysis to test whether household characteristics may be driving the results. Column (1) shows that the education of the household head significantly increases the expected education of other household members, and column (2) shows that the education of the household head significantly reduces the probability of working in agriculture after controlling for secondary school access. However, there is little to no change in the coefficients on secondary school access after controlling for the education of the household head.

VIII - III Robustness Check 3: Control for Non-farm Network Effects

As a final robustness check, I control for non-farm peer (or network) effects that might be correlated with secondary school access and the probability of moving out of farm work. There may be a multiplier effect from local secondary school access if an individual who

Table 9
Control for Education of the Household Head

VARIABLES	(1) Education	(2) Agriculture
Secondary School Access	1.414	-0.066
	(0.296)***	(0.027)**
Female	0.048	-0.239
	(0.108)	(0.021)***
Children in HH	-0.121	0.007
	(0.034)***	(0.003)**
Adults in HH	0.057	-0.005
	(0.033)*	(0.004)
Inherited Land	0.364	0.072
(100s of ha)	(0.219)	(0.054)
Education of HH Head	0.198	-0.005
	(0.023)***	(0.002)**
Observations	4,440	4,440
R-squared	0.330	0.313

All specifications include village FE, village-specific trends, and state*year FE.
Robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

takes a non-farm job positively influences the probability that his or her peers work in the non-farm sector. Children with access to secondary school are more likely to leave the farm sector, and they may form a network in the non-farm sector to help their peers obtain non-farm jobs. Networks are important to reduce the costs of job search and migration. The empirical literature shows that migration networks are location, sector, and gender specific (Davis, Stecklov and Winters, 2002; Guilmoto and Sandron, 2001; Mora and Taylor, 2006; Richter and Taylor, 2007). This suggests that the coefficient on secondary school access may capture both education and network effects since all children of the same age gain years of education at the same time. I test this hypothesis by repeating the analysis while additionally controlling for the percentage of peers, five or fewer years older than the individual, from the same village, who work in the non-farm sector. Table 10 shows the results.

Contrary to the hypothesis, non-farm peer networks have a significant positive effect on the probability of working in agriculture, other things being the same. A potential explanation for this finding is that reducing the number of individuals in the village working in agriculture increases the marginal product of labor in local agriculture, raising local agricultural wages and increasing the incentives for peers of non-farm workers to remain in agriculture. Conversely, rather than providing a network to improve the chances of finding higher-paying non-farm jobs, peers may compete for the same non-farm jobs. Controlling for the percentage of the peer reference group that works in the non-farm sector, the coefficients on secondary school access change only slightly.

Table 10
Control for Non-Farm Peer Effects

VARIABLES	(1) Education	(2) Agriculture
Secondary School Access	1.416	-0.050
	(0.281)***	(0.026)*
Percentage Non-Farm in Network	-0.005	0.001
	(0.003)*	(0.000)**
Female	0.137	-0.248
	(0.099)	(0.020)***
Children in HH	-0.149	0.007
	(0.033)***	(0.003)**
Adults in HH	-0.011	-0.005
	(0.030)	(0.003)
Inherited Land	0.561	0.063
(100s of ha)	(0.250)**	(0.051)
Observations	5,022	5,022
R-squared	0.307	0.319

All specifications include village FE, village-specific trends, and state*year FE.
Robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

IX. Conclusion

This paper shows that policies directed towards improving access to education can accelerate the agricultural transformation. This is currently occurring in rural Mexico. I use unique household panel data nationally representative of rural Mexico to measure the impacts of secondary school access on the probability of working in agriculture. The findings show that local access to secondary school at age 12 reduces the probability of working in agriculture at age 20 by 5.4 percentage points. The magnitude of this impact grows as individuals age, and by age 30, secondary school access reduces the probability of working in agriculture by 12.4 percentage points.

I use sustained increases in school enrollment rates within villages to proxy for secondary school access because the locations of secondary schools and years of construction are not observed directly. I test the accuracy of this proxy by visiting more than 25 percent of the sample villages and asking residents when schools were constructed. These new field data affirm that the enrollment rate proxy performs well. I further find that the results are robust to several alternative hypotheses. I find no evidence that the main results are driven by concurrent changes in access to non-farm jobs, unobservable household characteristics, or increased peer networks working in the non-farm sector.

