Scaling Education to Marginalized Populations: Long-Run Impacts of Technology-Aided Schools *

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Abstract

Millions of children worldwide remain out of school due to the high costs of reaching them and a shortage of qualified teachers. Can ICT-based instruction help close this gap and deliver the long-term benefits of traditional schooling? This paper provides causal evidence on the long-term educational and labor market effects of using ICT to expand last-mile access to post-primary education. We focus on Mexico's TV-schools –physical lower secondary schools that replace most on-site teachers with televised instruction– one of the largest formal mass media-based education models globally, serving over 1.4 million children every year. Exploiting nationwide geographic variation and cohort exposure to TV-school openings during 1980-2000, we find that high exposure to TV-schools increased lower secondary graduation by 8 percentage points, educational attainment by 0.4 years, and it led to a long-term 8% increase in hourly earnings. We show evidence that most TV-school students would have otherwise remained out of school, and that the labor market returns from additional schooling are comparable to those from standard secondary schools. The program benefits both agrarian and more economically diversified areas, with those in the latter experiencing three times higher earning gains. Our findings show that low-tech, scalable educational models can be a cost-effective way to generate significant labor market returns in underserved regions, even before high-tech solutions become widespread.

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I Introduction

Broad access to education is thought to be a fundamental driver of economic prosperity. Yet many governments struggle to ensure universal schooling access, despite the hundreds of billions invested in increasing enrollment. This challenge is particularly acute in marginalized and rural areas, where high operational costs and teacher shortages constrain both the scale and quality of education. Consequently, 250 million children are out of school, the majority having completed no more than primary education (UNESCO, 2017). This lack of access limits learning opportunities and carries lifelong consequences for individuals' earnings and economic mobility.

Information and Communication Technologies (ICT) have been widely proposed as a solution to expand education in underserved areas, but their effectiveness remains debated. Proponents argue that ICT-based instruction can reach more students by reducing reliance on in-person teachers. Technology can also dramatically lower per-student costs while maintaining uniform instruction quality (World Bank, 2016). However, skeptics question whether these tools improve learning, citing uneven student engagement and the risk of displacing effective teaching (UNESCO, 2023b). ICT may also hinder the development of broader skills and the holistic learning needed for long-term success (UNESCO, 2023a). These concerns intensify if ICT models scale across diverse, unequal settings, potentially widening existing disparities by neglecting local needs. Together, these issues cast doubt on the long-term effectiveness of relying on digital tools for expanding education access, particularly in the marginalized communities that governments struggle to serve.

This paper provides causal evidence on the long-term effectiveness of ICT-based education. We find that it can increase both school participation and adult earnings, with positive effects observed across regions at different levels of economic development. We study this question in the context of Mexico's two-decade nationwide rollout of *telesecundarias*, or TV-schools. This large-scale investment effort led to the construction of new lower secondary schools (grades 7–9), primarily in rural and underserved communities, where students receive broadcast televised instruction in a classroom supported by a single generalist teacher. From a public finance perspective, TV-schools lower delivery costs compared to standard secondary schools by replacing multiple subject-specialist teachers with technology. This is particularly relevant at the post-primary level, where covering the more advanced curriculum typically requires subject-specialized instruction. From a learners perspective, TV-schools offer a blended learning model, combining expert-designed televised lessons with in-person support in a physical school setting. Today, TV-schools serve approximately 1.4 million students annually –about 20% of Mexico's lower secondary enrollment– making them the government's primary tool for providing secondary education in rural and hard-to-reach communities.

To estimate the impact of increased access to TV-schools on children's school enrollment and their labor market outcomes later in life, we rely on municipal-level variation in TV-school availability, driven by their gradual expansion between 1980 and 2000. We match administrative school construction data with the 2010 Mexican Census to observe cohorts in adulthood. Our difference-in-differences approach compares long-term outcomes across cohorts who were exposed to different levels of TV-school access during their school-age years.

We find that these TV-schools successfully increased formal education enrollment and attainment. As adults, individuals in areas with high TV-school density were eight percentage points more likely to have graduated from lower secondary school, and four percentage points more likely to have completed primary school. On average, exposure to high TV-school density increased educational attainment by 0.4 years. These gains were mainly in basic education, as we observe no impact on upper-secondary school completion. Using administrative data, we show that the majority of students attending TV-schools would have otherwise remained out of school, rather than enrolling in a standard lower secondary school.

In the labor market, cohorts exposed to a high TV-school density experienced significant increases in adult labor market earnings. On average, their monthly income rose by 365 pesos (∼\$30 USD), which corresponded to an 8 percent rise in hourly wages. These income gains were accompanied by a three-percentage-point increase in the probability of employment, with higher participation in the service sector. While part of the income growth might be attributed to an overall rise in employment, particularly in services, the relatively small changes in labor market composition suggest that improvements within sectors and occupations were key drivers of the observed earnings growth.

These findings remain robust to alternative estimators that address potential biases in staggered difference-in-differences (Sun and Abraham, 2021), a matched sample of municipalities, alternative measures of treatment variation, and an alternative identification strategy based on the 1993 law mandating lower secondary access. Since the census only records location of residence in adulthood, selective migration could pose a potential threat to our results. However, additional analyses suggest that differential migration is unlikely to explain our findings.

The estimated educational and labor market effects are substantial, and we demonstrate this in three ways. First, back-of-the-envelope estimates of the returns to education from TV-school expansion show that each additional year of schooling increases long-term monthly income by 607 to 1,141 pesos (∼\$48 to \$90 USD), or raises hourly wages by 10 to 19%. Second, we compare these returns with those from standard lower-secondary schools in Mexico, estimated using analogous sources of variation and identification strategies to measure the impacts of these schools on educational attainment and earnings. While TV-schools and standard schools often serve different areas and marginal students, making direct comparisons of impact challenging, we find that TV-school expansion led to comparable labor market returns per additional year of education, even though standard schools had a larger overall effect on educational attainment and income. Finally, drawing on detailed cost data, we calculate a cost-benefit ratio of at least 3:1.

While the nationwide estimates highlight significant average long-term benefits of TV-schools, their expansion beyond their original focus on remote and rural communities into semi-urban areas raises important questions about the model's effectiveness across diverse local contexts. In these more developed areas, where other school types were available, substitution from standard schools to TV-schools was possible, and local labor markets may have valued skills acquired through TV instruction differently. However, we find that TV-schools increased educational attainment and earnings across regions with varying levels of economic development. Educational improvements were similar across both types of areas, with a 6-percentage-point increase in lower secondary graduation rates and a rise in overall educational attainment of 0.27–0.33 years. While labor market earnings increased in both settings, gains were notably larger in more developed regions with diversified local economies. In rural municipalities, monthly earnings rose by 121 pesos, whereas in more sectorally diversified regions, the increase was three times larger. These findings underscore the value of education, even in agrarian settings with limited off-farm opportunities, and emphasize the importance of local labor markets in determining the long-term earning impacts of education.

This paper's primary contribution is to provide causal evidence on the long-term labor market effects of expanding education access in underserved areas through ICT-based instruction. Existing research on ICT in education has largely focused on short-term outcomes, such as test scores, and typically compares technology use in classrooms against traditional instruction. Evidence from high-income countries is generally less favorable toward digital technologies for instruction (Escueta et al., 2017), whereas studies in low- and middle-income countries (LMICs) find more favorable results (Banerjee et al., 2007; Muralidharan et al., 2019; Rodriguez-Segura, 2022).[1] In settings where access to high-quality instruction is limited, even remote or partially remote instruction can improve learning outcomes. For example, in Pakistan, instructional videos from highly effective teachers outperformed both fully technology-driven and traditional instruction on test scores (Beg et al., 2022), while in Ghana, videoconferencing significantly improved student learning (Johnston and Ksoll, 2017). In our context, Borghesan and Vasey (2024) find that attending TV-schools, rather than standard schools, in areas where both options were available, increased seventh-grade test scores.[2]

We add to this literature in three ways. First, we shift the focus from short-term learning gains to long-term impacts, recognizing that test scores may not fully capture the skills relevant for labor market success (Chetty et al., 2011; Jackson, 2018), that learning effects may fade over time (Banerjee et al., 2007), and that general equilibrium effects shape long-run labor market outcomes. Closest to our focus on long-term outcomes is Bianchi et al. (2019), who find that expanding digital infrastructure, including remote teaching, within rural Chinese schools led to substantial labor market benefits. Second, unlike most of the literature, which examines the use of digital tools within existing school settings, we investigate a different counterfactual: limited or no schooling at all. This allows us to assess the potential for ICT to expand education at scale in underserved areas.[3] Third, we provide estimates that are less susceptible to concerns about external validity by

[1] A potential explanation for these divergent findings is the nature of the counterfactual. In high-income countries, ICT is typically compared against high-quality in-person instruction, often finding negative effects from replacing them with technology (Figlio et al., 2013; Heissel, 2016; Bettinger et al., 2017; Bueno, 2020). In contrast, in developing countries, the counterfactual is often low-quality instruction, absent teachers, or no formal schooling at all.

[2] To estimate test score impacts, Borghesan and Vasey (2024) use a marginal treatment effects framework with distance to school as an instrumental variable. Earlier research on TV-schools on learning outcomes was largely descriptive or qualitative, with mixed conclusions (Mayo et al., 1975; Santos, 2001; Calixto Flores and Rebollar Albarrán, 2008).

[3] Our approach builds on studies exploring how technology can expand educational access in contexts with weak formal systems, though most have focused on enrollment. Relevant work includes online learning to boost college attendance in the U.S. (Goodman et al., 2019), and early evidence on radio-based education expansion (Jamison et al., 1981). Related research also examines television as educational entertainment, such as the effects of Sesame Street on educational progression in the U.S. (Kearney and Levine, 2015), and the influence of soap operas on economic decisions like fertility (La Ferrara et al., 2012).

using two decades of nationwide data from a large-scale government-managed program reaching millions.[4] Operating within real-world implementation constraints common in LMICs, this large-scale context allows us to provide more realistic estimates of the effectiveness of such interventions if scaled up by governments in similar contexts.

In addition, this work also contributes to the literature on the labor market impacts of secondary education in LMICs, providing robust evidence of significant positive effects, particularly on earnings. Existing work has already shown that preschool and primary school construction increases enrollment and attainment (Berlinski and Galiani, 2007; Burde and Linden, 2013; Aaronson and Mazumder, 2011) and leads to long-term labor market improvements (Duflo, 2001; Akresh et al., 2023). However, evidence on the long-run effects of post-primary school construction in developing countries remains limited. Causal studies leveraging variation from admission cutoffs or scholarship assignments have largely found null effects of secondary education on earnings (Spohr, 2003; Ozier, 2016; Duflo et al., 2021). In contrast, we provide evidence that expanding secondary education led to substantial earnings gains.

Taken together, the results of this paper expand our understanding of how different educational environments contribute to human capital development, challenging the notion that only traditional schooling models or advanced, student-targeted technologies can generate meaningful gains in lifetime earnings. While much of the current excitement around ICT in education centers on its potential to personalize instruction (Muralidharan et al., 2019), less attention has been given to whether uniform, low-tech approaches can serve as viable alternatives for expanding access, at least until digital infrastructure becomes more widely available in low income contexts.[5] Our findings show that even basic, mass media-based instruction can generate substantial long-term benefits, highlighting the need to explore scalable, alternative education models, particularly in regions where governments face persistent barriers to establishing or sustaining traditional schools. As advanced digital technologies become more widespread, these simpler models could serve as a foundation for more advanced solutions, with our results providing a conservative estimate of the

[4]This is in contrast to small-scale evaluations, which often face generalizability issues due to site selection bias (Allcott, 2015), loss of implementation fidelity by bureaucracies (Bold et al., 2018), or general equilibrium effects that alter impacts of pilot programs (Muralidharan and Niehaus, 2017).

[5]A stark example of this was seen during the COVID-19 pandemic when, in response to global school closures, over 60 LMICs turned to television-based at-home education to reach students, as internet access and digital infrastructure were unavailable (World Bank, 2020; Barron Rodriguez et al., 2021).

potential impacts of technology-aided schools.

The rest of the paper is organized as follows. Section II describes the institutional background of lower secondary education in Mexico and provides details on Mexico's TV-schools and their nationwide rollout. Section III describes the data sources and Section IV presents the empirical strategy. Section V discusses results and investigates the sensitivity of the results to alternative econometric and sample specifications. Section VI benchmarks the impacts of TV-schools. Section VII presents impacts by types of municipalities affected. Section VIII concludes.

II The *Telesecundarias*, Mexico's TV-Schools

LOWER SECONDARY AND TV-SCHOOLS. Basic education in Mexico comprises primary education (grades 1 through 6, ages 6 to 12), lower secondary education (grades 7 to 9, ages 12 to 15), and upper secondary education (grades 10 to 12, ages 16 to 18). At the lower secondary level, there are three main school modalities: general schools *(secundaria general)*, technical schools *(secundaria tecnica)*, and TV-schools or *telesecundarias*. All lower secondary modalities cover the same core curriculum and issue an equally recognized certificate of completion necessary for enrollment in upper secondary.

In 2016, there were 6.7 million lower secondary students in Mexico: 51% and 27% attended general and technical schools, respectively, and 1.4 million attended TV-schools, representing 21% of the total lower secondary enrollment. Moreover, out of the 39,265 lower secondary school buildings in the country, 48% were TV-schools (INEE, 2017).

General and technical lower secondary schools operate like any other ordinary school, with subject-specialized teachers for each area of the curriculum.[6] Throughout this article, we refer to both of these school modalities as 'standard' schools. Standard schools tend to be large, with an average of 385 students in general schools and 404 students in technical schools (INEE, 2017). In contrast, TV-schools are smaller, usually with only one class per grade and 15 to 30 students per class, totaling an average of 76 students per TV-school.

The key feature of the TV-school model is that lessons are delivered in a classroom setting via centrally-produced television broadcasts, with a single in-person monitor teacher (*maestro monitor*)

[6]The main difference between general schools and technical schools is that in addition to the academic common core, technical schools offer technical subjects or workshops. Lower secondary diploma students can graduate with a certificate on the workshop they took.

per classroom, who supports students across all subjects.[7] In standard schools, students in a given classroom are typically taught by 6 to 8 teachers, with an average of 22 teachers per school.

Televised lessons adapt pedagogical content for visual learning, with scripted instruction and integrated audiovisual resources to improve engagement, all overseen by specialists. These lessons are recorded in television studios by TV-teachers (*telemaestros*), selected for their effective communication skills. Programs are then broadcast nationwide to TV-schools according to a pre-established schedule. At the TV-schools, students use printed study guides that complement the televised lessons. The classroom monitor teacher supervises activities, facilitates discussion, answers questions, and grades homework and exams. Responsible for all subjects, these monitor teachers rely on detailed teaching guides aligned with the televised curriculum.[8]

Each school day features 18 lessons aired Monday through Friday, and it is structured to integrate televised instruction with in-classroom activities. Each hour is dedicated to a different subject, typically with a 15-minute televised lesson followed by 35 minutes of classwork led by the monitor teacher, with the help of the study guides (INEE, 2005). Lessons for different grades are staggered throughout the hour so that one grade starts its televised lesson as another finishes. Depending on the schedule, students receive 2 to 6 hours of televised instruction per day (INEE, 2016).

While the fixed costs of establishing a TV-based school system, including the construction of physical facilities, transmission infrastructure, and production of television programs, are substantial, the advantage of this model lies in its lower marginal operating costs compared to what it would cost to operate standard schools in the same areas (Calderoni, 1998). In fact, the average administrative cost per TV-school student is about half the cost per student in a standard school (Martinez Rizo, 2005). We discuss costs in more detail in Section VI.

As is often the case with large-scale public service delivery, there is considerable variation in infrastructure adequacy and service quality. In 2001, an estimated 40% of monitor teachers did not have formal monitor teacher training. Moreover, not all TV-schools had essential resources

[7]Several other countries around the world have experimented with television to solve the problem of teaching students in places where the cost of recruiting teachers would be prohibitive. Appendix A.5 discusses several examples.

[8]In its early years, in the late 1960s, TV-schools were managed by nearby standard schools, with strong community involvement in setting up makeshift classrooms despite financial and material challenges. In 1970, authorities introduced guidelines to standardize facilities, providing prototype classroom designs and construction support. By 1980, the curriculum design had been improved, leading to the standardized model that remains largely unchanged. Appendix A.3 provides more details on the model and its evolution over the years

such as electricity, television signal reception, or textbooks, and many schools operated with only one teacher covering multiple grades (Creed and Perraton, 2001). In light of this, our estimates should be interpreted as intent-to-treat effects, reflecting the implementation challenges typical of large-scale government programs in LMICs.

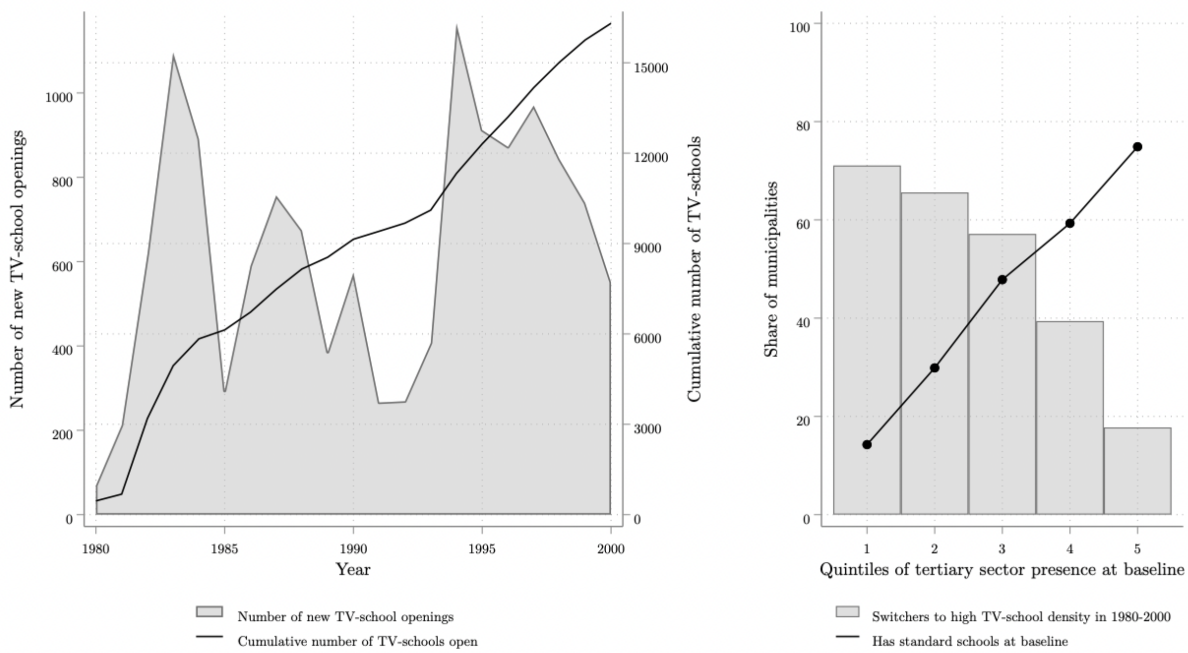
TV-SCHOOL ROLLOUT AND PLACEMENT. Mexico introduced TV-schools in 1968 as a response to the shortage of qualified secondary school teachers willing to work in remote rural areas and the dispersed distribution of primary education graduates seeking to continue their studies (Calderoni, 1998). We examine the rollout of TV-schools from 1980 to 2000, a period during which approximately 13,000 TV-schools opened across the country. We exclude the 1970s from our analysis due to the smaller scale and distinct operational model of that period, as well as the lack of reliable data before the 1980s, when Mexico began to systematically track school openings.

The left-side graph in Figure 1 shows the steady expansion of TV-schools between 1980 and 2000, displaying both the yearly number of new TV-school openings and the cumulative total. Before 1980, only a few hundred TV-schools existed, and the federal government controlled their placement, selecting school locations based on ad hoc criteria. While subsequent growth was continuous, the figure depicts two major expansion waves. The first was around 1982, when several agreements between states and the federal governments accelerated TV-school expansion (Martinez Rizo, 2005).[9] Placement criteria varied across states, with schools aiming to serve different objectives, such as providing education in underserved areas, or supporting local economic development. The second major expansion took place in 1993 when lower secondary education became compulsory, constitutionally mandating the government to provide access. TV-schools, with their lower costs and reduced teacher requirements, became a practical solution for meeting this demand (Jiménez et al., 2010).

TV-schools were originally designed to provide education in rural and remote areas where standard schools were unavailable or too costly to operate. However, some were also built in marginalized regions of urban and peri-urban areas. The right-side graph in Figure 1 illustrates this by showing the proportion of municipalities –the administrative division below the state, similar to a

[9]Appendix A.1 provides a general account of the process and evolution of placement criteria through which TV-schools were rolled out, and A.4 summarizes details of the specific rollout in the state of Puebla, highlighting the somewhat haphazard nature of the expansion.

Figure 1: TV-school Rollout and Placement



Notes: This figure shows the number of TV-school openings over time and the share of municipalities with high TV-school density construction by tertiary sector prevalence. The left graph shows the annual (area) and cumulative (solid line) number of new TV-school from 1980 to 2000. The right graph shows the share of municipalities with high TV-school density, categorized by quintiles of tertiary sector prevalence in 1980. The solid black line indicates the proportion of municipalities with a standard school in 1980 in each quintile. See Section III for details on variable construction. The data is sourced from the Mexican Secretariat of Education (SEP), and the 1980 Mexican census (10% IPUMS subsample).

county in the United States– with high-intensity TV-school construction by quintile of the share of workers employed in the tertiary (service) sector in 1980 (see Section III for variable construction). We use municipalities as the unit of analysis because they provide a meaningful geographic level that captures regional economic conditions, access to education services, and labor market opportunities. Additionally, the share of tertiary sector employment in 1980, which is strongly correlated with measures of rurality and poverty, serves as a proxy for economic development, allowing us to classify areas based on their initial conditions.[10]

During our study period, over 70% of the most rural and economically disadvantaged municipalities experienced high TV-school construction, confirming that the program primarily targeted high-poverty, rural areas with low tertiary sector presence. However, TV-schools were also built in more developed municipalities–about 40% of those in the 4th quintile and 20% in the 5th quintile

[10] Appendix Figure A2 shows that the proportion of the working-age population employed in the tertiary sector in 1980 is strongly correlated with rurality and other poverty indicators at the time.

experienced significant growth in TV-schools.

The figure also shows a black line representing the proportion of municipalities with at least one standard secondary school in 1980, highlighting how their presence also varied by municipality type. In the lowest quintile, fewer than 20% of municipalities had a standard secondary school before TV-schools were introduced, compared to about 60% in the 4th quintile and nearly 80% in the 5th quintile. Given this distribution, it is unsurprising that TV-school students generally come from lower-income backgrounds than those in standard schools. In 2017, 75% of TV-school students lived in areas with high or very high marginalization, compared to less than 30% of students in standard schools (INEE, 2017). Supporting this account, Appendix A.2 provides further details on the characteristics of municipalities with high TV-school density, including municipal-level correlates of TV-school openings and their timing.

While TV-schools were designed to expand last-mile access, variation in the economic conditions of the areas where they were established offers a useful opportunity to examine whether the long-term impacts of ICT-based instruction differ by context. This is especially relevant given differences in alternative schooling options and local labor markets. We explore this heterogeneity in Section VII.

III Data, Sample, and Descriptive Statistics

We discuss data sources and sample characteristics in this section. Additional details can be found in Appendix J.

Census and Outcome Data. Outcome data for our primary specifications comes from the 10 percent subsample of the 2010 Mexican census, accessed through the Integrated Public Use Microdata Series (IPUMS) project (IPUMS, 2013) and collected by the National Statistics Office (INEGI). This dataset provides information on individual's education, labor market outcomes, and other socio-demographic characteristics in adulthood. In particular, we report effects on years of education and the probability of completing primary, lower secondary, and upper secondary school. For labor market outcomes, we estimate effects on employment status (relative to being inactive or unemployed), reported monthly labor income (winsorzised at the 0.1% level to address extreme top outliers), hourly wages, the unconditional probability of working in the primary, secondary or tertiary sectors, and the probability of reporting enrollment in social security, a proxy for formal employment.

Census data provides a large, nationally representative sample that enables precise estimation of effects, even in rural areas where alternative data sources are scarce. However, a key challenge in using Mexico's census is accounting for migration, as it does not record individuals' municipality of birth. Instead, it reports municipality of residence, state of birth, and municipality of residence five years prior. Therefore, we rely on reported municipality of residence in adulthood to assign treatment status. While this might raise some concerns, in Section V.1 we discuss several tests conducted to ensure that our results are not simply driven by selective migration.

Finally, we also use the 1980 census to obtain baseline municipality-level characteristics, including population size, share of people in the tertiary sector, school enrollment rates, the fraction of people living in rural localities, and poverty levels. We also use data from the 2000 census to perform migration-related robustness checks.

Administrative School Data. The census data is merged with administrative records from the Mexican Secretariat of Education (SEP), which provide the number of new TV-schools opened per year in each municipality from 1980 to 2000. This database contains the address and opening date of schools by service type nationwide. To integrate this data, we collapse the number of schools-shifts by school type at the municipal level.[11]

While TV-schools operated before the 1980s, the SEP did not maintain a systematic and consolidated database of schools until then, making early data on school openings unreliable. To address this issue, we focus on schools constructed after 1980, and exclude from the analysis the 191 municipalities that reportedly experienced high-intensity TV-school construction before 1980. Further discussion of this data quality issue is provided in Appendix J.

To investigate concurrent changes in school enrollment by school type following the introduction of TV-schools, we use yearly student enrollment data at the school-shift-grade level from a separate administrative database maintained by the SEP (*Formato 911*). These enrollment counts were systematically reported by each school but are only available from 1990 onward.

[11] In Mexico, many school buildings operate in both morning and afternoon shifts, which we count as two separate schools. However, nearly all TV-schools operate in a single shift.

Sample. We focus on the period from 1980 to 2000 for TV-school openings, excluding the 191 municipalities that reportedly experienced high-intensity openings between 1968 and 1979. We also exclude Mexico City due to its unique characteristics, where municipalities correspond to closely located neighborhoods with high levels of intra-area migration.

The sample includes individuals born between 1945 and 1990 (aged 20 to 65 in 2010), as most in this age range would have already entered the labor market. We further restrict the sample to non-migrants who remained in their state of birth, since we cannot accurately determine the origin of municipal in-migrants. Including them would introduce misclassification, confounding program impacts with other local opportunities. While this restriction limits the estimates to individuals who did not migrate across states, they still represent 92% of the relevant cohorts. In Section V.1, we show the robustness of our findings to different assumptions regarding the treatment of these migrants.

Descriptive Statistics. The sample includes 54,450 municipality-cohort observations from 2,325 municipalities. Of these, 1,164 municipalities belong to the 'switcher group'— municipalities that eventually have a high-density of TV-schools, and 1,161 belong to the 'non-switcher group', municipalities that consistently have low-density of TV-schools. Switcher status serves as our main treatment indicator, capturing municipalities that transitioned to high TV-school presence over time (we discuss treatment construction in Section IV). Appendix Table C1 reports summary statistics for the analysis sample using the 2010 census, showing separately averages for the entire sample, for municipalities by treatment status (switchers and non-switchers), by sectoral composition at baseline, and by average density of standard schools presence. We display weighted means and standard deviations to ensure they are representative of the population.

The sample is balanced by gender and the average age is 32 years. On average, individuals have 9.22 years of education, though schooling is lower in switcher municipalities (7.46 years) compared to non-switchers (9.79 years). Graduation rates are also lower in switcher municipalities: 74% graduated from primary school and 47% from lower secondary school, compared to 89% and 70%, respectively, in non-switcher municipalities. Labor market participation is also lower in switcher municipalities (57% vs. 69% in non-switchers). Average monthly income is 3,091 pesos, with non-switchers earning nearly twice as much (3,530 pesos vs. 1,736 pesos in switchers). Sectorally, switchers have a higher share of agricultural employment (19% vs. 6%), while non-switchers are more concentrated in services (41% vs. 23%).

In 1980, 97% of switcher municipalities were rural, compared to only 19% of non-switchers. The rural-urban divide persisted in 1990, with 77% of switcher municipalities still rural, compared to just 11% of non-switchers. Baseline educational outcomes taken from the 1980 census further highlight these existing differences: lower secondary school enrollment was significantly lower in switcher municipalities (14%) compared to non-switchers (33%), highlighting the lack of educational infrastructure prior to the high-intensity rollout of TV-schools.

IV Empirical strategy

Our main empirical strategy combines two sources of identifying variation: whether an area eventually experienced high-intensity TV-school construction, and the staggered timing of this expansion over the 1980 to 2000 period. Additionally, we exploit the fact that children older than 15 at the time of high-intensity construction were unlikely to benefit, as they would have already left school. We measure the intensity of TV-school exposure using the following density variable at the cohort-municipality level:

$$TS_{mc} = \frac{\text{Number of TV-schools}_{mc}}{\text{Population ages 12 to 14}_{m}} \times 50$$

where TS_{mc} represents the TV-school density— the number of TV-schools available in municipality m per 50 eligible children when a given cohort c was 15 years old.[12] Normalizing by the eligible population accounts for variations in population size and aligns with the approximate number of seats available in a newly created TV-school.

Our primary treatment variable, $AboveTS_{mc} \equiv 1[TS_{mc} \text{ above median}]$, "having high TV-school density", is a binary indicator which equals to 1 if the TV-school density exceeds the overall sample median. Municipalities where this indicator turns on during the study period are "switchers", transitioning from low to high TV-school density. Between 1980 and 2000, municipalities con-

[12] Students typically enter lower secondary school around age 12, but grade repetition is common, especially in marginalized and rural areas. In 2017, 16.9% of 3rd graders in TV-schools had repeated at least one grade, resulting in many students being older than expected for their grade level. Specifically, 48.9% of students were 15 years old, and 13.2% were 16 or older (INEE, 2017). To accurately identify cohorts unlikely to be exposed to TV-schools, we set 15 as the upper bound for potential exposure.

structing TV-schools had a median density of one school per 369 eligible children. Areas with high TV-school intensity had 3.5 times greater availability than low-intensity areas–one school per 136 children versus one per 471.

A potential concern with this binarized treatment variable is that treatment classification might be driven by small increases in TV-school construction in already high TV-density municipalities. However, Appendix B shows this is not the case: nearly half (48%) of municipalities at least doubled their TV-schools during the switch year, while only 15% saw an increase of less than 20%. Most transitions to high TV-school intensity occurred in municipalities with few or no prior TV-schools, typically adding one or two. Nearly 70% of switching municipalities had at most four TV-schools before transitioning, with 24% having none and 16% having just one. While additional schools continued to be built in later years, the sharpest increase occurred in the switch year, with no systematic surge afterward. Moreover, while we take this binary classification as our primary treatment variable, we also present results using the continuous exposure measure TS_{mc}. Our conclusions remain consistent regardless of the treatment definition we use.

Our identifying variation comes from a 'hybrid' data structure (Miller, 2023), as shown in Figure 2a. About half of the municipalities in the sample never transition to high-intensity TV-school construction, and the timing of the switch varies across years. Figure 2b shows how the density of TV-schools and standard schools changed over time in municipalities classified as having high and low TV-school density at the end of our study period. The solid black line highlights the variation used to identify effects, showing a sharp increase in TV-schools when municipalities transitioned to high-density TV-school construction, followed by a more gradual TV-school rise in subsequent years.

For computational ease we collapse our data into birth-year by municipality-of-residence cells and implement a dynamic two-way fixed-effects difference-in-differences regression (TWFE) model, estimating the following equation for cohort c living in municipality m:

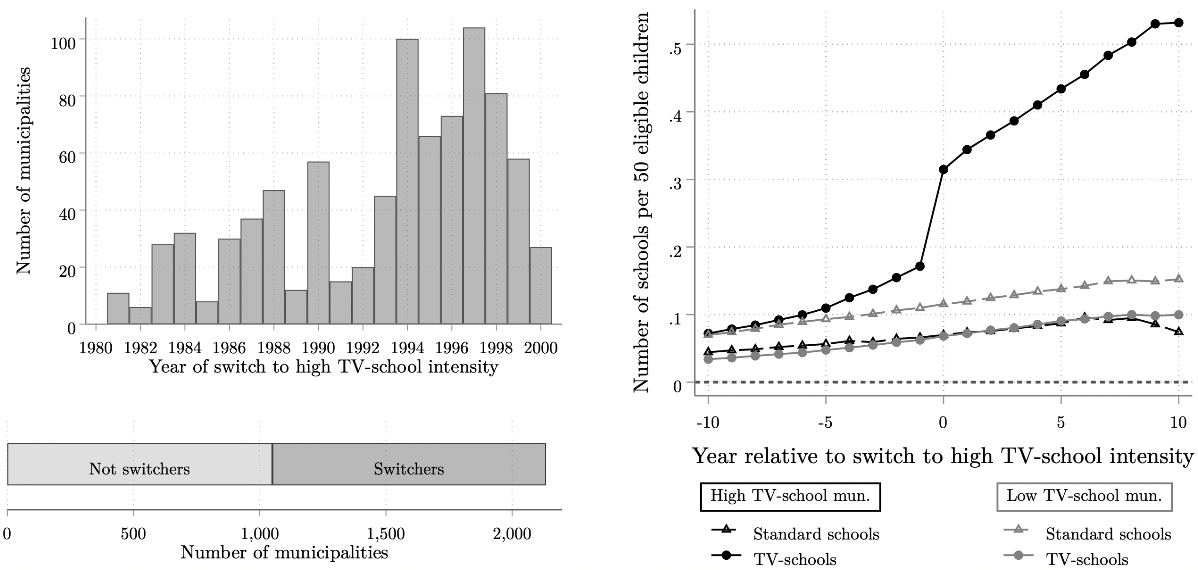
$$Y_{mc} = \alpha + \sum_{\tau \in [25,5], \tau \neq 16} \beta_\tau (\text{AboveTS})_m \times 1[\text{Age at switch}_m = \tau] + \gamma_m + \lambda_c + \gamma_m \cdot t_c + \varepsilon_{mc} \qquad (1)$$

Where Y_{mc} is the outcome of interest, $(\text{AboveTS})_m$ indicates whether municipality m transitioned to high TV-school density, and $1[\text{Age at switch}_m = \tau]$ is a binary variable indicating whether indi-

Figure 2: Data Structure and Source of Variation

(a) Municipalities Switching to High TV-School Intensity

(b) Density of Schools Relative to Switching Year



Notes: The bottom of Figure (a) shows the number of municipalities in the analysis data that eventually switch to high TV-school intensity status (n=1,084) and those that do not (n=1,050). The top of Figure (a) presents a histogram of the switching event dates, with one observation per municipality, restricting to the municipalities that experienced high-density construction. Figure (b) shows the TV-school density and the standard school density in municipalities that are ever classified as having high TV-school intensity from 1980 to 2000, and those that never get this classification (low intensity). A synthetic switching year is assigned to the latter group. The data is sourced from the Mexican Secretariat of Education (SEP).

viduals were age τ at the time of the transition. Municipality and cohort fixed effects (γ_m and λ_c) control for municipality- and cohort-specific differences, while a municipality-specific linear time trend ($\gamma_m \cdot t_c$) accounts for underlying linear trends in the outcome variables that differ across municipalities. ε_{mc} is the error term. The coefficient β_τ captures the average treatment on the treated (ATT) difference-in-differences effect estimate of the TV-school exposure intensity at different ages τ during the high-intensity TV-school switch. Unlike study designs that rely on a single-year event, the staggered rollout of TV-schools means that, to bias our estimates, any confounding factor would need to systematically coincide with high-density switching years and only affect cohorts younger than 15. To account for the presence of heteroskedasticity and serial correlation, robust standard errors are clustered at the municipal level.

We restrict our analysis to a $\pm$ 10-year window around the time of high-intensity transition, i.e., focusing on cohorts aged 5 to 25 at the time of switch.[13] For non-switcher municipalities, we impose similar cohort restrictions by creating a "synthetic switching year", randomly drawn from the distribution of actual switching years in treated municipalities, and assigning it to a control municipality.

