Secondary Schools with Televised Lessons:
The Labor Market Returns of the Mexican Telesecundaria

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Abstract

In areas with an insufficient supply of qualified teachers, delivering instruction through technology may be a solution to provide education. This paper analyzes the educational and labor market impacts of an expansion of junior secondary education in Mexico through schools using televised lessons, the *telesecundarias*. Exploiting their staggered rollout from 1968 to 2000, I show that for every additional telesecundaria per 50 children, ten students enroll in junior secondary education. I find that an additional year of education increases long-run income by 12.5–13.9%, driven partly by increased labor force participation and a shift away from agriculture and the informal sector.

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1 Introduction

After steadily increasing for 15 years, the worldwide secondary school enrollment rate has stagnated at about 66% since 2013 (The World Bank, 2019). This leaves more than 200 million children of secondary-school age out of school (UNESCO, 2017). Providing post-primary education requires teachers specialized in subjects at advanced levels, but such teachers are in short supply in rural and marginalized areas worldwide, especially in developing countries (Banerjee et al., 2013). Given this constraint, delivering content through information and communication technologies (ICT) as a substitute for trained in-person teachers has the potential to help expand post-primary education around the world.

This paper investigates the educational and labor market impacts of a large-scale expansion of secondary education in Mexico through schools using televised lessons, called *telesecundarias*. Telesecundarias are a type of junior secondary school[1] that delivers all lessons through television broadcasts in a classroom setting, with a single support teacher per grade. The televised content follows the national curriculum and is complemented with learning guides and in-classroom work and discussions. They started in 1968 and by 2016, 18,754 telesecundarias served 1.43 million students, representing 21.4% of all junior secondary students. Exploiting the staggered rollout of telesecundarias across different geographical areas and over time, I find that a high density of telesecundarias significantly increases educational attainment, long-run employment, and average income among individuals who could have attended them. I then use the staggered rollout to estimate the labor market returns to pursuing secondary education through telesecundarias.

This is not an isolated program: A dozen low- and middle-income countries started using televisions in education between 1950 and 1970 (Calixto Flores and Rebollar Albarrán, 2008), and many more have implemented similar programs since then.[2] Interactive televised lessons have been introduced in the past years in rural schools in Brazil, Ethiopia, and Ghana (Assefa, 2016; Johnston and Ksoll, 2017). More recently, the worldwide school closures due to the Covid-19 pandemic have dramatically increased the need to use ICT to deliver educational content, and many governments have adopted low-tech educational technologies such as radio and televised lessons (Barron Rodriguez et al., 2021). After investing in capacity-building and in developing and scaling-up these technologies, policy-makers in low- and middle-income countries may want to use them in school settings in a permanent way to solve remaining educational challenges.

The Mexican telesecundaria expansion has two features that make it useful for examining the labor market impacts of secondary schools using remote lessons. First, the 50-years

[1]The typical ages for junior secondary education are 12 to 14.

[2]Besides telesecundarias, some of the most well-known and successful examples are the Telecurso in Brazil (1978) and the National Open School of India (1989) (The World Bank, 2005).

history of telesecundarias allows me to investigate very long-run effects of providing access to secondary education in general, and through schools using remote lessons in particular. This feature overcomes the difficulty of documenting the long-run effectiveness of using technologies in the classroom due to the short track record of most of these initiatives. Second, many developing countries today face similar educational challenges to those faced by Mexico during the 1960s. As such, studying the long-term effects of telesecundarias may inform other governments currently considering the large-scale use of remote lessons in the classroom.

In the first part of the paper, I estimate the causal effects of the telesecundaria expansion on long-run education and labor market outcomes. Given that telesecundaria students come from relatively disadvantaged backgrounds, a simple comparison between individuals with differential telesecundaria access would likely underestimate the true effects of the program. I exploit the quasi-exogenous variation in telesecundaria availability generated by the gradual expansion of telesecundarias by using a difference-in-differences approach. Intuitively, it compares the labor market outcomes of individuals with access to different densities of telesecundarias, net of cohort and locality averages. To do so, I combine school-level construction data for all secondary schools in Mexico from the Ministry of Education with detailed individual-level data from the Employment and Occupation National Survey (ENOE) on labor market outcomes and working conditions for almost 875,000 individuals. I find that for every additional telesecundaria per 50 school-aged children in a locality, ten students enroll in junior secondary education. This results in an average increase of 0.8 additional years of education. Additionally, there is a significant reduced-form increase in hourly income, partly driven by increased labor force participation, a shift away from the agricultural sector towards services, and a transition to the formal sector.

In the second part of the paper, I use the gradual telesecundaria expansion to estimate the returns to enrolling in junior secondary education—through telesecundarias—on earnings. An important concern is that unobserved factors affecting labor market outcomes may be correlated with the decision to enroll in a telesecundaria. To address it, I implement an instrumented difference-in-differences approach, using the intensity of telesecundaria expansion as an instrument for junior secondary enrollment. An additional year of education after enrolling in a telesecundaria increases income on average twenty years after attending secondary education by 12.5–13.9%.[3] To interpret these results, it is important to understand whether the increase in returns is relative to not pursuing secondary education at all, or whether these are the impacts of attending telesecundarias relative to attending conventional secondary schools. I provide empirical evidence that the compliers come from a combination

[3]Estimates of the private rate of return to secondary education worldwide through Mincerian regressions are about 7.2%, and the rate of return to tertiary education is about 15.2% (Montenegro and Patrinos, 2014).

of both types of counterfactuals, and that between 26% and 70% of them would have not attended any secondary school had the additional telesecundarias not been constructed.

