Education Accelerating the Agricultural Transformation: Panel Data Analysis of Rural Mexico

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Abstract

Economic theory shows that education is critical to economic development and to labor sector choice, yet there is little research to indicate the role school access plays in the agricultural transformation, the stage of development when the labor force shifts from primarily agriculture to non-agriculture. This paper identifies the impact of secondary school access on the probability of working in agriculture using 31 years of household panel data nationally representative of rural Mexico. The findings show that local secondary school access reduces the probability of working in agriculture at age 20 by 5.4 percentage points and the impacts grow as individuals age. The model shows that instrumenting for education using changes in school supply leads to inflated coefficient estimates when there are heterogeneous returns to education across labor sectors. This is consistent with the empirical literature, which typically finds greater returns to education using instrumental variables compared to OLS. Nevertheless, estimating the reduced form impacts of school supply on labor decisions has important implications for policy makers. The findings in this paper show that increased rural education is a significant contributor to the agricultural transformation, which leads to higher incomes in both the farm and non-farm sectors.

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Expanding job opportunities outside of the agricultural sector is critical to raise incomes and reduce poverty, and in many rural developing economies restricted access to education is a limiting factor to obtain non-farm work. Understanding the impacts of education on labor sector decisions can inform policy to help alleviate poverty in rural areas. Economic theory predicts that education is an essential element to 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 primarily agriculture to non-agriculture. This transformation is expected to raise incomes by allocating labor more efficiently across farm and non-farm sectors and promoting capital investment, so that labor becomes more productive (Lewis, 1954).

Understanding the role of education in the agricultural transformation can help direct policy to improve rural livelihoods in developing countries and prepare an economy for a smooth transition of labor from primarily agricultural to non-agricultural activities. This paper identifies the impact of local secondary school access on the probability of working in agriculture and the probability of migrating out of rural Mexico between 1980 and 2010 using a unique proxy for school availability based on sustained increases in local secondary school enrollment rates.

Rural Mexico provides a timely setting for analysis because the rural labor force is currently transitioning out of the farm sector while school supply is expanding. Taylor, Charlton and Yúnez-Naude (2012) show that the farm labor supply from rural Mexico declined unexpectedly between years 2002 and 2010. This may, in part, reflect recent advances in rural education. Public spending on education increased by 36 percentage points between 1995 and 2001 (Santibañes, Vernez and Razquin, 2005). This paper uses unique household survey data nationally representative of rural Mexico that record where every household member and every child of the household head works between 1980 and 2010 along with schooling. I create a proxy for village-level access to secondary education when individuals are 12 years old, the age when children begin secondary school, to identify the impacts of investments in rural education on the probability of working in agriculture or migrating to work away from home as an adult. I first consider work outcomes at age 20 and repeat the analysis for ages 25 and 30 to test whether the effects of education grow or diminish with age.

Studies 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). This paper shows that secondary education reduces the probability of working in agriculture. I do not find a significant impact of education on the probability of migration within Mexico or to the United States. Descriptive evidence suggests that the returns to secondary education are greater in the non-farm sector in Mexico, even in the rural locations where the surveyed households are located. This implies that individuals seeking careers in the non-farm sector are likely to attend more years of school when they have access to education, and public investments in education have the potential to improve rural incomes.

Several studies find a positive correlation between education and employment in off-farm work (Zhang, Huang and Rozelle, 2002; Huffman, 1980; Janvry and Sadoulet, 2001), but they do not account for the potential endogeneity of education in the labor choice model. Duflo (2000) and Foster and Rosenzweig (1996) use school construction as an instrument to identify the impacts of education on income and find significant, positive effects, but they do not distinguish between farm and non-farm labor. Yet, 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). I know of only one study that 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).

This paper contributes to two families of literature, regarding the outcomes of education on labor sector selection and the transformation of rural developing economies out of agriculture. The model shows that local access to school is not a valid instrument to predict impacts of education on labor sector choice (or income) when the returns to education differ across labor sectors. This paper shows that the bias from this instrument inflates the estimated impact of education, and the empirical results using a naive OLS estimator and and 2-stage least squares estimator support this finding. This explains why instrumental variable estimates of the returns to education are often larger when using school supply as an instrument compared to the comparable OLS estimates (Card, 2001).

I find the marginal impacts of providing local access to secondary schools on labor outcomes, which has important implications for education policy in developing rural regions. I use a unique variable to proxy for secondary school access that exploits village-cohort level changes in secondary school enrollment rates. Ideally, I would observe an exogenous policy shock to school construction and the years that schools were constructed, as Duflo (2000) does. Unfortunately, such a policy and such data do not exist in rural Mexico, but I do observe the years of education across individuals of all ages within a village. The paper uses sustained increases in secondary school enrollment rates within villages to proxy for a gain in school access. This provides a good proxy for exogenous changes in school supply because rural communities have little influence over when and where schools are built. I conduct a series of robustness checks to test the validity of this explanatory variable, and the robustness checks confirm the results.

I find that local access to secondary school when 12 years old reduces the probability of working in agriculture at age 20 by 5.4 percentage points. This impact increases with age to 12.4 percentage points by age 30. Regressing migration directly on own education shows a significant positive correlation, but the coefficient on education is not significant when I regress migration outcomes on secondary school access. Nevertheless, descriptive regressions using three years of income data suggest that the returns to secondary education are greater in the non-farm sector than in the farm sector, even for individuals who do not migrate. These findings show that rural education promotes economic development by advancing the agricultural transformation, which is expected to lead to increased capital investment and higher wages throughout the economy.

The rest of the paper is organized as follows. Section I provides an overview of changes in the workforce and access to education in rural Mexico. Section II describes the model. Section III describes the data, and Section IV describes the empirical approach. Section V presents the results. Section VI shows the results of several robustness checks. Section VII discusses the findings, and Section VIII concludes.

I. 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. However, access and quality of education vary across communities and across time, and many students do not have access to basic education.

Mexico made considerable investments in rural education, particularly in the 1980s and 1990s. 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)[1] (Rolwing, 2006). Although federally required education changed in 1992, the mandate was not effectively enforced, particularly in rural areas where secondary schools were still often non-existent. Consequently, the mandate did not generate an exogenous change in expected eduction across rural communities. Rather gains in education were more gradual and differed across locations. This is evidenced by the rise in government spending for education over several years. Public spending on education rose from 2.9 percent of the GNP in 1980 to 5.1 percent in 2010.[2] Public spending alone does not account for a rise in education. Arguably, in many parts of Mexico, particularly rural areas, much of the public school funding does not benefit students. A 2005 report on education

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

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

spending in Mexico found that about 90 percent of the federal budget went towards teacher salaries, and in some states, as much as 98 percent. Teacher unions are strong in Mexico and salaries remain high even where teacher absenteeism is common and quality of teaching is low. In the states of Guerrero and Oaxaca, two of the poorest and most rural states in Mexico, teachers were in the classroom only about 50 percent of school days. On days when teachers were present, school hours were usually reduced by 2 to 3 hours (Santibañes, Vernez and Razquin, 2005). This suggests that limited access to education extends beyond constraints in school infrastructure and public mandates requiring students to attend school. Additionally, rural areas are likely to benefit from gains in public education more slowly than urban areas since they have less political influence.

The year that communities receive school improvements is not likely correlated with local changes in demand, particularly in rural locations. 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 many reports contend that the decentralization was mostly administrative. For example, all primary schools must use national curriculum and nationally produced books and secondary school curriculum must receive approval from SEP. Furthermore, principals and parents do not have the authority to hire, fire, or place teachers, so there is little teacher accountability to students and parents. Since the decentralization, states gained greater authority in school placement, but state governments still rely heavily on SEP for funding, further limiting power at the local level to influence when and where schools are built and teachers provided. Currently, the national government provides about 85 percent of educational funding (Santibañes, Vernez and Razquin, 2005). In 1997, SEP mandated that federal financial resources be distributed to states based on the number of schools and teachers that were decentralized in 1992. However, in 1992, many state schools operated side by side with federal schools. Consequently, states that gathered local funding for education may receive less federal support per pupil even though the demand for schools is high. In many locations, this policy effectively punished communities for gathering their own resources to meet educational demand, demonstrating the disconnect between school supply and demand at the local level.

Conversations with individuals in the field indicate that the federal government prioritizes building schools in communities located farthest from existing schools and in communities with the highest poverty rates, yet school infrastructure is not the only constraint to accessing education. Some children are denied access to the local school because of their ethnicity or religion. Physical obstructions, such as a washed out bridge, may prevent children from attending school in a nearby town. 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 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 student test scores tend to be lower in these schools, though other factors may be responsible for this performance gap.