Staggered Treatment. The TWFE estimator does not result in consistent estimates if treatment effects are heterogeneous across groups or time (Borusyak et al., 2024; de Chaisemartin, 2018; Sun and Abraham, 2021; Callaway et al., 2024). To address this concern, we re-estimate our results using the heterogeneity-robust estimators proposed by Sun and Abraham (2021). This estimator is appropriate and interpretable in the context of staggered treatment timing and treatment effect heterogeneity. It involves estimating a fully parametric saturated regression of municipality- and relative time-specific treatment effects through interaction terms, allowing for treatment effect heterogeneity, and using the never-treated units as controls. Then, the estimates are aggregated as a weighted average using the sample shares of each cohort in each period. To make it comparable to our primary estimator, we show Sun and Abraham (2021) estimators including and excluding municipal-linear trends (Strezhnev, 2024).

Single Estimates. We complement the dynamic specification with single coefficient estimates. The single pooled coefficient of a standard TWFE regression provides a variance-weighted average of the underlying dynamic coefficients, with weights based on the residual variance of the treatment variable after residualizing with respect to the controls, which, in our case, include municipality-specific linear trends. This can give rise to two sources of bias when estimating a single post-treatment coefficient (Downey, 2024). First, the TWFE pooled coefficient estimate will mechanically place more weight on the coefficients closer to the switching year than on longer-term coefficients. Second, whereas this single coefficient is a weighted average of the dynamic coefficients, the weights can be negative. Therefore, this pooled coefficient can be inconsistent and difficult to interpret.

In light of these issues, we calculate instead the average treatment on the treated (ATT) effect as the equally weighted mean of the dynamic treatment coefficients β_τ, considering only the fully

[13] Appendix Figure C1 shows the distribution of population weights in the sample, providing evidence of a steep drop ten years after the switch to high TV-school density.

treated periods $\tau \in [3, 10]$. This is our preferred specification and is reported as DiD_{ATT}. The standard TWFE single pooled-coefficient estimates, also excluding the partially treated periods, are reported as supplementary results and denoted as DiD_{TWFE}. In general, we find that in this setting, there is a considerable downward bias in the single pooled DiD_{TWFE} coefficients.

Parallel Trends. The lead coefficients relative to the time of switch $\tau = 16$ in equation (1) provide an empirical test of pre-treatment differential trends. If outcomes were already trending in the direction of the estimated treatment effects before the introduction of TV-schools, even after accounting for municipal-linear trends, it would suggest bias driven by underlying divergence in pre-existing trends. To complement this analysis, we also present "Honest DiD" estimates (Rambachan and Roth, 2023), which provide bounds on post-treatment coefficients under the assumption that any existing pre-treatment trends between treated and untreated municipalities persist into the future. We show these "Honest DiD" confidence intervals for specifications without municipal-linear trends, also providing a useful comparison for our main estimates.

Concurrent Programs, Expansion of Other Schools, and Potential Confounders. Since our empirical strategy relies on the staggered rollout of TV-schools, any confounding program or investment would need to align precisely with their timing and location to bias our results. Thus, it is unlikely that our estimates reflect unrelated policies coinciding with TV-school expansion. Still, Section V.1 shows that our effects remain robust even after accounting for other programs, such as the large-scale rollout of conditional cash transfers in Mexico.

Two additional factors warrant closer examination. First, whether the infrastructure investments required for TV-school expansion, such as roads and electricity, were deliberately timed to coincide with school construction. Even if such public investments occurred, our difference-in-differences strategy would account for them as long as their effects on labor market outcomes were uniform across cohorts within a municipality. Our cohort-based analysis shows clear trend breaks around age 15, suggesting that any alternative explanation based on confounding investments would need to explain why only specific school-age cohorts were selectively affected.

A second plausible confounder is whether the government, in its efforts to expand education, built standard lower secondary schools alongside TV-schools in the same municipalities. If so, our estimates might reflect the impact of broader school access rather than the specific effects of TV-schools. Figure 2b shows no evidence that the transition to high-TV-school density coincided with a simultaneous increase in standard school construction. Later, we also show that our results remain robust when controlling for the growth of standard schools.

V Nationwide Impacts on Education and Labor Outcomes

Education Outcomes. Figure 3 presents the main event studies on educational outcomes resulting from the nationwide construction of TV-schools, using our preferred binarized treatment variable. We document positive and statistically significant effects for primary and lower secondary graduation for cohorts aged 15 or younger when their municipality experienced intense TV-school construction, which result in overall increases in years of education.[14] The effects estimated using the continuous treatment variable —the number of TV-schools opened in the municipality, scaled by the eligible population—centered around the age at the year of the first TV-school construction lead to similar conclusions (Appendix F.1).[15] These are all intent-to-treat effects, capturing the influence of increased TV-school availability rather than direct attendance. Those who actually attended TV-schools likely experienced larger impacts.

Consistent with the assumption of parallel trends, we find near-zero effects for those aged 16 or older at the time of the transition to high TV-school intensity, since they were likely too old to benefit. Partially treated cohorts (ages 13 to 15) show smaller gains, likely because fewer individuals in this group attended TV-schools, having already dropped out of school. In contrast, fully exposed cohorts saw larger impacts with higher estimated effects for each subsequent cohort. Two factors likely explain why estimated effects increase across cohorts.[16] First, the "time of switch" was not a single policy shift but rather a period of accelerated TV-school construction. As Figure 2b show, construction continued to expand over time, meaning later cohorts had access to a higher density of TV-schools. Second, TV-school quality likely improved over time, which may have led to greater benefits for later cohorts.[17]

[14] The DiD_{ATT}, DiD_{TWFE}, and Sun and Abraham (2021) single-coefficient estimates are reported in Appendix Table D1. The dynamic treatment effects for these specifications are reported in Appendix Figures D1–D3.

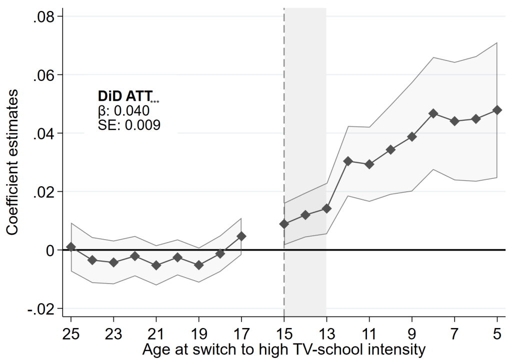
[15] Appendix Figures F1 and F2 which use the continuous treatment variable also show no pre-treatment trends.

[16] See Appendix Figure B1b and Appendix A.3 for more evidence on these claims.

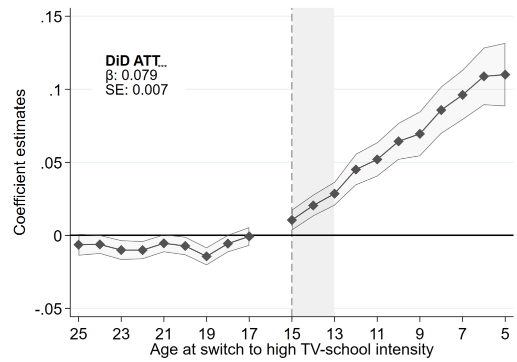
[17] The large point estimates for the youngest cohorts should be interpreted with caution. While the heterogeneity-robust estimators (Sun and Abraham, 2021) very closely align with the main estimates for cohorts aged 8 to 12, point estimates for younger groups are smaller and noisier.

Figure 3: Impacts of Access to High TV-School Intensity on Education Outcomes

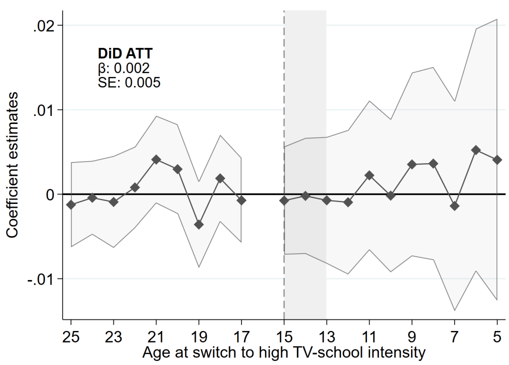
(a) Primary Graduation



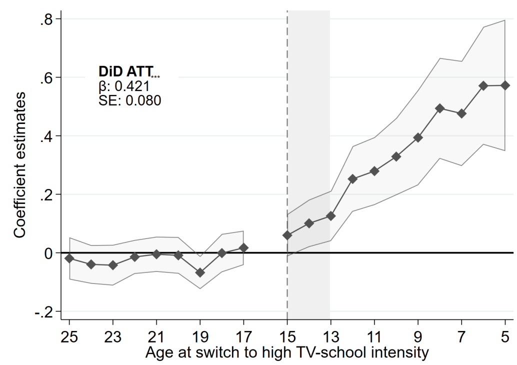
(b) Lower Secondary Graduation



(c) Upper Secondary Graduation



(d) Years of Education

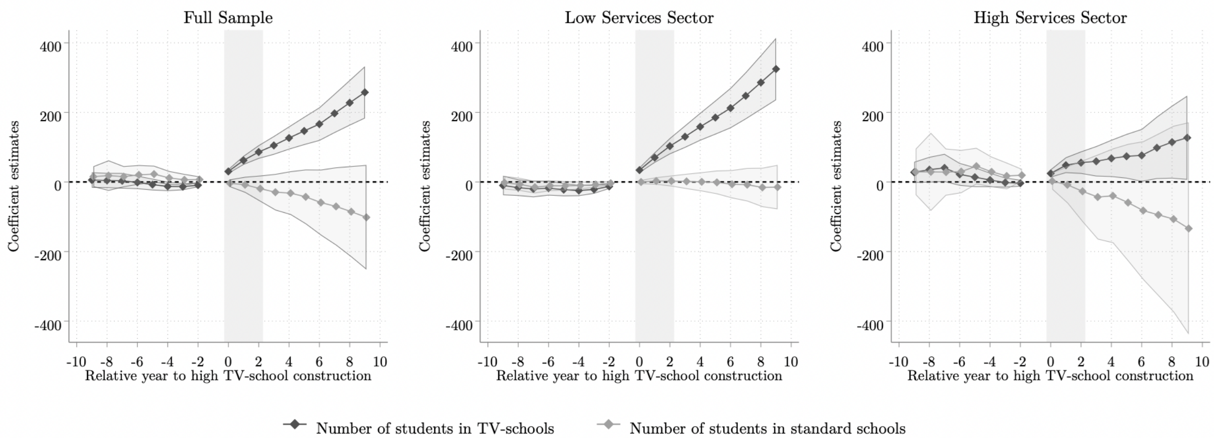


Notes: This figure shows the effect estimates of access to high TV-schools density by age at the year of switch to a high TV-school intensity construction on different outcomes. The econometric specification is a dynamic TWFE event study model that includes municipality and cohort fixed effects, and municipality-specific linear time trends. See Equation (1) for details. Event study coefficient estimates are shown with a solid line, and 95% confidence intervals are shown with a shaded area. All effects are computed with respect to age 16. The dynamic coefficient estimates are summarized with an equally weighted average treatment on the treated single point-estimate DiD_{ATT} superposed in the graph alongside its standard error. See Section IV for details. Outcomes are: indicators for graduating from primary, lower secondary, and upper secondary education, and years of education. Data is from the Mexican Secretariat of Education (SEP) for 1980–2000, and the 2010 Mexican census (10% IPUMS subsample).

Combining event study estimates for fully exposed cohorts, we find an 8 percentage point (p.p.) increase in lower secondary school graduation, a 12.6% rise over the baseline rate of 63% (Figure 3b). Primary school graduation rose by 4 p.p. from a baseline of 85% (Figure 3a), aligning with emerging research in LMICs that finds that access to higher levels of education can encourage completion at lower levels (Jagnani and Khanna, 2020; Sandholtz, 2022). In contrast, we find little evidence of meaningful gains in upper secondary graduation (Figure 3c). This is perhaps unsurprising, given the limited availability of upper-secondaries in most of these areas at the time.

Overall, in adulthood treated cohorts had gained, on average, an additional 0.4 years of education from a baseline of 9.2 (Figure 3d). Re-estimating the effects using the continuous treatment variable, we estimate that an additional TV-School per 50 eligible children also increased educational attainment of 0.4 years and raised primary and lower secondary school graduation rates by 5 and 13 p.p., respectively (Appendix Table F1).

Figure 4: Impacts of Access to High TV-School Intensity on School Enrollment by Type of School (post-1990)



Notes: This figure shows the effect estimates of access to high density of TV-schools on TV-school enrollment and standard school enrollment, calculated by academic year relative to the municipality year of switch to a high TV-school intensity construction. The estimates are computed for the full sample, and by sectoral composition at baseline. The outcome is measured as the number of students enrolled in first grade in a given secondary school type in the municipality. The econometric specification is a dynamic TWFE event study model that includes municipality and cohort fixed effects, and municipality-specific linear time trends. See Equation (1) for details. Event study coefficient estimates are represented by a solid line, and 95% confidence intervals with a vertical line. All effects are computed relative to the period before the high TV-school density switch. Data comes from the Mexican Secretariat of Education (SEP) for the years 1990–2000.

Interpreting TV-schools' impact on educational attainment requires considering children's counterfactual schooling options. To examine this, we use administrative data on concurrent average enrollment in standard and TV-schools within municipalities. As discussed, due to data limitations, this analysis is restricted to 1990 onward. The left-hand graph in Figure 4 shows enrollment impacts across both school types following the 'high-density' switch year for TV-schools. TV-school enrollment significantly rises after the treatment turns on, with steady growth over time. Meanwhile, standard school enrollment in affected municipalities starts to trend downward, though estimates remain noisy and statistically insignificant. If taken at face value, these estimates suggest that nationwide ten years after the switch, roughly two-thirds of affected children would not have enrolled in school without TV-schools, while up to one-third may have transferred from standard schools. Thus, human capital gains appear to stem primarily from enrolling previously out-of-school children rather than shifting students between school types.[18]

To examine potential counterfactuals by area type, the center and right-hand graphs in Figure 4 further break down these effects by municipalities' baseline economic development, proxied by the sectoral composition. In predominantly agricultural municipalities (low services sector), TV-schools expanded educational access without reducing standard school enrollment, as standard schools were largely unavailable. In these areas, the likely counterfactual was not attending lower secondary at all. In contrast, in more developed areas (high services sector), there is also evidence of a substitution effect from standard to TV-school enrollment, although the confidence intervals are wide. This suggests that in these municipalities, the counterfactual includes both not attending secondary school (extensive margin) and enrolling in a standard school (intensive margin). We further investigate impacts by baseline sectoral composition in Section VII.

Labor Market Outcomes. Figure 5a shows consistent gains in the monthly labor earnings of affected cohorts in adulthood. The pooled estimate corresponds to overall monthly gains of 365 pesos (approximately $30 USD at the time), corresponding to a 12% increase over the mean labor earnings of 3,110 pesos. We estimate an increase of 8% in the exposed individual's hourly income (Figure 5b).

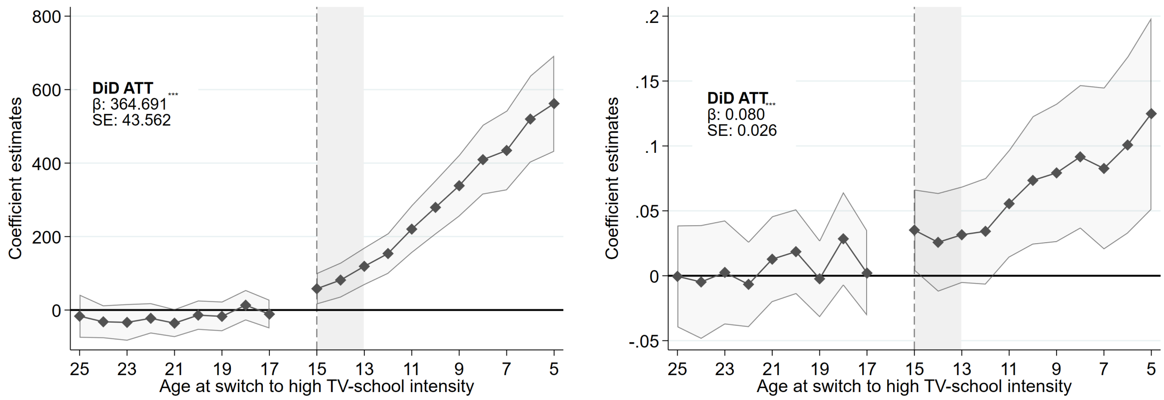
We then investigate the impacts related to labor market composition, which could be one mechanism contributing to the positive income effects. First, we find a 3 p.p. increase in the probability of working in adulthood (Figure 6a), matching the increase in the probability of reporting a non-zero income (Figure 6b). These increases correspond to a 4.6% and 6.4% rise from baseline values of 66% and 55%, respectively. There is also a significant 3.3 p.p. rise in the probability of working in the service or tertiary sector (Figure 6e), corresponding to an 8% increase. The shift toward service sector employment is primarily driven by higher employment in public services, financial and business services, and trade, with no significant changes in hospitality, transportation, or private household services (Appendix Table D2).

We find no significant decline in the likelihood of employment in the primary or agricultural sector (Figure 6c), with a precisely estimated zero effect. There is a small, marginally significant

[18] These figures reflect enrollment in the 1990s, when only 29% of municipalities lacked standard lower secondary schools. The effects of expanding access rather than substituting between school types were likely even larger in the 1980s when fewer standard schools existed.

Figure 5: Impacts of Access to High TV-School Intensity on Income

(a) Monthly Income (pesos) (b) Hourly Income (log)



Notes: This figure shows the effect estimates of access to high TV-schools density by age at the year of switch to a high TV-school intensity construction on different outcomes. The econometric specification is a dynamic TWFE event study model that includes municipality and cohort fixed effects, and municipality-specific linear time trends. See Equation (1) for details. Event study coefficient estimates are shown with a solid line, and 95% confidence intervals are shown with a shaded area. All effects are computed with respect to age 16. The dynamic coefficient estimates are summarized with an equally weighted average treatment on the treated single point-estimate DiD_{ATT} superposed in the graph alongside its standard error. See Section IV for details. Outcomes are: monthly adult income in pesos, and the logarithmic transformation of hourly income. We do not condition on whether individuals are working. Data is from the Mexican Secretariat of Education (SEP) for 1980–2000, and the 2010 Mexican census (10% IPUMS subsample).

0.6 percentage point increase in employment in the secondary or manufacturing sector (Figure 6d). Finally, while point estimates suggest higher enrollment in employment-related social security, a common proxy for formal sector participation, the pooled effect is not statistically significant (Figure 6f).

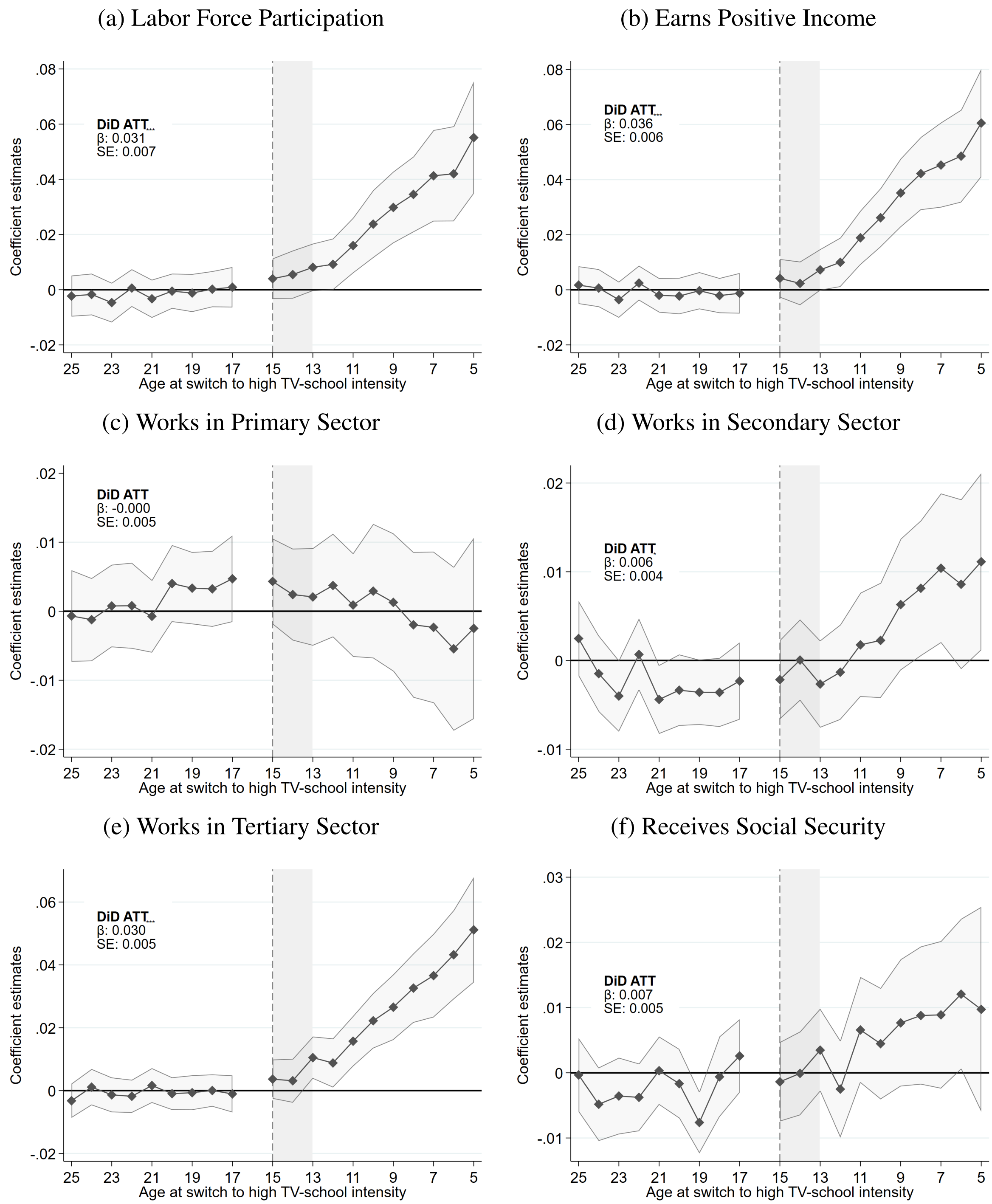
Overall, we conclude that cohorts exposed to high-intensity TV-school availability experience economically meaningful and statistically significant increases in adult labor market earnings. While part of this effect can be attributed to an overall rise in employment within the service sector, the relatively small sectoral shifts suggest that improvements within sectors likely played a significant role in the observed income gains.

V.1 Validity and Robustness

This section discusses several approaches to address potential threats to the identification strategy and discusses a battery of sensitivity analyses.

Alternative estimators and the parallel trend assumption. Next, we examine whether using an estimator that is robust to treatment effect heterogeneity affects our conclusions.

Figure 6: Impacts of Access to High TV-School Intensity on Labor Market Composition Outcomes



Notes: This figure shows the effect estimates of access to high TV-schools density by age at the year of switch to a high TV-school intensity construction on different outcomes. The econometric specification is a dynamic TWFE event study model that includes municipality and cohort fixed effects, and municipality-specific linear time trends. See Equation (1) for details. Event study coefficient estimates are shown with a solid line, and 95% confidence intervals are shown with a shaded area. All effects are computed with respect to age 16. The dynamic coefficient estimates are summarized with an equally-weighted average treatment on the treated single point-estimate DiD_{ATT} superposed in the graph alongside its standard error. See Section IV for details. Outcomes are: indicators for participation in the labor market and unconditional probability of earning positive income, unconditionally participating in the primary sector, secondary sector, and tertiary sector, and for receiving formal health insurance. Data is from the Mexican Secretariat of Education (SEP) for 1980–2000, and the 2010 Mexican census (10% IPUMS subsample).

Appendix Figures D1a and D1b compare our original results with those obtained using the estimator proposed by Sun and Abraham (2021), presenting results both with and without municipality-specific trends for each.[19]

There are two main takeaways from these figures. First, the point estimates from the Sun and Abraham (2021) estimator are largely consistent with those from our main TWFE dynamic specifications, though somewhat noisier for some variables among the youngest cohorts. This suggests that concerns about negative weights due to staggered treatment are minimal, supporting our decision to use the dynamic TWFE specification as our preferred approach.

Second, for some variables, excluding the municipal linear trends shows pre-trends in the periods leading up to the switch year. This is particularly noticeable for primary school graduation, which is perhaps not surprising, as TV-school construction likely targeted areas experiencing rising demand for secondary education from primary school graduates. The presence of these pre-trends in primary school graduation, and to a lesser extent in the educational attainment and income variables, is one reason for including these unit specific trend controls in our preferred specification. In contrast, there is little evidence of pre-trends affecting lower secondary graduation, employment likelihood, positive income, or work in the tertiary sector.

To further assess the extent to which existing pre-trends affect our estimates, Appendix Figures H1 through H3 present 95% "Honest DiD" confidence intervals following the procedure by Rambachan and Roth (2023). We show results for specifications that exclude municipal-linear trends and plot confidence intervals that allow for linear violations of parallel trends. Even in cases where pre-existing trends are present, these bounds remain informative at the 95% level for the majority of outcomes where we detect effects.

The 1993 Construction Shock as an Alternative Source of Variation. We also consider a specification that uses only variation from the rapid school construction that followed the constitutional amendment in 1993 that mandated universal lower secondary education. This policy change arguably provides a 'cleaner' source of exogenous variation in TV-school construction, mitigating concerns that municipalities endogenously established TV-schools based on factors correlated with their future growth.

[19] Single estimates for all these estimators are reported in Appendix Tables D1.

Effects are estimated using equation (1), but restricting treatment variation to the 145 municipalities that experienced high-intensity TV-school construction in 1993 and 1994. The estimated education effects are similar in magnitude and significance to those in the main analysis. While income and hourly wage effects are positive, they are also noisier, likely due to the smaller sample size. However, their magnitudes are very close to that of the main analysis (Appendix Figure D4).

MIGRATION. As discussed, the census reports individuals' state of birth and their municipality of residence in adulthood and five years prior, but not where they lived when they were adolescents. Consequently, we proxy treatment assignment using the municipality of residence in 2010. If migration decisions are uncorrelated with TV-school access, this assignment would just introduce measurement error, attenuating the estimated effects. However, if migration is selective—meaning individuals move in response to TV-school availability—our estimates might capture the effects of this regional sorting instead of the causal impact of TV-schools.[20] We conduct several robustness checks to investigate the extent to which our estimates are affected by these issues. All the results discussed in this section are reported in Appendix G.

First, our main specifications exclude interstate migrants, as the census only reports individuals' state of birth. This excludes 8% of the sample, meaning our estimates apply only to individuals who remained in their birth state. However, this restriction helps mitigate concerns about selective migration across states. To further assess whether out-migration may bias our estimates, we follow prior literature (Parker and Vogl, 2023; Atkin, 2016) and test whether cohort sizes changed differentially in municipalities with high TV-school density. If TV-schools reduced out-migration, we would expect to see relative increases in cohort size in switcher municipalities, and vice versa. Since individuals who migrate internationally are not captured in the census, this cohort-size approach also provides a way to assess potential bias from international migration.

We find no significant changes in cohort size following TV-school expansion when estimating equation (1) using the log of population for each municipality-cohort cell as the dependent variable (Appendix Figure G1a). We also test for changes in gender composition, given that Mexican

[20]For instance, if individuals with high returns to education permanently leave poorer municipalities (with high density of TV-schools) for urban municipalities (with relatively low density), they would be incorrectly classified as 'untreated', leading to an underestimation of TV-school effects. Conversely, if TV-school municipalities attract particularly motivated students, the impact of the program could be overestimated.

men are more likely to migrate to the U.S., and again find no significant differential effects on women-to-men ratios across cohorts (Appendix Figure G1b). Repeating the analysis with interstate migrants included yields similar results, suggesting no substantial inflow of state migrants into treated municipalities.[21]

As a second approach to directly test the effects of TV-school construction on short-term migration, we use the 2000 census, which records the municipality of residence in 1995. This allows us to approximate individuals' original locations closer to the time they would have attended lower secondary school. We focus on cohorts born between 1970 and 1985 (aged 10 to 25 in 1995) and restrict variation to TV-school construction during the 1990s, excluding municipalities with earlier high-construction periods. This ensures that the individuals' 1995 locations closely align with their municipality of secondary school attendance. We find no effects on short-term migration for affected cohorts, as measured by municipality of residence changes between 1995 and 2000 (Appendix Figure G2a). We also estimate short-term effects on lower secondary graduation using this sample and find effects of similar magnitude to our main estimates (Appendix Figure G2b).[22]

Finally, because assessing long-run migration impacts using census data is inherently challenging, we complement our analysis with data from the 2016 Módulo de Movilidad Social Intergeneracional (MMSI), a nationally representative household survey collected by INEGI. A key feature of this survey is a retrospective question on respondents' place of residence at age 14, which allows us to assign treatment status based on their reported locality at that age and directly estimate the effects of TV-schools on education and migration. While the MMSI does not ask questions about earnings, we find similar effects on lower secondary graduation as in our main estimates (Appendix Figure G3b). The effects on migration to a different municipality are small and only marginally significant, with combined estimates suggesting if anything, a 2.8 p.p. increase in the probability of moving (Appendix Figure G3a). This modest effect supports the notion that selective migration is unlikely to be large enough to explain our main results.

[21]Even if some interstate inflow of migrants occurred, our main estimates would remain unaffected, as interstate migrants are excluded from regressions. However, migration might still have indirect effectsfor example, if inflows influenced overall returns to education through general equilibrium effects.

[22]Our main results using the 2010 census are also robust to reassigning everyone to their municipality of residence in 2005. However, since 2005 is post-treatment it is unclear if this is a 'cleaner' assignment than that in 2010.

Alternative Samples and Controls. To address concerns about potential sources of bias contaminating our results, we conduct several robustness tests, reported in Appendix Table D3. Column (1) shows our main estimates for comparison. Column (2) presents estimates controlling for the simultaneous growth of standard secondary school density at the municipal level, which could confound the impacts of TV-school growth. Adding this control does not affect the magnitudes of the main estimates.

To address concerns that municipalities receiving TV-schools might have very distinct growth trajectories compared to other municipalities, we re-estimate effects using a sample that only includes municipalities that received at least one TV-school during the study period. We find similar effects for this group (Column 3). Column (4) shows the effects when excluding municipalities that received at least one TV-school but never "switched" to high-intensity construction. These municipalities tend to be more urban and populated, meaning the TV-density threshold per person is not met. Again, the conclusions remain similar. Column (5) combines the difference-in-difference approach with propensity score matching. This sample is restricted to municipalities that experienced construction and matched control municipalities with similar 1980 characteristics.[23] Again, the effects are positive and significant, and if anything, are somewhat larger than the original estimates.

Finally, we also consider whether the extensively studied Progresa/Oportunidades conditional cash transfer (CCT) program can explain the impacts. This program provided financial support to low-income rural households, conditional on children attending school among others (Parker and Todd, 2017). Since many TV-school students were CCT beneficiaries, it could raise concerns about whether the observed effects are a bundle from TV-schools or the CCT program. However, since the program was only fully implemented in 1997, the overlap with our sample is likely minor. Column (6) restricts the analysis to municipalities that switched to a high TV-school density *before* 1997 and the results remain largely unchanged, indicating that the observed impacts are primarily driven by the TV-schools rather than the CCT program.

[23] We matched based on the following characteristics in 1980: primary school enrollment, secondary school enrollment, the share of adults with incomplete primary education, the share of households without piped water, electricity, and with dirt floors, share of adults earning less than two minimum wages, the share of illiterate adults, total population, the share of people living in rural localities, and share of people in the primary sector.

VI Benchmarking the Labor Market Impacts of TV-Schools

We benchmark the estimates of the labor market impacts of TV-school construction using three approaches. First, we estimate the implied labor market returns to education using the TV-school construction as an exogenous source of variation. Second, we contrast these returns with those from standard lower secondary school construction during the same period, estimated through a similar identification strategy. Third, we combine the estimated returns and cost data to provide cost-benefit estimates of the TV-school program.

IMPLIED RETURNS TO EDUCATION. We estimate labor market returns to education using Wald estimates but acknowledge that the assumption underpinning their validity—the exclusion restriction, which requires no externalities or general equilibrium effects from TV-school construction—may not hold. Despite this limitation, these estimates provide a useful benchmark for assessing the impact of TV-schools relative to existing literature.

Table 1 shows the coefficients used to calculate returns to education. Panel A includes estimates from the main specification using the binarized treatment, while Panel B shows estimates using the continuous treatment variable. We estimate that an additional year of education resulting from the high-intensity construction of TV-schools is associated with a 19% increase in adult hourly income and an increase in monthly income of 866 pesos. For comparison, the OLS estimates of the returns to education for the same sample, are also 19%. Using the continuous TV-school density treatment, we find that an additional year of education resulting from an additional TV-school per 50 children is associated with an additional 1,141 pesos in monthly income and a 10% increase in hourly income, based on our preferred DiD_{ATT} estimates. Using the continuous density treatment and DiD_{TWFE} estimates, the increases are 607 pesos in monthly income and a 15% rise in hourly income.

For context, the worldwide average return to schooling is around 10%. Returns tend to be higher in LMICs, and lower for secondary education (7.2%) compared to tertiary education (15.2%) (Montenegro and Patrinos, 2014). In Mexico, OLS estimates from Mincerian regressions report an 8% return to an extra year of primary education, with the returns for an extra year of secondary education and of college are around 10% and 11%, respectively (Morales-Ramos, 2011).

Table 1: Impacts of Secondary School Construction on Educational Achievement and Income by Type of School

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Lower Sec. Grad.		Years of Education		Monthly Income (pesos)		Hourly Income (log)	
	DiD_{TWFE}	DiD_{ATT}	DiD_{TWFE}	DiD_{ATT}	DiD_{TWFE}	DiD_{ATT}	DiD_{TWFE}	DiD_{ATT}
Panel A: High-intensity School Construction (Binary Treatment)								
School type: TV-Schools								
High TV-School Intensity	0.038***	0.079***	0.216***	0.421***	133.861***	364.691***	0.023	0.080***
	(0.004)	(0.007)	(0.036)	(0.080)	(22.857)	(43.562)	(0.015)	(0.026)
Dependent Mean	0.64	0.63	9.23	9.18	3151.06	3110.25	2.77	2.75
Observations	42823	45393	42823	45393	42819	45389	42824	45394
Panel B: Number of Schools per 50 Children (Continuous Treatment)								
School type: TV-Schools								
TV-School Intensity	0.159***	0.128***	0.770***	0.410***	412.587***	468.063***	0.114**	0.041
	(0.011)	(0.014)	(0.101)	(0.108)	(63.285)	(87.321)	(0.045)	(0.070)
Dependent Mean	0.61	0.60	8.93	8.93	3168.45	3214.74	2.77	2.78
Observations	43026	47511	43026	47511	43026	47509	43027	47512
School type: Standard Schools								
Std. School Intensity	0.177***	0.113***	1.082**	1.215***	580.563	1045.685***	0.174	0.066
	(0.053)	(0.041)	(0.486)	(0.435)	(360.005)	(333.187)	(0.109)	(0.240)
Dependent Mean	0.60	0.60	8.91	8.89	3018.04	3009.43	2.73	2.73
Observations	42518	44651	42518	44651	42518	44649	42519	44652

Notes: This table shows the impact of access to schooling by school type (standard schools and TV-schools). Odd columns present single-coefficient estimates from a two-way fixed effects (TWFE) model, DiD_{TWFE}, which includes municipality and cohort fixed effects, and municipality-specific linear time trends. Even columns present our preferred specification, the equally-weighted average treatment on the treated (ATT) of post-treatment estimates from the dynamic TWFE event study model, DiD_{ATT}, also including municipality and cohort fixed effects, and municipality-specific linear time trends. See Equation (1) and Section IV for details on the econometric specifications. Panel A reports coefficient estimates for the binary treatment–an indicator identifying individuals with access to a high density of schools in the municipality at age 15, defined as being above the sample median density. This binary treatment effect is only reported for TV-schools. Panel B reports coefficient estimates for continuous treatment–school density in the municipality at age 15, measured as the number of TV-schools per 50 eligible children. This effect is reported both for standard schools and TV-schools. The outcomes are: an indicator for graduating from lower secondary education (col. 1-2), years of education (col. 3-4), the unconditional monthly adult income in pesos (col. 5-6), and logarithmic transformation of hourly income (col. 7-8). Regressions use administrative school construction data from the Mexican Secretariat of Education for 1980–2000, and outcome data from the 10% subsample of the 2010 Mexican census from IPUMS, restricting it to non inter-state migrants. Data is aggregated into birth-year by municipality-of-residence cells, and standard errors are clustered at the municipal level. Statistical significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

COMPARISONS TO STANDARD SCHOOLS. We use the expansion of standard lower secondary schools from 1980 to 2000 to examine how their long-term effects compare to those of TV-schools. However, this should not be viewed as a direct evaluation of the two schooling types for the same population, as TV-schools and standard schools were generally and deliberately placed in different types of areas. Nevertheless, this analysis offers insight into the magnitude of nationwide impacts from two different lower secondary schooling modalities.