This paper relates to several strands of literature. First, it relates to the body of research investigating the labor market returns to secondary education, focusing mainly on developed countries (see, for example, the literature surveyed in Card (1999) and Gunderson and Oreopoulos (2010)). Previous research has also documented the impacts of expanding access to primary education in the developing world on education and labor market outcomes, many using large school construction projects as sources of variation like this paper (Duflo, 2001; Duflo, 2004; Kazianga et al., 2013; Akresh et al., 2018; Karachiwalla and Palloni, 2019; Delesalle, 2019). Yet, few papers rigorously document the long-run labor market returns to secondary education in developing countries (Spohr, 2003; Ozier, 2016). Duflo et al. (2017) is the first evidence on the returns of free access to secondary education, using a randomized experiment providing scholarships in Ghana. To the best of my knowledge, this is the first paper computing the long-run returns to secondary education using a large country-wide schooling expansion as a natural experiment.

Second, it relates to the growing literature studying the impacts of technology in education (see Bulman and Fairlie (2016) and Escueta et al. (2017) for surveys).[4] Most of the research on remote lessons evaluates them as complements to formal schooling and face-to-face instruction in developed countries, focusing on Massive Open Online Courses (MOOCs) and college online classes (Figlio et al., 2013; Banerjee and Duflo, 2014; Alpert et al., 2016; Bettinger et al., 2017; Goodman et al., 2019) or early childhood educational TV programs (Kearney and Levine, 2015a). Recent work in developing countries shows that remote lessons deliver gains in student achievement (Johnston and Ksoll, 2017; Beg et al., 2019) and, in combination with a computer-assisted learning program, they additionally improve labor market outcomes and mental health (Bianchi et al., 2019). In contemporaneous work, Fabregas (2019) investigates the long-run effects of telesecundarias, finding increases in educational attainment, fertility reductions, and no significant effects on labor market outcomes.[5] Overall, most of these papers focus on understanding the effects of using technologies to deliver remote lessons in an educational context. My paper is distinct to this work, since its objective is to understand the impacts of *providing access* to secondary education through schools

[4] In a broad sense, the paper relates to the studies investigating the effectiveness of mass entertainment media programs on educational attainment and labor market outcomes (Gentzkow and Shapiro, 2008; Kearney and Levine, 2015b) and on changing perceptions of social norms and shaping behaviors (Chong and La Ferrara, 2009; La Ferrara et al., 2012; Berg and Zia, 2013; Kearney and Levine, 2015b; Banerjee et al., 2019). It contributes to the entertainment education literature by investigating the long-run impacts of televised content designed to cover a formal education curriculum.

[5] Differences in the labor market findings between Fabregas (2019) and this paper could be attributed to effects heterogeneity, since Fabregas (2019) exploits a different source of variation—the 1993 policy change making junior secondary education compulsory—and uses coarser treatment data at the municipality level.

that use low-cost technology as a substitute for in-person instruction.

The rest of the paper is organized as follows. Section 2 describes the institutional background of junior secondary education in Mexico and provides details on telesecundarias and their rollout. Section 3 describes the data sources. Section 4 presents the empirical strategy. Section 5 provides estimates of the reduced-form effects of telesecundaria on educational attainment and labor market outcomes. Section 6 computes the returns to secondary education and empirically investigates the counterfactuals to attending the telesecundarias. Section 7 investigates the sensitivity of the results to alternative econometric and sample specifications. Section 8 concludes.

2 Background

In this section, I outline the education system in Mexico and describe the specific characteristics and rollout process of telesecundarias.

Secondary education in Mexico. Compulsory basic education encompasses preschool education (ages 3 to 5), primary education (grades 1 through 6, ages 6 to 11), and junior secondary education (grades 7 to 9, ages 12 to 14). There are three junior secondary education modalities: General schools *(secundaria general)*, technical schools, offering a combination of general subjects and technical subjects, and telesecundarias, schools providing the junior secondary content through televised lessons complemented with in-class support.[6] In 2016, there were 6.71 million junior secondary students in Mexico: 50.6% and 27.1% attended general and technical schools, respectively, and 1.43 million attended telesecundarias, representing 21.4% of the total. Out of the 39,265 junior secondary schools, 47.8% were telesecundarias (INEE, 2017). Throughout my paper, "brick-and-mortar schools" denotes all junior secondary schools with face-to-face instruction, including general secondary schools and junior technical schools. After finishing junior secondary education, students receive a certificate of completion that is required to enroll in higher education. The administration of basic educational services is decentralized and is the responsibility of state authorities.[7]

The telesecundarias. Telesecundaria is a junior secondary school modality that provides all lessons through television broadcasts in a classroom setting. Telesecundarias are small schools, usually with only one class per grade and between 15 and 30 students per class.

[6]The residual junior secondary school modalities are community secondary schools (0.6%) and secondary education for workers (0.3%) (INEE, 2017).

[7]In particular, 84% of basic education students are the responsibility of the state educational authorities, less than 7% are the direct responsibility of the federal government, and 9% are in private schools (SEP, 2014).