The opportunity cost of time may be another significant constraint to education for poorer households, though this is partly overcome by government programs that subsidize school attendance for 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 random 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. However, these studies suggest that the impacts of education might be inflated by peer effects if the education and job choice of one individual influences his peers' education and occupation selection. I test this hypothesis in the robustness checks section, and I find no evidence that peer effects inflate the results.

This paper estimates the impacts of local secondary school access on the probability of working in agriculture. The year that a community gains access to a school is arguably exogenous to other community trends that may impact the decision to work in agriculture. Since communities cannot control or predict the year that a school is built (or school access improved) differences-in-differences regressions with village-specific trends are expected to provide unbiased estimates of the impacts of local secondary school access on job sector selection. 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 more likely to send their children to school for more years.

The existing literature suggests that the effects of education can be extensive, reaching across peer groups and from one generation to the next. Accessibility of school is an important factor in determining years of education, and education is shown to have large impacts on raising incomes. I focus on the impacts of education on labor sector decisions and migration, which are important components of the agricultural transformation and are expected to have long-lasting impacts on income, standard of living, and economic growth.

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 farm sector at subsistence wages since the labor supply from agriculture is plentiful and, initially, virtually 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). This agricultural transformation, as it is known, is one stage on the process of economic development. The role of education in this process is little understood. Showing that education advances the agricultural transformation would indicate a critical avenue by which education raises the welfare of farm and non-farm workers in a developing economy.

II. The Model

I will illustrate the decision to work in agriculture using a two-period model, where individuals maximize net discounted earnings over their lifetime. In the first period, individual i is school-age and he chooses how much time to invest in education. In the second period, the individual decides whether to work in the agricultural sector, denoted by A, or the non-agricultural sector, denoted by N. Adults do not switch back and forth between sectors, which is a reasonable simplifying assumption since sectors are associated with investments in specific skills and networks. This model assumes that schooling decisions are based on both immediate and anticipated costs and benefits for the sector where the children will work as adults.

Individual i is endowed with $\bar{T}_1$ units of time for work and school in period 1, and $\bar{T}_2$ units of time for work in period 2. In period 1, the individual chooses how much schooling, s_i, to acquire at the opportunity cost of time and lost wages. When i is not in school, he works at the baseline wage, $W_{0i} = w_0(\mu_i)$, where μ_i represents i's unobservable abilities and $\frac{dw_o}{d\mu_i} > 0$. Each unit of school, s_i, requires $Z_i = z(km_i, \mu_i)$ units of time, where km_i is the distance from i's home to the nearest school. Assume $\frac{\partial z}{\partial km_i} > 0$ and $\frac{\partial z}{\partial \mu_i} < 0$. That is, the time required to attend each year of school is increasing in the distance traveled to school and decreasing in ability. The latter assumption is that children with high ability do not have to study as many hours to complete a year of school. This assumption can be relaxed without consequence to the model's central findings.

Let $D_i = 1$ if individual i works in the agricultural sector, and $D_i = 0$ if he works in the non-agricultural sector. Earnings in the second period depend on which sector i chooses, how much education he acquires in period 1, and his given ability. Let wages in sector j be given by the quasiconcave function $W_i^j = w^j(s_i, \mu_i)$, where $\frac{\partial w^j}{\partial s_i} > 0$, $\frac{\partial w^j}{\partial \mu_i} > 0$, and $\frac{\partial^2 w^j}{\partial s_i \partial \mu_i} > 0$. That is, wages in period 2 are increasing in schooling and ability, and ability and education are complements in the wage function. Assume further that $\frac{\partial w^N}{\partial s_i} > \frac{\partial w^A}{\partial s_i}$, $\frac{\partial w^N}{\partial \mu_i} > \frac{\partial w^A}{\partial \mu_i}$, and $\frac{\partial^2 w^N}{\partial s_i \partial \mu_i} > \frac{\partial^2 w^A}{\partial s_i \partial \mu_i}$. That is, the returns to education, the returns to ability, and the complementarity between education and ability are greater in the non-agricultural sector compared to the agricultural sector.

The individual maximizes net earnings from each period, where δ represents the discount factor for earnings in period 2. I could represent net earnings as a sum of earnings from each year or unit of time in i's life, but the implications are unchanged. I use the 2-period model since it is more tractable.

The individual solves

$$\max_{D_i, s_i} \quad w_0(\mu_i)[\bar{T}_1 - s_i z(km_i, \mu_i)] + \delta \bar{T}_2[D_i w^A(s_i, \mu_i) + (1 - D_i) w^N(s_i, \mu_i)] \tag{1}$$

Since D_i is a dichotomous variable, I find the income-maximizing quantity of schooling that an individual would select for each sector of work. The optimal selection of schooling, s_i^{j*}, for individual i working in sector $j \in \{A, N\}$, is implicitly defined by the first order condition

$$\delta \bar{T}_2 \frac{\partial W_i^j}{\partial s_i^{j*}} = W_{0i} Z_i \tag{2}$$

where the left-hand side of equation (2) represents the discounted marginal benefit of schooling for an individual in sector j, and the right-hand side represents the marginal cost of schooling in terms of lost wages in period 1. It follows that $s_i^{N*} > s_i^{A*}$ since $\frac{\partial w^N}{\partial s_i} > \frac{\partial w^A}{\partial s_i}$, and earnings are quasi-concave.

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, conditional on schooling. The probability that an individual works in agriculture can be given by the expression

$$Pr(D_i = 1) = Pr[w_0(\mu_i) z(km_i, \mu_i)(s_i^{N*} - s_i^{A*}) > \delta \bar{T}_2 (w^N(s_i^{N*}, \mu_i) - w^A(s_i^{A*}, \mu_i))] \tag{3}$$

That is, the probability of working in the agricultural sector is equal to the probability that, compared to the agricultural sector, the additional marginal cost incurred from attending more years of school is greater than the gain in period 2 earnings for the non-agricultural sector. The more an individual discounts future earnings, the more likely he is to work in the agricultural sector as an adult since less education is required for a job in the agricultural sector. Likewise, the greater the base wages in period 1 and the more time required to attend school, the more likely an individual is to work in the agricultural sector.

When estimating the impact of education on the probability of working in agriculture, omitted variables are an obvious source of concern. For example, the econometrician cannot observe ability, μ_i, and ability is expected to indirectly impact the probability of working in agriculture through its impacts on wages and optimal years of education. Consequently, a naive OLS estimate of the impacts of education on the probability of working in agriculture is expected to give biased results that overestimate the impacts of education on the probability of working in agriculture.

A strategy often used to estimate the effects of education on earnings is to instrument for education using exogenous changes in the supply of schools across cohorts within a village. The support for this instrument argues that policies to increase school supply impact an individual's working-age earnings only through its impact on his education. Duflo (2000) uses this strategy to estimate the returns to education in Indonesia after a large nation-wide school construction project in the 1970s, and the estimated impacts of education on wages from the 2-stage least squares regressions were larger than the estimated OLS impacts. In fact, many empirical papers that employ changes in school supply as an instrument for education estimate larger impacts using 2-stage least squares compared to the OLS estimation. Card (2001) reviews several of these studies and he shows that this instrumental design is invalid if returns to education are heterogeneous across individuals. I show that this instrumental design is invalid if returns to education are heterogeneous across labor sectors, even if individuals are homogenous apart from their access to education.

In the model, the effect of increasing the supply of schools is to decrease km_i, that is, to decrease the distance to school. This, in turn, decreases the marginal opportunity cost of attending school since students can continue to go to school for a longer period while spending less time traveling to and from school each day. In the model, this means that $W_{0i}Z_i$ decreases as km_i decreases since $\frac{\partial Z_i}{\partial km_i} > 0$.

It is clear from the First Order Conditions for optimal schooling, that a decrease in km_i decreases Z_i and increases s_i^{j*}. The marginal impact of km_i on the probability of working in agriculture is given by

$$\frac{\partial(D_i = 1)}{\partial km_i} = W_{0i}\frac{\partial Z_i}{\partial km_i}(s_i^{N*} - s_i^{A*}) + W_{0i}Z_i(\frac{\partial s_i^{N*}}{\partial km_i} - \frac{\partial s_i^{A*}}{\partial km_i}) + \delta\bar{T}_2(\frac{\partial W_i^{A*}}{\partial s_i}\frac{\partial s_i^{A*}}{\partial km_i} - \frac{\partial W_i^{N*}}{\partial s_i}\frac{\partial s_i^{N*}}{\partial km_i}) \tag{4}$$

I inspect the expected sign of each term in Equation (4) individually to see how distance to school impacts labor sector choice. Since I am interested in the impacts of increasing school supply, I will consider the impacts of reducing km_i on each term. The first term, $W_{0i}\frac{\partial Z_i}{\partial km_i}(s_i^{N*} - s_i^{A*})$, is increasing in km_i since $s_i^{N*} > s_i^{A*}$. Thus, decreasing the distance to a school will cause the first term to decrease. This term shows the opportunity cost of time traveled to and from school as it differs for children pursuing a non-agricultural versus an agricultural career.