For this exercise, we focus on continuous measures of school density to allow for better comparability across both schooling types.[24] The impact of building one standard school and one TV-school per 50 children on lower secondary graduation rates is nearly identical (Table 1, Panel B). However, the overall educational attainment is almost three times higher for standard schools than for TV-schools (1.21 additional years versus 0.41 years). This difference in total educational attainment may come from gains in higher levels of education in areas with standard schooling growth, while no similar effects were observed with the TV-school rollout.

We estimate that an additional standard school increases monthly income by 1,046 pesos, more than double the 468 pesos increase from an additional TV-school. While both types of schools show positive increases on hourly income, these effects are not statistically significant when estimated with the continous treatment variable. Back-of-the-envelope calculations of the returns to education for both school types indicate that TV-schools are associated with a monthly income increase of 1,141 pesos per additional year of education, while standard schools are associated with a return of 864 pesos per additional year. Therefore, although standard schools show higher overall impacts on educational attainment and adult income, the estimated labor market returns per additional year of education are relatively similar across both school types.

The differences in the estimated labor market impacts between standard and TV-schools may reflect underlying differences in context and educational pathways. First, standard schools are more likely to be located in urban areas, serving children of higher socio-economic backgrounds. Second, these schools tend to be situated in regions with better access to upper secondary or tertiary education, as well as more sectorally diversified labor markets, which may contribute to higher economic impacts. Finally, standard schools might provide human capital that is more relevant to both continuing education and the labor market. In Section VII, we further explore some of these factors.

COST-BENEFIT CALCULATIONS. To evaluate the TV-school model as a public investment, we compare the costs and benefits of their construction during the 1980-2000 period. These calcu-

[24] Appendix Figures F4 and F5 show event studies for standard schools, centered around the first standard school built in the municipality, with no pre-treatment trends. When using a binary measure for standard school construction, analogous to the high-intensity TV-schools construction measure, we do not find significant effects. This is likely due to the gradual nature of standard school construction, which led to a less distinct increase in school density compared to the more immediate changes from TV-school rollouts. Table E1 reports the binary treatment estimates for both school types.

lations rely on a number of simplifying assumptions and should be interpreted with caution. We report all amounts in 2010 Mexican pesos or their USD equivalents, with detailed calculations provided in Appendix I.

We estimate benefits based on the lifetime earnings of individuals born between 1965 and 1990, the primary cohorts in our sample that were fully exposed to the TV-school rollout during the relevant period. Using the monthly earning gains of 468 pesos (Table 1), and assuming a 2% discount rate, a three-year delay in workforce entry, and no earnings growth, the discounted lifetime impact is estimated at 156,064 pesos (USD $12,350) per person, resulting in an aggregate impact of about 143.2 billion pesos (USD $11.3 billion).

We then consider both direct and indirect costs. Direct costs include the investment to set up and maintain TV-school infrastructure, such as program production, installation of school equipment, and satellite dishes, as well as recurring expenses for running the schools, including teacher salaries, benefits, training, and maintenance. Total direct costs are estimated at 33 billion pesos, with investment costs accounting for just under 20% of the per-student costs, while recurring costs (primarily teachers salaries and benefits) account for the remaining 80%. Indirect costs include the opportunity cost of attending school, calculated using census data from 2000. Assuming a 0.2 deadweight loss from taxation, the total costs amount to 42.2 billion pesos. Consequently, the benefit-cost ratio is at least 3.4, and likely higher due to a number of conservative assumptions, such as no wage growth and the exclusion of benefits from education beyond earnings impacts.

VII Scaling TV-Schools: Regional Needs and Opportunities

A common concern when scaling up programs is that their effects may vary depending on the context, not aligning with those estimated in small-scale, tightly controlled experiments (Banerjee et al., 2017; Al-Ubaydli et al., 2019). Recent research has documented significant heterogeneity in the effectiveness of educational programs following large-scale implementation, highlighting the importance of considering how local factors influence outcomes.[25]

The TV-school model was originally designed for rural areas with thin teacher labor pools and

[25] In education, several aspects have been shown to substantially affect program effectiveness, ranging from differences in design or inputs (Kerwin and Thornton, 2021; Ganimian, 2020), state capacity (Bold et al., 2018), and targeted population (Al-Ubaydli et al., 2017), to supply-side constraints (Davis et al., 2017), cultural practices (Ashraf et al., 2020), general equilibrium effects (Khanna, 2023), and available substitutes to the program (Mountjoy, 2022; Fort et al., 2020).

few schooling alternatives. However, as the model was scaled, TV-schools were established in municipalities with a variety of alternative schooling options, labor market opportunities and degrees of market integration. This raises the question of whether the positive nationwide average effects mask significant differences in program impacts based on area characteristics. In particular, examining whether TV-schools truly benefited the originally targeted rural areas is important, given the uncertain demand for and potential returns on education in places with limited off-farm employment opportunities. Additionally, the TV-school model may be less suitable for more developed municipalities with better access to standard schools and labor markets requiring skills potentially harder to impart through ICTs.

To understand this heterogeneity, we present differential impacts by comparing municipalities with above- and below-median shares of tertiary sector employment in 1980 (10%).[26] Table 2 reports the estimated DiD_{ATT}, calculated by running separate split-sample regressions for each group of municipalities. Figure 7 shows the estimated dynamic coefficients for years of education and monthly income.[27]

Educational Outcomes. We find no evidence that the availability of potentially higher-paying jobs influences enrollment in TV-schools or subsequent educational achievement. The effects on years of education and lower secondary education graduation rates are similar across areas with both low and high tertiary sector presence at baseline. In both cases, lower secondary graduation increases by 6 p.p., and overall years of education rise by 0.27 and 0.33, respectively. There are no significant differences in effects at the other educational levels.

Understanding these education estimates requires recognizing that the counterfactual to attending a TV-school likely varies by region. As shown in Figure 4, enrollment patterns across school types respond differently to high-intensity TV-school construction, depending on regional characteristics, likely reflecting differences in access to standard schools. In predominantly agricultural regions, TV-school enrollment rises without affecting standard school enrollment. In more economically developed areas, the estimates suggest a partial, though imprecise, substitution effect:

[26] Appendix C shows the evolution of constructions across space and over time by sectoral composition.

[27] Appendix E includes a table with the estimated differential effects between municipalities with low and high service presence, reporting the differential point estimates and p-values for the joint hypothesis of equality. These estimates come from a regression similar to equation (1) incorporating interactions for each heterogeneity group. The appendix also presents estimated dynamic coefficients for the rest of the outcomes.

Table 2: Heterogenous Effects of High TV-school Intensity by Type of Region

	Full sample	By services jobs		By standard school presence				Services jobs + standard school presence		
		Low	High	None at baseline	Low density	Has at baseline	High density	Low serv. + low density	High serv. + low dens.	High serv. + high dens.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
				Panel A: Education Outcomes						
Lower Sec. Graduation	0.079***	0.060***	0.063***	0.076***	0.074***	0.074***	0.066***	0.068***	0.062***	0.053***
	(0.007)	(0.009)	(0.012)	(0.008)	(0.008)	(0.013)	(0.013)	(0.010)	(0.015)	(0.018)
Mean	0.46	0.38	0.55	0.41	0.42	0.53	0.56	0.37	0.50	0.62
Observations	45393	23730	21663	25743	32020	19650	13373	20064	11956	9707
Years of Education	0.421***	0.265***	0.330**	0.297***	0.330***	0.478***	0.445***	0.279***	0.321***	0.225
	(0.080)	(0.079)	(0.150)	(0.070)	(0.079)	(0.146)	(0.168)	(0.092)	(0.124)	(0.282)
Mean	7.48	6.72	8.30	7.00	7.09	8.10	8.40	6.66	7.81	8.91
Observations	45393	23730	21663	25743	32020	19650	13373	20064	11956	9707
				Panel B: Income						
Monthly Income	364.691***	121.131***	403.200***	182.028***	190.840***	475.079***	544.608***	127.646***	220.292***	483.657***
	(43.562)	(36.884)	(81.575)	(41.590)	(38.541)	(69.983)	(92.779)	(40.820)	(81.165)	(145.672)
Mean	1807.08	1249.48	2417.72	1430.51	1513.25	2300.33	2510.51	1201.87	2035.63	2888.38
Observations	45389	23725	21664	25739	32016	19650	13373	20059	11957	9707
Hourly Income (log)	0.080***	0.018	0.102**	0.062	0.065**	0.084***	0.073	0.029	0.126**	0.038
	(0.026)	(0.035)	(0.041)	(0.040)	(0.031)	(0.032)	(0.048)	(0.038)	(0.058)	(0.051)
Mean	2.23	1.92	2.56	2.00	2.08	2.52	2.59	1.88	2.40	2.75
Observations	45394	23730	21664	25744	32021	19650	13373	20064	11957	9707
				Panel C: Labor market composition						
Labor Market Participation	0.031***	0.005	0.031***	0.015**	0.012**	0.042***	0.056***	0.002	0.020	0.030*
	(0.007)	(0.007)	(0.011)	(0.007)	(0.006)	(0.011)	(0.016)	(0.007)	(0.013)	(0.018)
Mean	0.58	0.55	0.62	0.56	0.56	0.61	0.63	0.54	0.60	0.65
Observations	45393	23729	21664	25743	32020	19650	13373	20063	11957	9707
Services Sector	0.030***	0.007	0.033***	0.020***	0.017***	0.036***	0.044***	0.006	0.029***	0.032
	(0.005)	(0.005)	(0.011)	(0.005)	(0.005)	(0.009)	(0.013)	(0.005)	(0.010)	(0.023)
Mean	0.23	0.16	0.30	0.19	0.19	0.28	0.30	0.16	0.26	0.34
Observations	45394	23730	21664	25744	32021	19650	13373	20064	11957	9707

Notes: This table shows the impact of access to a high density of TV-schools on education and labor market outcomes by different municipality characteristics using split-sample regressions. The samples of analysis are: Full sample (col. 1), below and above the median of the share of services sector in 1980 (col. 2-3), without and with presence of standard schools in 1980 (col. 4,6) below and above the density of standard schools in 2000 (col. 5,7), low share of services sector in 1980 and low density of standard schools in 2000 (col. 8), high share of services sector in 1980 and low density of standard schools in 2000 (col. 9), high share of services sector and high density of standard schools in 2000 (col. 10). The treatment is an indicator identifying individuals with access to a high density of schools in the municipality at age 15, defined as being above the sample median density of schools. The coefficient estimates are the equally-weighted average treatment on the treated (ATT) of post-treatment estimates from the dynamic TWFE event study model, DiD_{ATT}, which includes municipality and cohort fixed effects, and municipality-specific linear time trends. See Equation (1) and Section IV for details on the econometric specification. The outcomes are: an indicator for graduating from lower secondary education, years of education, the unconditional monthly adult income in pesos, the logarithmic transformation of hourly income, an indicator for participating in the labor market, and an indicator for participating in the services sector. Regressions use administrative school construction data from the Mexican Secretariat of Education for 1980–2000, and outcome data from the 10% subsample of the 2010 Mexican census from IPUMS. Data is aggregated into birth-year by municipality-of-residence cells, and standard errors are clustered at the municipal level. Statistical significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

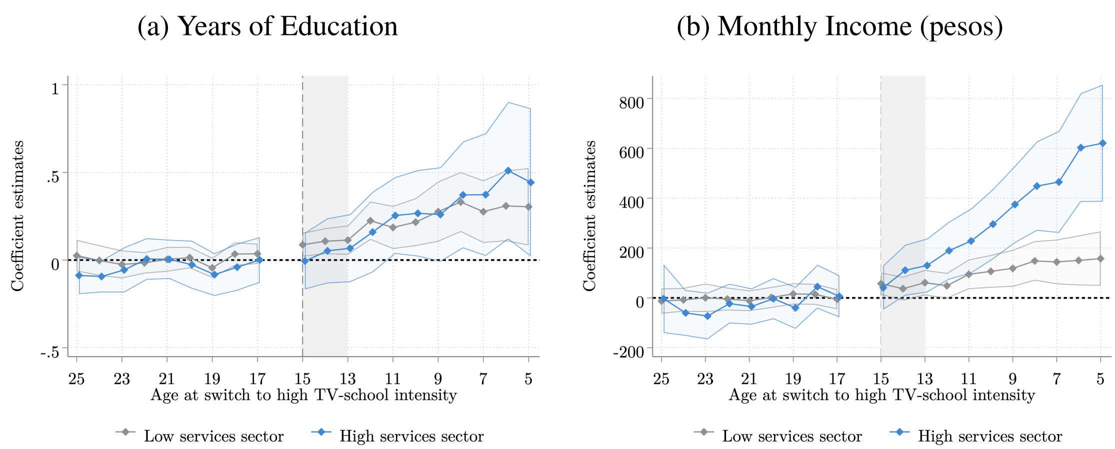
in the absence of TV-schools, some students may have enrolled in standard schools, while others might have forgone secondary education altogether.

To more formally investigate this potential source of impact heterogeneity, Table 2 examines the differential impacts of TV-schools based on the presence of standard schools in the municipality. We show results using a measure of standard schools at baseline (an indicator for the presence of at least one standard school in 1984) and a contemporaneous measure of standard school presence (an indicator variable for high-density of standard schools at the end of our sample period). Additionally, we examine the effects of TV-schools across different combinations of standard school presence and municipality types, where sample size permits.

Across municipalities with different characteristics, we find consistently significant impacts on lower secondary graduation rates and years of education. Consistent with Figure 4 evidence of partial substitution effect from standard schools, regions with a high density of standard schools exhibit slightly lower graduation rates following intense TV-school construction compared to regions with lower density of standard schools (Columns 4, 5, and 7). This pattern is further supported *within* high-services municipalities (Columns 9 and 10).

The impact on years of education is greater in high-services areas, with regions that have higher standard schools density seeing larger increases (0.44–0.48 years) than those with fewer standard schools (0.30–0.33 years). Overall, despite some potential student transfers from standard to TV-schools in certain areas, TV-school expansion led to largely comparable increases in lower secondary graduation rates across regions.

Figure 7: Event Studies of Impacts of Access to High TV-School Intensity on Outcomes by Sectoral Composition



Notes: This figure shows the effect estimates of access to high TV-schools density by age at the year of switch to a high TV-school intensity construction on years of education and unconditional monthly adult income in pesos. This is decomposed by the presence of services sector at baseline, defined as an indicator for whether the municipality had an above-median share of services sector jobs in 1980. The econometric specification is a dynamic TWFE event study model that includes municipality and cohort fixed effects, and municipality-specific linear time trends. See Equation (1) for details. Event study coefficient estimates are shown with a solid line, and 95% confidence intervals are shown with a shaded area. All effects are computed with respect to age 16. See Section IV for details. Data is from the Mexican Secretariat of Education (SEP) for 1980–2000, and the 2010 Mexican census (10% IPUMS subsample).

Labor Market Outcomes. We find consistently positive effects on labor income across areas, though the magnitude and statistical significance of these effects vary. The largest gains occur in more developed regions, where income increases by 403 pesos —a 17% increase from the average of 2,418 pesos. In more agricultural areas, income increases by 121 pesos, a 10% rise from an average of 1,250 pesos. The difference in impact between these regions is statistically significant at the 1% level. Regions with a high concentration of standard schools also see larger income gains, ranging from 475 to 544 pesos (21–22%), compared to areas with fewer standard schools, where increases range from 182 to 191 pesos (13%). These patterns likely reflect that areas with more standard schools also have other unobserved characteristics that contribute to stronger labor market impacts.[28]

Regarding changes in labor market composition, the probability of employment increases by 3 p.p.in municipalities with greater sectoral diversification but shows no significant change in areas with fewer service-sector jobs. In diversified regions, the share of individuals employed in the service sector also rises by 3 p.p. —an 11% increase. In contrast, we find no comparable shift in regions with limited baseline access to service jobs, raising questions about whether increased education alone is sufficient to drive labor reallocation in predominantly poor, agriculture-based areas.

Overall, the economic returns to lower secondary education appear to vary with the level of regional economic development. While not conclusive, the results suggest that a regions capacity to absorb post-primary skills may be a key determinant of the economic value of a secondary education. Importantly, we find no evidence of long-term negative effects from TV-school construction in areas where standard schooling options were already available. We interpret these findings as encouraging for the role of TV-schools in expanding educational access for children across diverse socioeconomic contexts.

VIII Conclusion

Improving access to public services for traditionally marginalized populations remains a critical concern for policymakers, especially in LMICs. In these settings, ICTs have emerged as a promising way to reach remote populations at scale by, by facilitating information dissemination, expanding service coverage, and reducing agency issues among public sector employees (Aker, 2017; World Bank, 2016; Jepsen and Rivkin, 2009). In education, the appeal of ICT lies not only in lowering the marginal costs of content delivery but also in reducing reliance on the availability and quality of labor inputs.

The challenge of attracting and retaining qualified teachers in rural and marginalized areas

[28]The estimates for hourly income are less precise and, using this outcome, we cannot rule out that there are no effects in more rural areas. The main hourly income gains appear in municipalities with a high-services prevalence and limited access to standard schools.

remains both significant and persistent, particularly at the post-primary level where subject specialization is often required. Those who do take up these positions are often less qualified and formally trained, with women particularly underrepresented in the teaching workforce (Evans and Acosta, 2023; Bobba et al., 2021; Elacqua et al., 2018). While many LMICs have attempted to address this through financial incentives, housing subsidies, and behavioral interventions (Pugatch and Schroeder, 2018; Castro and Esposito, 2022; Kamere et al., 2019; Ajzenman et al., 2022), these efforts have proven insufficient to close the gap in teacher availability and qualifications at current expenditure levels (Evans and Acosta, 2023).

This paper studies one of the largest and longest-running ICT-based education programs in the world: the expansion of television-based secondary schools in Mexico. This model reduced costs and addressed teacher shortages by delivering lessons via broadcast in classroom settings. Using a difference-in-differences design, we show that individuals exposed to high-intensity TV-school openings by age 16 completed 0.4 more years of schooling and gained significantly higher earnings as adults. Importantly, most students served by these schools would likely have remained out of school otherwise, and the returns to education from this model are comparable to those from traditional schools. Moreover, we find positive impacts across both rural, agrarian areas and more economically diversified regions, with the latter experiencing significantly larger earnings gains.

These findings provide rare long-term evidence on the effectiveness of a basic, low-tech form of technology-aided instruction. While recent attention has largely focused on the benefits of personalized, adaptive learning (e.g., Banerjee et al., 2007; Muralidharan et al., 2019), the Mexican TV-school model relies on a standardized, one-size-fits-all approach to lesson delivery. Its success underscores the potential of hybrid models that combine centralized, expert-led instruction with in-person classroom support, showing that even low-tech approaches can meaningfully improve lifetime earnings. As many countries, particularly in sub-Saharan Africa, continue to face large gaps in post-primary service provision, and others, especially in parts of Asia, move toward rural school closures due to high costs driven by declining population densities (Hannum and Wang, 2022), these types of ICT-based models may offer a viable solution for expanding or maintaining access to education in marginalized and remote communities.

As digital infrastructure continues to expand, these models could serve as a scalable foundation for more sophisticated, tech-enhanced approaches, making our estimates a potential lower bound for the potential of future ICT-based education. More broadly, the Mexican context opens new research directions on how governments can design and scale alternative service delivery models, the trade-offs they may face, and the long-term consequences of using different approaches to expand access to essential public services across diverse populations and settings.

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Online Appendix

Table of Contents

A Construction, Expansion and Evolution of the Telesecundarias

This section primarily draws from SEP (2010), unless otherwise noted.

A.1 Creation and Rollout Process

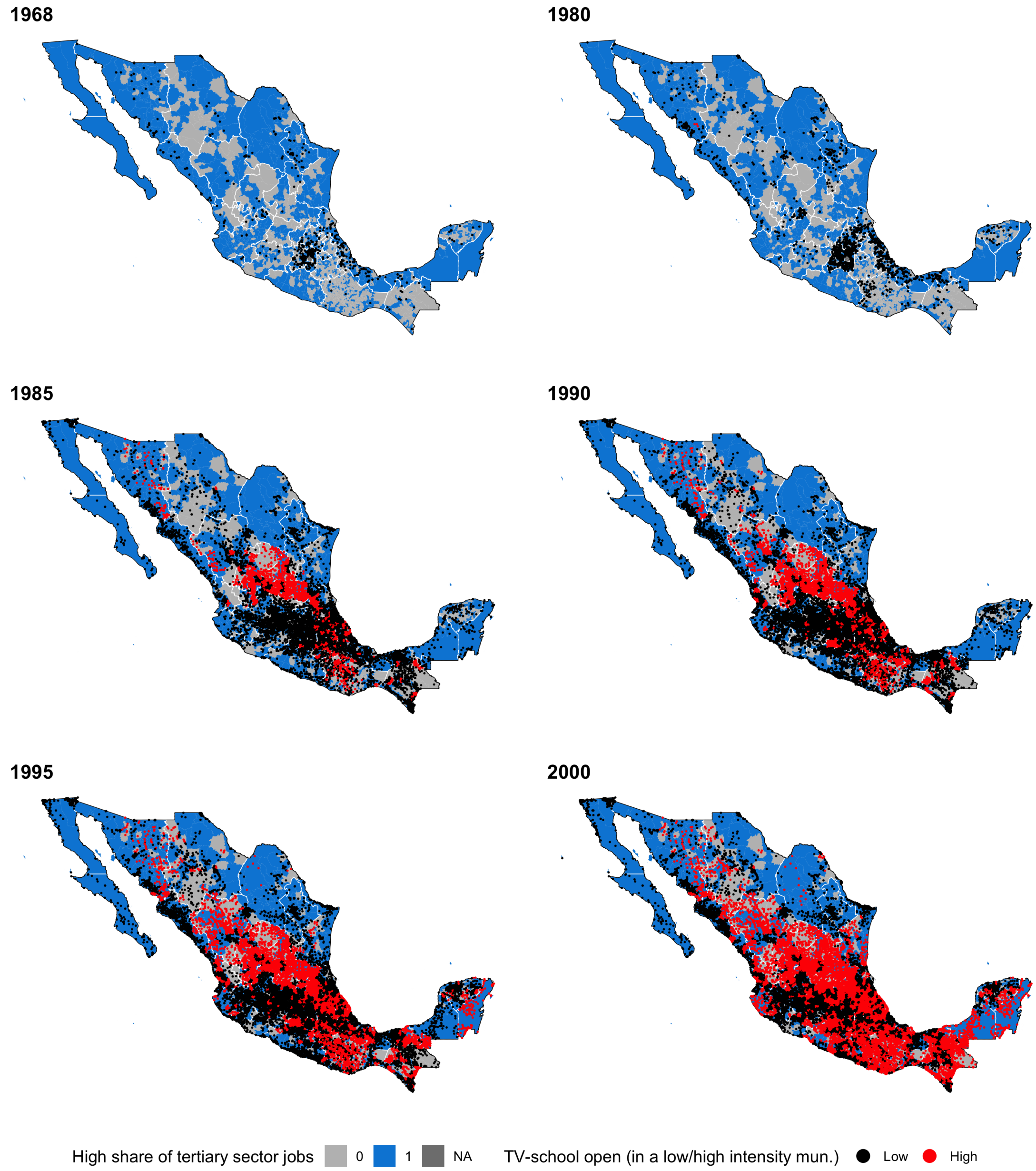
Before 1920, Mexico lacked a centralized education system, resulting in an illiteracy rate of 80%, with 85% of the population living in rural areas. By the 1940s, there were only approximately 212 secondary schools, increasing to 700 by the 1950s. However, only 32% of primary school graduates continued to secondary education.

In the 1960s, Mexico faced significant challenges in providing education for the growing number of primary school graduates seeking to continue their studies (Calderoni, 1998). For example, in 1965, 37% of sixth-grade graduates were unable to enroll in secondary school (Mayo et al., 1975). The rural distribution of the population made education access even more difficult. In 1970, 41% of Mexicans lived in small, remote communities of fewer than 2,500 inhabitants. Although this proportion decreased to about 21% by 2017, these communities continue to face challenges in receiving essential public services (OECD., 2019).

To address the shortage of qualified secondary school teachers in rural areas and following a successful pilot program in 1965, the Mexican government officially integrated *telesecundarias* into the national education system. On January 2, 1968, the Secretary of Public Education,formally incorporated TV-schools as a solution to the lack of resources–both human and financial–needed to build and staff conventional secondary schools in rural regions. Advances in communication technology further facilitated this innovative approach to secondary education.

Figure A1 shows how municipal TV-school density changed during the 1980–2000 period. In the early years (1968–1980), TV-schools were built in a few states and in small numbers. By 1985, however, they had spread across the country, with several municipalities reaching high densities of these schools. This expansion continued gradually, following a semi-uniform spatial pattern and reaching areas with different levels of baseline economic diversification. This gradual expansion can also be seen in Figure 1, which illustrates the annual construction of new TV-schools. The expansion of TV-schools and the criteria for their establishment varied over time and across states. We describe guidelines used to construct TV-schools during two different periods: Before

Figure A1: Expansion of TV-Schools (1968–2000)



Notes: The maps show the open TV-schools in each year, colored in red or black by whether their municipality is above or below the median TV-school density in a given year, conditional on having TV-school presence. TV-school density is defined as the number of schools per 50 children aged 11 to 14 in each municipality in 1980. Municipalities are also categorized by whether they have an above-median (blue) or below-median (gray) share of tertiary sector jobs in 1980. Geographical frontiers correspond to municipalities. Data comes from the school registry data from the Mexican Secretariat of Education (SEP).

1980, when TV-school construction was nationally centralized and, after 1980, when TV-school construction was decentralized to the states.

FIRST PERIOD: NATIONALLY CENTRALIZED (1968–1979). In the early years of TV-schools, the government centrally managed school allocation. During this first period (1968–1979), the initial states to receive TV-schools were Distrito Federal, Estado de México, Morelos, Oaxaca, Veracruz, Puebla, Hidalgo, and Tlaxcala. In 1968, communities were included in the program through an application process. That year, a nationwide call invited communities to apply for TV-school construction, aiming to involve as many as possible. However, the overwhelming number of applications—650 in total—surpassed the organizers' economic and logistical capacity, resulting in the approval of only 304 projects.

During this period, the government based school allocations on general and loosely defined criteria, such as *"geographical and urban conditions, economic, cultural, social, and hygienic factors"* (SEP, 1967). Below, we provide a translated copy of the full circular outlining the requirements for establishing TV-schools. The original Spanish version was extracted from Guerra López (1968):

CIRCULAR L-A

Section: *Office of Promotion and Organization of Boards of Trustees and Teleclassrooms*

SUBJECT: *Requirements for Boards of Trustees to Establish Teleclassrooms Mexico City, October 16, 1967*

This is to inform you that we have received your request notifying us of the establishment of a board of trustees to create a teleclassroom in your locality.

We remind you that it is essential to meet the following requirements:

- *A legally established board of trustees with its constitutive act.*
- *A facility for the teleclassroom, in good hygienic condition.*
- *A television receiver with an adequately sized screen.*
- *A list of enrolled students.*
- *Necessary furniture for the students.*
- *A desk and chair for the teacher.*
- *Curtains to darken the classroom during class broadcasts.*
- *A small bookshelf.*
- *A basic library of supplementary textbooks listed on page 13 of the instructional guide.*
- *Necessary tools for technology activity classes.*

NOTE: *It is important to verify that teleclass students possess a valid certificate of primary school completion and are able to purchase the study guides, priced at $24.00 per bimonthly volume.*

If the board of trustees agrees to comply with these requirements as outlined in the attached instructions, we kindly ask that you confirm by telegraph no later than October 30.

No applications confirmed after this date can be considered.

Upon receiving the telegram, the General Directorate of Audiovisual Education will conduct the necessary review to determine whether, within its capabilities and in coordination with the General Directorate of Secondary Education, a supervising teacher can be assigned to the teleclassroom, along with its administrative attachment to a nearby secondary school.

Sincerely,

Subdirector of Intra-School Affairs *Prof. Ricardo Mercado López.*

To ensure your Teleclassroom is fully registered with this Department, the following requirements must be fulfilled in your file:

1. *Supporting documents: Please send us the Constitutive Act of the Board of Trustees (when dealing with unestablished organizations).*
2. *Registration request: A formal registration request addressed to Mr. Lic. Álvaro Gálvez y Fuentes, General Director of Audiovisual Education.*
3. *Student list: A list of students, if they are already registered.*
4. *Furniture inventory: A detailed list of the furniture available in the Teleclassroom.*
5. *Confirmation of compliance: Indicate whether you agree with the requirements regarding the Boards of Trustees outlined in Circular L-A.*

1980 Onwards: State-Led Expansion. Beginning in 1980, the decentralization of education, required state governments to assume responsibility for the operation and management of TV-schools. A significant expansion followed in the 1981–1982 academic year, with enrollment increasing by over 30%. This growth was driven by agreements between the SEP and several states, including Aguascalientes, Chiapas, Chihuahua, Durango, Guanajuato, Guerrero, Michoacán, Nayarit, Quintana Roo, Sonora, Tabasco, Estado de México, Puebla, Tlaxcala, and San Luis Potosí. In 1981 alone, the number of TV-schools grew dramatically from 694 to 3,279 (Martinez Rizo, 2005).

To regulate and support this expansion, the Telesecundaria Unit was established. Its primary functions included standardizing school operations, assisting state governments in the expansion process, and providing printed and audiovisual materials while improving their quality. Meanwhile, the responsibility for school construction, equipment procurement, and school administration was delegated to SEP branches within each state.

The decentralization of TV-school construction led to considerable variation in criteria and requirements across states, as initially, no standardized national guidelines were in place. While there was no official documentation, anecdotal evidence suggests that the factors influencing school construction varied significantly by community. In some states, TV-schools addressed the lack of any secondary education options in underserved areas, despite facing technical and administrative challenges. In other regions, TV-schools aimed to stimulate economic and social development.

In 1986, the SEP developed a project to identify communities needing new or expanded schools, including TV-schools. The selection process had several stages. First, desk research (*trabajo de gabinete*) used maps, census data, enrollment forecasts, and community requests to identify underserved areas. Officials defined school influence areas,the geographic region served by a given school, based on accessibility. Standard schools were expected to be within 7 km on paved roads or 4.5 km on dirt roads, while TV-schools had stricter limits of 5 km and 1.5 km, respectively.

Fieldwork then verified feasibility, considering factors such as the presence of a primary school, the number of 6th-grade graduates, and how the new school would fit within existing services. Officials also evaluated land availability, electricity access, local economic activities to determine necessary vocational workshops, and geographical barriers that might prevent students from reaching nearby schools. Final recommendations were compiled into a state-level documents for further review.

Although SEP provided official guidelines, implementation varied across states. According to officials involved at the time, adherence to these rules was inconsistent. Even when recommendations followed the guidelines, approval was not guaranteed, as funding availability ultimately determined which schools were built.

A.2 Characteristics of Locations with TV-Schools

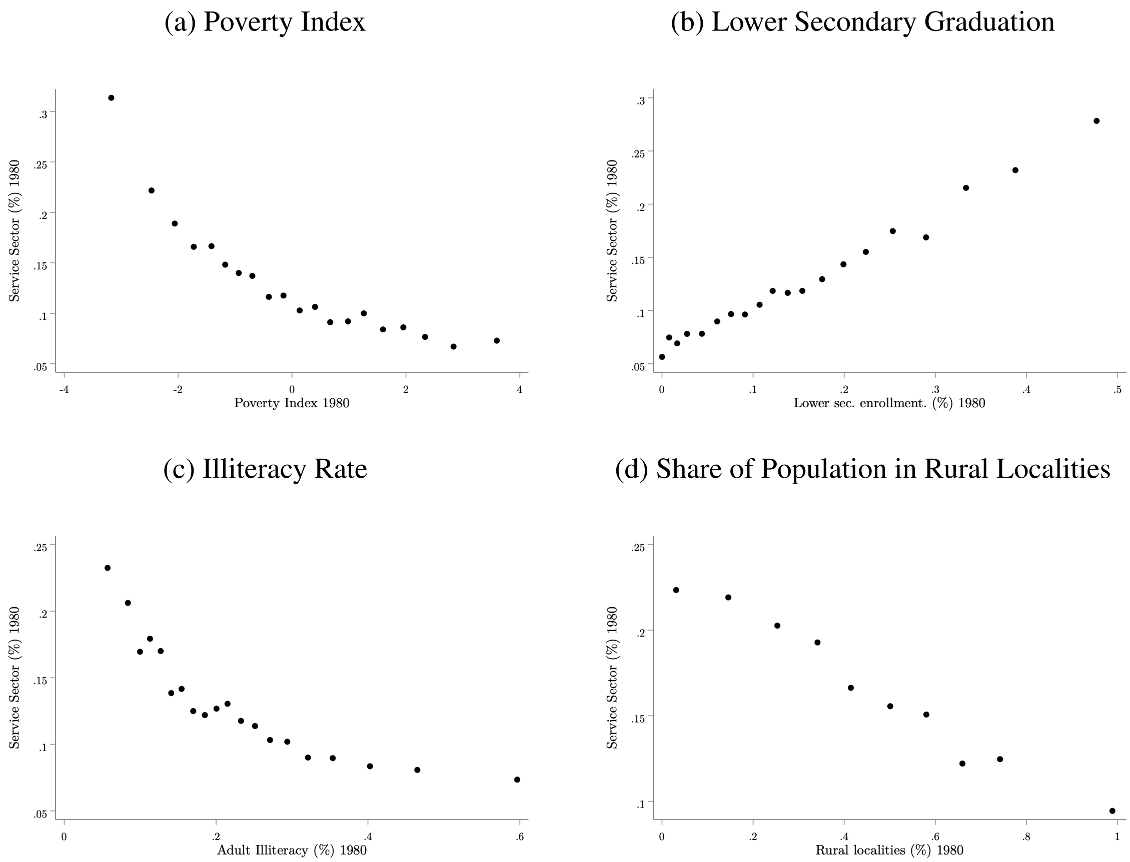
Although TV-schools primarily served rural areas, they were not limited to these locations.[29] Figure 1 illustrates that, during our period of interest, over 70% of the most rural and economically underserved municipalities experienced high-density TV-school construction. However, significant construction also occurred in municipalities in the 4th and 5th quintiles of tertiary sector presence, with approximately 40% and 20% of these municipalities experiencing notable TV-school growth, respectively. An example of this pattern, was evident in the State of Mexico, where most TV-schools were established in rural communities (85%) but also in urban-marginal areas (15%).

In our main analysis, we use tertiary sector presence in 1980 as the primary measure of a municipality's economic development at baseline. This variable is highly correlated with multiple indicators of rural poverty, including the poverty index, lower secondary graduation rates, illiteracy rates, and the proportion of the population living in rural localities (fewer than 2,500 residents). Figure A2 illustrates the strong correlations among these variables. Using a measure for rurality or poverty instead of tertiary sector presence in Figure 1, leaves the figure largely unchanged. We focus on tertiary sector presence to maintain consistency with the results presented in Section VII,

[29] As noted in SEP (2010, page 41): *"Schools in rural conditions were located in hard-to-reach areas, considered remote places inhabited by low-income families, whereas those in urban-marginal areas were set up in highly populated municipalities that lacked full public services."*

where this variable better reflects the diversification of local labor markets.