There is typically a single teacher per grade or even per school, the *maestro monitor* (supervisor teacher).[8] In contrast, brick-and-mortar schools have on average 11 or 12 teachers specialized in different subjects. Supervisor teachers are specially trained for this position and their duties are supervising the classroom, answering students' questions and grading homework and exams. They have teaching guides for all the subjects covered in the televised lessons. Daily classes are a combination of remote instruction and in-class work: Students watch a 15 minute televised lesson, followed by 35 minutes of class discussion and homework, guided by the *maestro monitor* and by basic concept books and learning guides (INEE, 2005). The televised lessons follow the national curriculum, are designed by pedagogical experts, and are recorded in a television studio in Ciudad de Mexico by teachers selected for their communication skills, the *telemaestros*. Lessons are simultaneously broadcasted to all telesecundarias in the country following a pre-established schedule. When the program was first introduced, transmission was through microwaves and TV antennas and, later, satellite technology, supplemented with videotapes and recordings. Telesecundarias' average administrative cost per student is half the cost of brick-and-mortar schools: In 2002, telesecundarias cost 6,811 pesos per student, compared to 12,460 pesos for general junior secondary schools and 14,572 for junior secondary technical schools (Martinez Rizo, 2005). Telesecundarias were initially designed to provide education in rural and isolated areas but, due to the lower administrative cost, they were later also introduced to urban areas, especially in marginalized locations with teacher supply constraints. As a result, telesecundaria students tend to come from families with a lower socioeconomic background than those attending brick-and-mortar schools,[9] and there is a wide range in the adequacy of infrastructure and quality of education services in telesecundarias.[10]

Telesecundaria introduction and rollout. Telesecundaria was created in 1968 to solve challenges related to the provision of secondary education. At the end of the 1950s, Mexico had very low literacy and school attendance rates,[11] but a successful initiative to expand access to primary education raised the number of primary school students from 4.1 million to 6.6 million in 10 years (Secretaría de Educación Pública, 2010). This accelerated

[8] In 2008, 20% of telesecundarias had only one or two teachers managing the three grades (SEP, 2014).

[9] For example, in 2016-2017, only 37% of telesecundaria students had mothers with secondary education or higher, and almost 60% benefited from the Prospera/Oportunidades conditional cash transfer (CCT) program, whereas the proportions were respectively 63% and 23% for brick-and-mortar students (INEE, 2016; INEE, 2017).

[10] In 2001, a survey revealed that 10.3% of telesecundarias didn't have electricity, 35% didn't have a television and 17% had one in bad shape, 25% had low reception signal, and 22% didn't have the introductory textbooks (Martinez Rizo, 2005). Supervisor teachers and students had to adapt the lessons and classes to these precarious circumstances.

[11] In the 1950s, forty-two percent of children between the ages of 6 to 14 were not attending basic education. Among those enrolled, only one third finished 6^{th} grade in urban areas and only 2% in rural areas (Secretaría de Educación Pública, 2010).

increase in primary school completion led to a sudden increase in demand for secondary education, exceeding by far the existing capacity, particularly in rural and isolated areas.[12] Telesecundarias were a solution to the inadequate supply of secondary education and to two specific challenges of constructing brick-and-mortar secondary schools: The shortage of qualified secondary school teachers willing to work in remote rural areas (Calderoni, 1998), and the scattered distribution of primary education graduates wanting to continue their studies. Telesecundarias were an attractive alternative because they could support smaller school and class sizes, and needed fewer qualified teachers. In the early days of telesecundarias, government agencies nationally planned school allocations based on "geographical and urban conditions, economic, cultural, social and hygienic factors" (SEP, 1967). In 2000, the Ministry of Education started to construct schools using, among other things, an algorithm that determines the unmet demand for each education level in every locality (SEP, 2012).

In terms of the spatial distribution of telesecundaria construction, many northern states have less than 10% of junior secondary students enrolled in telesecundarias, whereas the highest concentrations of telesecundaria students are between 39% and 45% of the total enrollment in Zacatecas, Veracruz, Hidalgo and Puebla (INEE, 2005).[13] Telesecundarias have been continuously and gradually constructed during 50 years, although there were two major waves of telesecundaria construction. In 1981, an expansion of telesecundarias to new states increased the number of telesecundarias from 694 to 3,279 (Martinez Rizo, 2005). In 1993, junior secondary education became compulsory, and telesecundarias—cheaper and requiring fewer teachers than brick-and-mortar schools—became an attractive option in places without access to junior secondary education, leading to a significant expansion in the years after the new legislation. I exploit this country-wide variation in the timing and location of telesecundaria constructions over 30 years to investigate the causal effects of telesecundarias.[14]

3 Data

In this section, I describe the main features of the data I use to measure the construction of telesecundarias and the long-run education and labor market outcomes.[15]

I use two sources of junior secondary school data from the *Secretaría de Educación Pública*

[12] In 1965, the number of primary school graduates unable to enter secondary school in Mexico was about 37% of the number of previous year's 6$^{\text{th}}$ graders (Mayo, 1975).

[13] Figure A.1 in the appendix shows the temporal and spatial distribution of telesecundaria construction, and Figure A.2a reports the distribution of the imputed school construction dates for all schools constructed in Mexican localities with fewer than 100,000 habitants.

[14] Other work investigates the impacts of telesecundaria using observational and descriptive techniques (e.g., Mayo, 1975; Calderoni, 1998; Santos, 2001), or exploiting the 1993 compulsory schooling law change (Fabregas, 2019).

[15] Additional details on the data sources, variables, and sample construction are provided in Appendix E.