The second term has an undetermined sign. It follows from the FOC that $\frac{\partial s_i^{j*}}{\partial km_i} < 0$ since $\frac{\partial s_i^{j*}}{\partial Z_i} < 0$ and $\frac{\partial Z_i}{\partial km_i} > 0$. My hypothesis is that the returns to education in the agricultural sector are near zero for all levels of education beyond primary school, so a change in the cost of traveling to school will have little impact on optimal school attendance for the agricultural sector. Then it follows that $|\frac{\partial s_i^{N*}}{\partial Z_i}| > |\frac{\partial s_i^{A*}}{\partial Z_i}|$, and the second term decreases when km_i decreases. This term describes the first period wages gained by forgoing additional education. As long as optimal schooling for the non-agricultural sector is more responsive to changes in school availability, there is greater expected income loss in the first period for an individual pursuing a non-agricultural career when km_i decreases.

The third term is expected to decrease when more schools become available given the assumptions that $\frac{\partial W_i^{N*}}{\partial s_i} > \frac{\partial W_i^{A*}}{\partial s_i}$ and $|\frac{\partial s_i^{N*}}{\partial km_i}| > |\frac{\partial s_i^{A*}}{\partial km_i}|$. The third term implies that there are greater marginal gains to second period income from additional schooling in the non-agricultural sector.

Taken together, this expression implies that the probability of working in agriculture is expected to decrease as distance to school decreases under the following conditions: (1) Individuals do not discount the future too much, and (2) the income gains from education in the non-agricultural sector are sufficiently high relative to expected income in the agricultural sector.

For an econometrician attempting to measure the impact of an additional year of school on the probability of working in agriculture, the first term in expression (4) is troublesome. Distance to school, km_i, impacts the probability of working in agriculture directly through its impact on Z_i. Thus, the impact of distance to school on the probability of working in agriculture is not limited to its indirect impacts through changes in schooling, and the exclusion principle for a valid instrumental variable is violated. This term shows that a decrease in distance to school decreases the opportunity cost of traveling to and from school for a child pursuing the non-agricultural sector by a larger amount than it decreases the opportunity cost of traveling to and from school for a child pursuing the agricultural sector since optimal schooling differs for each sector. Consequently, using school supply as an instrument for education is expected to overestimate the impacts of education on the probability of working in the agricultural sector.

I test this hypothesis by regressing the probability of working in agriculture directly on education in a naive OLS regression followed by a 2-stage least squares regression, instrumenting for education by local access to secondary school. If access to secondary schools is an invalid instrument, as I predict in this model, then the 2-stage least squares estimates for impacts of education will likely be larger in magnitude than the naive OLS estimates.

Although this model shows that I cannot identify the marginal impacts of education on the probability of working in agriculture using school supply as an instrument, I can find the impacts of local secondary school access on the probability of working in agriculture. This reduced-form model measures the impacts of expanding access to secondary schools in rural Mexico on the farm labor supply, which has important implications for rural educational policies that focus on school supply and educational opportunities.

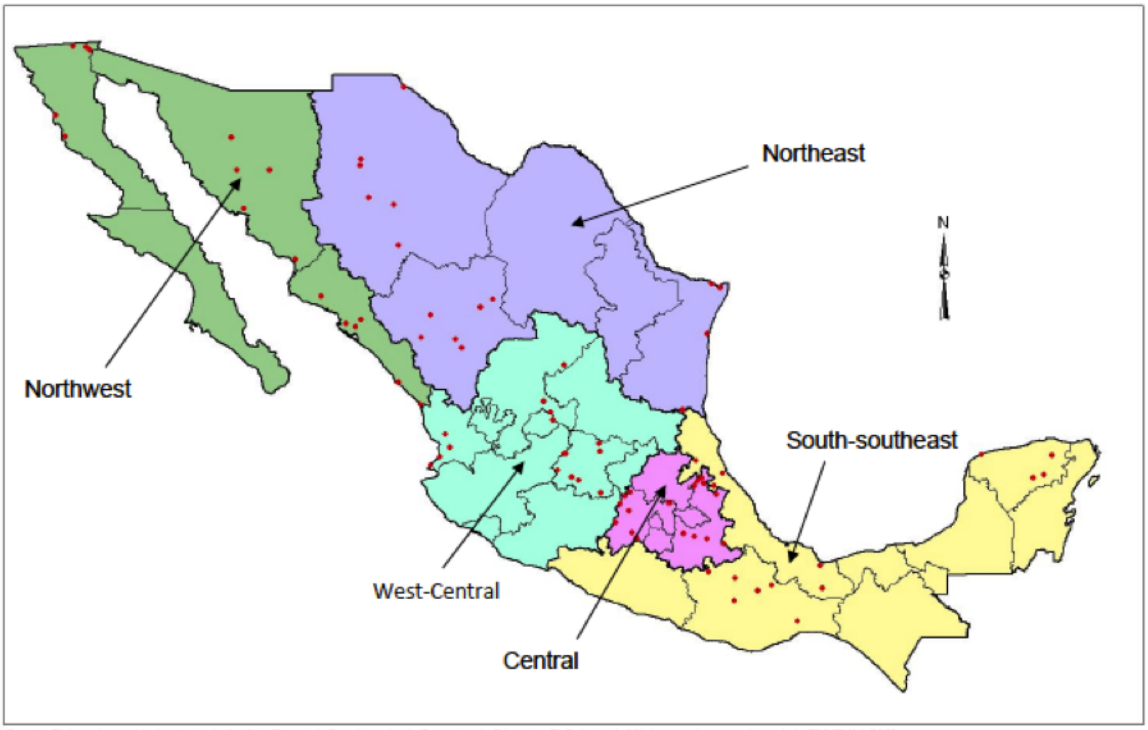
III. Data

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]

[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



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

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 dropped due to violence. The number of individuals age 20, households, and communities by survey work history period are recorded in Table 1. Note that there are fewer

randomly selected to retain the integrity of national representation.

households in the second round of the survey because the second survey gathers work histories for fewer years.

Table 1. Number of Observations by Survey Round

Years	Individuals (age 20)	Households (with 20 year-olds)	Communities
1980-2002	3,677	1,634	80
2003-2007	1,078	692	80
2008-2010	383	312	45

The first dependent variable of interest is a dummy variable equal to 1 if the individual works in agriculture at age 20. Each year, the survey records the primary sector that every household member works in for each of three locations: in the home community, migrated to another location within Mexico, and migrated to the United States. If the individual works primarily in the agricultural sector in any one of these three locations when he or she is 20 years old, then the dependent variable will be one.

Additionally, I look at the impact of secondary school access on the probability of migrating to farm or non-farm work. An individual migrates seasonally if he records working outside of his home village, either in Mexico or in the United States, and he also works in his home village when 20 years old. I define full-year migration equal to 1 if an individual reports only working outside of his home village when 20 years old. An individual works in local agriculture if he works in his home village and his primary occupation there is in the agricultural sector. Mexican agriculture refers to individuals who migrate to work in a different location in Mexico and work primarily in agriculture in that location. The same definitions apply for the non-agricultural sector in each location and for each sector in the United States.

Since I observe village-level panel data, each variable varies both within and between villages. I use within village variation to identify the model, so in Table 2, I collapse the data to the village level and take the overall, within, and between standard deviations.

The within variance measures

$s_w^2 = \frac{1}{NT-1} \sum_v \sum_t (x_{iv} - \bar{x_v})^2 = \frac{1}{NT-1} \sum_v \sum_t (x_{iv} - \bar{x_v} + \bar{x})^2.$

The between variance measures

$s_b^2 = \frac{1}{N-1} \sum_v (\bar{x_v} - \bar{x})^2.$

The overall variance measures

$s_o^2 = \frac{1}{NT-1} \sum_v \sum_t (x_{iv} - \bar{x})^2.$

The minimum and maximum columns in Table 2 measure the minimums and maximums of x_{iv} for overall variation, $\bar{x_v}$ for between, and $(x_{iv} - \bar{x_v} + \bar{x})$ for within.