Figure A2: Correlation between Share of Workers in the Tertiary Sector and Municipal Characteristics in 1980



Notes: The figures above show binscatter plots of the relationship between the share of the adult population working in the service sector in a given municipality and (a) the poverty index of that municipality (constructed using a primary component analysis including the share of illiterate people and people with incomplete primary over the age of 15, the share of households without piped water, with dirt floors, without electricity, and the share of the working population with income of up to 2 minimum salaries), (b) lower secondary school graduation, (c) the adult illiteracy rate, and (d) the share of the municipal population living in rural localities, defined as those with less than 2,500 people. All data is from the 1980 census (IPUMS subsample).

Table A1 shows associations between municipal characteristics in 1980 and an indicator for experiencing high-intensity of TV-school construction between 1980 and 2000 (Columns 1 to 4). Municipalities with high TV-school density tended to have higher poverty levels, lower secondary school enrollment, and greater share of small localities with fewer than 2,500 habitants.

Over time, from 1980 to 2000, the program gradually shifted from highly rural areas to poorer municipalities, even if they were less rural. This trend is shown in Table A1, columns 5 to 8, which examine the relationship between different socioeconomic indicators and the year a municipality saw a high intensity of TV-school construction. The results indicate that, among municipalities that eventually received a high number of TV-schools, those with later adoption tended to have higher poverty indices, but less proportion of localities with less than 2,500 habitants.

Table A1: Correlates of High-Intensity TV-School Openings and Timing

	High TV-School intensity				High TV-School Intensity Switch Year			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Poverty Index	0.137***	0.117***	0.058***	0.036***	0.538***	0.616***	0.783***	0.473***
	(0.005)	(0.007)	(0.010)	(0.010)	(0.113)	(0.121)	(0.181)	(0.175)
Tertiary sector (share)		-0.693***	-0.004	-0.239		4.327	0.134	3.703
		(0.140)	(0.151)	(0.160)		(2.874)	(3.203)	(2.823)
Primary enrollment			0.183*	0.055			-6.663***	-3.977**
			(0.096)	(0.092)			(1.665)	(1.790)
Lower sec. enrollment			-0.635***	-0.876***			5.919*	6.594**
			(0.126)	(0.131)			(3.119)	(2.753)
Rural locality (share)			0.407***	0.434***			-4.713***	-2.482**
			(0.040)	(0.041)			(1.045)	(1.076)
Log(total population)				0.037***				0.425*
				(0.010)				(0.221)
State FE	No	No	No	Yes	No	No	No	Yes
R^2	0.24	0.25	0.30	0.43	0.03	0.03	0.09	0.30
Observations	2109	2109	2109	2064	850	850	850	850

Notes: This table presents associations between the characteristics of municipalities in 1980 and a high-intensity TV-school indicator (columns 1 to 4). Columns 1 to 4 regress an indicator variable denoting a high intensity of TV-school openings in the 1980-2000 period on 1980 municipal characteristics, a poverty index, the share of rural localities, primary school enrollment, tertiary sector prevalence and lower secondary school enrollment. Columns 5 to 8 restrict the sample to municipalities with high-intensity construction during this period and regress the switching year to high-intensity on those same characteristics. Standard errors in parenthesis. ***p<0.01, **p<0.05, *p<0.10.

Given these correlations, it is not surprising that TV-school students generally come from lower-income backgrounds compared to those in standard secondary schools. In 2016–2017, only 37% of TV-school students had mothers with at least a secondary education, and nearly 60% received support from the (now defunct) Prospera/Oportunidades conditional cash transfer (CCT) program. In contrast, among students in standard secondary schools, these figures were 63% and 23%, respectively (INEE, 2017). Further evidence on the socioeconomic conditions of TV-school students comes from a national survey conducted in the 2002–2003 academic year. The survey found that 59% of students traveled on dirt roads to reach school. Travel times varied: 49% of students took 30 minutes or less, 28% took an hour, 15% spent two hours, and 10% needed up to three hours. Most students used buses, minibuses, or bicycles, while 35% walked to school.

A.3 Evolution of the TV-schools: Model and Infrastructure

In its early years, TV-schools were administratively managed by nearby standard schools, which handled report cards, certifications, and grading (Martínez, 2014). At this stage, citizen participation played a key role in establishing these schools. Communities, both rural and urban, took the initiative to set up learning spaces despite financial and material challenges. Classes were often held in donated makeshift locations such as sacristies, back rooms, union halls, and even bedrooms–any space equipped with the bare essentials to conduct teleclasses.

In 1970, educational authorities started to introduce guidelines to standardize TV-schools, seeking to ensure that the material conditions were similar across regions. The Administrative Committee of the Federal School Construction Program developed a prototype classroom and provided communities with building plans, technical guidance, or direct construction assistance.

After 1980, the efforts of the Telesecundaria Unit focused on improving the curriculum design and providing educational materials, addressing the concern of insufficient support materials and their quality. Study Guides were introduced, aligning them with the school calendar. Published monthly, they helped students prepare for upcoming lessons, promoting self-learning and reducing dependence on televised instruction as the sole source of knowledge. These guides contained objectives, summaries, activities, and assessments and served as the foundation for creating the TV lessons.

In parallel, the production of teleclasses also significantly improved when the Directorate of Educational Television (DTE) revamped the storage system for recorded lessons and restructured their production process. The Telesecundaria Unit sent study guides to the DTE, which assigned a team of specialists to adapt the pedagogical content to the televisions specific resources. Scripts were created with the target audience in mind, making the most of the visual languages flexibility. Preproduction meetings focused on selecting the best audiovisual resources for effective teaching, followed by the production and editing phase handled by professional TV producers.

Once completed, the programs were broadcast to TV-schools. Daily programming featured 18 lessons aired Monday through Friday (totaling 3,420 classes annually). Each lesson lasted 17 minutes and was broadcast hourly from 8:00 AM to 2:00 PM. A break from 11:24 AM to 12:00 PM featured *Telesecundaria News*, fostering communication between telesecundaris nationwide, as well as vocational guidance and educational support programs.

Between 1968 and 2000, the technological infrastructure for TV-based education improved significantly. In 1968, broadcasts started on Channel 5, with a repeater station in Veracruz on Channel 6. By the 1970s, coverage expanded through agreements with *Televisión Cultural de México* and the installation of 45 repeater stations, reaching more communities.

A major breakthrough came with the launch of the Edusat satellite network. Test broadcasts began in September 1994, and by December 1995, Edusat was officially inaugurated. Efforts focused on distributing satellite dishes and training rural schools in their use. In areas with weak signals or no satellite dishes, 305 schools received ground stations, later expanded to 339 more. Relay stations further extended coverage to 82 additional schools. Before Edusat, telesecundaria relied on conventional TV signals which posed reception problems, especially in very remote communities. The satellite network significantly improved access. In 1997 alone, nearly 800 units, including many television sets, were distributed.

Despite significant improvements, there was still considerable variation in the quality and adequacy of infrastructure. A 2000 study on telesecundarias in rural areas revealed several issues, such as a lack of satellite dishes, libraries, and laboratories in some schools. Many schools had only one teacher covering multiple grades, and in nearly all the schools studied, the principal also taught a class. Additionally, schools were rarely visited by supervisors, and there was high teacher turnover, which disrupted project continuity. Similarly, a national survey for the 2002-2003 school year found that 33% of schools lacked potable water, 28% had no drainage systems, and 10% had no electricity.

A.4 Anecdotal Evidence on the Creation of TV-schools in Puebla

Below, we present translated excerpts from a paper that reviews government actions related to TV-schools in the state of Puebla from 1981 to 1987 (Muñoz Nava, 2015). This is the only detailed account we found of the TV-schools creation process, including the explicit educational goals formulated and promoted by state authorities, as well as an explanation of the plans and early implementation. The paragraphs describe that, although there was a lot of excitement and local leaders proposed opening many TV-schools, the project faced delays and challenges. These included problems with meeting infrastructure requirements, slow construction, and a lack of resources. Despite the government's plans to build hundreds of TV-schools, only a small number were completed on time, and many were not fully ready when schools opened. The plan also struggled because it was based on federal guidelines without taking into account the specific needs of local communities, making it harder to address the region's unique challenges.

> "[In 1980], the locations for the construction of (the telesecundaria) schools would be determined by each municipal president, based on the sovereignty of the local governments. There was talk of an average investment of 200 million pesos, which included the cost of building classrooms, equipment, and furniture. The euphoria for the opening quickly spread to the municipalities, as some, like Ciudad Serdán, announced–contrary to the governor's proposal–the installation of 48 telesecundarias in different communities, and even had some land donated by private individuals for this purpose." *(page 13)*
>
> "On April 8, 1980, a reception was held for the supposed promoter of the project on a national scale, the director of RTC and sister of the president, Margarita López Portillo, who was named "Benefactor of Puebla"; during the event, the construction of 500 telesecundarias was announced, with a total of 1,500 classrooms, each equipped with a laboratory, sports field, and civic plaza. Additionally, in Capulac (Amozoc), the first teleclassroom was inaugurated. In that same month, construction work would begin in other municipalities, and the hiring of 1,500 teachers would also be announced. The shift to the concrete operation of the program required some modifications to the original proposal; for example, initially, two schools per municipality were discussed, but in April it was announced that (...) 72 schools would be built across 29 municipalities. This is understandable if we consider the requirements set for the communities: a 1,500 m^2 plot with water, electricity, drainage, and easy access. Many communities did not meet these conditions, so the two schools per municipality criterion was not applied." *(page 14)*
>
> "On the other hand, the construction of the telesecundarias did not keep pace with the rhetoric, as the first block of classrooms, for 72 communities, began in early May in the Tepeaca region. By mid-June 1981, only 145 of the 500 were being built, and by the end of that month, the construction of another 200 would begin, meaning not all the promised classrooms would be ready in time. In fact, by September of that year, when school activities began, only 300 teleclassrooms were available; the rest had to be temporarily adapted. In other words, only one-fifth of those announced. Even in October, in some communities, the land for the teleclassroom was still being expropriated. (...) The technical aspect, which was very important for the functioning of this type of education, was not overlooked. In April 1981, an agreement was signed to install six repeaters that would receive the signal via satellite, and in June 1982, the SEP reported, after signing an agreement with the U.S. government, that the "Intersat IV" satellite would be used to transmit across the entire country. On the other hand, the construction of the teleclassrooms faced several issues. In 1983, some of these problems surfaced. First, it was revealed to the leader of the League of Agrarian Communities that many telesecundarias had not been completed, some of which had been under construction for more than two years, in the Tepeaca and Tecamachalco areas. These were under the responsibility of the SAHOP of the state, and according to the complainants, nothing had been done in the last six months. Another complaint came from the municipal presidents, who were having 5% of their financial contributions withheld by the Ministry of Finance, to be applied to the completion of the schools." *(page 15)*
>
> "In the telesecundaria, the attempt to offer services in each municipality of the state was unsuccessful, so the rural communities with better infrastructure were the ones that benefited. However, some municipal capitals were able to have this service for the first time, which allowed for more access opportunities for primary school graduates. This is significant if we consider that, by mid-1984, 137 municipalities in the state (63%) did not have secondary education institutions." *(page 25)*
>
> "One more of the conclusions we can reach is the difficulty faced in the state educational sphere in developing educational plans, since the proposals are always taken from federal plans, without considering the diagnoses made or the specific problems of the entity. Such a situation has as one of its possible ex-

planations the fact that developing different projects, with specific objectives for the particular problems of the state, requires different behaviors on several levels, both organizational and political." *(page 30)*

A.5 Television Use in Education Around the World

Though rarely studied, television has been used as a medium of instruction in various contexts, including both high- and low-income countries. During the 1950s and 1960s, France, Great Britain, Portugal, Italy, and Romania experimented with television-based schools (Unwin and McAleese, 1988; Barros, 2012; Paulu, 1967). In Italy, *Telescuolas* began operating in 1954 and were designed to supplement public school education and expand learning in subjects typically included in the curriculum. The teaching staff was selected from Italian school teachers, who alternated their time between the program and their work in public schools. The programs were broadcast and received at locations set up in hard-to-reach areas. After several studies on the role of educational television in various countries, the Mexican government selected the Italian Telescuola model as the reference for the design of the *telesecundaria* (Martínez, 2014).

Dozens of low- and middle-income countries have also used televisions in education (Calixto Flores and Rebollar Albarrán, 2008; The World Bank, 2005). Televised lessons have been introduced with varying degrees of implementation success in Ivory Coast, Brazil, Ethiopia, El Salvador, Botswana, South Africa, Colombia, America Samoa, and Ghana (Assefa, 2016; Johnston and Ksoll, 2017).In the 1970s, Ivory Coast rolled out televised-based instruction in all primary classrooms in the country. The program faced implementation problems and teacher opposition and was later canceled (Koné and Jenkins, 1990). In El Salvador, television sets were installed in over 80% of all secondary schools in 1971, and in the 1960s, the entire American Samoa education system relied on television (Young et al., 2010). Later, these systems were abandoned. India has also experimented with various forms of television-based distance education since the 1960s (Rani, 2006) and in the early 2000s, over 700,000 students were enrolled in one or more of Brazil's *telecursos*, which were broadcast via television and operated by non-governmental organizations (Larach, 2001). In 2011, Botswana launched an educational television component to complement classroom teaching at the secondary level (Ramojela, 2016), and South Africa has provided at least 1,600 schools with educational television programming (Burns et al., 2019).

Especially relevant for this context, *telesecundaria* not only expanded within Mexico but also beyond its borders. The mexican broadcasting signal reached nearly the entire American continent. The Mexican SEP and the Commission for Cooperation with Central America from the Ministry of Foreign Affairs established an Educational Cooperation Agreement for Distance Education. This agreement offered TV channels, textbooks, and training to implement the TV-school educational model in Central America. Countries requesting it received the model and materials for free, to adapt and operate locally. The education ministries of Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, and Panama signed the agreement. In 1997, courses began in four of these countries. To support this, textbooks were shared, diagnostic evaluation meetings were held, and teachers from these countries visited TV-schools in Mexico. This led to the creation of the Telesecundaria in Costa Rica and Guatemala, Teleaprendizaje in El Salvador, and Telebásica in Panama and Honduras. By the year 2000, the system reached nearly 17,000 students in about 500 schools (SEP, 2010). Classes via television have also been available during teacher strikes, and as an option for displaced and refugee populations. [30]

More recently, worldwide school closures due to the COVID-19 pandemic have dramatically increased the need to use ICT to deliver educational content, and over 60 countries offered at-home remote educational options via television (World Bank, 2020; Barron Rodriguez et al., 2021).

[30] See for instance: https://aristeguinoticias.com/2208/mexico/ante-huelga-de-maestros-la-television-educara-a-los-ninos-de-oaxaca/ and https://theirworld.org/news/world-refugee-day-tv-show-teaches-arab-children-who-are-out-of-school.

B Details on the High TV-School Intensity Treatment, $AboveTS_{mc}$

This section provides additional descriptive evidence to help better understand what it means for a municipality to have a high TV-school intensity, $AboveTS_{mc} \equiv 1[TS_{mc}$ above median]. Over the period from 1980 to 2000, in areas where TV-schools were introduced, the median density was one TV-school per 369 eligible children (ages 12 to 14). For cohorts in municipalities classified as having high TV-school intensity, the average TV-school availability was 3.5 times higher than in lower-intensity municipalities. Specifically, in high-intensity areas, there was one TV-school per 136 children, compared to one per 471 children in lower-intensity areas.

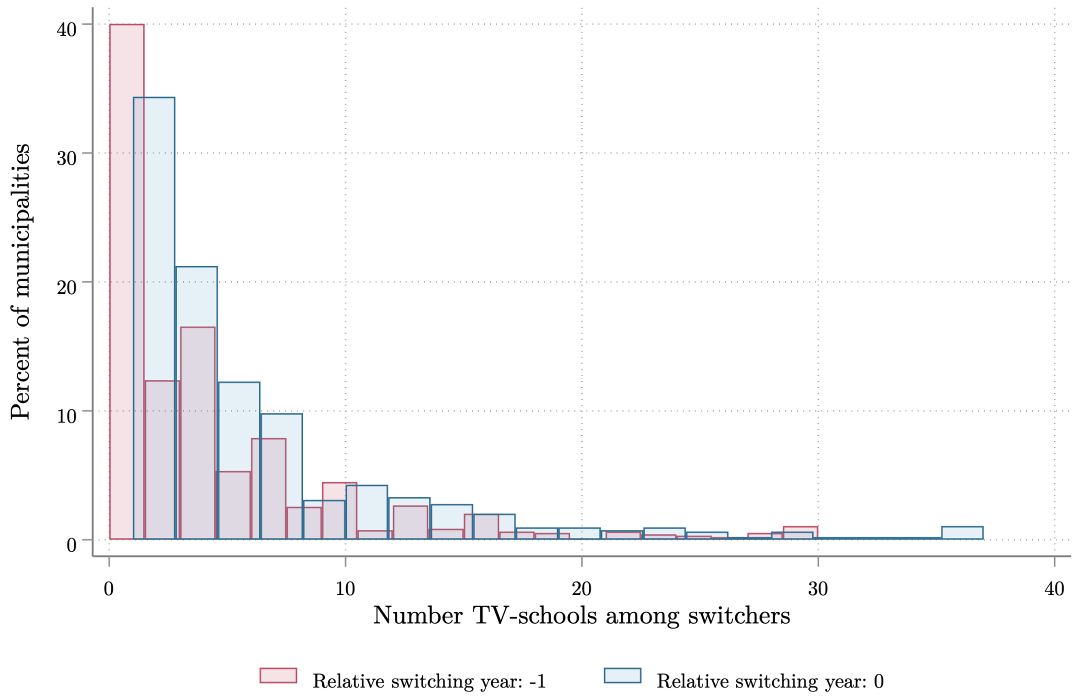
A potential concern with this binary classification of TV-school intensity is that some municipalities may have already had many TV-schools, and a single new school could have arbitrarily shifted them into the "high TV-school intensity" category. However, the evidence below suggests otherwise. Most of the variation in switching comes from a discrete increase in TV-schools at the time of transition. Specifically, municipalities that previously had no or very few TV-schools typically saw one or two new schools being built, rather than already high-density municipalities merely adding another school.

Figure B1a presents a histogram showing the number of TV-schools in municipalities before and after they transitioned to high TV-school intensity. The data indicate a significant shift in the distribution of the number of TV-schools precisely at the moment of transition ($\tau = -1$ to $\tau = 0$). Figure B1b further confirms that the most notable change in TV-school distribution occurs at the time of the switch. While additional schools continue to be built in later years, there is no subsequent drastic shift in distribution.

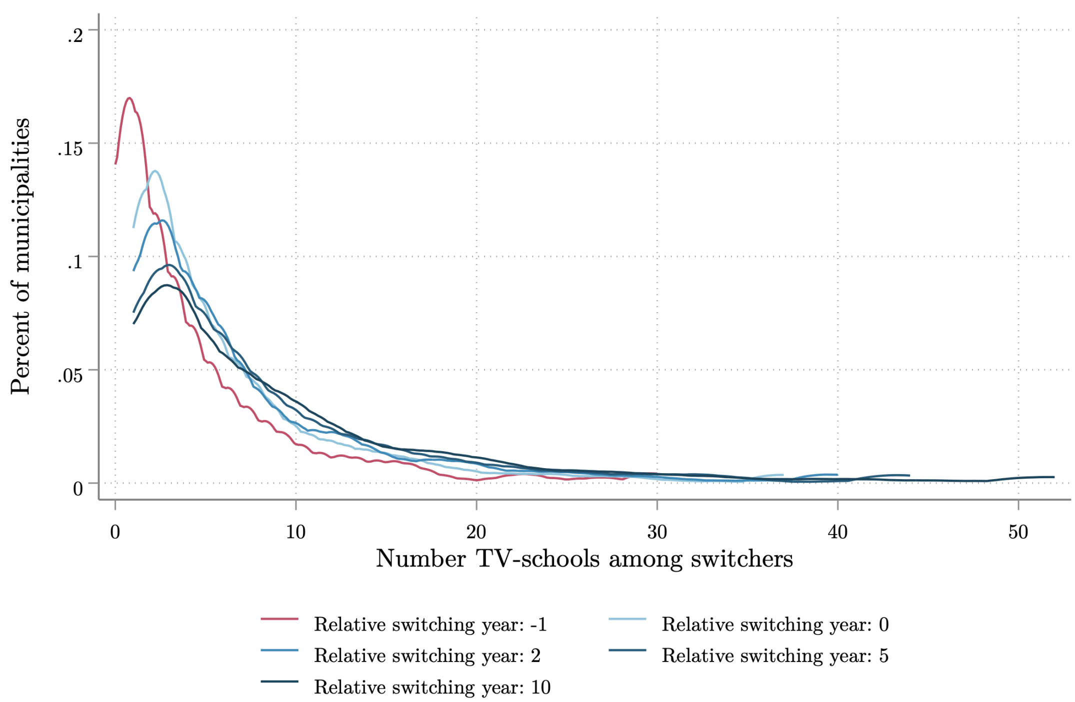
Nearly half (48%) of municipalities experience at least a doubling in the number of existing TV-schools during the transition year to high TV-school intensity, while only 15% see an increase o less than 20% in the number of schools constructed. This transition is primarily driven by municipalities that previously had few or no TV-schools. In fact, almost 70% of all switching municipalities had at most four TV-schools in the year before the transition, with 24% having none and 16% having just one.

Figure B1: Distribution of Schools by Year Relative to Switch Year

(a) Distribution of Number of TV-Schools at $\tau = -1, 0$



(b) Distribution of Number of TV-Schools over Time



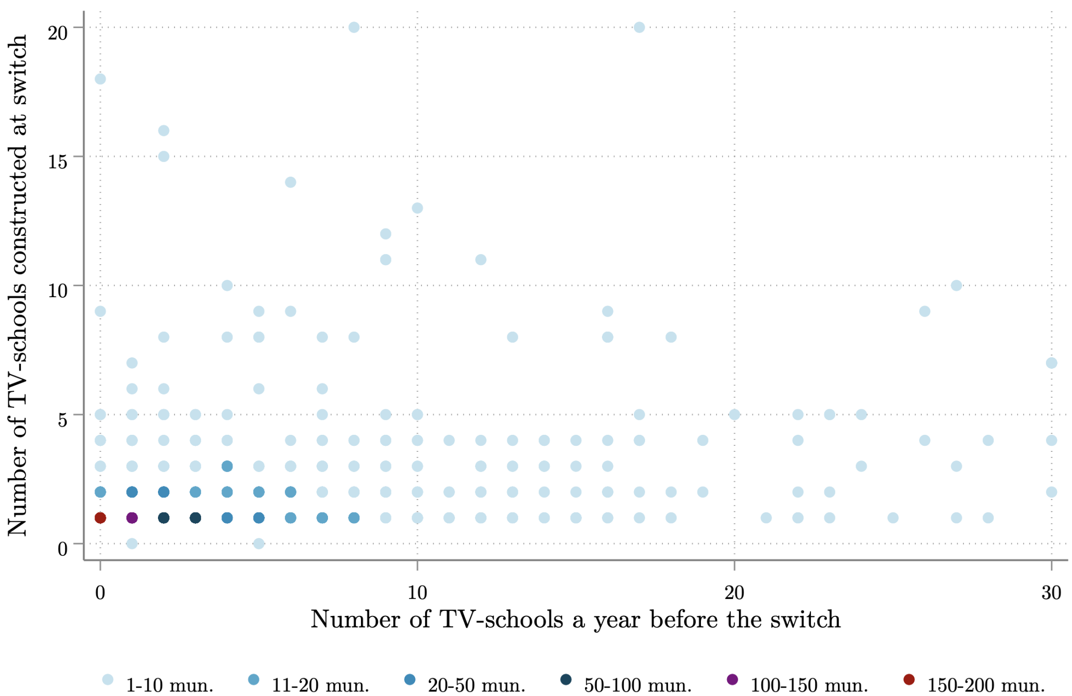
Notes: Figure (a) shows a histogram of the distribution of the number of TV-schools the year before the switch ($\tau = -1$) and the distribution of the number of TV-schools the year after the switch ($\tau = 0$) among municipalities that eventually switched to having a high intensity of TV-schools. Figure (b) shows a kernel density plot of the distributions of the number of schools at different years relative to the switch year, $\tau \in \{-1, 0, 2, 5, 10\}$. Data comes from the school registry data from the Mexican Secretariat of Education (SEP).

Figure B2 visually shows the relationship between the number of TV-schools in a municipality one year before it transitions to high TV-school intensity (relative time -1) and the number of TV-schools added in the transition year (relative time 0). Specifically, 193 (20%) municipalities transitioned from having no TV-schools to having one, and only 32 municipalities transitioned from having none to more than one. Additionally, 109 (12%) municipalities moved from having one school to two, while 72 (8%) municipalities moved from having two to three. Beyond these cases, the number of municipalities transitioning with different baseline and growth patterns declines sharply.

Overall, these findings indicate that most municipalities experiencing a switch to high TV-school intensity started with little to no TV-school presence. The transition was driven primarily by the construction of a small number of new schools, rather than marginal increases in already high-density areas.

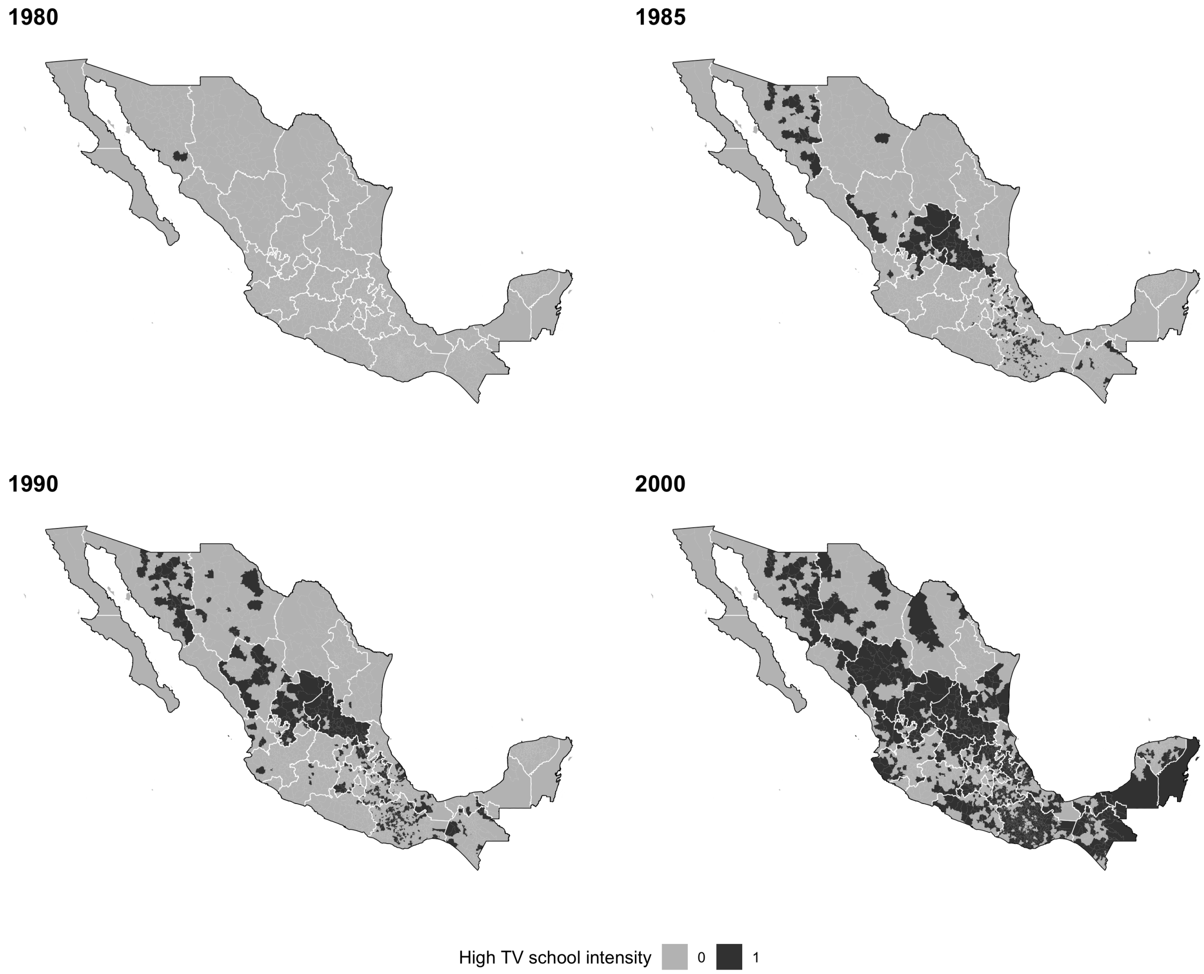
Lastly, Figure B3 illustrates the spatial and temporal evolution of TV-school expansion. The municipalities that transitioned to high TV-school intensity are shown in darker colors, with changes occurring every five years. This figure highlights that TV-school rollouts were gradual and widespread across the country. Additionally, municipalities that switched to high TV-school intensity were distributed across different states and time periods, rather than being concentrated in specific regions.

Figure B2: Number of TV-Schools Pre-Switch and School Growth at the Year of Switch



Notes: This scatterplot shows the relationship between the number of TV-schools a year before transitioning to a high TV-school intensity ($\tau = -1$) with the number of TV-schools being built after the transition, at $\tau = 0$. The shade of the dot indicates the number of municipalities in each point of the grid. Data comes from the school registry data from the Mexican Secretariat of Education (SEP).

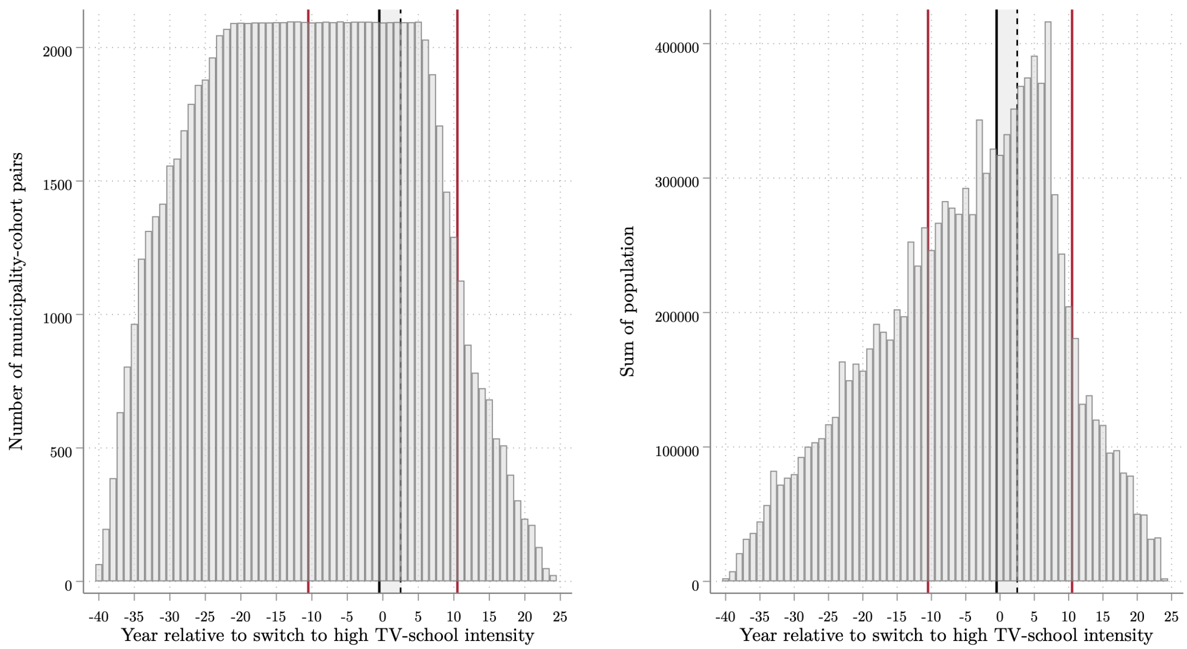
Figure B3: Switchers to High TV-school Intensity (1980–2000)



Notes: The maps show the spatial and temporal identifying variation used in the empirical strategy. It highlights the municipalities that switch to having a high TV-school intensity during the 1980-2000 period. Data comes from the school registry data from the Mexican Secretariat of Education (SEP).

C Supporting Descriptive Tables and Figures

Figure C1: Distribution of Sample Population Weights



Notes: This graph shows the distribution of the population weights by cohort relative to the switch year to high TV-school intensity. The left graph plots the number of municipality-cohort pairs at each relative year. The right graph plots the sum of the weighted average population at each relative year. The red lines indicate the relative year periods in the analysis. Data comes from the 2010 Mexican census (10% IPUMS subsample).