Table 1: Summary statistics

	All individuals		Excluding migrants	
	Mean	SD	Mean	SD
Panel A. Individual characteristics				
Female	0.52	0.50	0.52	0.50
Age	34.93	12.07	34.53	12.03
Years of education	8.75	4.37	8.65	4.30
Lower secondary ed. enrollment rate	0.64	0.48	0.63	0.48
Upper secondary ed. enrollment rate	0.35	0.48	0.34	0.47
Tertiary ed. enrollment rate	0.15	0.36	0.14	0.35
Labor force participation rate	0.67	0.47	0.67	0.47
Unemployment rate	0.04	0.21	0.04	0.21
Weekly hours worked	41.85	18.68	41.51	18.57
Hourly income (MXN pesos)	13.51	30.08	12.73	27.70
Hourly income of workers (MXN pesos)	21.06	35.37	20.01	32.56
Sector: Construction	0.09	0.29	0.09	0.29
Sector: Manufacturing	0.16	0.37	0.16	0.37
Sector: Commerce	0.17	0.38	0.17	0.38
Sector: Services	0.38	0.49	0.37	0.48
Sector: Agriculture	0.17	0.38	0.19	0.39
Informal occupation rate	0.40	0.49	0.41	0.49
Social security access rate	0.32	0.47	0.31	0.46
Panel B. Schooling access				
Has access to secondary schools	0.68	0.47	0.67	0.47
Has access to telesecundarias	0.25	0.43	0.26	0.44
Has access to brick-and-mortar schools	0.57	0.49	0.56	0.50
Has access to both secondary school types	0.15	0.36	0.15	0.36
Number of secondary schools (if access)	6.06	7.10	5.83	6.94
Number of telesecundarias (if access)	1.61	1.05	1.60	1.05
Number of brick-and-mortar (if access)	6.41	6.84	6.22	6.69
Secondary schools per 50 children (if access)	0.25	0.36	0.26	0.37
Telesecundarias per 50 children (if access)	0.28	0.48	0.30	0.48
Brick-and-mortar per 50 children (if access)	0.16	0.13	0.16	0.13
Total population in 1990	22884	28285	21113	27223
Observations	1058112		874496	

Variable means displayed to the right of the variable name. Standard deviations displayed next to the mean. Individual-level data from all quarters of the 2005-2016 ENOE waves, with only the first observation for each individual. Summary statistics computed at the individual level for individuals in localities with less than 100,000 habitants and ages between 18 and 65 (Columns 1 and 2) and for the subsample of these that are not inter-state or international migrants (Columns 3 and 4). See section 3 for more details on sample selection and restrictions.

(Ministry of Education): The 2015-2016 school directory of all junior secondary schools in Mexico, and yearly school records of all junior secondary schools for the 1990-2014 period. Each dataset includes the school's unique identifier, address, geographical coordinates and school modality. The school directory contains information on the foundation date, date registered on the system, and closing and reopening dates. The annual records additionally include the total number of enrolled students by grade.

The identification strategy relies on comparing outcomes of cohorts from the same locality with different levels of telesecundaria exposure, which requires knowing the exact year each telesecundaria was constructed. Given that there are differences between the three sources of information for school construction dates—foundation date, date registered into the system, and yearly records—I combine the three variables and impute the school construction date for 19% of telesecundarias.[16] Mexico City is completely excluded from the analysis given its particular status as a federal district during part of the period of interest.

Although telesecundarias were initially intended to provide secondary education in rural and isolated areas where it was not feasible to construct brick-and-mortar secondary schools, they were later introduced in urban localities, especially in marginalized neighborhoods. Given this, the analysis focuses on the effects of telesecundarias in low urbanization localities, defined as the localities with less than 100,000 habitants by the Statistics and Geography National Institute (INEGI).[17] Of the 6,586 localities in the sample, 81% are rural localities and 15% are sub-urbanization localities.[18] Table 1 reports descriptive statistics related to schooling access for individuals in localities with less than 100,000 habitants (Columns 1 and 2). 68% of individuals in the sample had access to some type of secondary education in their locality after they finished primary school: 57% had access to brick-and-mortar schools, and 25% to telesecundarias.

Individual education and labor market outcomes are constructed using data from the *Encuesta Nacional de Ocupación y Empleo* (ENOE, Employment and Occupation National Survey), administered by the *Instituto Nacional de Estadística y Geografía* (INEGI, Statistics and Geography National Institute). The ENOE is a quarterly household survey on the labor market characteristics of the population and is administered as a five-quarter rotating panel.[19]

The policy-relevant treatment is the intensity of telesecundaria exposure when the individual was 12 years-old, so it is relevant to identify the localities in which individuals resided during their school-age years. A limitation of the ENOE dataset is that it doesn't record the locality of birth, only the state of birth and the locality of residence at the time of the survey. I define the measure of telesecundaria exposure for the individual's locality of residence, assuming they did not move from the locality after reaching school-age. To be consistent with this assumption, I restrict the sample to individuals born in the same state they were living

[16]75% of the differences between telesecundaria construction date sources are within two years or less. The technical details of the imputation procedure of the school construction date are in Appendix E.2. The main results are robust to alternative imputation procedures.

[17]The INEGI denotes the localities with less than 2,499 habitants as "rural localities", those with between 2,500 and 14,999 habitants as "sub-urbanization localities" and those with between 15,000 and 100,000 habitants as "low urbanization localities".

[18]Figure A.3 in the appendix shows the school construction rollout for only those localities used in the analysis.

[19]The survey is representative at the national and state levels, and for localities with less than 100,000 habitants. Although it is not representative at the locality-cohort level—the level of treatment—the distribution of individuals by year of the first telesecundaria construction in the ENOE sample is roughly similar to the distribution of construction dates for all schools in Mexico, mitigating the concerns of having a highly selected sample (Figure A.2a Panel (a), and Figure A.4a Panel (a)).

during the survey year, excluding from the analysis interstate and international migrants. I discuss the extent of the migration concerns and conduct sensitivity analysis in Section 7.