The summary statistics in Table 2 show that the mean share of 20 year-olds in a rural Mexican village who work in agriculture is 29.1 percent. The mean share that work in the non-agricultural sector is 35.9 percent. The remainder do not report working. The overall standard deviation in the share who work in agriculture is 0.361. The standard deviation between villages is 0.176, and the standard deviation within villages is 0.317. A small share of the population migrates outside of their home village for only part of the year (2.5 percent on average). A much larger share works outside of their home village for a full year (18.7 percent on average). Among those who work in their home village, most work in agriculture, and among those who migrate away from home, the majority work in the non-farm sector.

In addition to work histories, I also observe several individual and household characteristics, including years of education, gender, 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. These data are summarized in Table 3.

Table 2. Sector and Location of Work for 20 Year-old Individuals by Village, 1980-2010

VARIABLE		Mean	SD	Min	Max	Observations
Agriculture	overall	.291	.361	0	1	2,023
	between	.	.176	0	.818	80
	within	.	.317	-.527	1.24	25.3
Non-agriculture	overall	.359	.373	0	1	2,023
	between	.	.157	.052	.815	80
	within	.	.338	-.382	1.31	25.3
Self-Employed Agriculture	overall	.114	.248	0	1	2,023
	between	.	.116	0	.516	80
	within	.	.22	-.402	1.07	25.3
Agriculture Salary Workers	overall	.179	.3	0	1	2,023
	between	.	.133	0	.479	80
	within	.	.27	-.3	1.13	25.3
Seasonal Migration	overall	.025	.114	0	1	2,023
	between	.	.032	0	.16	80
	within	.	.109	-.134	.988	25.3
Year-Round Migration	overall	.187	.3	0	1	2,023
	between	.	.113	.017	.475	80
	within	.	.278	-.288	1.11	25.3
Local Agriculture	overall	.262	.349	0	1	2,023
	between	.	.168	0	.759	80
	within	.	.307	-.497	1.21	25.3
Local Non-Agriculture	overall	.19	.31	0	1	2,023
	between	.	.163	.004	.808	80
	within	.	.263	-.504	1.13	25.3
Agriculture Elsewhere in MX	overall	.016	.102	0	1	2,023
	between	.	.03	0	.198	80
	within	.	.098	-.182	.977	25.3
Non-Agriculture Elsewhere in MX	overall	.113	.244	0	1	2,023
	between	.	.099	0	.425	80
	within	.	.223	-.312	1.07	25.3
U.S. Agriculture	overall	.019	.103	0	1	2,023
	between	.	.032	0	.191	80
	within	.	.098	-.172	.983	25.3
U.S. Non-Agriculture	overall	.066	.191	0	1	2,023
	between	.	.093	0	.502	80
	within	.	.17	-.436	1.02	25.3

Table 3. Summary of Individual and Household Characteristics

VARIABLE	Mean	SD	Min	Max	Obs
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

The mean educational attainment in the full sample is 7.69. However, years of education differs substantially across generations, the younger generations being more highly educated than the older generations on average. Table 4 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.

Table 4. Educational Attainment by Age in 2010

Age in 2010	**Mean**	**SD**	**Min**	**Max**	**Obs**
20-29	8.94	3.42	0	17	1,320
30-39	7.74	3.67	0	21	1,314
40-49	6.58	3.96	0	18	996
50-59	5.04	3.65	0	19	614

One of the factors that prevents many children from advancing their education is poor access to schools. Many children in rural Mexico have to travel to other locations to attend school, which often entails high costs. Table 5 shows where students in ENHRUM villages, sorted by level of education, attended school in 2010.[5] It shows whether they attended school in their home village, elsewhere in Mexico, or in the United States. As expected, as students advance in their studies, a much greater share travel to other

[5]Upper-secondary school refers to grades 10-11, 12, or 13 depending on the program.

locations to attend school. As the distance to school increases, attending school becomes more costly, both in the expense of travel and in the opportunity cost of time.

Table 5. Where Students Attended School in 2010 by Education Level

Type of School		Local	Elsewhere in Mexico	U.S.	Total
Primary	frequency	18,135	1,550	124	19,809
	percentage	91.55	7.82	0.63	100
Lower-Secondary	frequency	6,386	3,534	124	10,044
	percentage	63.58	35.19	1.23	100
Upper-Secondary	frequency	1,674	3,565	155	5,394
	percentage	31.03	66.09	2.87	100

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 records with me, which indicate the most advanced school located in each village each year from 1990 through 2012. However, field visits to some of these villages revealed that schools were actually built many years prior to the year indicated by the SEP records, and I developed a different strategy for approximating the year of school construction in each village.

Since I am unable to visit every village in the sample, I constructed a proxy for local secondary school access using annual village-level enrollment rates of 12 year-old children recorded in the ENHRUM surveys each year. 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 these rural villages, qualified teachers are unlikely to come from within the village, which reduces the probability of endogenous selection based on village demand for a school and hiring a teacher from within the village.

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 aged 12 attend school, then I assume that the village gained access to secondary school in the first of the 4 years. In some village-years there are no 12 year-old children 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 consecutive years with sustained enrollment rates. 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. Table 6 summarizes the number of 12 year-old children with education data by village-year for years 1970 through 2010. There are 2.5 children per village-year on average with a range from 0 to 11.

Table 6. Mean Number of 12 Year-Olds per Village-Year (Years 1970 through 2010)

	Mean	sd	Minimum	Maximum	Observations
Number of 12 Year-Olds	2.53	1.76	0	11	3,175

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.

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. I do find that the school enrollment rates are significantly higher in years subsequent to the switch. Figure 3 shows the kernel densities of secondary school enrollment rates before and after the proxy turns 1. There is a marked improvement in school enrollment rates in years after to the proxy change, providing support that the

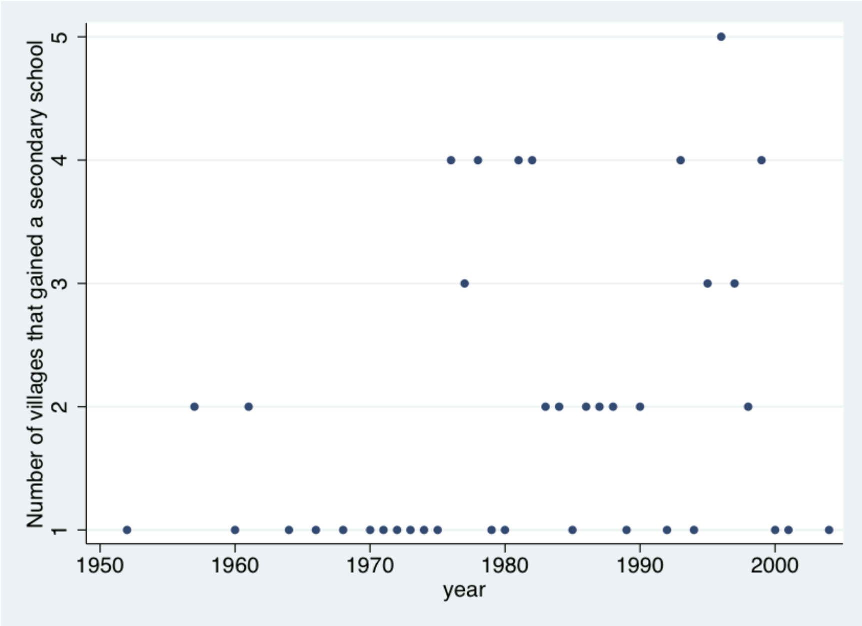


Figure 2: Number of Villages that Gained Secondary School Access

proxy captures changes in school supply.

Figure 4 demonstrates the correlation between school access and mean years of education. The x-axis in Figure 5 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. Expected years of education are rising in years before and after villages gain access to secondary schools. However, the mean years of education jump upwards for the cohort that becomes school age in the year that the village gains school access to around 9 years of school, or the completion of lower-secondary school.

Figure 5 shows the mean secondary school enrollment rates, and there is a jump in enrollment rates the year that the proxy turns one.