I also estimate the local average treatment effects of an additional year of education on the probability of working in agriculture using access to secondary school as an instrument for education. The results show that education plays a larger role in the decision to leave agriculture for children from villages initially denied access to a secondary school. A possible explanation of this is that individuals from more isolated villages may have fewer connections to networks of friends and family working in the non-farm sector so they rely more heavily on their education as a signal of ability when applying for non-farm jobs. This implies that constructing schools in villages with poor access to education is particularly impactful in accelerating the agricultural transformation since it promotes education in the populations most affected by an increase in education.

The agricultural transformation is a critical stage in economic development, and this paper shows that access to education plays an important role in this process. Part of the workforce must move out of the agricultural sector before labor productivity, and consequently wages, can rise. However, the transition from a primarily agricultural to a non-agricultural workforce is not always smooth. Understanding the mechanisms that instigate or perpetuate the agricultural transformation can help populations make this transition smoothly, better connect markets, and protect the welfares of the most vulnerable populations.

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A Summarizing the Returns to Education Across Sectors

One of the critical assumptions in this paper's model is that the returns to education are greater in the non-farm sector than in the farm sector. If this assumption is not accurate, then there is no reason for individuals to switch into non-farm work when local school access improves. I do not have a formal test for the returns to education across sectors, but I do run some descriptive regressions to compare correlations between education and earnings across sectors and locations of work.

The ENHRUM surveys collect income data for all household members in three years: 2002, 2007, and 2010. The surveys ask the monthly incomes of salaried workers and the daily wages of wage workers in the local sectors. The surveys also ask the total yearly incomes and remittances of individuals who worked elsewhere in Mexico or in the United States. I divide these responses by the number of months individuals migrated to find the mean monthly incomes and remittances of migrants by sector. I control for gender and whether the individual had at least some secondary education (that is, more than 6 years of education). The regressions include only individuals who worked in the location of interest. Income data are reported in 2002 pesos.

Table A1 shows the correlations between education and earnings of individuals who work in the local community after controlling for state-year fixed effects and village fixed effects. The table shows that those with at least some secondary education have significantly higher weekly earnings if they work in the non-farm sector at a salaried job. The correlations between education and earnings are not significantly different from zero for those employed in daily wage work in the non-farm sector or for those working in the farm sector.

Table A2 shows the correlations between monthly mean earnings and secondary education for individuals who migrated to work elsewhere in Mexico, controlling for state-year fixed effects and village fixed effects. The first column shows that individuals with at least some secondary school education have significantly higher monthly income. The second column additionally controls for working in the non-farm sector. Non-farm work is associated with higher income, but the coefficient is not statistically different from zero.

Table A1.
Correlations Between Secondary Education and Local Earnings

VARIABLES	(1) Weekly Non-farm salary	(2) Non-farm Daily wages	(3) Ag Weekly salary	(4) Ag Daily wages
female	-283.299	-44.428	-84.133	0.218
	(30.758)***	(13.293)***	(43.825)*	(2.426)
>primary school	141.507	8.845	5.307	-2.139
	(30.637)***	(11.725)	(33.767)	(2.072)
Observations	2,159	619	433	2,148
R-squared	0.172	0.329	0.425	0.446

Regressions include state-year FE and village FE
Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The final column shows whether the returns to education are different across sectors. The returns to education appear significantly greater than zero only in the non-farm sector.

The income tables show differences in apparent returns to education across sectors for those who work in Mexico. These tables suggest that the returns to secondary education are greater in the non-farm sector within Mexico. It is important to keep in mind that these tables show correlations only and do not control for selection into each sector or location of work. Nor do they control for omitted variables likely correlated with education and work selection. Nevertheless, the income correlations give some descriptive evidence that rising education and expanding work opportunities have the potential to reduce poverty in Mexico, and they support the assumption that returns to education are greater in the non-farm sector.

Table A2. Correlations between Secondary Education and Mean Monthly Income if Migrated Elsewhere in MX

VARIABLES	(1) Monthly Income	(2) Monthly Income	(3) Monthly Income
female	-346.069	-361.093	-361.528
	(212.595)	(213.354)*	(213.826)*
>primary school	640.472	621.186	
	(221.333)***	(222.512)***	
non-farm		290.786	
		(339.053)	
≤ primary school*nonfarm			280.486
			(438.898)
>primary school*farm			599.131
			(636.379)
>primary school*nonfarm			904.057
			(441.814)**
Observations	820	820	820
R-squared	0.270	0.270	0.270

Regressions include state-year FE and village FE
Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1