I use all ENOE waves from the 2005-2016 period, keeping only the first observation for each unique individual to avoid non-random attrition in subsequent survey waves. The sample includes only individuals aged between 18 and 65 at the time of the interview and, as explained above, living in the same state they were born in and in localities with less than 100,000 inhabitants. The final sample consists of 874,496 individuals, 40% of them living in rural localities and almost 28% in sub-urbanization localities. Within these localities, I exploit the construction of 2,663 telesecundarias in 2,317 different localities, more than 83% being constructed in rural areas.

The first panel of Table 1 reports descriptive statistics related to education and labor market outcomes of the individuals in the analysis sample (Columns 3 and 4) and of the sample including inter-state and international migrants (Columns 1 and 2). Based on a discrete educational level variable, I define four indicator variables for whether the individual enrolled in junior secondary education, graduated from junior secondary education, enrolled in upper secondary education, and enrolled in tertiary education. The dataset does not include information on the type of junior secondary school attended—telesecundarias or brick-and-mortar schools—only on whether individuals enrolled in junior secondary education. The average individual in the sample completed 8.65 years of schooling: 63% of individuals completed some junior secondary grades, 34% some upper secondary grades, and 14% completed some years of college or a upper technical qualification.

Regarding the long-term labor market outcomes, I investigate the individual's labor market participation, unemployment status, weekly hours worked, hourly income, labor market sector and occupation informality. The labor market participation identifies economically active individuals, either working or actively looking for a job.[20] Among individuals in the analysis, there is a labor force participation rate of 67% and there is a low unemployment rate of only 4%. The average number of hours worked in a week is 41, and the average income earned per hour worked among workers is 20 Mexican pesos (MXN). 19% of individuals work in the agricultural sector, 33% in manufacturing and commerce, and 37% in the services sector. Vulnerable and precarious labor market conditions are prevalent among workers in the sample: Almost 41% of individuals work in an informal occupation, and 31% do not have health care benefits through their jobs.

[20]The ENOE defines workers as individuals engaged in an economic activity in the week prior to the interview—either working in a formal job, earning some income informally, or helping in land work or in the family business—individuals temporarily not working (e.g., for a strike) or absent but with a secured job after the temporality finishes.

4 Empirical strategy

The main source of identifying variation is the staggered expansion of telesecundarias during the period between 1968 and 2000.[21] The gradual process of school construction naturally leads to variation in the availability of telesecundarias across regions and across cohorts. I measure the intensity of exposure through a variable identifying the telesecundaria density at the cohort-locality level:

$$TS_{lc} = \frac{\text{Number of telesecundarias}_{lc}}{\text{Population ages 12 to 14}_{l}} \times 50$$

where TS_{lc} is the number of telesecundarias available in locality l per 50 eligible children when individuals from cohort c were 12 years-old. The normalization of the number of schools with the size of the targeted population mitigates the imprecision in the measurement of the intensity of telesecundaria exposure, and the scaling factor of 50 approximates the number of seats available in a newly created telesecundaria. All results are reported using the continuous measure of telesecundaria exposure, TS_{lc}, as well as an alternative binarized measure, $AboveTS_{lc} \equiv 1[TS_{lc} \text{ above median}]$, identifying individuals with access to a density of telesecundarias above the sample median.[22]

4.1 Reduced-form effects estimation

Telesecundarias were not constructed at random; instead, they were specifically concieved to improve access to education in areas where it was unfeasible to provide educational services through traditional secondary schools. Hence, a simple comparison of mean outcomes between individuals from localities with different telesecundaria exposure may lead to biased estimates of the program effects, due to the correlation between telesecundaria construction and (observed and unobserved) factors directly influencing education and labor market outcomes.[23] A comparison of mean outcomes between old and young cohorts from the same locality with different telesecundaria exposure would likely overestimate the impacts as well, since education attainment tends to increase over time for a given population.

[21] I exclude school constructions after 2000 since they were partially decided following a centralized algorithm and, hence, more likely to be systematically correlated with other factors.

[22] The median density of telesecundarias is one telesecundaria per 54 eligible children (ages 12 to 14). Among individuals with access to a high density of telesecundarias ($AboveTS_{lc} = 1$), the average and the median telesecundaria densities are one telesecundaria per 33 and per 38 secondary-aged children, respectively. The density variable is winsorized at the 99% level.

[23] This bias has an ex-ante unknown direction: On the one hand, if telesecundarias are constructed in underdeveloped regions in need of other public investments, the results would likely underestimate the true impacts of telesecundarias. On the other hand, if telesecundarias are built in areas where they are likely to be successful, the true effects would be overestimated.