ENHRUM includes surveys of community infrastructure in 2002 and 2007. As sup-

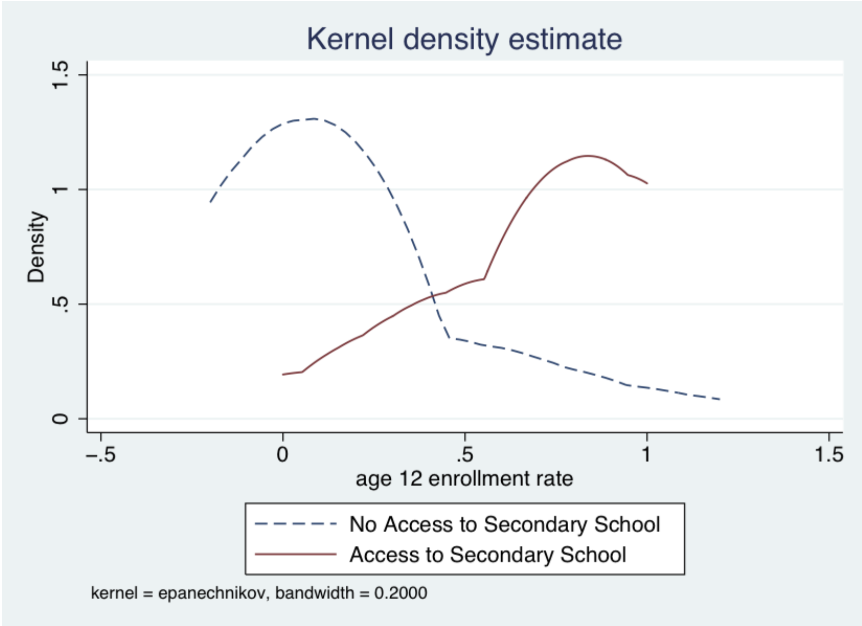


Figure 3: Kernel Density of Secondary School Enrollment Rates by Proxy for Access to Secondary School

port 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 7 records the number of villages where the highest school level located in the village is primary, lower-secondary, and upper-secondary school in 2002 and 2007 according to the ENHRUM community survey. Table 8 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 does have 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.

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

Table 7. Highest Level of School in Village According to ENHRUM Community Survey

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

Finally, I verify the proxy for secondary school access by comparing the constructed proxy based on school enrollment rates with the reported year of school construction in a sample of 22 villages in Southern Mexico. I lacked resources to visit all villages in the ENHRUM sample, so I visited only villages in Estado de México, Veracruz, Puebla, Yucatán, and Oaxaca. The years when villages gained secondary school access according to each data source (SEP, the constructed proxy, and recall from residents in the village) are summarized in Table 9. The recall data indicate when a secondary school was constructed within 10 minutes of the village by car. 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 town. Children from more remote villages may walk

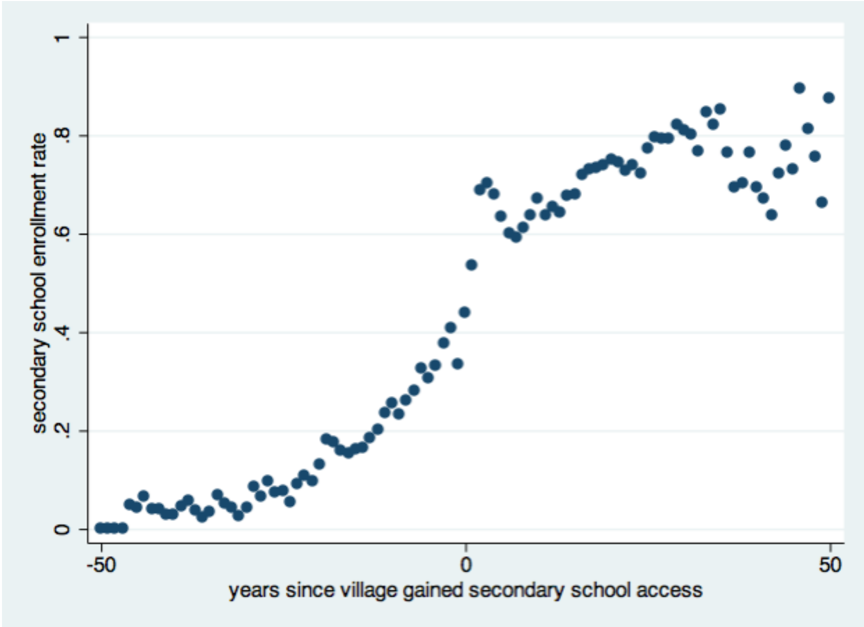


Figure 5: Mean Secondary School Enrollment Rate Before and After Villages Gained Access to Secondary School

Table 8. 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

to school in a neighboring villages, but it is usually a much more cumbersome commute.

Table 9 shows that SEP records indicate gains in school access several years after school enrollment rates rise and after residents recall the construction of a secondary school in their village. The first row of Table 9 indicates the number and percentage of villages that gained access to a secondary school before 1990. Official government records indicate that only 31 percent of the villages in the ENHRUM dataset had a secondary school before 1990. The enrollment rate proxy indicates that 60 percent of the ENHRUM villages had access to a secondary school. The recall data indicate that 57 percent of the villages in the subsample had access to a secondary school by 1990. SEP indicates a greater percentage of villages gained access between 1990 and 2010 than do the enrollment rate proxy or the recall 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 recall data show only 9 percent of villages without secondary school access.

The lower half of Table 9 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 year later than the enrollment rate proxy indicates on average. The recall data indicate that villages gained secondary schools 6.23 years earlier than the enrollment rate proxy indicates, and 20.79 years earlier than SEP indicates. The enrollment rate proxy that I use in the analysis typically predicts gains in secondary school access somewhere between the years that recall data indicate and that official government records indicate. The enrollment rate proxy seems to be closer to the recall 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.

Table 9. Comparison of Potential Proxies for Secondary School Access

	Official Government Records		Constructed Proxy Rise in Secondary School Enrollment Rates		Recall Data from Fieldwork 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

IV. Empirical Approach

The objective of this analysis is to measure the impacts of education on the probability of working in agriculture from rural Mexico. Let $Y_{i,v,t}$ be the outcome of interest. 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. Let edu_i be the explanatory variable, the number of years that individual i attended school. 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 simultaneous statewide shocks using state-year fixed effects, $\phi_{s,t}$, and village-specific trends, $\gamma_v * t$.

$$Y_{i,v,t} = \alpha + \beta edu_i + \eta X_i + \lambda_v + \phi_{s,t} + \gamma_v * t + \epsilon_{i,v,t} \tag{5}$$

I refer to the above equation as the naive OLS regression because omitted variables correlated with education and labor sector choice are likely to bias the estimates for causal impact of education on labor sector choice. An alternative strategy to regressing labor sector choice on own education is to investigate the impacts of education on labor sector choice using the supply of schools as an exogenous shock to education. Construction of schools near villages in the study are expected raise children's educational attainment within the village. I measure the impact of gaining secondary school access within villages on expected education, while controlling for potential confounding factors correlated with state-wide shocks and village trends as in the equation above. Let sec_i be a dummy variable equal to 1 if individual i's village had a secondary school when i was 12 years old and zero otherwise. This is the first-stage regression since I expect that school supply affects labor outcomes primarily through its impact on years of education.

$$edu_i = \alpha + \beta sec_i + \eta X_i + \lambda_v + \phi_{s,t} + \gamma_v * t + \epsilon_{i,v,t} \tag{6}$$

The key regression of interest measures the impact of secondary school access on the probability of working in agriculture. I call this the reduced form regression because it measures the supply-side impact of providing access to schools without measuring the direct impact of education on labor sector choice. The reduced form impact is of particular interest from a policy perspective because it shows how policies to improve rural school supply affect the farm labor supply.

The resulting equation is similar to the differences-in-differences estimator (DD), which measures the variation in probability of working in agriculture within villages across individuals with and without access to a local secondary school due to an exogenous change in school supply. The key assumption for DD is that school access and trends in sector choice would be the same across all villages absent of treatment (that is absent any changes in school supply). 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 the villages located closer to urban centers gain access to secondary schools more quickly, then the estimated coefficient in the DD estimator will be biased downward. Controlling for village-specific trends, $\gamma_v * t$, removes any trends within the village that correlate with both school supply and local supply of non-farm jobs. The reduced form equation is expressed below.

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

Schools supply is often used as an instrument for own education in much of the education literature. However, as this paper shows in the modeling section, school supply is not a valid instrument for education when there are heterogeneous returns to education across labor sectors. The instrumental variables approach is expected to inflate the measured causal impact of education. I test this hypothesis by doing two-stage least squares, instrumenting for own education using school supply, and I compare the IV coefficient to the β coefficient in the naive OLS regression. Assuming that the returns to education are greater in the non-farm sector compared to the agricultural sector, β will be negative in both the naive OLS regression and in the IV regression, and it will be of larger magnitude in the IV regression.