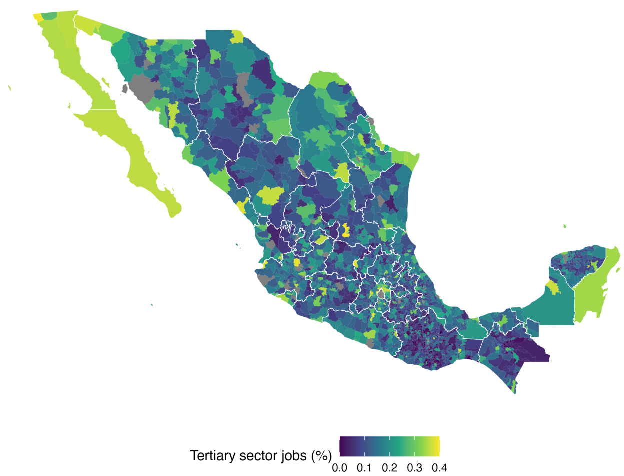
Table C1: Summary Statistics

	Full Sample	Treatment Status		Sectoral Composition		Standard School Density	
		Switchers	Non-Switchers	Agricultural	Services	Low Density	High Density
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Population Characteristics							
Female	0.52	0.53	0.52	0.53	0.52	0.53	0.52
	(0.06)	(0.07)	(0.06)	(0.08)	(0.06)	(0.07)	(0.06)
Age	32.25	32.55	32.16	32.43	32.22	33.02	31.96
	(7.70)	(8.88)	(7.28)	(8.61)	(7.51)	(8.63)	(7.30)
Years of Education	9.22	7.46	9.79	6.79	9.71	7.42	9.89
	(2.04)	(1.96)	(1.72)	(1.90)	(1.69)	(1.95)	(1.63)
Primary Graduation	0.85	0.74	0.89	0.69	0.89	0.74	0.90
	(0.15)	(0.19)	(0.11)	(0.20)	(0.11)	(0.19)	(0.11)
Lower Sec. Graduation	0.64	0.47	0.70	0.40	0.69	0.46	0.71
	(0.21)	(0.22)	(0.18)	(0.21)	(0.17)	(0.22)	(0.16)
Higher Sec. Graduation	0.33	0.19	0.37	0.15	0.37	0.19	0.38
	(0.17)	(0.14)	(0.15)	(0.12)	(0.15)	(0.13)	(0.15)
Labor Market Participation	0.66	0.57	0.69	0.56	0.68	0.58	0.69
	(0.11)	(0.11)	(0.10)	(0.11)	(0.10)	(0.11)	(0.10)
Earns Positive Income	0.56	0.43	0.61	0.39	0.60	0.45	0.61
	(0.15)	(0.16)	(0.12)	(0.16)	(0.13)	(0.16)	(0.13)
Monthly Income	3,091.38	1,736.57	3,530.03	1,451.23	3,422.63	1,842.32	3,558.41
	(1,603.50)	(982.03)	(1,518.16)	(915.30)	(1,506.09)	(1,036.14)	(1,526.37)
Hourly Income (log)	2.75	2.26	2.91	2.09	2.88	2.31	2.91
	(0.57)	(0.57)	(0.46)	(0.59)	(0.46)	(0.57)	(0.47)
Agricultural Sector	0.09	0.19	0.06	0.23	0.07	0.19	0.06
	(0.11)	(0.12)	(0.08)	(0.13)	(0.08)	(0.12)	(0.08)
Manufacturing Sector	0.16	0.12	0.18	0.12	0.17	0.13	0.18
	(0.08)	(0.08)	(0.08)	(0.09)	(0.08)	(0.09)	(0.08)
Services Sector	0.37	0.23	0.41	0.18	0.40	0.23	0.41
	(0.15)	(0.13)	(0.13)	(0.11)	(0.13)	(0.12)	(0.13)
Formal Health Insurance	0.41	0.21	0.47	0.16	0.46	0.22	0.48
	(0.22)	(0.15)	(0.19)	(0.14)	(0.19)	(0.16)	(0.19)
Panel B: Municipality Regional Characteristics							
Density of TV-schools	0.13	0.31	0.07	0.28	0.10	0.24	0.09
	(0.15)	(0.18)	(0.06)	(0.20)	(0.11)	(0.18)	(0.11)
Density of standard schools	0.15	0.12	0.16	0.09	0.16	0.05	0.18
	(0.10)	(0.12)	(0.09)	(0.10)	(0.10)	(0.04)	(0.10)
Rural area (1980 census)	0.38	0.97	0.19	0.91	0.27	0.76	0.23
	(0.55)	(0.50)	(0.42)	(0.43)	(0.51)	(0.50)	(0.50)
Rural area (1990 census)	0.27	0.77	0.11	0.81	0.16	0.64	0.13
	(0.44)	(0.42)	(0.31)	(0.39)	(0.36)	(0.48)	(0.34)
Lower sec. enroll. (1980 census)	0.29	0.14	0.33	0.10	0.32	0.16	0.33
	(0.14)	(0.09)	(0.12)	(0.07)	(0.12)	(0.10)	(0.12)
Poverty Index (1980 census)	-1.64	0.38	-2.30	0.74	-2.13	0.01	-2.27
	(1.79)	(1.47)	(1.34)	(1.50)	(1.42)	(1.63)	(1.42)
Municipality-cohort Count	54,450	30,091	24,359	28,406	26,044	39,205	15,245
Municipalities Count	2,325	1,164	1,161	1,156	1,169	1,614	711

Notes: This table reports the summary statistics for the population variables used in the analysis (Panel A) and for relevant municipality characteristics (Panel B) for different municipality subsamples: Full sample (col. 1), municipalities that do not or do switch to having high-density of TV-schools in 1980–2000 (col. 2-3), municipalities with below or above the median share of services sector in 1980 (col. 4-5), and municipalities with below or above the density of standard schools in 2000 (col.6-7). The population outcomes reported are an indicator for gender, age, graduation from primary, lower secondary, and higher education, participation in the labor market, unconditional probability of earning positive income, unconditional monthly adult income in pesos, logarithmic transformation of hourly income, and indicators for unconditionally participating in the primary sector, secondary sector, and tertiary sector. The region characteristics reported are the density of TV-schools, measured as the number of TV-schools per 50 eligible children, the density of standard schools, measured as the number of standard schools per 50 eligible children, indicators for being a rural municipality using the 1980 and 1990 census, municipality-level lower secondary enrollment in 1980, and the municipal poverty index in 1980. The table shows the sample mean with population weights, and the standard deviation in parentheses below. The school construction data comes from administrative records from the Mexican Secretariat of Education (SEP) for 1980–2000, and outcome data from the 10% subsample of the 2010 Mexican census from IPUMS.

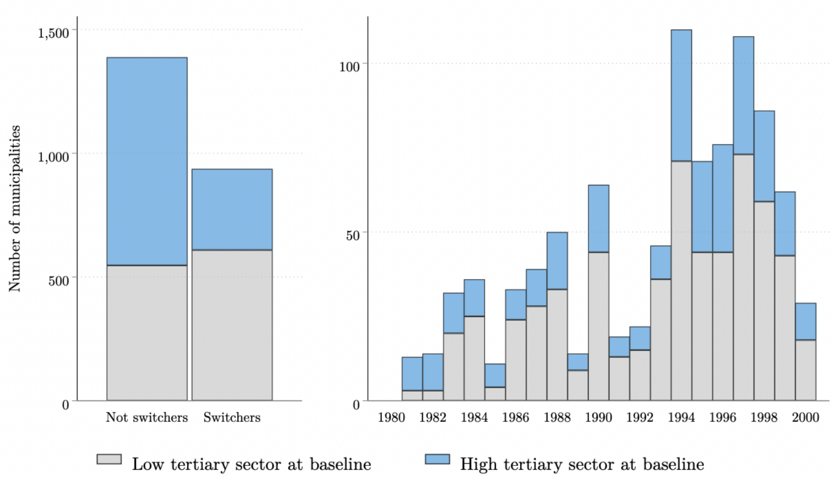
Figure C3 shows the evolution of constructions over time by sectoral composition. Figure C2 show that despite the Southern regions of Mexico having fewer tertiary sector jobs compared to the North, there is substantial spatial heterogeneity even within states. This within- and across-state variation in this labor market characteristic makes it conducive for investigating the heterogeneity of the treatment effects. It is also a policy-relevant dimension observable in most censuses.

Figure C2: Prevalence of the Tertiary Sector in 1980



Notes: The maps show the share of the population working on tertiary sector jobs in 1980 in each municipality. Data comes from the 1980 Mexican census.

Figure C3: Evolution of TV-School Constructions by Sectoral Composition in 1980



Notes: The left panel shows the number of municipalities in the analysis data that eventually switch to high TV-school intensity status (n=1,164) and those that do not (n=1,161) by prevalence of tertiary sector at baseline. The right panel presents a histogram of the switching event dates, with one observation per municipality by prevalence of tertiary sector at baseline. The data is sourced from the Mexican Secretariat of Education (SEP).

D Estimates using Different Econometric Specifications

Table D1: Comparison of the Estimates across Specifications of the Impacts of a High-Intensity of TV-Schools on Education and Labor Market Outcomes

	DiD_{TWFE}	DiD_{ATT}	DiD_{TWFE}	DiD_{ATT}	SA'21	SA'21	
	(1)	(2)	(3)	(4)	(5)	(6)	Mean
Panel A: Education Outcomes							
Lower Sec. Graduation	0.067***	0.068***	0.038***	0.079***	0.068***	0.073***	0.63
	(0.005)	(0.005)	(0.004)	(0.007)	(0.005)	(0.007)	
N	42823	45393	42823	45393	45393	45393	
Years of Education	0.543***	0.466***	0.216***	0.421***	0.460***	0.319***	9.18
	(0.045)	(0.053)	(0.036)	(0.080)	(0.060)	(0.084)	
N	42823	45393	42823	45393	45393	45393	
Primary Graduation	0.085***	0.064***	0.028***	0.040***	0.064***	0.029***	0.85
	(0.006)	(0.006)	(0.004)	(0.009)	(0.006)	(0.007)	
N	42823	45393	42823	45393	45393	45393	
Higher Sec. Graduation	-0.008***	-0.002	-0.000	0.002	-0.004	-0.000	0.32
	(0.003)	(0.003)	(0.003)	(0.005)	(0.004)	(0.006)	
N	42823	45393	42823	45393	45393	45393	
Panel B: Labor Market Outcomes							
Monthly Income	410.350***	354.612***	133.861***	364.691***	372.007***	306.724***	3110.25
	(39.938)	(36.400)	(22.857)	(43.562)	(38.557)	(42.748)	
N	42819	45389	42819	45389	45389	45389	
Hourly Income (log)	0.091***	0.091***	0.023	0.080***	0.091***	0.064**	2.75
	(0.012)	(0.016)	(0.015)	(0.026)	(0.017)	(0.026)	
N	42824	45394	42824	45394	45394	45394	
Labor Market Participation	0.016***	0.018***	0.007**	0.031***	0.019***	0.022***	0.66
	(0.003)	(0.004)	(0.003)	(0.007)	(0.004)	(0.007)	
N	42823	45393	42823	45393	45393	45393	
Earns Positive Income	0.030***	0.027***	0.011***	0.036***	0.027***	0.023***	0.56
	(0.003)	(0.004)	(0.003)	(0.006)	(0.005)	(0.006)	
N	42819	45389	42819	45389	45389	45389	
Agricultural Sector	-0.011***	-0.006**	0.000	-0.000	-0.005*	0.003	0.10
	(0.002)	(0.003)	(0.002)	(0.005)	(0.003)	(0.005)	
N	42824	45394	42824	45394	45394	45394	
Manufacturing Sector	0.002*	0.001	0.003*	0.006*	0.001	0.002	0.17
	(0.001)	(0.002)	(0.002)	(0.004)	(0.002)	(0.004)	
N	42824	45394	42824	45394	45394	45394	
Services Sector	0.027***	0.026***	0.006**	0.030***	0.025***	0.021***	0.36
	(0.003)	(0.004)	(0.003)	(0.005)	(0.004)	(0.006)	
N	42824	45394	42824	45394	45394	45394	
Formal Health Insurance	0.010***	0.007**	0.002	0.007	0.007*	0.003	0.41
	(0.002)	(0.003)	(0.002)	(0.005)	(0.004)	(0.006)	
N	42823	45393	42823	45393	45393	45393	
Mun-specific trends	No	No	Yes	Yes	No	Yes	

Notes: This table compares the impact of access to TV-schools on education outcomes (Panel A) and labor market outcomes (Panel B) using a binary treatment and different econometric specifications. The models are: A standard two-way fixed effects (TWFE) model, which only includes municipality and cohort fixed effects, specified as a single-coefficient estimate model (col. 1) and as an equally-weighted average treatment on the treated (ATT) of post-treatment estimates from a dynamic TWFE event study model (col. 2); a TWFE model that besides municipality and cohort fixed effects, also includes municipality-specific linear time trends, specified as a single-coefficient estimate model (col. 3) and as an equally-weighted ATT of post-treatment estimates from the dynamic TWFE event study model (col. 4), which is our preferred specification; and an heterogeneity-robust estimator proposed by Sun and Abraham (2021), without (col. 5) and with municipality-specific linear time trends (col. 6). See Equation (1) and Section IV for details on the econometric specifications. The treatment is an indicator identifying individuals with access to a high density of TV-schools in the municipality at age 15, defined as being above the sample median density, measured as the number of TV-schools per 50 eligible children. The outcomes are: an indicator for graduating from primary, lower secondary, and upper secondary education, years of education, participation in the labor market, unconditional probability of earning positive income, unconditional monthly adult income in pesos, logarithmic transformation of hourly income, and indicators for unconditionally participating in the primary sector, secondary sector, and tertiary sector, and for receiving formal health insurance. Regressions use administrative school construction data from the Mexican Secretariat of Education (SEP) for 1980–2000, and outcome data from the 10% subsample of the 2010 Mexican census from IPUMS, restricting it to non inter-state migrants. Data is aggregated into birth-year by municipality-of-residence cells, and standard errors are clustered at the municipal level. Statistical significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

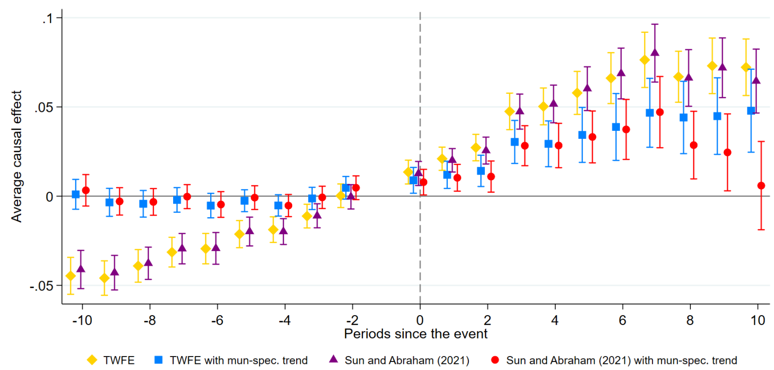
Table D2: Comparison of the Estimates across Specifications of the Impacts of a High-Intensity of TV-Schools on Participation in Industries

	DiD_{TWFE}	DiD_{ATT}	DiD_{TWFE}	DiD_{ATT}	SA'21	SA'21	
	(1)	(2)	(3)	(4)	(5)	(6)	Mean
Panel A: Participation in Primary Sector Industries							
Agriculture, fishing, and forestry	-0.012***	-0.006**	0.000	0.000	-0.005*	0.004	0.09
	(0.002)	(0.002)	(0.002)	(0.005)	(0.002)	(0.005)	
N	42824	45394	42824	45394	45394	45394	
Mining and extraction	0.001**	0.000	0.000	-0.001	0.000	-0.001	0.00
	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)	
N	42824	45394	42824	45394	45394	45394	
Panel B: Participation in Secondary Sector Industries							
Manufacturing	-0.001	0.000	0.002*	0.007***	0.001	0.005*	0.11
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.003)	
N	42824	45394	42824	45394	45394	45394	
Electricity, gas, water and waste management	0.001***	0.000	0.000	-0.000	0.000	-0.000	0.00
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	
N	42824	45394	42824	45394	45394	45394	
Construction	0.002***	0.000	0.001	-0.000	-0.000	-0.002	0.06
	(0.001)	(0.001)	(0.001)	(0.003)	(0.002)	(0.003)	
N	42824	45394	42824	45394	45394	45394	
Panel C: Participation in Tertiary Sector Industries							
Wholesale and retail trade	0.004***	0.006***	0.002	0.011***	0.007***	0.010***	0.11
	(0.001)	(0.001)	(0.001)	(0.003)	(0.001)	(0.003)	
N	42824	45394	42824	45394	45394	45394	
Hotels and restaurants	0.001	0.001	-0.000	-0.001	0.001	-0.001	0.03
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	
N	42824	45394	42824	45394	45394	45394	
Transportation, storage, and communications	0.003***	0.002**	0.001	0.002	0.002**	0.002	0.03
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.002)	
N	42824	45394	42824	45394	45394	45394	
Financial services and insurance	-0.000	0.000	0.001**	0.002***	0.000	0.001**	0.01
	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	
N	42824	45394	42824	45394	45394	45394	
Public administration and defense	0.005***	0.006***	0.002**	0.008***	0.006***	0.008***	0.03
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	
N	42824	45394	42824	45394	45394	45394	
Business services and real state	0.002***	0.002***	0.001	0.002**	0.002***	0.001	0.03
	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	
N	42824	45394	42824	45394	45394	45394	
Education	0.005***	0.005***	0.001	0.007***	0.005***	0.006**	0.04
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.003)	
N	42824	45394	42824	45394	45394	45394	
Health and social work	0.002***	0.002***	0.001	0.002*	0.002***	0.001	0.02
	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	
N	42824	45394	42824	45394	45394	45394	
Other services	0.001*	-0.002	-0.002	-0.004	-0.003	-0.008	0.04
	(0.001)	(0.003)	(0.001)	(0.005)	(0.005)	(0.008)	
N	42824	45394	42824	45394	45394	45394	
Private household services	0.005***	0.003***	-0.000	0.000	0.003***	0.000	0.02
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	
N	42824	45394	42824	45394	45394	45394	
Mun-specific trends	No	No	Yes	Yes	No	Yes	

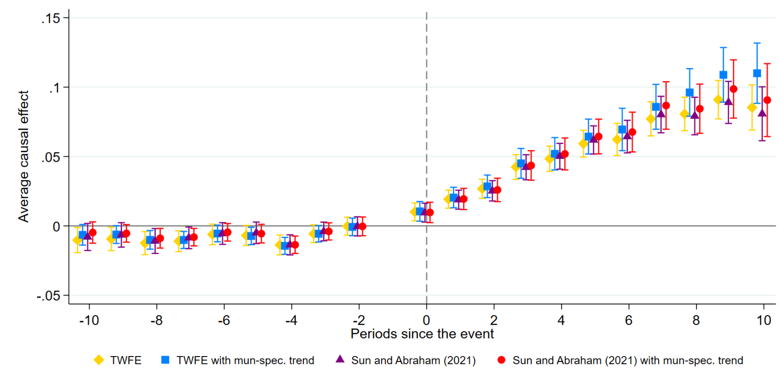
Notes: This table compares the impact of access to TV-schools on participation in labor market industries using a binary treatment and different econometric specifications. The models are: A standard two-way fixed effects (TWFE) model, which only includes municipality and cohort fixed effects, specified as a single-coefficient estimate model (col. 1) and as an equally-weighted average treatment on the treated (ATT) of post-treatment estimates from a dynamic TWFE event study model (col. 2); a TWFE model that besides municipality and cohort fixed effects, also includes municipality-specific linear time trends, specified as a single-coefficient estimate model (col. 3) and as an equally-weighted ATT of post-treatment estimates from the dynamic TWFE event study model (col. 4), which is our preferred specification; and an heterogeneity-robust estimator proposed by Sun and Abraham (2021), without (col. 5) and with municipality-specific linear time trends (col. 6). See Equation (1) and Section IV for details on the econometric specifications. The treatment is an indicator identifying individuals with access to a high density of TV-schools in the municipality at age 15, defined as being above the sample median density, measured as the number of TV-schools per 50 eligible children. The outcomes are indicators for the (unconditional) participation in different labor market industries, specified in the row names. Regressions use administrative school construction data from the Mexican Secretariat of Education (SEP) for 1980–2000, and outcome data from the 10% subsample of the 2010 Mexican census from IPUMS, restricting it to non inter-state migrants. Data is aggregated into birth-year by municipality-of-residence cells, and standard errors are clustered at the municipal level. Statistical significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Figure D1: Event Studies of Impacts of Access to High TV-School Intensity using Different Econometric Specifications on Education Outcomes

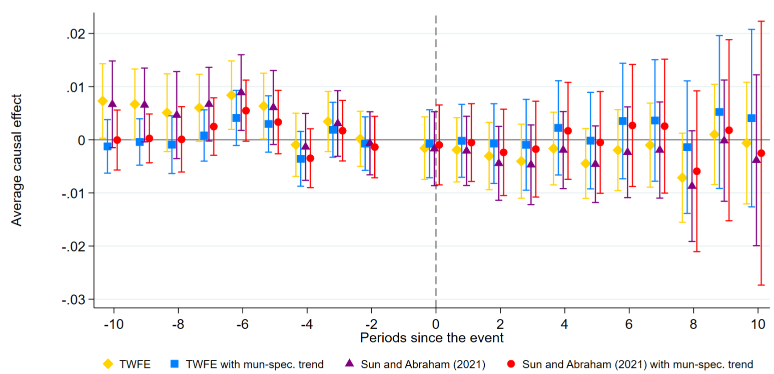
(a) Primary Graduation



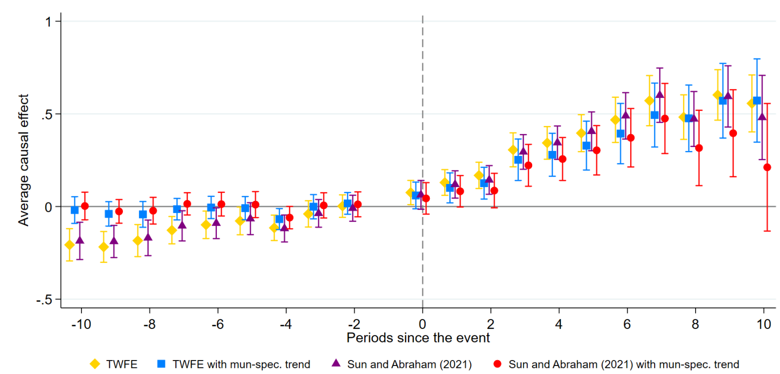
(b) Lower Secondary Graduation



(c) Upper Secondary Graduation



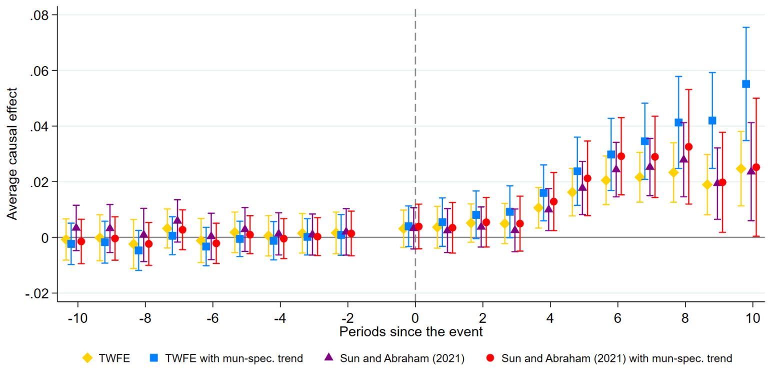
(d) Years of Education



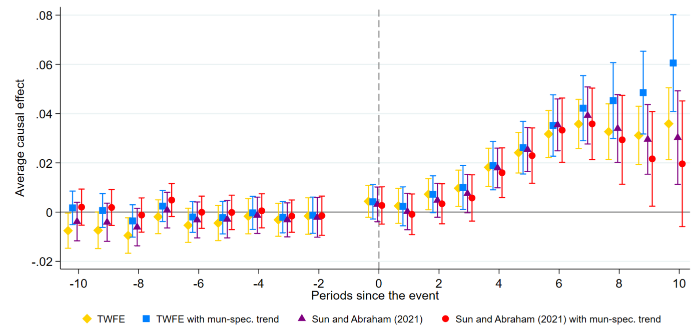
Notes: This figure shows the estimated effects of access to high TV-schools density on educational outcomes, by periods relative to the year of the switch to a high TV-school intensity. The econometric specifications are: A standard dynamic two-way fixed effects model only including municipality and cohort fixed effects (TWFE), a dynamic TWFE with municipality and cohort fixed effects and municipality-specific linear time trends (TWFE with mun-spec. trend), the Sun and Abraham (2021)'s heterogeneity-robust estimator without (Sun and Abraham) and with municipality-specific linear time trends (Sun and Abraham with mun-spec. trend). Outcomes are: indicators for participation in the labor market and unconditional probability of earning positive income, unconditional monthly adult income in pesos, and the logarithmic transformation of hourly income. Event study coefficient estimates are shown with dots, and 95% confidence intervals are shown with a shaded area. All effects are calculated with respect to period -1. See Section IV for details. Data is from the Mexican Secretariat of Education (SEP) for 1980–2000, and the 2010 Mexican census (10% IPUMS subsample).

Figure D2: Event Studies of Impacts of Access to High TV-School Intensity using Different Econometric Specifications on Labor Outcomes

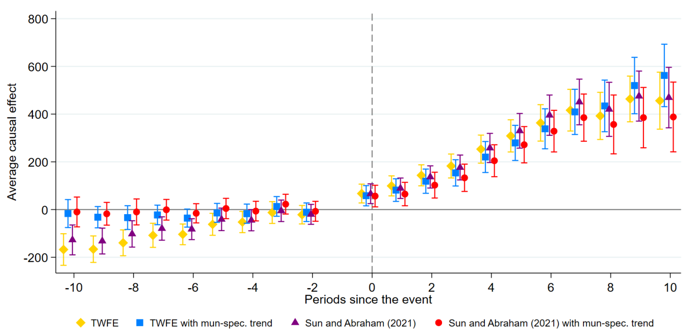
(a) Labor Force Participation



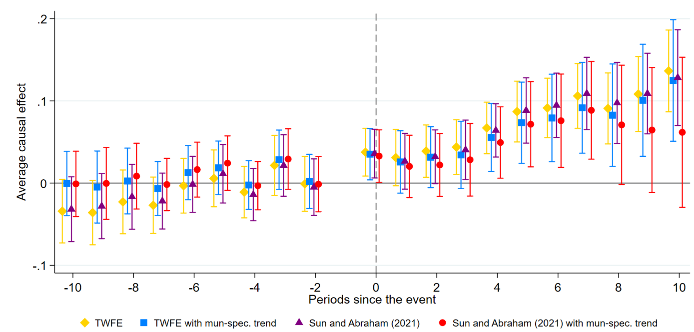
(b) Earns Positive Income



(c) Monthly income (pesos)



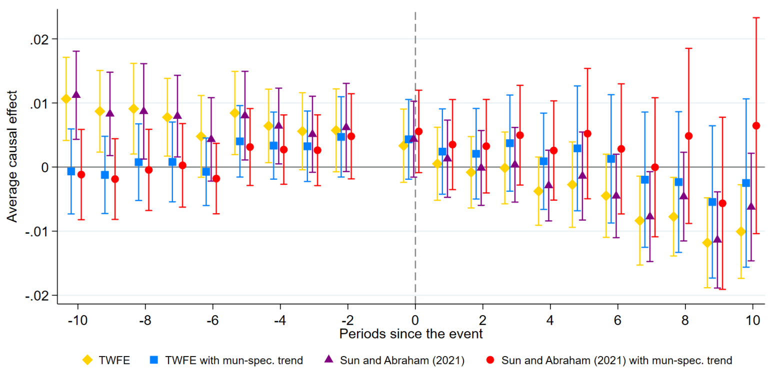
(d) Hourly income (log)



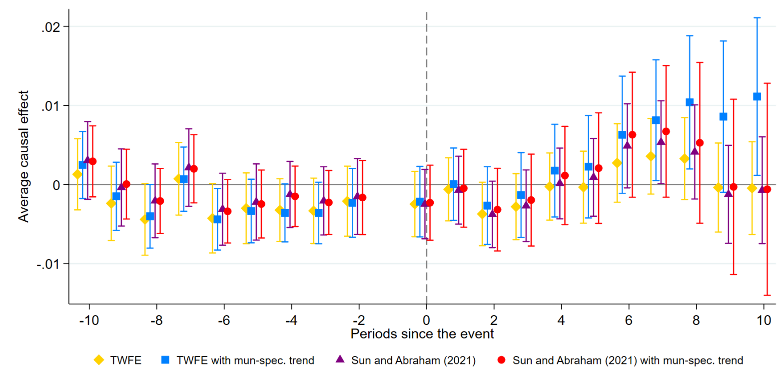
Notes: This figure shows the estimated effects of access to high TV-schools density on educational outcomes, by periods relative to the year of the switch to a high TV-school intensity. The econometric specifications are: A standard dynamic two-way fixed effects model only including municipality and cohort fixed effects (TWFE), a dynamic TWFE with municipality and cohort fixed effects and municipality-specific linear time trends (TWFE with mun-spec. trend), the Sun and Abraham (2021)'s heterogeneity-robust estimator without (Sun and Abraham) and with municipality-specific linear time trends (Sun and Abraham with mun-spec. trend). Outcomes are: indicators for graduating from primary, lower secondary, and upper secondary education, and years of education. Event study coefficient estimates are shown with dots, and 95% confidence intervals are shown with a shaded area. All effects are calculated with respect to period -1. See Section IV for details. Data is from the Mexican Secretariat of Education (SEP) for 1980–2000, and the 2010 Mexican census (10% IPUMS subsample).

Figure D3: Event Studies of Impacts of Access to High TV-School Intensity on using Different Econometric Specifications on Labor Market Composition Outcomes

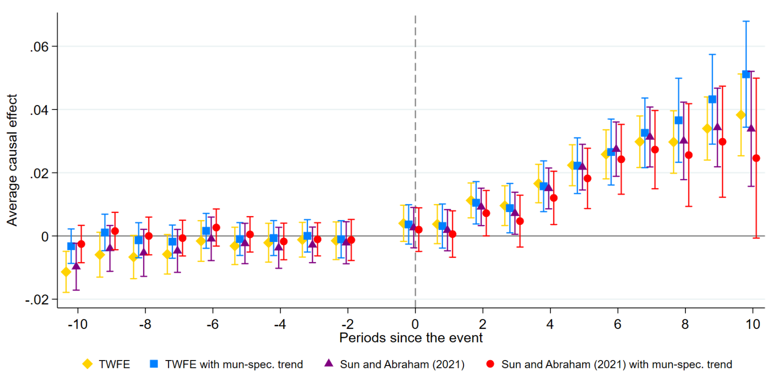
(a) Works in Primary Sector



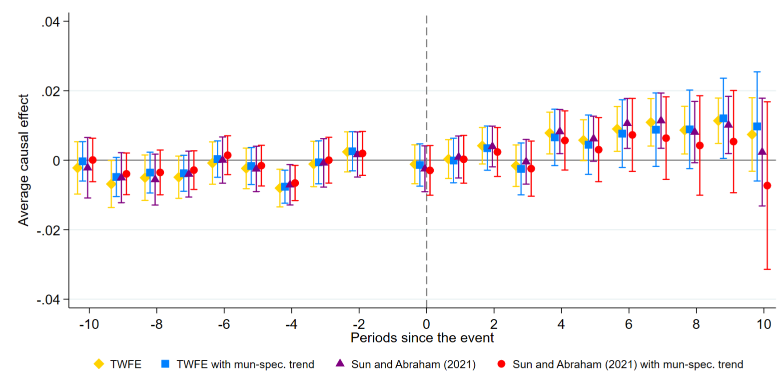
(b) Works in Secondary Sector



(c) Works in Tertiary Sector



(d) Receives Formal Health Insurance



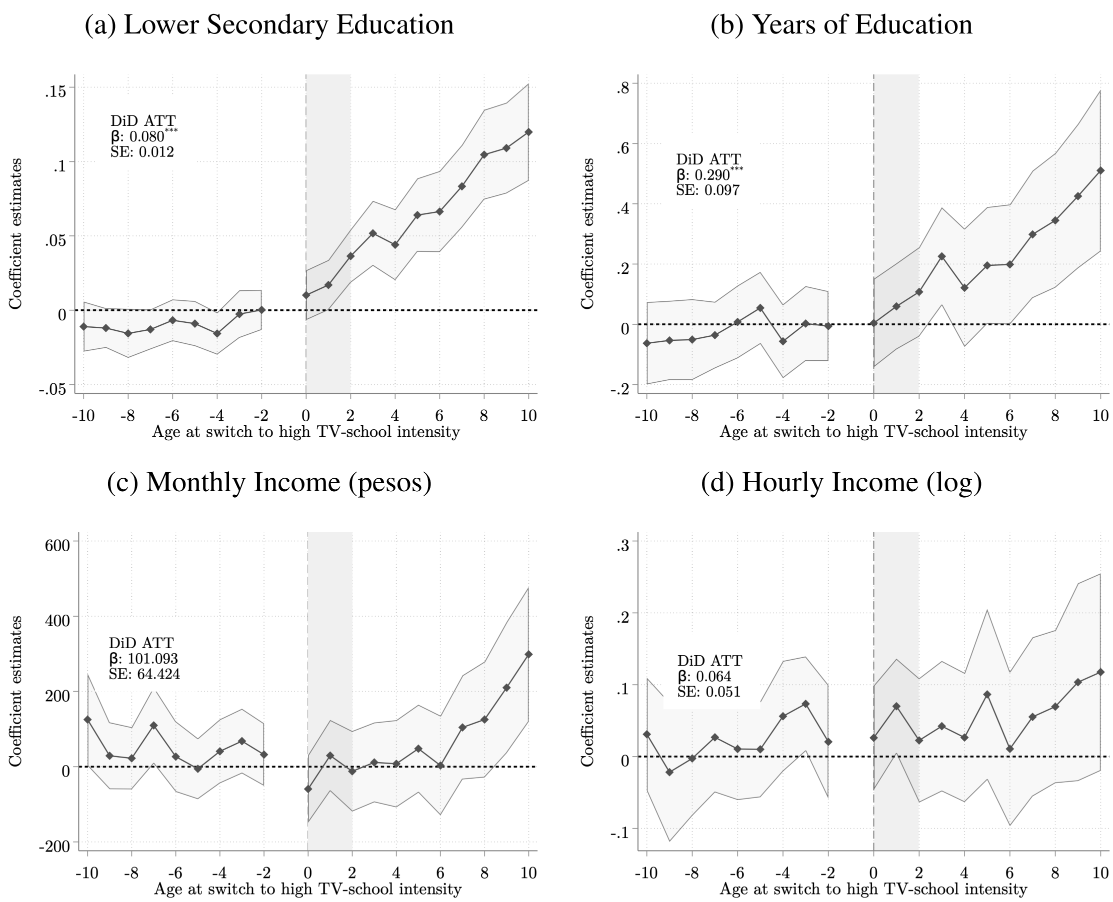
Notes: This figure shows the estimated effects of access to high TV-schools density on educational outcomes, by periods relative to the year of the switch to a high TV-school intensity. The econometric specifications are: A standard dynamic two-way fixed effects model only including municipality and cohort fixed effects (TWFE), a dynamic TWFE with municipality and cohort fixed effects and municipality-specific linear time trends (TWFE with mun-spec. trend), the Sun and Abraham (2021)'s heterogeneity-robust estimator without (Sun and Abraham) and with mun-spec. trend (Sun and Abraham with mun-spec. trend). Outcomes are: indicators for unconditionally participating in the primary sector, secondary sector, and tertiary sector, and for receiving formal health insurance. Event study coefficient estimates are shown with dots, and 95% confidence intervals are shown with a shaded area. All effects are calculated with respect to period -1. See Section IV for details. Data is from the Mexican Secretariat of Education (SEP) for 1980–2000, and the 2010 Mexican census (10% IPUMS subsample).

Table D3: Robustness to Alternative Samples and Specifications

	Main	Control std. school	Exclude Never TS	Exclude low TS	PSM sample	Switchers up to 1996
	(1)	(2)	(3)	(4)	(5)	(6)
Primary Graduation	0.040***	0.040***	0.037***	0.047***	0.034*	0.024***
	(0.009)	(0.009)	(0.009)	(0.009)	(0.019)	(0.009)
Lower Sec. Graduation	0.079***	0.078***	0.075***	0.068***	0.117***	0.074***
	(0.007)	(0.007)	(0.008)	(0.008)	(0.022)	(0.008)
Years of Education	0.421***	0.425***	0.400***	0.316***	0.673***	0.295***
	(0.080)	(0.078)	(0.081)	(0.085)	(0.182)	(0.090)
Labor Market Participation	0.031***	0.033***	0.031***	0.014**	0.045*	0.013*
	(0.007)	(0.007)	(0.007)	(0.007)	(0.027)	(0.007)
Monthly Income	364.691***	369.728***	359.909***	221.083***	409.475**	259.337***
	(43.562)	(41.344)	(45.498)	(45.913)	(186.790)	(46.690)
Hourly Income (log)	0.080***	0.085***	0.076***	0.046	0.159**	0.056*
	(0.026)	(0.026)	(0.026)	(0.028)	(0.074)	(0.030)
Mun-specific trends	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table shows the impact of high-density school construction for different samples and including controls. Column (1) shows the main estimates for reference. Column (2) controls for the concurrent growth of standard schools (standard school density interacted with year-fixed effects. Column (3) excludes municipalities that never experienced TV-School construction. Column (4) excludes municipalities that experienced construction o fat least one TV-school, but not enough to switch to high density. Column (5) uses a matched sample of municipalities to estimate effects. The table presents our preferred specification, the equally-weighted average treatment on the treated (ATT) of post-treatment estimates from the dynamic TWFE event study model, DiD_{ATT}, also including municipality and cohort fixed effects, and municipality-specific linear time trends. See Equation (1) and Section IV for details on the econometric specifications. The treatment is an indicator identifying individuals with access to a high density of schools in the municipality at age 15, defined as being above the sample median density, measured as the number of schools per 50 eligible children. The outcomes are: an indicator for graduating from lower secondary education, years of education, the unconditional monthly adult income in pesos, and logarithmic transformation of hourly income. Regressions use administrative school construction data from the Mexican Secretariat of Education for 1980–2000, and outcome data from the 10% subsample of the 2010 Mexican census from IPUMS, restricting it to non inter-state migrants. Data is aggregated into birth-year by municipality-of-residence cells, and standard errors are clustered at the municipal level. Statistical significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Figure D4: Event Studies of Impacts of TV-School Intensity on Education and Labor Market Outcomes (1993 construction shock)



Notes: This figure shows the effect of the TV-schools density by age from high-density construction in 1993 or 1994. The econometric specification is a dynamic TWFE event study model that includes municipality and cohort fixed effects, and municipality-specific linear time trends. See Equation (1) for details. Event study coefficient estimates are shown with a solid line, and 95% confidence intervals are shown with a shaded area. All effects are computed with respect to age 16. The dynamic coefficient estimates are summarized with an equally-weighted average treatment on the treated single point-estimate DiD_{ATT} superposed in the graph alongside its standard error. See Section IV for details. Outcomes are migration and lower secondary graduation. Data is from the Mexican Secretariat of Education (SEP), and the 2010 Mexican census (10% IPUMS subsample).