A difference-in-differences strategy addresses this identification challenge by comparing the mean outcomes of individuals with different telesecundaria exposure, net of locality and cohort averages. Intuitively, it compares the difference in outcomes of individuals living in the same locality from cohorts with different levels of telesecundaria exposure due to the timing of telesecundaria construction, with the difference in outcomes between individuals from the same cohorts in localities that did not experience a change in telesecundaria exposure. I implement it using a two-way fixed-effects difference-in-differences regression (TWFE), an ordinary least square regression of the outcome of interest on the telesecundaria exposure at the locality-cohort level, and on locality and cohort fixed effects. Formally, for individual i from cohort c living in locality l:

$$Y_{ilc} = \alpha + \beta(\text{TS exposure})_{lc} + \gamma_l + \lambda_c + \mathbf{X}_{ilc}\theta + \varepsilon_{ilc} \tag{1}$$

where Y_{ilc} is the outcome of interest (educational attainment, labor market participation, income, ...), $(\text{TS exposure})_{lc} \in \{TS_{lc}, AboveTS_{lc}\}$ is defined as above, γ_l and λ_c are locality and cohort fixed effects, $\mathbf{X}_{ilc}$ is a vector of individual characteristics, and ε_{ilc} is the error term. To account for the presence of heteroskedasticity and serial correlation, standard errors are clustered at the locality level. In a framework with 2 localities and 2 periods, β would capture the average treatment effect on the treated (ATT). In this setting—with multiple localities and cohorts—the treatment effect β is a weighted average of ATTs obtained from all possible two-by-two DiD estimators across all localities and cohorts, where the weights on the two-by-two DiDs are proportional to the group sizes and the treatment variance within each pair (de Chaisemartin and D'Haultfœuille, 2020; Goodman-Bacon, 2018).

I investigate the heterogeneity of the DiD effects by age at the first telesecundaria construction with the following equation:

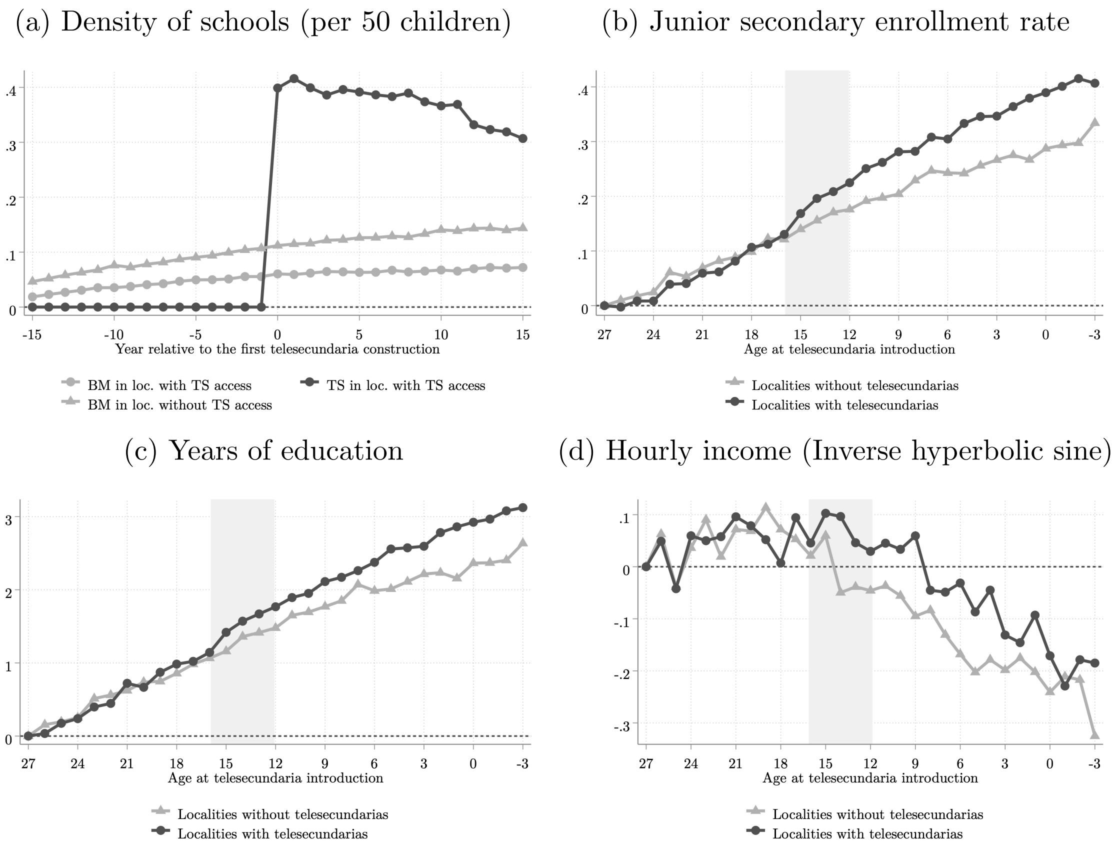
$$Y_{ilc} = \alpha + \sum_{\tau \in [27,-3], \tau \neq 17} \beta_\tau (\text{TS exposure})_l \times 1[\text{Age at constr.}_l = \tau] + \gamma_l + \lambda_c + \mathbf{X}_{ilc} + \varepsilon_{ilc} \tag{2}$$

where τ denotes the individual's age when the first telesecundaria was constructed in their locality, $(\text{TS exposure})_l$ is $AboveTS_l$—whether locality l has a telesecundaria density above median at some point—or TS_l—the average density of telesecundarias after the first one is constructed. All other parameters are defined as in equation (1). β_τ is the DiD effect estimate of the exposure intensity to telesecundarias at age 12 as a function of the individual's age when the first telesecundaria was constructed in their locality.

The main assumption needed to be able to interpret the estimated β as the reduced form effect of telesecundaria exposure is a common trends assumption, which requires that the potential growth path of the outcomes is independent from the actual treatment assigment.

Since the regression relies on group sizes and treatment variances weighting up the two-by-two DiD estimates, the appropriate identifying assumption is a variance-weighted version of the common trends assumption between all groups (Goodman-Bacon, 2018).