V. Results

V - 1 Probability of Working in Agriculture Regressed on Own Education

Table 10 reports the results from regressing the dummy for working in agriculture at age 20 directly on own education. The first column includes a constant, a dummy for access to secondary school, and no additional controls. Column (2) controls for observable individual and household characteristics, including gender, the number of children under age 15 in the household when the individual was 12 years old, the number of adults in the household ages 15 to 65 when the individual was 12 years old, and hundreds of hectares of land the household inherited as of 2002. Column (3) includes village fixed effects, column (4) further includes state-year fixed effects, and column (5) additionally includes village-specific trends.

The coefficient on education is significantly less than zero in all specifications. After I control for village fixed effects in column (3) the magnitude of the coefficient on years of education shrinks to -1.4 percentage points, demonstrating that unobserved time-invariant characteristics of the village are correlated with educational attainment and sector choice. After including village trends in column (5), the model indicates that an additional year of education is associated with a reduction in the probability of working in agriculture of 1.4 percentage points. However, I expect that unobservable characteristics impact both educational attainment and sector choice, so I cannot interpret the coefficient on education as the causal impact of education on sector choice.

V - 2 Impact of Secondary School Access on Expected Education

I expect that gaining local access to a secondary school will lead to more years of education, and consequently 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 11.

Table 10. Probability of Working in Agriculture Regressed on Own Education
Linear Probability Model (Age 20)

VARIABLES	(1) Agriculture	(2) Agriculture	(3) Agriculture Village FE	(4) Agriculture Village FE State*Year FE	(5) Agriculture Village FE State*Year FE Village Trends
Years of Education	-0.023	-0.019	-0.014	-0.014	-0.014
	(0.003)***	(0.003)***	(0.002)***	(0.002)***	(0.002)***
Female		-0.253	-0.257	-0.257	-0.252
		(0.020)***	(0.019)***	(0.019)***	(0.019)***
Children in HH		0.009	0.008	0.008	0.005
		(0.004)**	(0.003)***	(0.003)***	(0.003)*
Adults in HH		-0.006	-0.007	-0.007	-0.004
		(0.003)*	(0.003)***	(0.003)***	(0.003)
Inherited Land (hundreds of ha)		0.065	0.083	0.083	0.083
		(0.057)	(0.051)	(0.051)	(0.050)
Observations	5,138	5,138	5,138	5,138	5,138
R-squared	0.032	0.115	0.239	0.239	0.259

Robust standard errors in parentheses, clustered at the village level
*** p<0.01, ** p<0.05, * p<0.1

The coefficient on access to secondary schools is highly significant in all specifications. The coefficient becomes smaller with the inclusion of state-year fixed effects and village-specific trends. This is indicative of rising education throughout rural Mexico over time. In the final specification I find that local access to secondary school increases the expected years of education by 1.3 years. Since secondary school is 3 years, these findings show that take-up is not complete. Some students choose not to attend school even though a local school is supplied and some students choose not to complete secondary school even though they begin. Still other students attend school in years prior to gaining local access, further reducing the impact of gaining local school access.

The coefficient on inherited land is significantly greater than zero in all specifications, which shows that children from households with greater landholdings tend to attend more years of school. This finding is not obvious ex-ante. On one hand, the opportunity cost of time may be greater for households with greater landholdings, which would reduce expected education. On the other hand, households with more inherited land are likely more wealthy and may be able to hire additional labor when needed.

V - 3 Impact of Secondary School Access on Probability of Working in Agriculture

Table 12 reports the results from regressing the dummy for working in agriculture at age 20 on a dummy for having access to secondary school at age 12. Inclusion of observed characteristics in column (2) shows no impact on the coefficient for school access. However, the additional controls show that women are about 25 percentage points less likely to work in agriculture and those who grow up in households with more younger children are slightly more likely to work in agriculture.

After I control for village fixed effects in column (3) the magnitude of the coefficient on secondary school access shrinks from -12.8 percentage points to -6.5 percentage points, demonstrating that unobserved time-invariant characteristics of the village are correlated with school access and sector choice. The coefficient becomes insignificant

Table 11. Effects of Secondary School Access on Expected Educational Attainment
Linear Probability Model

VARIABLES	(1) Education	(2) Education	(3) Education Village FE	(4) Education Village FE State*Year FE	(5) Education Village FE State*Year FE Village Trends
Secondary School Access	2.673	2.401	2.150	1.329	1.291
	(0.172)***	(0.176)***	(0.172)***	(0.205)***	(0.260)***
Female		0.196	0.184	0.121	0.115
		(0.097)**	(0.097)*	(0.098)	(0.099)
Children in HH		-0.188	-0.175	-0.142	-0.147
		(0.031)***	(0.029)***	(0.031)***	(0.032)***
Adults in HH		0.023	0.035	-0.016	-0.013
		(0.024)	(0.026)	(0.029)	(0.030)
Inherited Land (hundreds of ha)		0.950	0.687	0.549	0.580
		(0.357)***	(0.272)**	(0.252)**	(0.258)**
Observations	6,527	5,138	5,138	5,138	5,138
R-squared	0.133	0.153	0.218	0.294	0.309

Robust standard errors in parentheses, clustered at the village level
*** p<0.01, ** p<0.05, * p<0.1

with the inclusion of state-year fixed effects. However, it is significantly less than zero after I additionally control for village trends, suggesting that confounding trends mask the effects of secondary school access when I do not control for them. The results show that exogenous gains in access to secondary school when school age reduce the probability of working in agriculture as an adult by 5.4 percentage points.

Table 12. Effects of Secondary School Access on the Probability of Working in Agriculture Linear Probability Model (Age 20)

VARIABLES	(1) Agriculture	(2) Agriculture	(3) Agriculture Village FE	(4) Agriculture Village FE State*Year FE	(5) Agriculture Village FE State*Year FE Village Trends
Secondary School Access	-0.153	-0.128	-0.065	-0.016	-0.054
	(0.030)***	(0.031)***	(0.018)***	(0.024)	(0.025)**
Female		-0.254	-0.259	-0.249	-0.248
		(0.020)***	(0.020)***	(0.019)***	(0.019)***
Children in HH		0.009	0.010	0.008	0.007
		(0.004)**	(0.003)***	(0.003)***	(0.003)**
Adults in HH		-0.003	-0.007	-0.004	-0.004
		(0.003)	(0.003)**	(0.003)	(0.003)
Inherited Land (hundreds of ha)		0.047	0.074	0.065	0.064
		(0.047)	(0.048)	(0.051)	(0.052)
Observations	5,138	5,138	5,138	5,138	5,138
R-squared	0.027	0.110	0.231	0.298	0.316

Robust standard errors in parentheses, clustered at the village level
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

V - 4 Instrumental Variables: Two-Stage Least Squares

Table 13 reports the second stage results, instrumenting for education using local access to secondary schools. The results are significant at the 5 percent level in the specification that controls for village fixed effects, state-year fixed effects, and village-specific trends. The magnitude of the coefficient decreases when village fixed effects are included, and it rises somewhat in the fifth column compared to column (3). The results indicate that an additional year of school is associated with a 4.2 percentage point reduction in the probability of working in agriculture.

The coefficient on education is substantially larger in magnitude in the IV estimates compared to the naive OLS regressions, as expected. The test for endogeneity of education using the Durbin-Wu-Hausman test, which allows for heteroskedastic errors, shows that the IV results are significantly different from the naive OLS results. I find an F-statistic of $F(1, 79) = 2.85$ and a corresponding p-value of 0.095.

An alternative explanation for the large coefficients on education in the IV regressions, in addition to the one proposed by the theoretical model, 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. Tests for instrument strength, even in the last column regression, which includes village and state-year fixed effects and village trends, the instrument is strong. The first-stage F-statistic in Column (5) is $F(1,79) = 24.6$, which is far above the threshold F-statistic of 10. Since the standard errors in the regression are clustered at the village level, I use Stock and Yogo's test for weak instruments, which adjusts for heteroskedastic standard errors, and I again reject the null hypothesis that the instrument is weak with a high level of confidence.

The results support the hypothesis that instrumenting for education using access to schools inflates the estimated impact of education on labor sector selection.