E Additional Results on Heterogeneity of Impacts

Table E1: Impacts of Access to High-Intensity of Schools on Educational Achievement and Labor Income by Type of School

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Lower Sec. Grad.		Years of Education		Monthly Income (pesos)		Hourly Income (log)	
	DiD_{TWFE}	DiD_{ATT}	DiD_{TWFE}	DiD_{ATT}	DiD_{TWFE}	DiD_{ATT}	DiD_{TWFE}	DiD_{ATT}
School Type: TV-Schools								
High TV-School Intensity	0.038***	0.079***	0.216***	0.421***	133.861***	364.691***	0.023	0.080***
	(0.004)	(0.007)	(0.036)	(0.080)	(22.857)	(43.562)	(0.015)	(0.026)
Dependent Mean	0.64	0.63	9.23	9.18	3151.06	3110.25	2.77	2.75
Observations	42823	45393	42823	45393	42819	45389	42824	45394
School Type: Standard Schools								
High Std. School Intensity	0.013**	-0.009	0.098**	-0.004	56.548	-172.576*	0.022	0.017
	(0.006)	(0.009)	(0.047)	(0.088)	(50.018)	(88.732)	(0.016)	(0.026)
Dependent Mean	0.56	0.57	8.53	8.60	3070.94	3141.67	2.74	2.76
Observations	39864	40962	39864	40962	39861	40959	39865	40963

Notes: This table shows the impact of access to schooling by school type (standard schools and TV-schools). Odd columns present single-coefficient estimates from a two-way fixed effects (TWFE) model, DiD_{TWFE}, which includes municipality and cohort fixed effects, and municipality-specific linear time trends. Even columns present our preferred specification, the equally-weighted average treatment on the treated (ATT) of post-treatment estimates from the dynamic TWFE event study model, DiD_{ATT}, also including municipality and cohort fixed effects, and municipality-specific linear time trends. See Equation (1) and Section IV for details on the econometric specifications. The treatment is an indicator identifying individuals with access to a high density of schools in the municipality at age 15, defined as being above the sample median density, measured as the number of schools per 50 eligible children. The outcomes are: an indicator for graduating from lower secondary education (col. 1-2), years of education (col. 3-4), the unconditional monthly adult income in pesos (col. 5-6), and logarithmic transformation of hourly income (col. 7-8). Regressions use administrative school construction data from the Mexican Secretariat of Education for 1980–2000, and outcome data from the 10% subsample of the 2010 Mexican census from IPUMS, restricting it to non inter-state migrants. Data is aggregated into birth-year by municipality-of-residence cells, and standard errors are clustered at the municipal level. Statistical significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table E2: Heterogenous Impacts of Access to High-Intensity of TV-Schools on Educational Outcomes by Services Sector Presence

	Difference in heterogeneity estimates				DiD_{ATT} **estimates**	
	DiD_{TWFE}	DiD_{ATT}	DiD_{TWFE}	DiD_{ATT}	Low services	High services
	(1)	(2)	(3)	(4)	(5)	(6)
Primary Graduation	0.016	0.011	-0.007	-0.001	0.031^{***}	0.030^{***}
	(0.011)	(0.012)	(0.008)	(0.017)	(0.012)	(0.012)
p-value	0.159	0.346	0.402	0.946	0.010	0.015
N	42823	45393	42823	45393	45393	45393
Lower Sec. Graduation	0.034^{***}	0.029^{***}	0.001	0.003	0.060^{***}	0.063^{***}
	(0.008)	(0.010)	(0.008)	(0.015)	(0.009)	(0.012)
p-value	0.000	0.003	0.911	0.842	0.000	0.000
N	42823	45393	42823	45393	45393	45393
Higher Sec. Graduation	0.010	0.010	0.002	0.014	-0.011^{**}	0.004
	(0.006)	(0.008)	(0.006)	(0.012)	(0.005)	(0.011)
p-value	0.100	0.195	0.683	0.242	0.047	0.746
N	42823	45393	42823	45393	45393	45393
Years of Education	0.174^{**}	0.134	-0.024	0.064	0.265^{***}	0.330^{**}
	(0.076)	(0.099)	(0.068)	(0.170)	(0.079)	(0.150)
p-value	0.023	0.176	0.719	0.705	0.001	0.028
N	42823	45393	42823	45393	45393	45393
Mun-specific trends	No	No	Yes	Yes	Yes	Yes

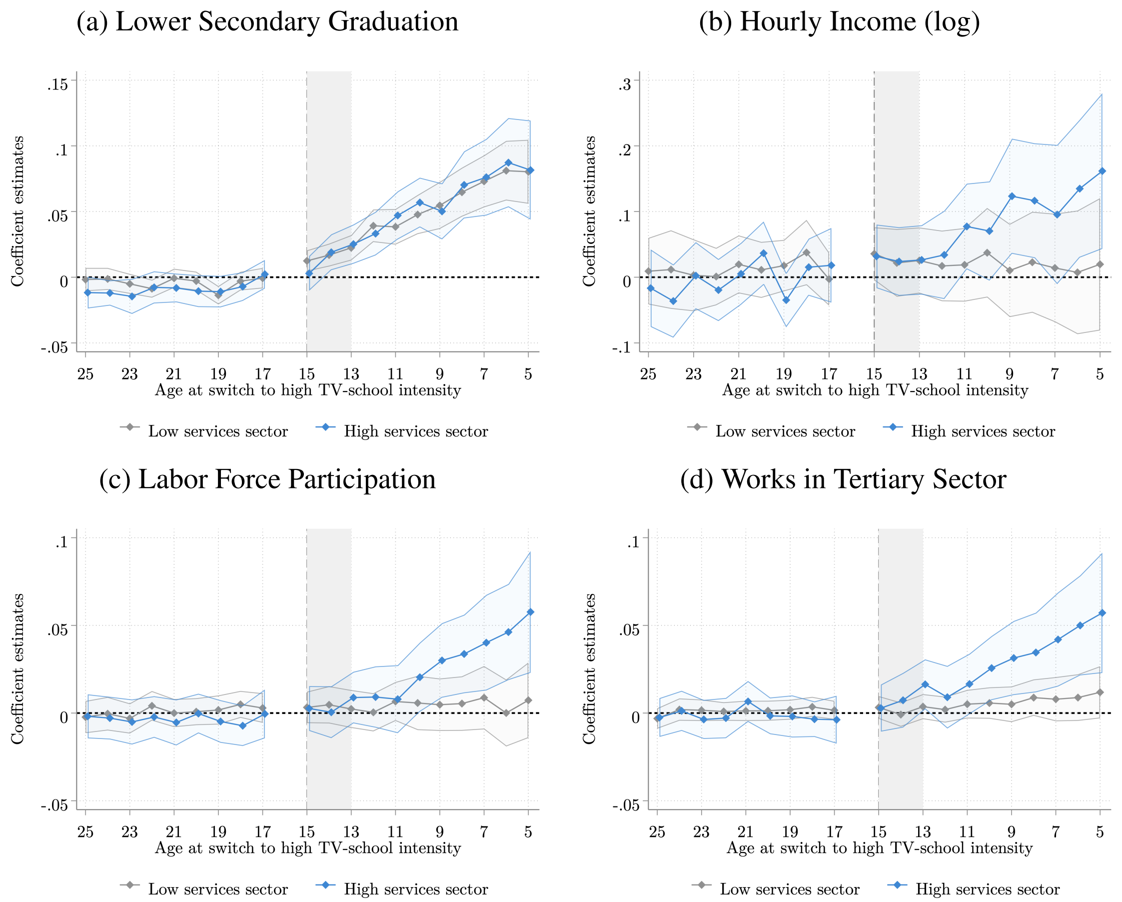
Notes: This table shows the impact of access to high-intensity of TV-schools on educational outcomes by the presence of services sector at baseline, defined as an indicator for whether the municipality had an above median share of services sector jobs in 1980. The first set of coefficient estimates are the interaction term between the treatment coefficient and the sectoral presence indicator from a fully-interacted single-coefficient two-way fixed effects (TWFE) model, DiD_{TWFE}, which includes municipality and cohort fixed effects (col .1), and additionally includes municipality-specific linear time trends (col. 3). The second set of coefficient estimates present the test of the linear combination of the equally-weighted average treatment on the treated (ATT) of post-treatment estimates by the sectoral presence indicator, coming from the dynamic TWFE event study model, DiD_{ATT}, also including municipality and cohort fixed effects (col. 2), and additionally including municipality-specific linear time trends (col. 4). See Equation (1) and Section IV for details on the econometric specifications. The last set of coefficients are the equally-weighted average treatment on the treated (ATT) of post-treatment estimates from the dynamic TWFE event study model, DiD_{ATT}, including municipality and cohort fixed effects, and municipality-specific linear time trends, ran as split-sample regressions by below-median services sector at baseline (col. 5) and above-median services sector at baseline (col. 6). The treatment is an indicator identifying individuals with access to a high density of TV-schools in the municipality at age 15, defined as being above the sample median density, measured as the number of TV-schools per 50 eligible children. The outcomes are: an indicator for graduating from primary, lower secondary, and upper secondary education, and years of education. Regressions use administrative school construction data from the Mexican Secretariat of Education for 1980–2000, and outcome data from the 10% subsample of the 2010 Mexican census from IPUMS, restricting it to non inter-state migrants. Data is aggregated into birth-year by municipality-of-residence cells, and standard errors are clustered at the municipal level. Statistical significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table E3: Heterogenous Impacts of Access to High-Intensity of TV-Schools on Labor Outcomes by Services Sector Presence

	Difference in heterogeneity estimates				DiD_{ATT} estimates	
	DiD_{TWFE}	DiD_{ATT}	DiD_{TWFE}	DiD_{ATT}	Low services	High services
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Labor Outcomes						
Labor Market Participation	0.017***	0.016**	0.006	0.026*	0.005	0.031***
	(0.006)	(0.008)	(0.007)	(0.013)	(0.007)	(0.011)
p-value	0.003	0.033	0.374	0.054	0.506	0.006
N	42823	45393	42823	45393	45393	45393
Earns Positive Income	0.027***	0.026***	0.012*	0.023*	0.011*	0.034***
	(0.006)	(0.009)	(0.007)	(0.014)	(0.006)	(0.012)
p-value	0.000	0.003	0.074	0.095	0.076	0.005
N	42819	45389	42819	45389	45389	45389
Monthly Income	400.694***	402.875***	110.590**	282.069***	121.131***	403.200***
	(66.380)	(75.379)	(44.303)	(89.496)	(36.881)	(81.544)
p-value	0.000	0.000	0.013	0.002	0.001	0.000
N	42819	45389	42819	45389	45389	45389
Hourly Income (log)	0.063***	0.069**	-0.012	0.083	0.018	0.102**
	(0.023)	(0.031)	(0.030)	(0.054)	(0.035)	(0.041)
p-value	0.007	0.024	0.679	0.125	0.601	0.014
N	42824	45394	42824	45394	45394	45394
Panel B: Labor Sectoral Composition						
Agricultural Sector	-0.010***	-0.016***	0.001	-0.003	0.001	-0.002
	(0.003)	(0.005)	(0.004)	(0.009)	(0.006)	(0.007)
p-value	0.002	0.001	0.781	0.772	0.911	0.770
N	42824	45394	42824	45394	45394	45394
Manufacturing Sector	0.006**	0.009**	0.000	0.001	0.001	0.002
	(0.003)	(0.004)	(0.004)	(0.008)	(0.004)	(0.007)
p-value	0.028	0.016	0.965	0.889	0.862	0.791
N	42824	45394	42824	45394	45394	45394
Services Sector	0.024***	0.024***	0.007	0.026**	0.007	0.033***
	(0.005)	(0.007)	(0.006)	(0.012)	(0.005)	(0.011)
p-value	0.000	0.001	0.236	0.032	0.161	0.003
N	42824	45394	42824	45394	45394	45394
Formal Health Insurance	0.005	0.000	0.001	0.002	0.002	0.003
	(0.004)	(0.006)	(0.005)	(0.012)	(0.005)	(0.011)
p-value	0.149	0.958	0.858	0.881	0.718	0.752
N	42823	45393	42823	45393	45393	45393
Mun-specific trends	No	No	Yes	Yes	Yes	Yes

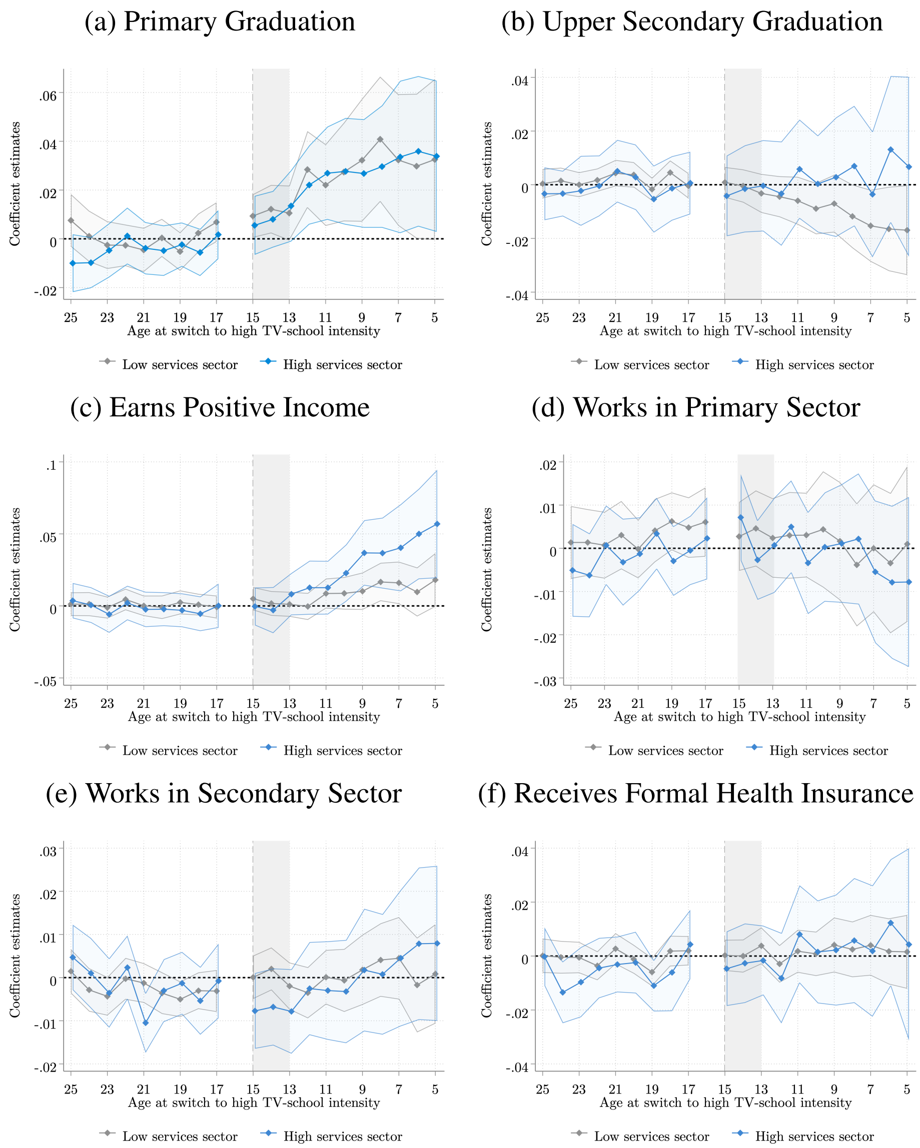
Notes: This table shows the impact of access to high-intensity of TV-schools on labor market outcomes by the presence of services sector at baseline, defined as an indicator for whether the municipality had an above median share of services sector jobs in 1980. The first set of coefficient estimates are the interaction term between the treatment coefficient and the sectoral presence indicator from a fully-interacted single-coefficient two-way fixed effects (TWFE) model, DiD_{TWFE}, which includes municipality and cohort fixed effects (col .1), and additionally includes municipality-specific linear time trends (col. 3). The second set of coefficient estimates present the test of the linear combination of the equally-weighted average treatment on the treated (ATT) of post-treatment estimates by the sectoral presence indicator, coming from the dynamic TWFE event study model, DiD_{ATT}, also including municipality and cohort fixed effects (col. 2), and additionally including municipality-specific linear time trends (col. 4). See Equation (1) and Section IV for details on the econometric specifications. The last set of coefficients are the equally-weighted average treatment on the treated (ATT) of post-treatment estimates from the dynamic TWFE event study model, DiD_{ATT}, including municipality and cohort fixed effects, and municipality-specific linear time trends, ran as split-sample regressions by below-median services sector at baseline (col. 5) and above-median services sector at baseline (col. 6). The treatment is an indicator identifying individuals with access to a high density of TV-schools in the municipality at age 15, defined as being above the sample median density, measured as the number of TV-schools per 50 eligible children. The outcomes are: an indicator for participation in the labor market, unconditional probability of earning positive income, unconditional monthly adult income in pesos, logarithmic transformation of hourly income, and indicators for unconditionally participating in the primary sector, secondary sector, and tertiary sector, and for receiving formal health insurance. Regressions use administrative school construction data from the Mexican Secretariat of Education for 1980–2000, and outcome data from the 10% subsample of the 2010 Mexican census from IPUMS, restricting it to non inter-state migrants. Data is aggregated into birth-year by municipality-of-residence cells, and standard errors are clustered at the municipal level. Statistical significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Figure E1: Event Studies of Impacts of Access to High TV-School Intensity on Outcomes by Sectoral Composition



Notes: This figure shows the effect estimates of access to high TV-schools density by age at the year of switch to a high TV-school intensity construction on different outcomes. This is decomposed by the presence of services sector at baseline, defined as an indicator for whether the municipality had an above-median share of services sector jobs in 1980. The econometric specification is a dynamic TWFE event study model that includes municipality and cohort fixed effects, and municipality-specific linear time trends. See Equation (1) for details. Event study coefficient estimates are shown with a solid line, and 95% confidence intervals are shown with a shaded area. All effects are computed with respect to age 16. See Section IV for details. Outcomes are: years of education, an indicator for graduating from lower secondary education, unconditional monthly adult income in pesos, and the logarithmic transformation of hourly income, indicators for participation in the labor market, and for unconditionally participating in the tertiary sector. Data is from the Mexican Secretariat of Education (SEP) for 1980–2000, and the 2010 Mexican census (10% IPUMS subsample).

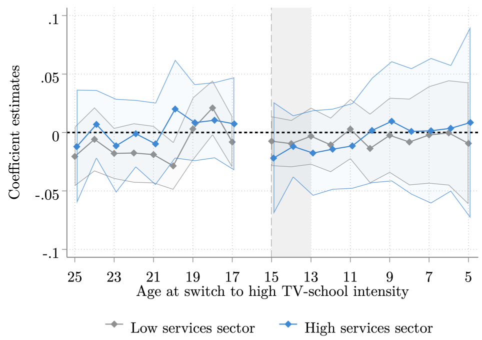
Figure E2: Event Studies of Impacts of TV-School Intensity on Outcomes by Sectoral Composition



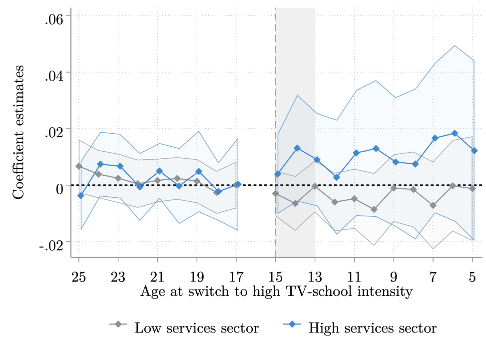
Notes: This figure shows the effect estimates of access to high TV-schools density by age at the year of switch to a high TV-school intensity construction on different outcomes. This is decomposed by the presence of services sector at baseline, defined as an indicator for whether the municipality had an above-median share of services sector jobs in 1980. The econometric specification is a dynamic TWFE event study model that includes municipality and cohort fixed effects, and municipality-specific linear time trends. See Equation (1) for details. Event study coefficient estimates are shown with a solid line, and 95% confidence intervals are shown with a shaded area. All effects are computed with respect to age 16. See Section IV for details. Outcomes are: indicators for graduating from primary and upper secondary education, for participation in the labor market and unconditional probability of earning positive income, and indicators for unconditionally participating in the primary sector and the secondary sector. Data is from the Mexican Secretariat of Education (SEP) for 1980–2000, and the 2010 Mexican census (10% IPUMS subsample).

Figure E3: Event Studies of Impacts of TV-school Intensity on Cohort Population Size and Share of Females by Sectoral Composition

(a) Log(Municipal Population)



(b) Share of Females



Notes: This figure shows the effect estimates of the TV-schools density by age at the first TV-school construction on different outcomes. This is decomposed by the presence of services sector at baseline. The econometric specification is a dynamic TWFE event study model that includes municipality and cohort fixed effects, and municipality-specific linear time trends. See Equation (1) for details. Event study coefficient estimates are shown with a solid line, and 95% confidence intervals are shown with a shaded area. All effects are computed with respect to age 16. The dynamic coefficient estimates are summarized with an equally-weighted average treatment on the treated single point-estimate DiD_{ATT} superposed in the graph alongside its standard error. See Section IV for details. Outcomes are the logarithm of the population in a cohort, and the share of females in the cohort. Data is from the Mexican Secretariat of Education (SEP) for 1980–2000, and the 2010 Mexican census (10% IPUMS subsample).

F Effects using the TV-school Density as Continuous Treatment

This section reports the estimated results using the continuous measure of exposure to TV-schools TS_{mc}, the number of TV-schools available in municipality m per 50 eligible children when individuals from cohort c were 15 years old,

$$TS_{mc} = \frac{\text{Number of TV-schools}_{mc}}{\text{Population ages 12 to 14}_{m}} \times 50$$

We implement a dynamic two-way fixed-effects difference-in-differences regression (TWFE), formally estimating the following equation for cohort c living in municipality m:

$$Y_{mc} = \alpha + \sum_{\tau \in [25,5], \tau \neq 16} \beta_\tau \text{TS}_m \times 1[\text{Age at first TS construct.}_m = \tau] + \gamma_m + \lambda_c + \gamma_m \cdot t_c + \varepsilon_{mc} \quad (2)$$

Where Y_{mc} is the outcome of interest, TS_m is a binary variable indicating whether the municipality ever has a TV-school during the time period, $1[\text{Age at first TS construct.}_m = \tau]$ is a binary variable indicating whether the age of the cohort was τ when the first TV-school was constructed in the municipality, and γ_m and λ_c are municipality and cohort fixed effects. We also include a municipality-specific linear time trend ($\gamma_m \cdot t_c$) to control for underlying linear trends in the outcome variables that differ across municipalities. β_τ is the average treatment on the treated (ATT) difference-in-differences effect estimate of an additional TV-school construction at age 15 in their municipality, as a function of the individual's age τ.

Differences-in-differences with continuous treatment require the so-called "strong" parallel trend assumption (Callaway et al., 2024), which intuitively stipulates that changes in outcomes for municipalities with small changes in TV-schools access provide a good counterfactual for the changes in outcomes that would have been observed for municipalities with larger changes in TV-school construction.

See section IV for more details on the treatment definition and the empirical strategy.

F.1 Estimates of the impacts of TV-schools

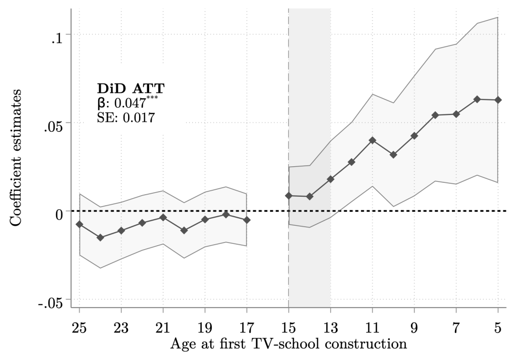
Table F1: Estimates of the Impacts of the Density of TV-Schools on Education and Labor Market Outcomes

	DiD_{TWFE}	DiD_{ATT}	DiD_{TWFE}	DiD_{ATT}	Mean
	(1)	(2)	(3)	(4)	
Panel A: Education Outcomes					
Lower Sec. Graduation	0.212***	0.077***	0.159***	0.128***	0.60
	(0.014)	(0.011)	(0.011)	(0.014)	
N	43026	47511	43026	47511	
Years of Education	1.578***	0.598***	0.770***	0.410***	8.93
	(0.115)	(0.069)	(0.101)	(0.108)	
N	43026	47511	43026	47511	
Primary Graduation	0.227***	0.092***	0.091***	0.047***	0.83
	(0.016)	(0.012)	(0.014)	(0.017)	
N	43026	47511	43026	47511	
Higher Sec. Graduation	-0.006	-0.014**	-0.011*	-0.005	0.31
	(0.006)	(0.005)	(0.007)	(0.009)	
N	43026	47511	43026	47511	
Panel B: Labor Market Outcomes					
Monthly Income	1065.834***	342.939***	412.587***	468.063***	3214.74
	(92.662)	(51.983)	(63.285)	(87.321)	
N	43026	47509	43026	47509	
Hourly Income (log)	0.336***	0.099***	0.114**	0.041	2.78
	(0.028)	(0.035)	(0.045)	(0.070)	
N	43027	47512	43027	47512	
Labor Market Participation	0.036***	0.008	0.040***	0.038***	0.66
	(0.006)	(0.007)	(0.008)	(0.013)	
N	43027	47511	43027	47511	
Earns Positive Income	0.081***	0.025***	0.039***	0.052***	0.57
	(0.007)	(0.007)	(0.008)	(0.012)	
N	43026	47509	43026	47509	
Agricultural Sector	-0.037***	-0.011*	0.004	-0.007	0.10
	(0.004)	(0.006)	(0.006)	(0.011)	
N	43027	47511	43027	47511	
Manufacturing Sector	0.001	-0.007*	0.010**	0.010	0.17
	(0.003)	(0.004)	(0.005)	(0.007)	
N	43027	47511	43027	47511	
Services Sector	0.078***	0.026***	0.029***	0.038***	0.36
	(0.006)	(0.005)	(0.006)	(0.010)	
N	43027	47511	43027	47511	
Formal Health Insurance	0.032***	0.005	0.009*	-0.016*	0.41
	(0.004)	(0.005)	(0.005)	(0.009)	
N	43027	47512	43027	47512	
Mun-specific trends	No	No	Yes	Yes	

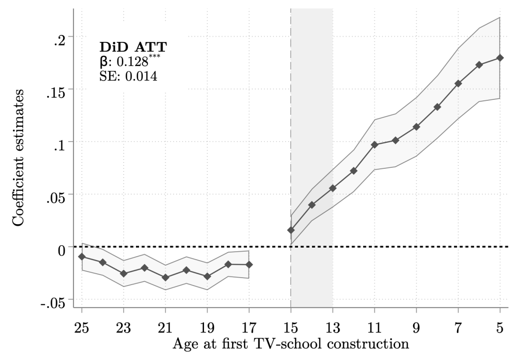
Notes: This table compares the impact of access to TV-schools on education outcomes (Panel A) and labor market outcomes (Panel B) using a continuous treatment and different econometric specifications. The models are: A standard two-way fixed effects (TWFE) model, which only includes municipality and cohort fixed effects, specified as a single-coefficient estimate model (col. 1) and as an equally-weighted average treatment on the treated (ATT) of post-treatment estimates from a dynamic TWFE event study model (col. 2); a TWFE model that besides municipality and cohort fixed effects, also includes municipality-specific linear time trends, specified as a single-coefficient estimate model (col. 3) and as an equally-weighted ATT of post-treatment estimates from the dynamic TWFE event study model (col. 4), which is our preferred specification. See Equation (1) and Section IV for details on the econometric specifications. The continuous treatment is school density in the municipality at age 15, measured as the number of TV-schools per 50 eligible children. The outcomes are: an indicator for graduating from primary, lower secondary, and upper secondary education, years of education, participation in the labor market, unconditional probability of earning positive income, unconditional monthly adult income in pesos, logarithmic transformation of hourly income, and indicators for unconditionally participating in the primary sector, secondary sector, and tertiary sector, and for receiving formal health insurance. Regressions use administrative school construction data from the Mexican Secretariat of Education (SEP) for 1980–2000, and outcome data from the 10% subsample of the 2010 Mexican census from IPUMS, restricting it to non inter-state migrants. Data is aggregated into birth-year by municipality-of-residence cells, and standard errors are clustered at the municipal level. Statistical significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Figure F1: Event Studies of Impacts of TV-School Intensity on Education Outcomes and Income (Continuous Treatment Variable)

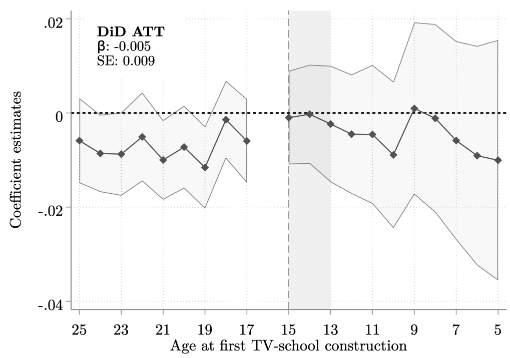
(a) Primary graduation



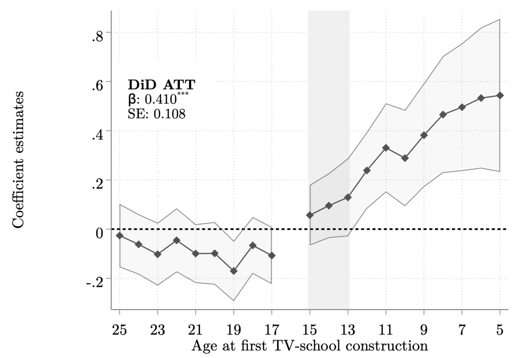
(b) Lower secondary graduation



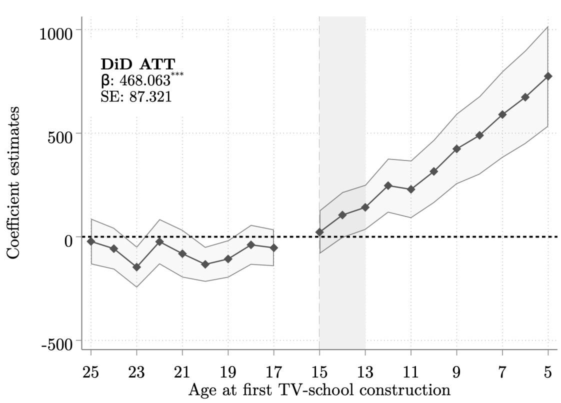
(c) Upper secondary graduation



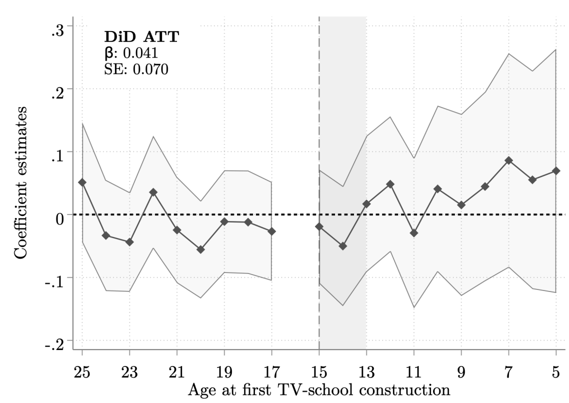
(d) Years of Education



(e) Monthly Income (pesos)



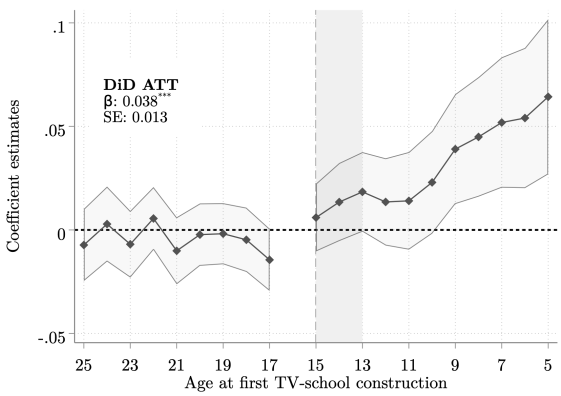
(f) Hourly Income (log)



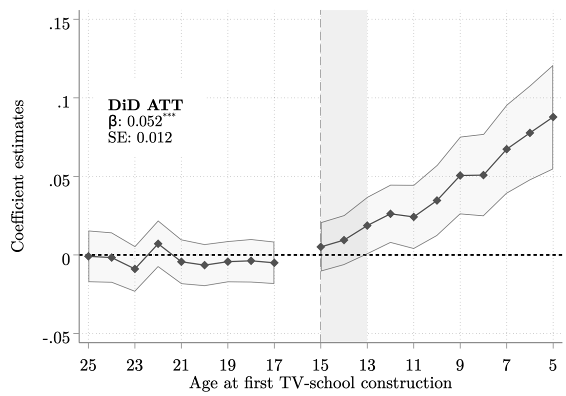
Notes: This figure shows the effect estimates of the TV-schools density by age at the first TV-school construction on different outcomes, using the continuous treatment variable. The econometric specification is a dynamic TWFE event study model that includes municipality and cohort fixed effects, and municipality-specific linear time trends. See Equation (1) for details. Event study coefficient estimates are shown with a solid line, and 95% confidence intervals are shown with a shaded area. All effects are computed with respect to age 16. The dynamic coefficient estimates are summarized with an equally-weighted average treatment on the treated single point-estimate DiD_{ATT} superposed in the graph alongside its standard error. See Section IV for details. Outcomes are: indicators for graduating from primary, lower secondary, and upper secondary education, years of education, unconditional monthly income in pesos, and the logarithmic transformation of hourly income. Data is from the Mexican Secretariat of Education (SEP) for 1980–2000, and the 2010 Mexican census (10% IPUMS subsample).