Figure 1: Evolution of outcomes relative to age at telesecundaria introduction



Notes: This figure presents the density of schools by type relative to the year of telesecundaria introduction (Panel (a)), and descriptive population trends of the average junior secondary enrollment rate (Panel (b)), average years of education (Panel (c)) and average hourly income (Panel (d)) in localities that never had a telesecundaria (light gray) and localities that eventually had one (black). The averages are computed with respect to the age of individuals the year the first telesecundaria was constructed in their locality. Localities that never had telesecundarias receive a random placebo year that follows the distribution of construction years in the sample. The outcome average is normalized at zero at the age of 27 for both groups.

Figure 1 provides evidence in favor of the validity of the parallel trends assumption by displaying descriptive trends using raw averages of the junior secondary enrollment rate, years of education and hourly income in localities with and without telesecundaria presence over the entire period. The averages are computed with respect to the age of individuals the year the first telesecundaria was constructed in their locality, or with respect to a randomly assigned placebo year if they never had a telesecundaria constructed. The vertical axis shows the raw average of the outcome, normalized to zero for the first year in the graph—the 27 relative age—for comparison purposes, and the horizontal axis shows the age at the construction of the first telesecundaria in the individual's locality. The graphs show that the cohort outcome averages follow the same trends in localities with and without telesecundaria construction for all cohorts too old to benefit from the telesecundaria expansion. The outcome averages start to diverge for the cohorts that had access to telesecundarias in their locality, while the averages for the same cohorts without access maintain the same trend. I consider the cohorts aged 13 to 16—highlighted with a grey band in Figure 1—as partially treated, either because they may have started school at later ages or have repeated some grades,[24] or because there may be one or two year discrepancies during the imputation of construction date, incorrectly classifying slightly older cohorts as untreated. Overall, these figures suggest that the common trends assumption is likely to hold in this context.

An additional concern related to the exogeneity assumption is the simultaneous introduction of other policies that can confound the effect estimates of the program of interest. In contrast to DiD designs exploiting a one-time policy change as main source of identification, I use the construction of 2,663 telesecundarias across Mexico over 30 years as the identifying variation. It is unlikely that other policies introduced at the federal, state or local level systematically coincide with the construction of telesecundarias. Nevertheless, a telesecundaria expansion could be accompanied by infrastructure investment—for example, roads, electricity, or TV antenna installation—needed to construct the televised school. If these public investments had constant direct effects on labor market outcomes for all cohorts in a given locality, the DiD strategy would rule them out. If, instead, these infrastructure improvements differentially affected younger cohorts, the reduced-form estimates would likely overestimate the true effects of the telesecundaria expansion. Although this is a confound I cannot completely rule out, the analysis by cohort in Figure 1 displaying clear trend breaks for cohorts around 12 to 15 years-old when telesecundarias were introduced (as well as the event study results in Figure 2a and Figure 2b) mitigates the extent of this concern.

Because the specification has multiple localities and periods, the DiD setting also requires a treatment monotonicity assumption and a stable treatment effect over time assumption (de Chaisemartin and D'Haultfœuille, 2020). The first automatically holds if the treatment is constant within each locality $\times$ period cell, which is the case when the treatment is defined at the locality-cohort level. The second allows for treatment effect heterogeneity across localities but not over time. An additional concern in two-way fixed-effects settings is the potential existence of negative weights on the weighted average, which can severely bias the estimated average treatment effect if treatment effects are heterogeneous across units (Borusyak et al., 2021; Callaway and Sant'Anna, 2021; de Chaisemartin and D'Haultfœuille, 2020; Goodman-Bacon, 2018; Sun and Abraham, 2021).[25] In Section 7, I investigate the

[24]As a reference, in 2016, 13% of 9$^{\text{th}}$ graders in telesecundarias were 17 or older. Additionally, 17% had repeated some grades since primary school (INEE, 2017).

[25]Goodman-Bacon (2018) shows that these only occur when treatment effects vary over time, and that they tend to bias the DiD estimates away from the sign of the true effect.

extent of the potential bias of the two-way fixed-effects estimates using de Chaisemartin and D'Haultfœuille (2020) approach for assessing the sensitivity of the results to heterogeneous treatment effects. The diagnostic measures suggest that the main results are unlikely to be sensitive to heterogeneous treatment effects. Nevertheless, following de Chaisemartin and D'Haultfœuille (2021), I also compute alternative DiD estimators robust to heterogeneous and dynamic treatment effects. The main results hold using this alternative specification, showing smaller impacts of telesecundaria on junior secondary enrollment and years of education, and substantially larger effects on adult labor market participation and hourly wage.

4.2 Returns to education estimation

An important metric to measure the effectiveness of educational interventions is the estimation of labor market returns as the average monetary returns of an extra year of schooling. In the telesecundaria setting, an OLS estimation of the effect of attending junior secondary education on labor market income is subject to two potential biases: First, a bias related to unobserved differences correlated with access to education, explained above. Second, a selection bias if individuals decide to enroll in secondary education based on some unobserved characteristics correlated with their future labor market outcomes, like their academic ability. I use an instrumented difference-in-differences (IV-DiD) approach to overcome these identification challenges. Let Y_{ilc} be the long-run labor market income, and $D_{ilc}^{S} \in \{0,1\}$ be a binary variable indicating whether the individual enrolled in junior secondary education.[26]

The equation of interest is:

$$Y_{ilc} = \alpha + \beta D_{ilc}^{S} + \gamma_l + \lambda_c + \mathbf{X}_{ilc}\theta + \varepsilon_{ilc} \tag{3}$$

with all parameters defined as in equation (1). I use the measures of telesecundaria density as the instrumental variables for junior secondary education enrollment, $Z_{lc}^{T} \in \{T_{lc}, AboveTS_{lc}\}$.[27]

Three assumptions are needed to interpret the estimated coefficients as local average treatment effects (LATE): The exclusion restriction and the monotonicity assumption, standard in the IV literature, and the common trends assumption, which has to be satisfied for both the treatment and the outcome.[28] If all assumptions hold, β^{LATE} identifies weighted sums of the LATEs of the switchers in each group and period, where switchers are the units that experience a change in their treatment status between two consecutive periods. In

[26] We can also replace the binary variable of attending secondary school with a discrete variable measuring the years of education received: $S_{ilc} \in \{1,2,\ldots\}$.