V - 5 Migration Outcomes

Table 14 reports the results from regressing several migration-sector dummy variables on equation (7). The dependent variable in the first column is equal to 1 if the individual works both locally and elsewhere in Mexico or the U.S. in the same year (that is, the individual migrates for part of the year). The dependent variable in column (2) is equal to 1 if the individual only reports working away from home in the given year. The results show that having local access to secondary school reduces the probability of working in

Table 13
Effects of Education on the Probability of Working in Agriculture at Age 20
Instrument for Education using Access to Secondary Schools (2SLS)

	(1)	(2)	(3)	(4)	(5)
	Agriculture	Agriculture	Agriculture	Agriculture	Agriculture
			Village FE	Village FE	Village FE
				State*Year FE	State*Year FE
VARIABLES					Village Trends
Years of Education	-0.058	-0.053	-0.030	-0.012	-0.042
	(0.010)***	(0.012)***	(0.009)***	(0.016)	(0.017)**
Female		-0.244	-0.253	-0.248	-0.243
		(0.020)***	(0.019)***	(0.018)***	(0.017)***
Children in HH		-0.001	0.004	0.006	0.001
		(0.004)	(0.004)	(0.004)*	(0.004)
Adults in HH		-0.002	-0.005	-0.004	-0.005
		(0.004)	(0.003)*	(0.003)	(0.003)*
Inherited Land (hundreds of ha)		0.098	0.095	0.071	0.088
		(0.061)	(0.053)*	(0.050)	(0.053)*
Observations	5,138	5,138	5,138	5,138	5,138
R-squared		0.046	0.225	0.305	0.286
Test for endogeneity of education. H_0: education is exogenous					
F(1,79)	14.155***	8.988***	3.881 *	0.000	2.849
First-stage F-stats. H_0: secondary=0 using robust standard errors					
F(1,79)	216.903***	186.031***	156.213***	41.896***	24.598***
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	772.335	599.478	262.920	50.323	34.329

Robust standard errors in parentheses, clustered at the village level
*** p<0.01, ** p<0.05, * p<0.1

the agricultural sector in Mexico (both locally and elsewhere in Mexico). Although the coefficients on secondary school access are greater than zero for non-farm work locally, elsewhere in Mexico, and the in the U.S., none of these coefficients are significantly different from zero. Therefore, I find no evidence that secondary school access improves mobility to work in different locations.

The coefficients on the control variables indicate that women are less likely to work in any sector and location, and in particular they are less likely to work in the local agricultural sector and less likely to migrate year-round compared to men. Individuals from homes with more young children are significantly more likely to work locally while individuals from homes with more adults when growing up are more likely to migrate. Finally, I find that additional hectares of inherited land decrease the probability of migrating.

Table 14. Impact of Secondary School Access on Migration at Age 20 Linear Probability Model)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	Migrate Seasonally	Migrate All Year	Local Ag	Local Non-Ag	MX Ag	MX Non-Ag	U.S. Ag	U.S. Non-Ag
Secondary School Access	-0.003	0.040	-0.051	0.028	-0.014	0.032	0.001	0.015
	(0.010)	(0.028)	(0.024)**	(0.024)	(0.006)**	(0.022)	(0.012)	(0.018)
Female	-0.031	-0.103	-0.211	-0.010	-0.017	-0.019	-0.030	-0.069
	(0.006)***	(0.015)***	(0.020)***	(0.017)	(0.005)***	(0.013)	(0.007)***	(0.012)***
Children in HH	-0.001	-0.002	0.007	0.001	-0.000	-0.004	-0.000	0.002
	(0.001)	(0.003)	(0.003)**	(0.003)	(0.001)	(0.002)*	(0.001)	(0.001)
Adults in HH	-0.002	0.008	-0.003	-0.004	-0.002	0.003	-0.001	0.005
	(0.001)	(0.003)**	(0.003)	(0.002)	(0.001)**	(0.002)	(0.001)	(0.002)**
Inherited Land (hundreds of ha)	-0.011	-0.006	0.067	-0.025	-0.005	-0.020	0.001	0.007
	(0.005)**	(0.018)	(0.054)	(0.059)	(0.003)	(0.010)**	(0.003)	(0.010)
Observations	5,138	5,138	5,138	5,138	5,138	5,138	5,138	5,138
R-squared	0.135	0.200	0.295	0.251	0.144	0.209	0.171	0.213

Village FE, State*Year FE, and Village Trends included in each regression
Robust standard errors in parentheses, clustered at the village level
*** p<0.01, ** p<0.05, * p<0.1

VI. Robustness Checks

VI - 1 Labor Decisions at Ages 25 and 30

The analysis thus far investigates the labor decisions of adults when they are 20 years old. I now investigate whether these results are robust to labor decisions at older ages. Table 15 shows the results for adults at age 25. All specifications include village fixed effects, state-year fixed effects, and village-specific trends. Column (1) shows the results for the naive OLS regression. Column (2) shows the first stage regression of education on secondary school access, and column (3) shows the reduced form regression of agricultural labor outcome on secondary school access. For 25 year-olds, having local access to secondary school reduces the probability of working in agriculture by 7.3 percentage points, 1.9 percentage points more than that found for 20 year-olds.

The impact of education on labor outcomes at age 30 is also large. I find that local access to secondary school reduces the probability of working in agriculture at age 30 by 12.4 percentage points and the results are significant at the 1 percentage level. The results are recorded in Table 16. The results might become larger as individuals age because it takes a few years to find a job in the chosen sector. Individuals may work in the agricultural sector in their early twenties while they search for jobs in the non-farm sector. More research to support this theory is needed.

VI - 2 Balance Tests

I regress several pre-determined variables on Equation (7) to test whether access to secondary schools is indicative of other changes in the population. Table 17 reports the

Table 15. Outcomes at Age 25

VARIABLES	(1) Agriculture Naive OLS	(2) Education First Stage	(3) Agriculture Reduced Form	(4) Agriculture 2SLS
Secondary School Access		1.184	-0.073	
		(0.286)***	(0.030)**	
Years of Education	-0.016			-0.061
	(0.002)***			(0.024)**
Female	-0.235	-0.003	-0.235	-0.235
	(0.019)***	(0.112)	(0.019)***	(0.017)***
Children in HH	0.002	-0.120	0.003	-0.004
	(0.003)	(0.030)***	(0.003)	(0.004)
Adults in HH	-0.006	0.008	-0.006	-0.005
	(0.003)**	(0.033)	(0.003)*	(0.003)*
Inherited Land (hundreds of ha)	0.041	0.303	0.036	0.055
	(0.019)**	(0.198)	(0.019)*	(0.022)**
Observations	4,762	4,763	4,762	4,762
R-squared	0.319	0.321	0.306	0.211

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

Table 16. Outcomes at Age 30

VARIABLES	(1) Agriculture Naive OLS	(2) Education First Stage	(3) Agriculture Reduced Form	(4) Agriculture 2SLS
Secondary School Access		1.178	-0.124	
		(0.366)***	(0.028)***	
Years of Education	-0.015			-0.105
	(0.002)***			(0.033)***
Female	-0.228	-0.034	-0.227	-0.231
	(0.018)***	(0.129)	(0.019)***	(0.018)***
Children in HH	-0.000	-0.115	0.001	-0.011
	(0.003)	(0.030)***	(0.003)	(0.005)**
Adults in HH	-0.012	0.035	-0.012	-0.009
	(0.003)***	(0.033)	(0.003)***	(0.004)**
Inherited Land (hundreds of ha)	0.106	0.446	0.099	0.145
	(0.042)**	(0.253)*	(0.042)**	(0.050)***
Observations	4,238	4,238	4,238	4,238
R-squared	0.327	0.343	0.317	

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

results. I find no evidence that access to secondary school is correlated with any systematic changes in the village population Inclusion of these controls in the equations of interest are expected to only add efficiency to the estimates, and the absence of significant impacts in Table 17 supports the model.

Table 17. Balance Tests

VARIABLES	(1) Children in HH	(2) Adults in HH	(3) Indigenous Lang	(4) 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, state*year FE, and village-specific trends.
Robust standard errors in parentheses, clustered at the village level
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

VI - 3 Falsification Tests

Secondary school access at age 12 may 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 18 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 results from the naive OLS regression and the results are little changed with the inclusion of the control for a village having a secondary school when the individual is 20. Column (2) 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 secondary school enrollment rates rise substantially. However, there is little change in the coefficient on secondary school access at age 12.

Column (3) shows the results from the reduced form equations, 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.

Column (4) shows the 2-stage least squares results, which are larger in magnitude than the naive OLS results.

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.