Figure F2: Event Studies of Impacts of TV-School Intensity on
Labor Market Composition Outcomes (Continuous Treatment Variable)

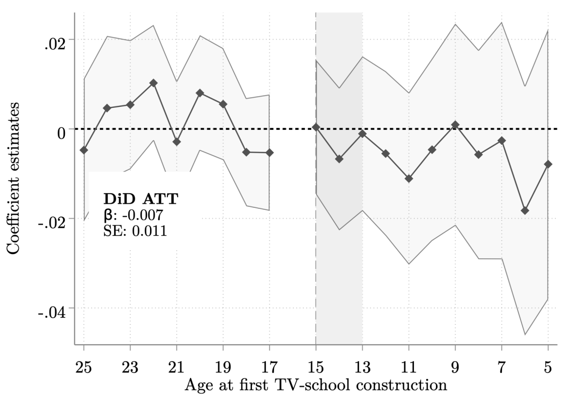
(a) Labor Force Participation



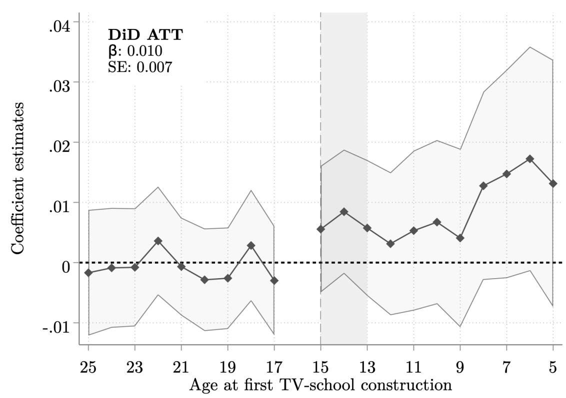
(b) Earns Positive Income



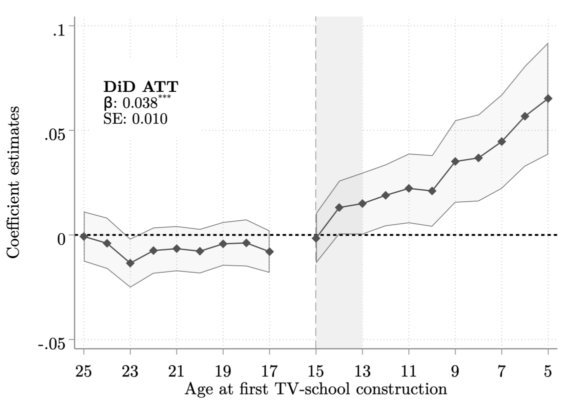
(c) Works in Primary Sector



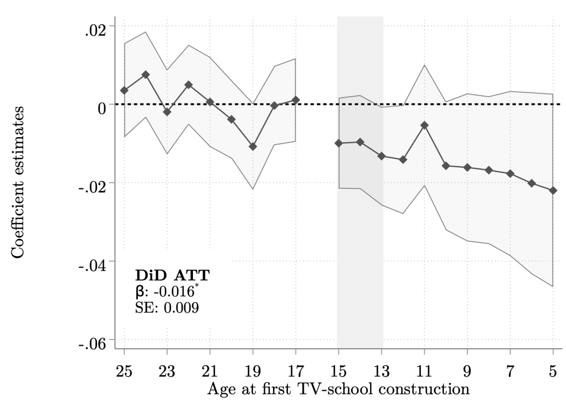
(d) Works in Secondary Sector



(e) Works in Tertiary Sector



(f) Receives Formal Health Insurance



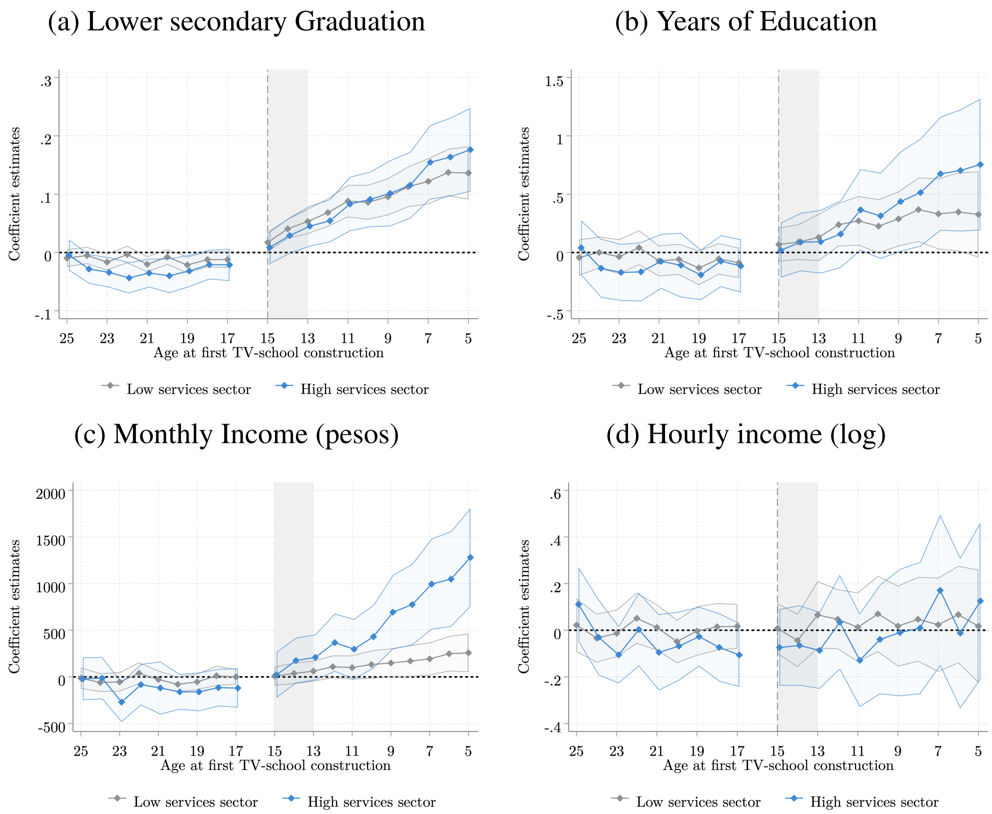
Notes: This figure shows the effect estimates of the TV-schools density by age at the first TV-school construction on different outcomes, using the continuous treatment variable. The econometric specification is a dynamic TWFE event study model that includes municipality and cohort fixed effects, and municipality-specific linear time trends. See Equation (1) for details. Event study coefficient estimates are shown with a solid line, and 95% confidence intervals are shown with a shaded area. All effects are computed with respect to age 16. The dynamic coefficient estimates are summarized with an equally-weighted average treatment on the treated single point-estimate DiD_{ATT} superposed in the graph alongside its standard error. See Section IV for details. Outcomes are: indicators for participation in the labor market and unconditional probability of earning positive income, unconditionally participating in the primary sector, secondary sector, and tertiary sector, and for receiving formal health insurance. Data is from the Mexican Secretariat of Education (SEP) for 1980–2000, and the 2010 Mexican census (10% IPUMS subsample).

Table F2: Heterogenous Impacts of the Density of TV-schools on Educational Outcomes by Services Sector Presence

	Difference in heterogeneity estimates				DiD_{ATT} **estimates**	
	DiD_{TWFE}	DiD_{ATT}	DiD_{TWFE}	DiD_{ATT}	Low services	High services
	(1)	(2)	(3)	(4)	(5)	(6)
Primary Graduation	0.090**	0.092***	-0.043*	0.017	0.035	0.052*
	(0.036)	(0.026)	(0.023)	(0.035)	(0.022)	(0.027)
p-value	0.013	0.000	0.066	0.636	0.110	0.056
N	43026	47511	43026	47511	47511	47511
Lower Sec. Graduation	0.062**	-0.008	-0.006	0.012	0.106***	0.117****
	(0.026)	(0.024)	(0.023)	(0.031)	(0.016)	(0.027)
p-value	0.019	0.739	0.798	0.709	0.000	0.000
N	43026	47511	43026	47511	47511	47511
Higher Sec. Graduation	0.008	-0.013	0.001	0.014	-0.013	0.001
	(0.016)	(0.014)	(0.015)	(0.020)	(0.009)	(0.018)
p-value	0.610	0.346	0.957	0.500	0.163	0.969
N	43026	47511	43026	47511	47511	47511
Years of Education	0.589**	0.470***	-0.224	0.190	0.299**	0.490**
	(0.237)	(0.164)	(0.182)	(0.242)	(0.126)	(0.206)
p-value	0.013	0.004	0.218	0.431	0.018	0.018
N	43026	47511	43026	47511	47511	47511
Mun-specific trends	No	No	Yes	Yes	Yes	Yes

Notes: This table shows the impact of the density of TV-schools on educational outcomes by the presence of services sector at baseline, defined as an indicator for whether the municipality had an above median share of services sector jobs in 1980. The first set of coefficient estimates are the interaction term between the treatment coefficient and the sectoral presence indicator from a fully-interacted single-coefficient two-way fixed effects (TWFE) model, DiD_{TWFE}, which includes municipality and cohort fixed effects (col .1), and additionally includes municipality-specific linear time trends (col. 3). The second set of coefficient estimates present the test of the linear combination of the equally-weighted average treatment on the treated (ATT) of post-treatment estimates by the sectoral presence indicator, coming from the dynamic TWFE event study model, DiD_{ATT}, also including municipality and cohort fixed effects (col. 2), and additionally including municipality-specific linear time trends (col. 4). See Equation (1) and Section IV for details on the econometric specifications. The last set of coefficients are the equally-weighted average treatment on the treated (ATT) of post-treatment estimates from the dynamic TWFE event study model, DiD_{ATT}, including municipality and cohort fixed effects, and municipality-specific linear time trends, ran as split-sample regressions by below-median services sector at baseline (col. 5) and above-median services sector at baseline (col. 6). The continuous treatment is TV-school density in the municipality at age 15, measured as the number of TV-schools per 50 eligible children. The outcomes are: an indicator for graduating from primary, lower secondary, and upper secondary education, and years of education. Regressions use administrative school construction data from the Mexican Secretariat of Education for 1980–2000, and outcome data from the 10% subsample of the 2010 Mexican census from IPUMS, restricting it to non inter-state migrants. Data is aggregated into birth-year by municipality-of-residence cells, and standard errors are clustered at the municipal level. Statistical significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Figure F3: Event Studies of Impacts of TV-School Intensity on Education Outcomes and Income by Sectoral Composition



Notes: This figure shows the effect estimates of the TV-schools density by age at the first TV-school construction on different outcomes. This is decomposed by the presence of services sector at baseline, defined as an indicator for whether the municipality had an above-median share of services sector jobs in 1980. The econometric specification is a dynamic TWFE event study model that includes municipality and cohort fixed effects, and municipality-specific linear time trends. See Equation (1) for details. Event study coefficient estimates are shown with a solid line, and 95% confidence intervals are shown with a shaded area. All effects are computed with respect to age 16. See Section IV for details. Outcomes are: indicators for graduating from lower secondary education, years of education, unconditional monthly adult income in pesos, and the logarithmic transformation of hourly income. Data is from the Mexican Secretariat of Education (SEP) for 1980–2000, and the 2010 Mexican census (10% IPUMS subsample).

Table F3: Heterogenous Impacts of the Density of TV-Schools on Labor Market Outcomes by Services Sector Presence

	Difference in heterogeneity estimates				DiD ATT estimates	
	DiD_{TWFE}	DiD_{ATT}	DiD_{TWFE}	DiD_{ATT}	Low services	High services
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Labor Outcomes						
Labor Market Participation	0.035***	0.006	0.020	0.018	0.025	0.043*
	(0.012)	(0.013)	(0.017)	(0.029)	(0.016)	(0.024)
p-value	0.004	0.669	0.237	0.528	0.123	0.075
N	43027	47511	43027	47511	47511	47511
Earns Positive Income	0.069***	0.044***	0.026	0.028	0.034**	0.062***
	(0.014)	(0.015)	(0.017)	(0.027)	(0.014)	(0.023)
p-value	0.000	0.003	0.129	0.297	0.013	0.007
N	43026	47509	43026	47509	47509	47509
Monthly Income	1157.376***	744.696***	242.246*	566.161***	169.974**	736.136***
	(167.465)	(131.511)	(142.819)	(216.262)	(76.143)	(202.414)
p-value	0.000	0.000	0.090	0.009	0.026	0.000
N	43026	47509	43026	47509	47509	47509
Hourly Income (log)	0.215***	0.083	0.097	-0.019	0.038	0.019
	(0.057)	(0.067)	(0.096)	(0.155)	(0.086)	(0.129)
p-value	0.000	0.216	0.312	0.902	0.659	0.884
N	43027	47512	43027	47512	47512	47512
Panel B: Labor Sectoral Composition						
Agricultural Sector	-0.029***	-0.034***	-0.010	-0.029	0.005	-0.024
	(0.009)	(0.010)	(0.013)	(0.022)	(0.014)	(0.017)
p-value	0.002	0.001	0.421	0.198	0.714	0.171
N	43027	47511	43027	47511	47511	47511
Manufacturing Sector	0.004	-0.001	-0.005	0.015	0.003	0.018
	(0.007)	(0.008)	(0.010)	(0.016)	(0.008)	(0.014)
p-value	0.611	0.889	0.630	0.347	0.721	0.189
N	43027	47511	43027	47511	47511	47511
Services Sector	0.066***	0.042***	0.029**	0.032	0.018	0.050***
	(0.012)	(0.011)	(0.014)	(0.021)	(0.011)	(0.018)
p-value	0.000	0.000	0.046	0.125	0.100	0.006
N	43027	47511	43027	47511	47511	47511
Formal Health Insurance	0.016*	0.009	-0.002	-0.005	-0.015	-0.020
	(0.009)	(0.010)	(0.015)	(0.021)	(0.010)	(0.018)
p-value	0.079	0.366	0.886	0.801	0.136	0.265
N	43027	47512	43027	47512	47512	47512
Mun-specific trends	No	No	Yes	Yes	Yes	Yes

Notes: This table shows the impact of the density of TV-schools on labor market outcomes by the presence of services sector at baseline, defined as an indicator for whether the municipality had an above median share of services sector jobs in 1980. The first set of coefficient estimates are the interaction term between the treatment coefficient and the sectoral presence indicator from a fully-interacted single-coefficient two-way fixed effects (TWFE) model, DiD_{TWFE}, which includes municipality and cohort fixed effects (col .1), and additionally includes municipality-specific linear time trends (col. 3). The second set of coefficient estimates present the test of the linear combination of the equally-weighted average treatment on the treated (ATT) of post-treatment estimates by the sectoral presence indicator, coming from the dynamic TWFE event study model, DiD_{ATT}, also including municipality and cohort fixed effects (col. 2), and additionally including municipality-specific linear time trends (col. 4). See Equation (1) and Section IV for details on the econometric specifications. The last set of coefficients are the equally-weighted average treatment on the treated (ATT) of post-treatment estimates from the dynamic TWFE event study model, DiD_{ATT}, including municipality and cohort fixed effects, and municipality-specific linear time trends, ran as split-sample regressions by below-median services sector at baseline (col. 5) and above-median services sector at baseline (col. 6). The continuous treatment is TV-school density in the municipality at age 15, measured as the number of TV-schools per 50 eligible children. The outcomes are: an indicator for participation in the labor market, unconditional probability of earning positive income, unconditional monthly adult income in pesos, logarithmic transformation of hourly income, and indicators for unconditionally participating in the primary sector, secondary sector, and tertiary sector, and for receiving formal health insurance. Regressions use administrative school construction data from the Mexican Secretariat of Education for 1980–2000, and outcome data from the 10% subsample of the 2010 Mexican census from IPUMS, restricting it to non inter-state migrants. Data is aggregated into birth-year by municipality-of-residence cells, and standard errors are clustered at the municipal level. Statistical significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table F4: Heterogenous Impacts of the Density of TV-schools by Type of Region

	Full sample	By services jobs		By standard school presence				Services jobs + standard school presence		
		Low	High	None at baseline	Low density	Has at baseline	High density	Low serv. + low density	High serv. + low dens.	High serv. + high dens.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
					Panel A: Education Outcomes					
Lower Sec. Graduation	0.128***	0.106***	0.117***	0.122***	0.116***	0.075***	0.116***	0.123***	0.087**	0.120***
	(0.014)	(0.016)	(0.027)	(0.016)	(0.016)	(0.025)	(0.030)	(0.017)	(0.035)	(0.044)
Mean	0.43	0.35	0.51	0.38	0.39	0.49	0.52	0.34	0.46	0.57
Observations	47511	24823	22688	26663	33363	20848	14148	20916	12447	10241
Years of Education	0.410***	0.299**	0.490**	0.447***	0.372***	-0.099	0.332	0.432***	0.293	0.470
	(0.108)	(0.126)	(0.206)	(0.119)	(0.114)	(0.235)	(0.259)	(0.135)	(0.217)	(0.408)
Mean	7.16	6.44	7.94	6.73	6.79	7.71	8.02	6.40	7.45	8.54
Observations	47511	24823	22688	26663	33363	20848	14148	20916	12447	10241
					Panel B: Income					
Monthly Income	468.063***	169.974**	736.136***	189.806**	206.294***	722.351***	939.170***	154.573**	337.432	1003.049***
	(87.321)	(76.150)	(202.489)	(81.765)	(80.198)	(207.265)	(237.998)	(75.816)	(216.242)	(378.700)
Mean	1847.28	1256.69	2493.33	1444.48	1542.45	2362.38	2566.05	1209.96	2101.06	2970.14
Observations	47509	24820	22689	26661	33361	20848	14148	20913	12448	10241
Hourly Income (log)	0.041	0.038	0.019	0.042	0.034	-0.070	-0.013	0.051	0.023	-0.063
	(0.070)	(0.086)	(0.129)	(0.084)	(0.078)	(0.130)	(0.160)	(0.088)	(0.171)	(0.162)
Mean	2.24	1.93	2.58	2.00	2.09	2.54	2.60	1.88	2.42	2.77
Observations	47512	24823	22689	26664	33364	20848	14148	20916	12448	10241
					Panel C: Labor market composition					
Labor Market Participation	0.038***	0.025	0.043*	0.022	0.017	0.041	0.078**	0.013	0.031	0.018
	(0.013)	(0.016)	(0.024)	(0.015)	(0.014)	(0.028)	(0.036)	(0.017)	(0.027)	(0.048)
Mean	0.58	0.55	0.63	0.56	0.57	0.61	0.63	0.54	0.60	0.66
Observations	47511	24822	22689	26663	33363	20848	14148	20915	12448	10241
Services Sector	0.038***	0.018	0.050***	0.022**	0.028***	0.043**	0.046*	0.021*	0.043**	0.024
	(0.010)	(0.011)	(0.018)	(0.010)	(0.010)	(0.022)	(0.024)	(0.011)	(0.021)	(0.032)
Mean	0.23	0.16	0.30	0.18	0.19	0.28	0.31	0.16	0.26	0.35
Observations	47511	24822	22689	26663	33363	20848	14148	20915	12448	10241

Notes: This table shows the impact of access to a high density of TV-schools on education and labor market outcomes by different municipality characteristics using split-sample regressions. The samples of analysis are: Full sample (col. 1), below and above the median of the share of services sector in 1980 (col. 2-3), without and with presence of standard schools in 1980 (col. 4,6) below and above the density of standard schools in 2000 (col. 5,7), low share of services sector in 1980 and low density of standard schools in 2000 (col. 8), high share of services sector in 1980 and low density of standard schools in 2000 (col. 9), high share of services sector and high density of standard schools in 2000 (col. 10). The continuous treatment is TV-school density in the municipality at age 15, measured as the number of TV-schools per 50 eligible children. The coefficient estimates are the equally-weighted average treatment on the treated (ATT) of post-treatment estimates from the dynamic TWFE event study model, DiD_{ATT}, which includes municipality and cohort fixed effects, and municipality-specific linear time trends. See Equation (1) and Section IV for details on the econometric specification. The outcomes are: an indicator for graduating from lower secondary education, years of education, the unconditional monthly adult income in pesos, the logarithmic transformation of hourly income, an indicator for participating in the labor market, and an indicator for participating in the services sector. Regressions use administrative school construction data from the Mexican Secretariat of Education for 1980–2000, and outcome data from the 10% subsample of the 2010 Mexican census from IPUMS. Data is aggregated into birth-year by municipality-of-residence cells, and standard errors are clustered at the municipal level. Statistical significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

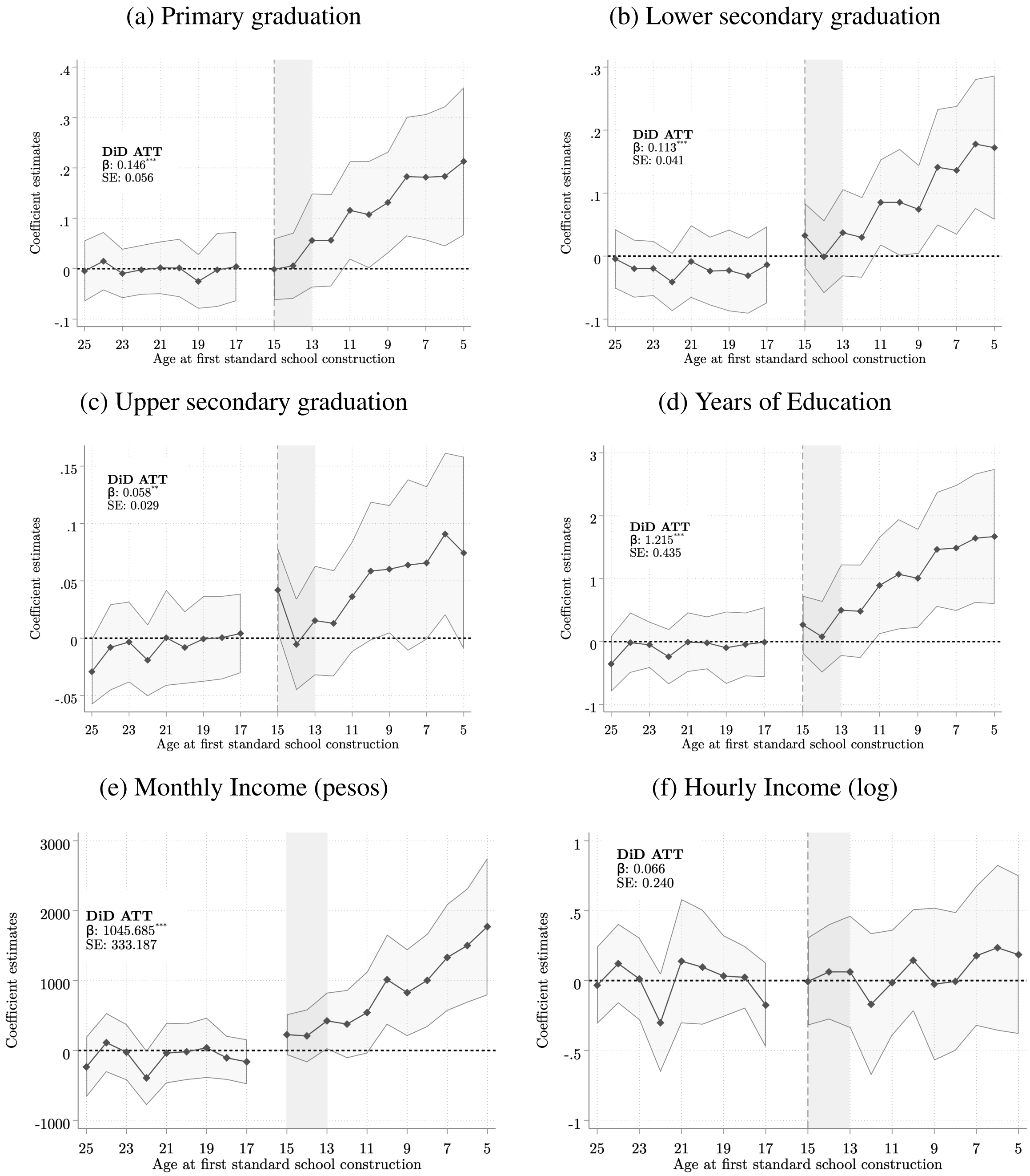
F.2 Estimates of the Impacts of Standard Schools

Table F5: Estimates of the Impacts of the Density of Standard Schools on Education and Labor Market Outcomes

	DiD_{TWFE}	DiD_{ATT}	DiD_{TWFE}	DiD_{ATT}	Mean
	(1)	(2)	(3)	(4)	
Panel A: Education Outcomes					
Lower Sec. Graduation	-0.156***	0.067**	0.177***	0.113***	0.60
	(0.043)	(0.031)	(0.053)	(0.041)	
N	42518	44651	42518	44651	
Years of Education	-2.153***	0.850***	1.082**	1.215***	8.89
	(0.406)	(0.280)	(0.486)	(0.435)	
N	42518	44651	42518	44651	
Primary Graduation	-0.316***	0.116***	0.143***	0.146***	0.83
	(0.054)	(0.039)	(0.048)	(0.056)	
N	42518	44651	42518	44651	
Higher Sec. Graduation	-0.009	0.018	0.003	0.058**	0.32
	(0.019)	(0.020)	(0.026)	(0.029)	
N	42518	44651	42518	44651	
Panel B: Labor Market Outcomes					
Monthly Income	-3.0e+03***	566.964***	580.563	1045.685***	3009.43
	(472.463)	(177.681)	(360.005)	(333.187)	
N	42518	44649	42518	44649	
Hourly Income (log)	-0.765***	0.129	0.174	0.066	2.73
	(0.103)	(0.146)	(0.109)	(0.240)	
N	42519	44652	42519	44652	
Labor Market Participation	-0.061***	0.028	0.108***	0.092*	0.65
	(0.023)	(0.025)	(0.039)	(0.049)	
N	42519	44651	42519	44651	
Earns Positive Income	-0.139***	0.021	0.118***	0.067*	0.55
	(0.028)	(0.022)	(0.042)	(0.038)	
N	42518	44649	42518	44649	
Agricultural Sector	0.096***	0.008	-0.013	0.023	0.10
	(0.013)	(0.014)	(0.016)	(0.028)	
N	42519	44651	42519	44651	
Manufacturing Sector	-0.017*	-0.024*	0.040**	-0.018	0.16
	(0.010)	(0.014)	(0.017)	(0.031)	
N	42519	44651	42519	44651	
Services Sector	-0.149***	0.043**	0.090**	0.095***	0.35
	(0.026)	(0.020)	(0.036)	(0.032)	
N	42519	44651	42519	44651	
Formal Health Insurance	-0.075***	0.045**	0.031	0.008	0.39
	(0.021)	(0.019)	(0.022)	(0.038)	
N	42519	44652	42519	44652	
Mun-specific trends	No	No	Yes	Yes	

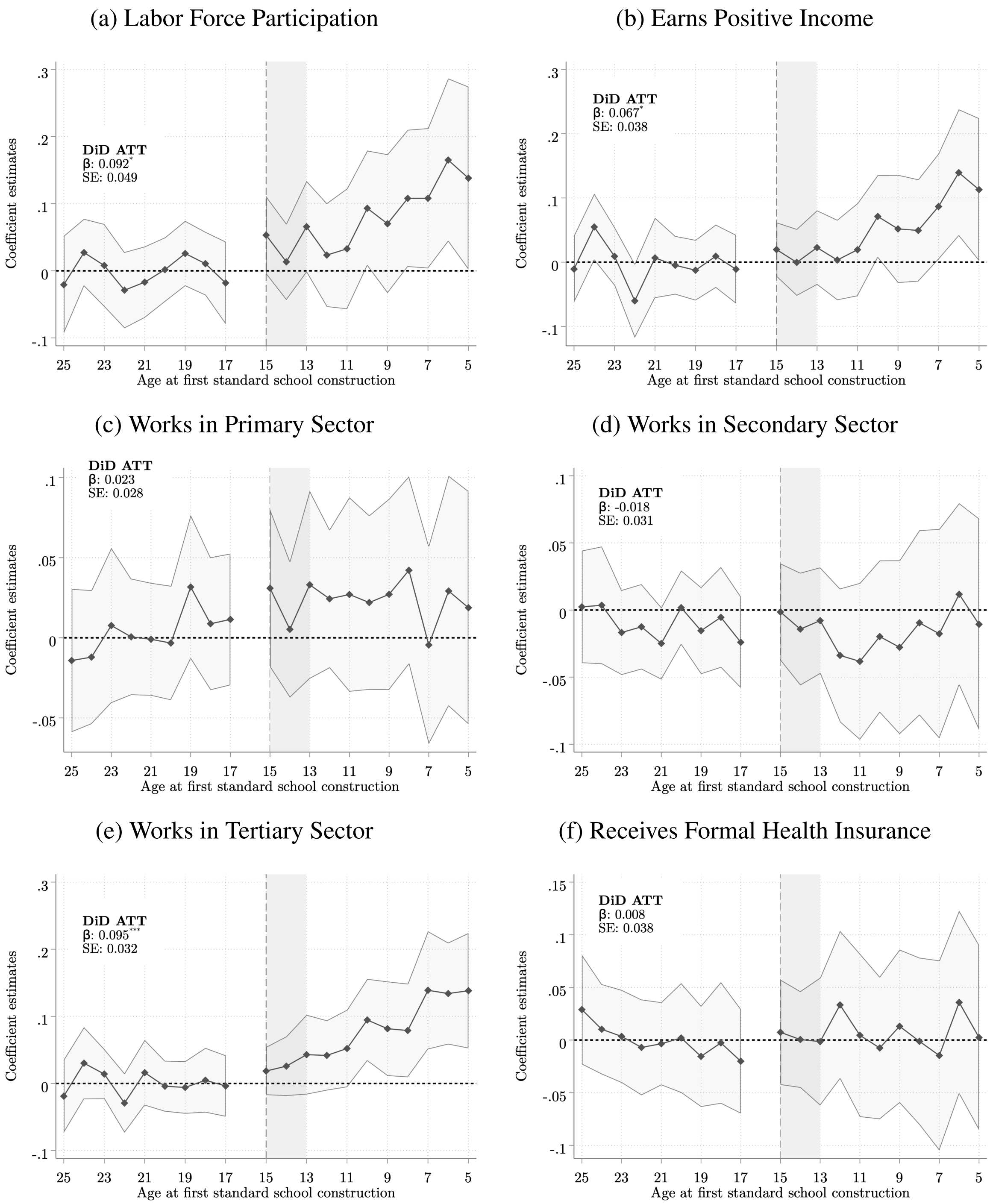
Notes: This table compares the impact of access to standard schools on education outcomes (Panel A) and labor market outcomes (Panel B) using a continuous treatment and different econometric specifications. The models are: A standard two-way fixed effects (TWFE) model, which only includes municipality and cohort fixed effects, specified as a single-coefficient estimate model (col. 1) and as an equally-weighted average treatment on the treated (ATT) of post-treatment estimates from a dynamic TWFE event study model (col. 2); a TWFE model that besides municipality and cohort fixed effects, also includes municipality-specific linear time trends, specified as a single-coefficient estimate model (col. 3) and as an equally-weighted ATT of post-treatment estimates from the dynamic TWFE event study model (col. 4), which is our preferred specification. See Equation (1) and Section IV for details on the econometric specifications. The continuous treatment is school density in the municipality at age 15, measured as the number of standard schools per 50 eligible children. The outcomes are: an indicator for graduating from primary, lower secondary, and upper secondary education, years of education, participation in the labor market, unconditional probability of earning positive income, unconditional monthly adult income in pesos, logarithmic transformation of hourly income, and indicators for unconditionally participating in the primary sector, secondary sector, and tertiary sector, and for receiving formal health insurance. Regressions use administrative school construction data from the Mexican Secretariat of Education (SEP) for 1980–2000, and outcome data from the 10% subsample of the 2010 Mexican census from IPUMS, restricting it to non inter-state migrants. Data is aggregated into birth-year by municipality-of-residence cells, and standard errors are clustered at the municipal level. Statistical significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Figure F4: Event Studies of Impacts of Standard School Intensity on Education Outcomes and Income (Continuous Treatment Variable)



Notes: This figure shows the effect estimates of the standard school density by age at the first standard school construction on different outcomes, using the continuous treatment variable. The econometric specification is a dynamic TWFE event study model that includes municipality and cohort fixed effects, and municipality-specific linear time trends. See Equation (1) for details. Event study coefficient estimates are shown with a solid line, and 95% confidence intervals are shown with a shaded area. All effects are computed with respect to age 16. The dynamic coefficient estimates are summarized with an equally-weighted average treatment on the treated single point-estimate DiD_{ATT} superposed in the graph alongside its standard error. See Section IV for details. Outcomes are: indicators for graduating from primary, lower secondary, and upper secondary education, years of education, unconditional monthly income in pesos, and the logarithmic transformation of hourly income. Data is from the Mexican Secretariat of Education (SEP) for 1980–2000, and the 2010 Mexican census (10% IPUMS subsample).

Figure F5: Event Studies of Impacts of Standard School Intensity on Labor Market Composition Outcomes (Continuous Treatment Variable)



Notes: This figure shows the effect estimates of the standard school density by age at the first standard school construction on different outcomes, using the continuous treatment variable. The econometric specification is a dynamic TWFE event study model that includes municipality and cohort fixed effects, and municipality-specific linear time trends. See Equation (1) for details. Event study coefficient estimates are shown with a solid line, and 95% confidence intervals are shown with a shaded area. All effects are computed with respect to age 16. The dynamic coefficient estimates are summarized with an equally-weighted average treatment on the treated single point-estimate DiD_{ATT} superposed in the graph alongside its standard error. See Section IV for details. Outcomes are: indicators for participation in the labor market and unconditional probability of earning positive income, unconditionally participating in the primary sector, secondary sector, and tertiary sector, and for receiving formal health insurance. Data is from the Mexican Secretariat of Education (SEP) for 1980–2000, and the 2010 Mexican census (10% IPUMS subsample).

G Migration

A key consideration in our analysis using census data is that we observe only an individual's current municipality of residence, not where they received treatment. Thus, we proxy treatment status based on current residence, which may introduce misclassification if migration occurs. Assessing the role of migration on our estimates requires distinguishing three key issues.

First, if migration is unrelated to treatment, misclassification introduces measurement error but would not bias the estimates. Second, even if migration is unrelated to treatment, heterogeneous returns to education may arise between migrants and non-migrants. For example, while TV-school exposure may not influence migration likelihood, returns to education could be higher in certain destinations. Consequently, our main estimates are most relevant for individuals who remain in their state of birth.

Third, migration could undermine our causal interpretation if it systematically alters treatment and comparison group composition. Our identification strategy assumes similar trajectories absent treatment, but if TV-school exposure affects migration in ways that change group composition, it could bias estimates. Addressing this concern is a key focus of the following discussion.

In the next sections, we review literature on Mexicos migration patterns and their link to education. We then conduct robustness tests using census data to assess migration trends and potential biases.

Existing evidence on human Capital and migration in Mexico. Existing literature on migration and human capital examines whether migrants are positively or negatively selected based on education or skills. Chiquiar and Hanson (2005) find that Mexican immigrants in the U.S. tend to have higher education levels than non-migrants, while Richter and Taylor (2008) document that rural migrants generally have more education than those who stay. Since TV-schools were primarily in rural areas with lower education levels, if access to TV-schools led more educated individuals to migrate –whether to urban areas or abroad– we might underestimate effects by misclassifying treated individuals as untreated or missing those with higher education from the sample. However, other studies suggest lower-educated workers migrate more in areas with higher returns to education (Ibarraran and Lubotsky, 2007), making the direction of bias unclear. Importantly, these studies do not directly answer how an exogenous increase in secondary education affects migration, and disentangling unobserved factors remains a challenge.

A relevant piece of evidence to consider comes from the long-term follow-up of the Progresa experiment, Mexicos flagship conditional cash transfer (CCT) program aimed at keeping children in lower secondary school. Evaluated through a randomized controlled trial, Progresa significantly increased school enrollment during the transition from primary to secondary education. Araujo and Macours (2021) tracked children from rural, low-income areas who were randomly exposed to the program. Treated children were in 6th grade in 1998, while control children received the program 1.5 years later and were more likely to drop out, creating a substantial exogenous shock to lower secondary educational attainment. By 2017, when these individuals were 29 to 35 years old, migration was high: only 60% remained in their state of origin, 47% in their municipality, and 34% in their locality, with 12% migrating to the U.S. However, the key question is whether increased schooling due to Progresa influenced migration decisions. The study finds that migration from the locality of origin rose by five percentage points, while migration from the municipality increased only slightly (1.4 percentage points) and was statistically insignificant. Since our analysis is at the municipality level, this would suggest that municipal migration –our main threat– is unlikely to severely bias our estimates. Similarly, the program did not significantly affect permanent U.S. migration.

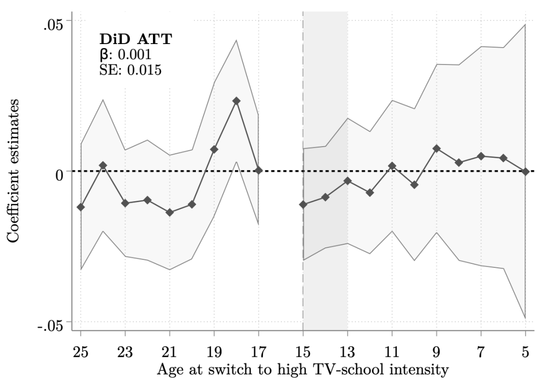
These results are encouraging for the internal validity of our estimates. Moreover, there are reasons to believe that our sample might be even less affected by migration than the CCT sample. For instance, overall migration seems to be lower in our sample, with only 8% of respondents reporting migration from their state of birth. Moreover, CCTs might be more conducive to migration than simple access to schools, as the cash transfers themselves can lower financial constraints to migration (Angelucci, 2015).

MIGRATION CHECKS USING 2010 CENSUS DATA. We consider different choices to account for migration and its potential impact on our estimates. First, we restrict the analysis to individuals who remained in their state of birth, as we cannot accurately assign treatment status to those who migrated out of state. Leaving these individuals in the sample would result in their fundamental misclassification since their location is reported in adulthood. Second, even among those who stayed in their state, TV-school access may have influenced migration between municipalities within a state, potentially affecting our estimates. Finally, international migrants who leave the sample entirely are unobserved, introducing another source of potential bias. We examine the evidence for these concerns in the following discussion.