As a final falsification test, 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 peer networks affect the probability of leaving farm work. If an individual who takes a non-farm job positively influences the probability that his or her peers take a non-farm job, then peer effects will multiply the effect of gaining access to secondary school. Improved education

Table 18
Control for Secondary School in Village at Age 20

VARIABLES	(1) Agriculture Naive OLS	(2) Education First Stage	(3) Agriculture Reduced Form	(4) Agriculture 2SLS
Years of Education	-0.013			-0.037
	(0.002)***			(0.018)**
Secondary School Access (age 12)		1.365	-0.050	
		(0.248)***	(0.027)*	
Secondary School in Village (age 20)	0.048	0.549	0.033	0.053
	(0.034)	(0.277)*	(0.036)	(0.031)*
Female	-0.246	0.117	-0.248	-0.243
	(0.019)***	(0.099)	(0.019)***	(0.017)***
Children in HH	0.006	-0.147	0.007	0.002
	(0.003)*	(0.032)***	(0.003)**	(0.004)
Adults in HH	-0.004	-0.014	-0.004	-0.004
	(0.003)	(0.030)	(0.003)	(0.003)*
Inherited Land (hundreds of ha)	0.072	0.584	0.064	0.085
	(0.052)	(0.258)**	(0.052)	(0.052)
Observations	5,138	5,138	5,138	5,138
R-squared	0.323	0.309	0.316	0.299

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

in the village after the village gains a secondary school increases the expected years of education for all children in the village. The children who get higher education are more likely to leave farm work to take a non-farm job. These individuals create a network in the non-farm sector, helping their peers from home obtain non-farm jobs as well, thereby reducing the costs or risks associated with switching sectors. Empirical literature shows that migration networks are location and sector 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 likely captures 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 19 shows the results.

Contrary to the hypothesis, non-farm peer networks have a significant positive effect on the probability of working in agriculture. 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 incentive for the 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. When one individual obtains a non-farm job it then reduces the probability that his or her peers receive a non-farm job.

Controlling for the percentage of the peer reference group that work in the non-farm sector, the coefficient on secondary school access (column (3)) changes only slightly.

VI - 4 Investigating the Returns to Education Across Sectors

The crucial assumption in the 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.

Table 19
Control for Non-Farm Peer Effects

VARIABLES	(1) Agriculture Naive OLS	(2) Education First Stage	(3) Agriculture Reduced Form	(4) Agriculture 2SLS
Years of Education	-0.013			-0.035
	(0.002)***			(0.017)**
Secondary School Access		1.416	-0.050	
		(0.281)***	(0.026)*	
Percentage Non-Farm in Network	0.001	-0.005	0.001	0.001
	(0.000)*	(0.003)*	(0.000)**	(0.000)*
Female	-0.247	0.137	-0.248	-0.244
	(0.019)***	(0.099)	(0.020)***	(0.018)***
Children in HH	0.005	-0.149	0.007	0.002
	(0.003)*	(0.033)***	(0.003)**	(0.004)
Adults in HH	-0.005	-0.011	-0.005	-0.005
	(0.003)	(0.030)	(0.003)	(0.003)*
Inherited Land (hundreds of ha)	0.071	0.561	0.063	0.083
	(0.051)	(0.250)**	(0.051)	(0.050)*
Observations	5,022	5,022	5,022	5,022
R-squared	0.326	0.307	0.319	0.304

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

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 salary 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 20 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 salary 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 21 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 are associated with 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. The final column shows whether the returns to education appear different across sectors. The returns to education appear significantly greater than zero only in the non-farm sector.

Table 20. Correlations Between Secondary Education and Local Earnings

VARIABLES	(1) weekly nonfarm salary	(2) nonfarm 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

Table 22 displays the correlations between secondary education and mean monthly earnings for migrants to the United States. These correlations show no significant returns to secondary education in either sector. In the U.S. labor market the returns to secondary education may be quite low, especially in labor markets where unauthorized workers are likely to be employed. Previous literature indicates that U.S. migrants select from those with a medium level of education (Chiquiar and Hanson, 2005).

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 and secondary education has no impact on earnings in the U.S. 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 do have the potential to reduce poverty in Mexico, and they validate the model that returns to education are greater in the non-farm sector.

Table 21

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)***	
nonfarm		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

Table 21

Correlations between Secondary Education and Mean Monthly Income from U.S. Migrants

VARIABLES	(1) monthly income	(2) monthly income	(3) monthly income
female	-3,054.313	-3,029.763	-3,031.669
	(1,166.037)***	(1,185.967)**	(1,186.924)**
>primary school	149.947	160.403	
	(967.992)	(972.951)	
nonfarm		-132.513	
		(1,140.763)	
≤primary school*nonfarm			66.713
			(1,436.724)
>primary school*farm			528.628
			(1,883.377)
>primary school*nonfarm			105.369
			(1,469.995)
Observations	691	691	691
R-squared	0.196	0.196	0.196

Regressions include state-year FE and village FE

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

VII. Discussion

The findings indicate that increasing rural access to secondary education accelerates the agricultural transformation, one of the critical stages of economic development. I find larger impacts of education on labor sector selection in the instrumental variables model than in the naive OLS regressions. A possible explanation for this finding is that children attend more years of school if they plan to work in the non-farm sector than if they plan to work in the farm sector, so gaining local access to a secondary school reduces the opportunity cost of traveling to and from school more for the non-farm sector than for the farm sector. In fact, the model shows that school supply is not a valid instrument for education when the returns to education differ across labor sectors. This result holds even when unobserved individual ability is homogenous.

This finding is consistent with Card (2001)'s observation that IV results are nearly always as large or larger than OLS results in studies that measure the returns to education using exogenous changes in school supply as an instrument for education. Card (2001) explains this phenomenon by suggesting that populations with initially high marginal cost of going to school have higher relative returns to education on average. This paper shows that individual returns to education do not have to be correlated with school supply if the returns to education differ across potential work sectors and children choose years of school to optimize their earnings as an adult given the returns to education in each potential sector of work.

Even though I do not identify the impact of an additional year of school on the probability of working in agriculture, I do find reduced form impacts of providing local secondary school access. This paper uses a unique proxy for secondary school access since the locations of secondary schools are not observed. I proxy for secondary school access using sustained increases in secondary school enrollment within villages. One concern with this empirical design is that secondary school enrollment rates may be correlated with improved access to roads, factories, or other non-farm jobs. I test this hypothesis in the falsification tests section, and I do not find evidence that the results are influenced by changes in access to non-farm jobs correlated with changes in access to secondary schools. State-year fixed effects control for any changes that may occur at the state level while village time trends control for any linear changes in non-farm labor demand at the local level. Additional field work to learn when schools are built across all villages and how children travel to and from school over time can potentially strengthen the analysis.

VIII. Conclusion

The findings in this paper show that policies directed towards improving access to education can accelerate the agricultural transformation. This is currently occurring in rural Mexico. 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 in rural Mexico. The impact appears more dramatic as individuals age. At age 30, I find a negative 12.4 percentage point impact of secondary school access on the probability of working in agriculture.

Although I find that secondary school access reduces the probability of working in agriculture, I do not find significant impacts on the probability of migration. This shows that policies to improve access to secondary schools in rural areas decrease the farm labor supply but potentially have no impact on labor mobility across locations. Further analysis is needed in this area.

Understanding education's role in the agricultural transformation has important implications for income, risk, and welfare. Much of the literature on the economic returns to education shows that both increasing education and obtaining work outside of the agricultural sector are associated with higher incomes and less income variability. If the returns to education are greater in the non-farm sector than in the farm sector, then policies that reduce the costs of going to school can help individuals complete more years of school and find higher-paying jobs, which is likely to help alleviate poverty in rural areas.

Education plays a critical role in the agricultural transformation, which is a crucial stage of economic development. Part of the workforce must move out of the agricultural sector before labor productivity, and consequently wages, can rise. Growth in the non-farm sector can complement the agricultural sector by producing capital and generating market demand for agricultural products. However the transition from a primarily agricultural to a non-agricultural economy is not always smooth. Market linkages are needed to connect the two sectors, and both sectors must prepare for shifts in labor supply and changes in wages as labor productivity rises. Understanding the mechanisms that instigate or promote the agricultural transformation can help populations pass through this transition smoothly, better connect markets, and protect the welfares of the most vulnerable populations.

To my knowledge, this is the first paper to investigate the role of local school access in the agricultural transformation using a unique proxy for secondary school access and data that are nationally representative of a rural population. The findings show that providing secondary education in rural populations significantly reduces the probability of working in agriculture, accelerating the pace of the agricultural transformation and helping agricultural households, most of which are poor, gain access to a wider range of economic opportunities.

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