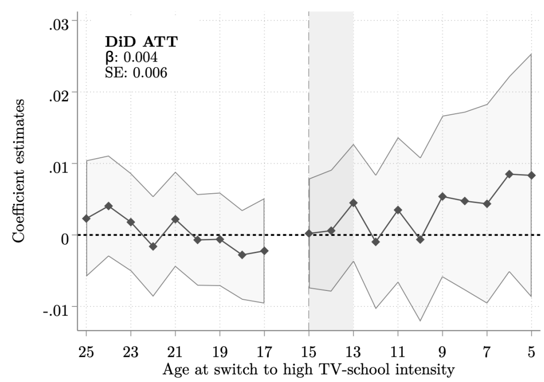
Figure G1: Event Studies of Impacts of TV-School Intensity on Cohort Population Size and Share of Females

Panel A. Excluding inter-state migrants (main sample)

(a) Log (Municipal Population)

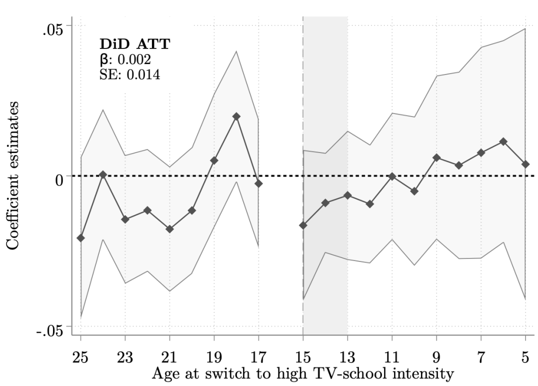


(b) Share of Females

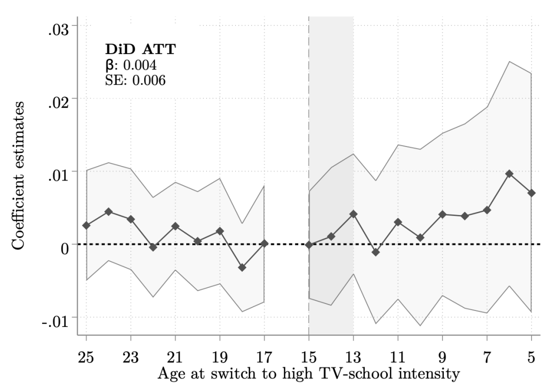


Panel B. Including inter-state migrants

(c) Log (Municipal Population)



(d) Share of Females



Notes: This figure shows the effect estimates of the TV-schools density by age at the first TV-school construction on different outcomes. The econometric specification is a dynamic TWFE event study model that includes municipality and cohort fixed effects, and municipality-specific linear time trends. See Equation (1) for details. Event study coefficient estimates are shown with a solid line, and 95% confidence intervals are shown with a shaded area. All effects are computed with respect to age 16. The dynamic coefficient estimates are summarized with an equally-weighted average treatment on the treated single point-estimate DiD_{ATT} superposed in the graph alongside its standard error. See Section IV for details. Outcomes are the logarithm of the population in a cohort, and the share of females in the cohort. Data is from the Mexican Secretariat of Education (SEP) for 1980–2000, and the 2010 Mexican census (10% IPUMS subsample).

First, we assess whether municipal out-migration affects our estimates by examining whether cohort sizes differ by treatment status. For instance, if TV-school access increased migration, we would expect to find smaller cohorts in treated municipalities compared to comparison municipalities. Importantly, analyzing cohort sizes helps address concerns about both domestic and international migration, as individuals who migrate abroad are typically absent from survey data.

Figure G1a presents coefficients from a regression analogous to equation 1, where the dependent variable is the log of population size for each municipality-cohort cell. This uses our primary analysis sample, which excludes migrants from their state of birth. We find no significant changes in municipal cohort sizes following the introduction of TV-schools. Given that men are also more likely to migrate to the U.S., we also test whether the treatment affected the gender ratio by cohort. Again, we find no significant changes (Figure G1b). We re-run these estimates including those individuals who reported migrating from their state of birth. This likely captures a potential differential inflow of migrants into municipalities. Again, we find no differential effects by municipal treatment status when including this population (Figures G1c and G1d).

MIGRATION CHECKS USING 2000 CENSUS DATA. As a second approach to address concerns about domestic migration, we use data from the 2000 census, which records respondents' municipality of residence in 1995. This allows us to 'move' individuals back in time to their 1995 municipality, which, if we focus on those treated around that time, brings them to where they likely lived during lower secondary school. By assigning treatment status based on their 1995 municipality and tracking their outcomes in 2000, regardless of whether they migrate, this approach reduces concerns that selective migration could distort our estimates.

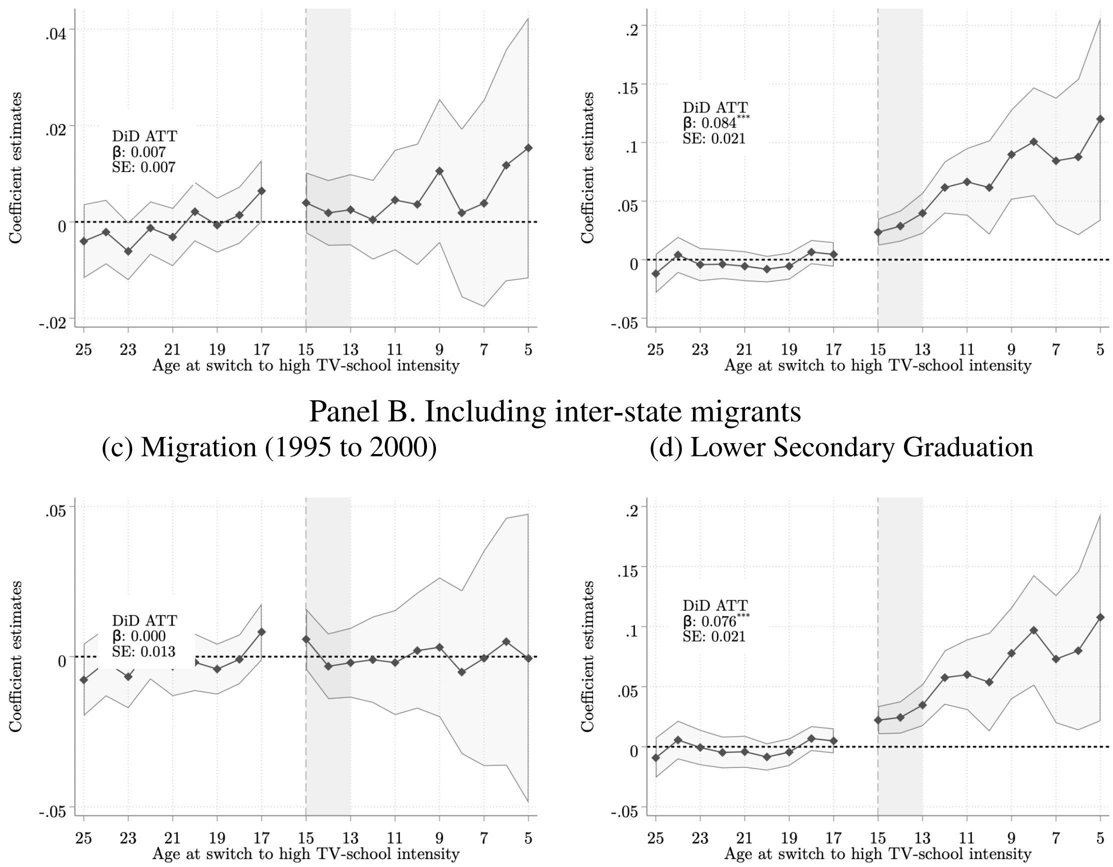
Figure G2: Event Studies of Impacts of TV-School Intensity on Migration (1995-2000) and Short-Term Effects on Education (2000 Census)

Panel A. Excluding inter-state migrants

(a) Migration (1995 to 2000) | (b) Lower Secondary Graduation

Panel B. Including inter-state migrants

(c) Migration (1995 to 2000) | (d) Lower Secondary Graduation



Notes: This figure shows the short-term effect estimates of the TV-schools density by age as measured in 2000. The econometric specification is a dynamic TWFE event study model that includes municipality and cohort fixed effects, and municipality-specific linear time trends. See Equation (1) for details. Event study coefficient estimates are shown with a solid line, and 95% confidence intervals are shown with a shaded area. All effects are computed with respect to age 16. The dynamic coefficient estimates are summarized with an equally-weighted average treatment on the treated single point-estimate DiD_{ATT} superposed in the graph alongside its standard error. See Section IV for details. Outcomes are migration and lower secondary graduation. Data is from the Mexican Secretariat of Education (SEP) for 1990–2000, and the 2000 Mexican census (10% IPUMS subsample). Panel A excludes individuals who report migrating from their state of birth. Panel B includes these individuals.

We focus on cohorts born between 1970 and 1985 (aged 10 to 25 in 1995) and exploit variation from TV-school construction in the 1990s. For this analysis, we exclude municipalities with high levels of construction in earlier years. We present two types of results: first, effects on migration from 1995 to 2000, and second, estimated effects on lower secondary completion. We do not examine labor market outcomes, as treated cohorts would still be too young to be meaningfully affected.

Panel B in Figure G2 use a sample that includes individuals who in 2000 reported migrating from their state of birth. Figure G2a shows no discernible significant effects on short-term migration between 1995 and 2000. Meanwhile, Figure G2b shows a 7.6 percentage point increase in lower secondary graduation, consistent in magnitude with our main estimates.

Figures G2c and G2d repeat this analysis but with a sample that excludes individuals who reported migrating from their state of birth, making it more similar to that of our main specification. Reassuringly, we observe very little change in point estimates, suggesting that this restriction does not introduce bias. If the short-term effects for these cohorts, who are less subject to selective migration, are representative of the broader sample, this provides further confidence that our estimates are unlikely to be severely biased by selective migration.

ESTIMATING IMPACTS WITH ALTERNATIVE HOUSEHOLD SURVEY DATA. Since assessing long-run migration impacts using census data is inherently challenging, we complement our analysis with data from the 2016 Módulo de Movilidad Social Intergeneracional (MMSI) 2016, a nationally representative survey collected by INEGI to study social mobility among individuals aged 25 to 64. A key feature of this survey is its retrospective question on respondents' place of residence at age 14, allowing us to assign treatment status based on their reported locality at that age and directly estimate effects of TV schools on education and migration.

The MMSI dataset has two main limitations. First, it lacks information on labor market outcomes, including current earnings or income, preventing direct analysis of these variables. Second, its smaller sample size, particularly in rural areas, reduces statistical power. In fact, when using municipal-level TV-school construction as our treatment variable it leads to very noisy and inconclusive point estimates. However, to increase power, we leverage locality-level TV-exposure exposure at age 14. Localities are an administrative unit below the municipalities (similar to a large neighborhood). Exposure to a TV-school in the locality is likely a more intensive treatment and we have more variation to identify impacts.

To maximize power and reduce noise, we pool contiguous cohorts and restrict the analysis to a $\pm$ 15-year window around the switch year. Additionally, we use a continuous measure of TV-school construction, standardized by the localitys population of 12- to 14-year-olds, multiplied by 50 for comparability.

Formally, we estimate:

$$Y_{lmc} = \alpha + \sum_{\tau \in [36,0], \tau \neq 16,15} \beta_\tau (\text{TS})_l \times 1[\text{Age at switch}_m = \tau] + \gamma_l + \lambda_c + \gamma_m \cdot t_c + \varepsilon_{lc} \tag{3}$$

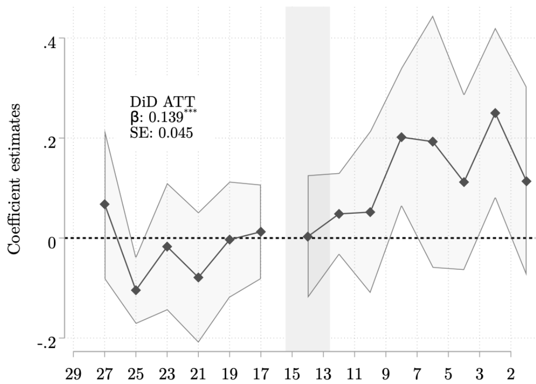
Where we include locality and cohort fixed effects and municipality-specific linear time trends. Standard errors are clustered at the locality level.

According to the MMSI, 41% of individuals report living in a different locality than they did at age 14, 34% migrated from their municipality, and 18% changed states. However, our key question is the extent to which this migration is related to treatment. Figure G3 presents the results. The estimates are noisy but suggest positive effects on lower secondary graduation. When combining effects into a single point estimate (which excludes partially treated), we find a 14 p.p. increase, nearly identical to the 13 p.p. estimate from our municipal-level analysis using a continuous treatment variable. This similarity is reassuring, as these estimates are unaffected by migration after age 14.

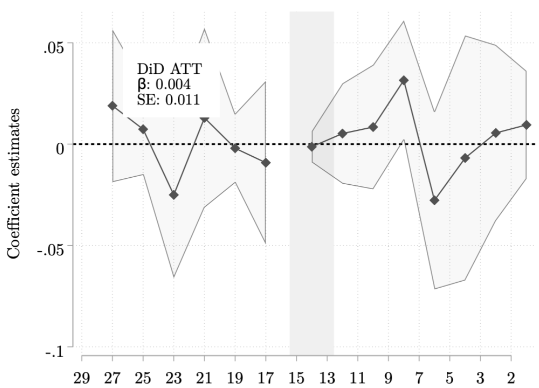
We also directly estimate the effects of TV-school exposure on migration, examining whether individuals moved to a different municipality or state by age 14. We find little evidence of differential migration across states, which is also reassuring for our main analysis, which restricts the sample to non-migrants from their state of birth. The estimates for migration to a different municipality are noisier but suggest a 2.8 p.p. increase in the probability of moving. This effect is modest and only marginally significant, suggesting that selective migration is unlikely to substantially bias our main results.

Figure G3: Event Studies of Impacts Using Household Survey Data

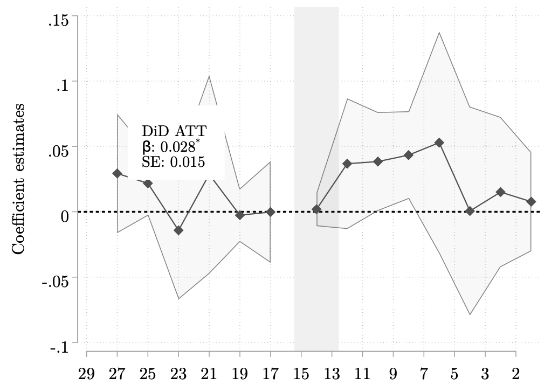
(a) Lower Secondary Graduation



(b) Migrated from state at age 14



(c) Migrated from municipality at age 14



Notes: This figure shows effect estimates of the TV-schools continues density measure using data from the Módulo de Movilidad Social Intergeneracional (MMSI). The econometric specification is a dynamic TWFE event study model that includes locality and cohort fixed effects, and municipality-specific linear time trends. Event study coefficient estimates are shown with a solid line, and 95% confidence intervals are shown with a shaded area. All effects are computed combining two years together, to increase power. The dynamic coefficient estimates are summarized with an equally-weighted average treatment on the treated single point-estimate DiD_{ATT} superposed in the graph alongside its standard error.

H Honest DiD

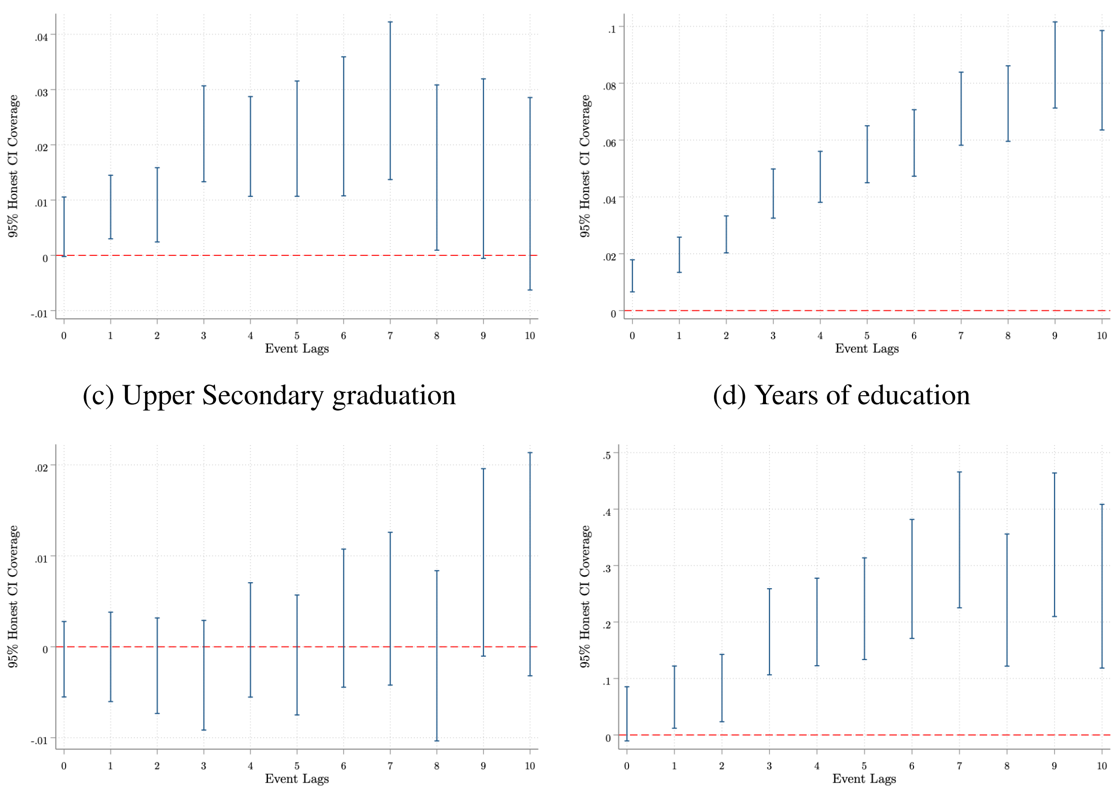
Figure H1: Educational outcomes

(a) Primary graduation

(b) Lower Secondary graduation

(c) Upper Secondary graduation

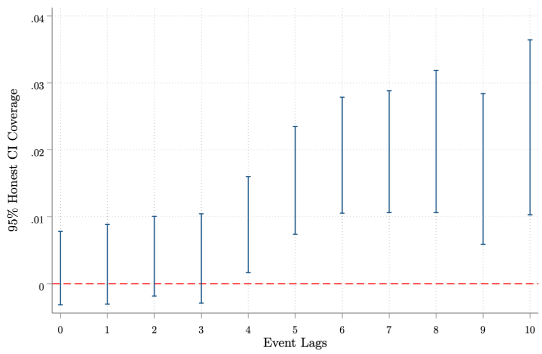
(d) Years of education



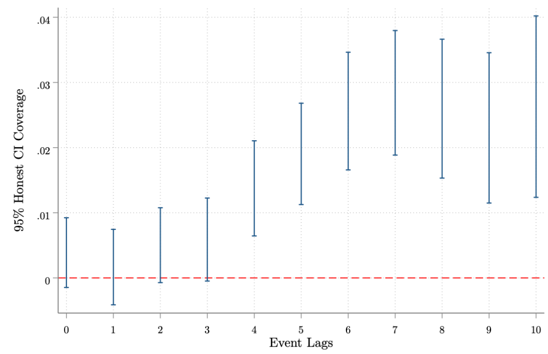
Notes: We show 95% confidence intervals estimated with Rambachan and Roth (2023) "Honest DiD" methods. These corresponds to the dynamic TWFE specifications without municipal linear trends. Here instead of assuming parallel trends or imposing municipal linear trends, valid 95% confidence intervals are constructed under the assumption that post-treatment trends in treated municipalities relative to untreated would have followed their prevailing path from the pre-treatment period, allowing for violations of standard parallel trend assumption.

Figure H2: Labor Market Outcomes

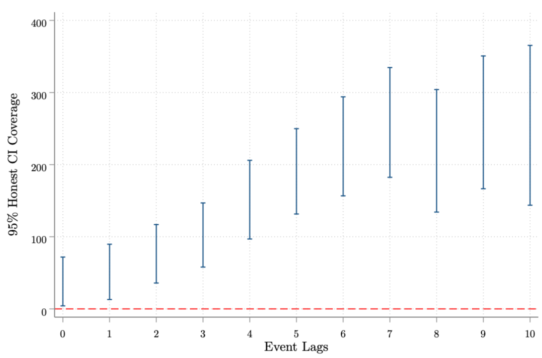
(a) Labor Market Participation



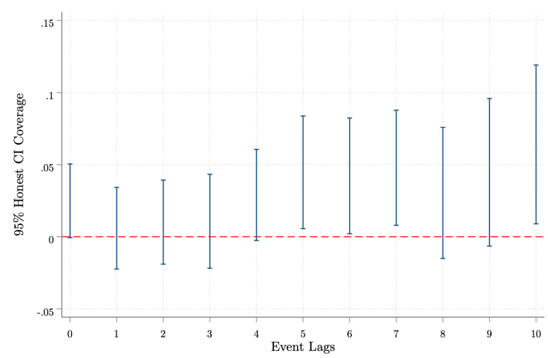
(b) Earn Positive Income



(c) Monthly Income



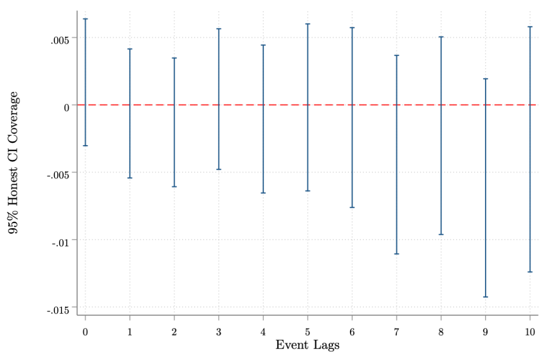
(d) Hourly Income (log)



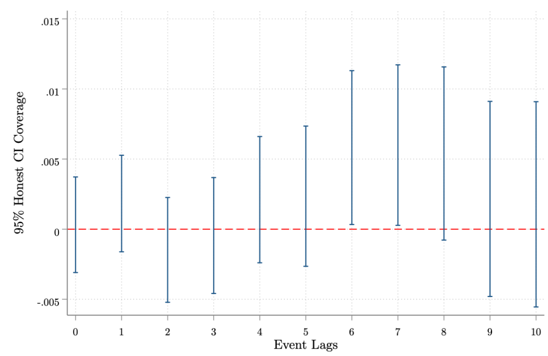
Notes: We show 95% confidence intervals estimated with Rambachan and Roth (2023) "Honest DiD" methods. These correspond to the dynamic TWFE specifications without municipal linear trends. Here instead of assuming parallel trends or imposing municipal linear trends, valid 95% confidence intervals are constructed under the assumption that post-treatment trends in treated municipalities relative to untreated would have followed their prevailing path from the pre-treatment period, allowing for violations of standard parallel trend assumption.

Figure H3: Labor Market Composition Outcomes

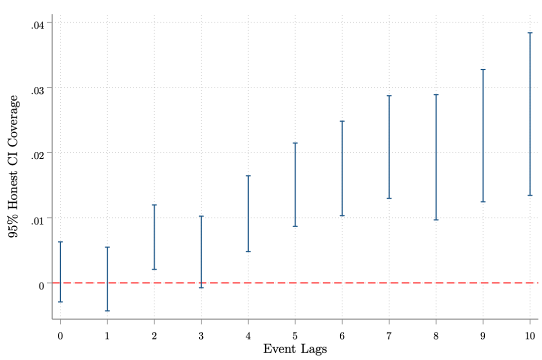
(a) Works in Primary Sector



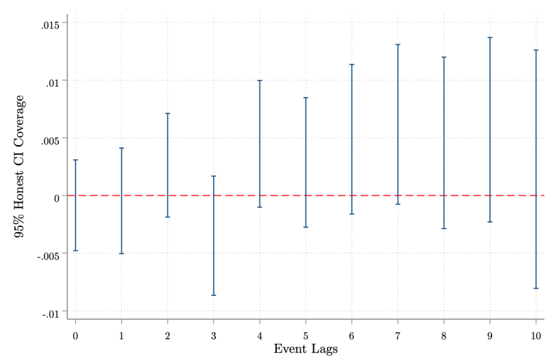
(b) Works in Secondary Sector



(c) Works in Tertiary Sector



(d) Receive Formal Health Insurance



Notes: We show 95% confidence intervals estimated with Rambachan and Roth (2023) "Honest DiD" methods. These corresponds to the dynamic TWFE specifications without municipal linear trends. Here instead of assuming parallel trends or imposing municipal linear trends, valid 95% confidence intervals are constructed under the assumption that post-treatment trends in treated municipalities relative to untreated would have followed their prevailing path from the pre-treatment period, allowing for violations of standard parallel trend assumption.

I Cost-Benefit Analysis

This section provides additional details on the cost-benefit analysis, comparing the earnings gains from the additional education attained by affected cohorts during the school construction period with the estimated costs of operating TV-schools during this time. All reported costs are in 2010 Mexican pesos or the corresponding nominal USD amount. We use price deflators from the World Bank and OECD and the MXN peso to USD exchange rate has been sourced from IMF records.

BENEFITS. We estimate the effects of the rollout of TV schools during our study period on the aggregate discounted lifetime earnings of fully exposed cohorts. We assume this includes individuals born between 1965 and 1990, the primary cohorts in our sample that were exposed to the expansion during this period. However, we note that this is a conservative assumption, as several subsequent cohorts could have benefited from later construction dates.

For comparability in later calculations, we use the estimated effect based on the continuous treatment variable, which results in an impact of 468 pesos per month, or 5,616 pesos per year (equivalent to US \$444). We assume a 2% discount rate and a 3-year delay in workforce entry, with individuals remaining in the labor market for 45 years. Additionally, we conservatively assume no earnings growth over the lifecycle. Under these assumptions, we estimate a discounted lifetime impact of 156,064 pesos (USD \$12,350) per person. Multiplying this amount by the total cohort sizes, we arrive at an aggregate impact of 143.2 billion pesos (USD \$11.3 billion).

COSTS. We consider two types of costs: direct and indirect. We discuss each one in turn.

Direct costs. Direct costs are associated with the investment required to set up and maintain the TV-school infrastructure and system, as well as the recurring costs of running these schools during the 1980-2000 period. We base our calculations on the TV-school cost data from Calderoni (1998), which provides detailed information on both investment and recurring costs for managing these schools and is the most comprehensive cost data we could find. These reported costs already include several assumptions, which we take as given, such as the length of replacement cycles for various inputs (e.g., school buildings lasting 30 years, audiovisual equipment for 8 years, etc.), and an assumed investment opportunity cost of 10%. An additional simplification is the TV-school program could become fully operational within a year, disregarding the higher per-student costs associated with earlier, smaller-scale implementation. The only main adjustments we make to these reported costs are related to scale, specifically estimating the number of schools built during the relevant period and assuming that each school could serve 15 students per grade. Additionally, we adjust the reported costs from 1997 USD to 2010 Mexican pesos.

Investment costs include expenses related to television program setup, such as script development, production, materials, installing receivers, and satellite dishes, as well as infrastructure costs for school equipment and facility setup. Recurrent costs primarily cover TV-school program development, teacher and principal salaries and benefits, training, operational maintenance, and other costs related to the day-to-day centralized administration of these schools.

Overall, we estimate that direct costs amount to about 33 billion pesos during this period. It is interesting to note that while investment costs represent a large part of the setup costs for TV-schools, on a per-student basis, these costs account for just under 20% of the total costs, whereas recurring costs make up 80%, with teacher and staff salaries and benefits still representing 34% of the per-student costs.

Indirect costs. For indirect costs, we consider the opportunity cost of attending school and the deadweight loss of taxation.

To assess opportunity costs, we use 2000 census data to estimate lost earnings due to students' additional time spent in school. We estimate that the earnings for those who dropped out (conditional on working) were about 2,535 pesos per month. While some students might have dropped out as early as 1980, we believe this figure is more representative of their earnings during the time they were in school. We assume that, had students not enrolled or dropped out, they could have worked for an additional 10 months each year. Since we estimate that the program increased years of education by 0.42, we assume that across the population, the forgone earnings correspond to 4.21 months. We also adjust this number to reflect that 5% and 13% of primary and lower secondary students, respectively, would not have completed their education without the TV-schools, as per our estimates. We further assume a 0.2 deadweight loss from taxation, similar to Duflo (2001), since we do not have precise estimates for this figure in Mexico.

Aggregating all these direct and indirect costs, we arrive at a total of 42.2 billion pesos. Given the assumptions required for this analysis, our estimates should be interpreted with caution. However, they provide a rough sense of the magnitudes of the benefit-cost ratio. Under these assumptions, we estimate the benefit-cost ratio to be at least 3.4. It's likely that this number would be higher as we assumed no wage growth, and did not account for other potential benefits associated with increased education that may not be directly reflected in earnings.

For comparison, we also conduct a rough calculation of the benefit-cost ratio for standard schools. Since we lack detailed cost data for standard schools and do not observe what their impacts would have been had they served the same areas and students as TV-schools, this exercise relies on two strong assumptions. First, we assume that the benefits of standard schools are at least as large as those of TV-schools. Second, we estimate costs by starting with the TV-school cost structure, subtracting expenses related to televised instruction, and adding the cost of employing at least six teachers per school. Under these assumptions, the benefit-cost ratio for standard schools is approximately 1.5. To match the benefit-cost ratio of TV-schools, standard schools would need to generate more than twice the earnings gains for these students.

J Data Sources and Variable Descriptions

School construction date. The secondary school data comes from the Mexican Secretariat of Education (*Secretaría de Educación Pública*, SEP). We use two sources for lower secondary school data: the 2015-2016 school directory, and yearly school enrollment records from 1990 to 2000. The 2015-2016 school directory is a database of all lower secondary schools in Mexico, including each school's unique identifier, address, geographical coordinates, school type, foundation date, registration date into the school record, and, if applicable, closing and reopening dates. The registration system was created in 1981, and all schools existing before 1981 have the same registration date, making the distinction between the foundation date and registration date important. The yearly school records are annual databases of all lower secondary schools opened in a given academic year in Mexico, including each school's unique code, address, geographical coordinates, school type, and total number of enrolled students by grade.

We use three sources of information to determine the school construction date: the foundation date and registration date from the 2015-2016 school directory, and the annual records that show when schools were operating. These three dates should match, but they sometimes do not, and the number of date discrepancies varies significantly by state. We impute the school construction date by combining these three data sources using the procedure described below. The earliest year among the foundation date, registration date, and yearly opening is designated as the "probable school construction date". However, the school registry was created in 1981, and in some states, schools built before this year were recorded as being constructed in 1981 or 1982. Similarly, since yearly records began in 1990, some schools built before this year are recorded as having opened in 1990. Therefore, sudden large increases in recorded school constructions at the state level in 1981, 1982, or 1990 are considered as unreliable.[31]

Due to this, states are manually assigned into groups based on the reliability of their probable construction dates. This reliability is determined visually. The classification is as follows: Groups 1 and 5 do not have any school date replacements. Constructions in Groups 2, 4, and 6 are considered unreliable if the school construction date is prior to 1982. Constructions in Group 3 are considered

[31] Note that in 1981-1982, there was a TV-school construction boom, with the introduction of this school modality to new states. Hence, this unreliability assignment is potentially overly restrictive, and we are throwing away potentially useful variation for caution.

unreliable if the school construction date is prior to 1983. Additionally, schools constructed in 1990 are deemed unreliable if they came from the yearly files and were not included in the previous exceptions. We create the "first construction year" variable as the earliest year a school is open at the municipality and school-type level (TV-school, standard school).

We combine several sources of school coordinates to have the maximum coverage. We use the school coordinates from the school directory and the yearly school records, if available. If not, we use the locality coordinates if the locality is rural, and the locality centroid coordinates for urban localities. Lastly, we use the average of primary schools coordinates from the same locality.

CONSTRUCTION OF VARIABLES RELATED TO SCHOOL TREATMENTS. All the variables below are defined at the (municipality)-(year)-(school-type) level:

- **Imputed first construction year (minimum):** This variable is marked as missing if no school was constructed during the 1980-2000 period, if the first school was constructed after 2000, or if the first construction year is considered unreliable (see above).

- **Number of schools open (sum)**: If the number of schools is missing or if the first construction occurred post-2000, it is marked as zero. If deemed unreliable, it is marked as missing for all years prior to the probable first construction year.

- **Presence of a school type:** This is defined as having a positive number of schools open, with a zero if the number is zero and not unreliable. If deemed as unreliable, it is marked as missing if the year is prior to the probable first construction year and the start year is not missing

- **Density of a school type (continuous treatment, $_{mc}$):** Defined as the number of schools open at the municipality-year level divided by the population aged 12 to 14 in 1980, multiplied by 50. The density is marked as zero if the number of schools open is zero, and as missing if the population data is missing or deemed unreliable for all the years prior to the probable first construction date. The density variable is winsorized at the 99 percentile.

- **Year relative to the first construction year**: This is the difference between the current year and the municipality's probable first construction year. It is marked as missing if the starting year is missing, either due to no schools being constructed in the relevant period or because it is considered unreliable.

- **Post-treatment average density (used for the continuous event study):** This variable is the average density of schools after the first construction year.

- Above-median density treatment indicator (binary treatment, $AboveTS_{mc}$): This indicator is computed by determining whether the municipality-year has a density above the median of all positive densities across all years. If the density is missing, the indicator is marked as missing if the switching year occured *before* or *at* the unreliable probable date.

- **Year of switching to above median density:** This identifies the first year the municipality switches from not being above median to being above median, excluding missing years. If no school was ever constructed, if the data is unreliable, or if the switch occurred after 2000, it is marked as missing.

- **Relative year to the switching year:** This is the difference between the current year and the year the municipality switches to above-median density. It is marked as missing if the switching year is missing.

We manually correct incorrectly allocated TV-schools in the years prior to 1968, setting their probable construction year to 1968. We create "placebo relative years" for municipalities without school constructions or without switching by assigning a placebo first construction year (switching year). We generate a variable containing all the years of school constructions between 1980 and 2000, separate them by percentiles, and randomly assign the percentile values to all untreated municipalities. This variable is used only for sample restriction purposes before analysis, ensuring balanced samples between treated and control municipalities during the window timing sample restrictions around the switching event.

AGGREGATE ENROLLMENT SHARES. To construct the aggregate enrollment shares, we combine the annual secondary school enrollment data from the Mexican Secretariat of Education for the period 1990-2000, and population counts from the Mexican census. The school records are yearly databases of all lower secondary schools open in a given academic year in Mexico. Among other information, they include the unique school code for each school, address, geographical coordinates, school type and total number of enrolled students per grade. The population counts at the locality level come from the 1990, 2000 and 2010 census and from the 1995 and 2005 population counts, all from the Instituto Nacional de Estadística y Geografía (INEGI).[32] The population counts in each census year are aggregated at the locality-cohort level. For individuals older than 25 years-old, they are also binned in 5-age intervals.

Whenever possible, we split the 5-age population count bins into cohort population counts following the cohort proportions from the 1990 census. If the specific cohorts proportions are not available, and given that there are almost no differences in cohort sizes within a 5-age bin, we divide the population groups into five equally-sized cohorts. We obtain yearly population counts using a cubic spline interpolation across census years.

We aggregate the school-level enrollment data by separately computing the total number of standard school and TV-school students in a given locality and year. Assuming no individuals leave their locality to attend a school, we use the cohort size from the imputed population data to compute the enrollment shares in TV-schools and standard school students, and proportion of individuals not enrolled in secondary education.

[32] Specifically, the population data come from the following datasets: *XI Censo General de Población y Vivienda 1990*, *I Conteo de población y vivienda 1995*, *XII Censo General de Población y Vivienda 2000*, *II Conteo de población y Vivienda 2005*, and *XIII Censo de Población y Vivienda 2010 Cuestionario Básico*.

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