[27] Then, the first-stage and the reduced-form equations are respectively $D_{ilc}^{S} = \pi_0 + \pi_1 Z_{lc}^{T} + \gamma_l + \lambda_c + \mathbf{X}_{ilc}\theta + \nu_{ilc}$ and $Y_{ilc} = \phi_0 + \phi_1 Z_{lc}^{T} + \gamma_l + \lambda_c + \mathbf{X}_{ilc}\varphi + \upsilon_{ilc}$, with all parameters defined as in equation (1).

[28] Instead of the IV independence assumption, the exogeneity of the instrument in the IV-DiD relies on the common trends assumption. As above, this TWFE specification also requires a stable treatment assumption and a monotonicity of treatment assumption.

other words, β^{LATE} estimates the effect of enrolling in junior secondary education through telesecundarias on long-run outcomes for the complier subpopulation, i.e., those individuals induced to enroll in secondary education because they had access to a high density of telesecundarias who would have not enrolled otherwise.

As before, the plausibility of the common trends assumption is graphically assessed with Figure 1, Figure 2a and Figure 2b. The monotonicity assumption requires that all individuals are weakly more likely to attend junior secondary education after more telesecundarias are constructed in their locality.[29] Although the assumption is not empirically testable, it intuitively makes sense. The exclusion restriction requires that the only way the telesecundaria expansion affects labor market outcomes is through its effects on the probability of enrolling in secondary education.[30] The potential confounders have to systematically coincide with the telesecundaria construction in many localities and exclusively affect cohorts young enough to attend them. The construction of higher education institutions, if they tended to occur a few years after the construction of telesecundarias, would satisfy this criteria. However, the absence of significant effects in the likelihood of enrolling in higher secondary education reported in Section 5.1 mitigates this concern. An endogenous selection of individuals in or out of sample after the telesecundaria expansion also challenges the exclusion restriction. If individuals with differential returns decided to migrate, the estimated effects would be biased. I address this concern by excluding from the analysis interstate and international migrants, and I also assume there is no intrastate migration. I further discuss the migration concerns in Section 7.

5 Effects of telesecundaria construction

In this section, I examine the reduced-form effects of telesecundaria access on long-run education and labor market outcomes. The estimates show that the construction of telesecundarias significantly increases enrollment at the junior secondary educational levels, raising the average years of education by 0.8, and there are no spillover effects to higher educational levels. The results also show a significant rise in the average hourly income, partly due to an increase in the extensive margin of the labor supply, and a shift away from the agricultural and informal sectors towards the services sector.

Table 2 presents the estimates of the DiD specification (1) using both treatment measures—the continuous density of telesecundarias and the binarized measure of above median density—on educational outcomes, and Table 3 presents the treatment effect estimates on adult labor market supply and labor market income. Since the estimates for both treatment measures

[29]Formally, $Pr(D^T(1)_{ilt} \geq D^T(0)_{ilt}) = 1$.

[30]Formally, $Y(d, z)_{ilc} = Y(d)_{ilc}$ for all d, z.

are very similar, for simplicity below I only comment on the coefficients for the continuous measure. The regressions include as individual-level controls gender, age, age^2 and interactions between them. All standard errors are clustered at the locality level. Figure 2a reports the DiD effects estimates by age at the first telesecundaria construction in the locality from equation (2) using as treatment the density of telesecundarias.[31] The horizontal axis shows the individual's age at the construction of the first telesecundaria in their locality, and the vertical axis the DiD estimated effect for the given age group, β_τ, with a 95% confidence interval. All effects are relative to the effect for individuals age 17 at the time the first telesecundaria was introduced, which is set to zero. Each point estimate can be interpreted as the causal effect of an additional telesecundaria construction per 50 children, relative to the same effect for 17 year-olds in a given locality.

5.1 Impacts on educational attainment

I estimate that the construction of an additional telesecundaria per 50 children encourages 10 individuals to enroll in junior secondary education, causing an average increase of 0.8 additional years of education among individuals that could have attended it. There are also no statistically significant effects on the probability of enrolling in upper secondary education and a slight decrease in the probability of attending tertiary education, suggesting that telesecundarias have no knock-on effects beyond the targeted education level.

Table 2 shows that the construction of an additional telesecundaria per 50 children increases the average junior secondary enrollment rate by 13.3 percentage points, statistically significant at the 1% level (Column 1). This is an economically meaningful change, representing a 21% increase from the mean enrollment rate of 63%. A similar increase in junior secondary graduation rate (Column 2) suggests that the completion rate in this type of schools is quite high, consistent with the Ministry of Education (SEP) reports of a 8.7% dropout rate in telesecundarias (Secretaría de Educación Pública, 2010). The positive effect of telesecundaria exposure on enrollment confirms that interventions providing access to post-primary education through supply-side investments in school construction can successfully raise educational achievement at the targeted level. An additional telesecundaria constructed per 50 children increases the average years of education among eligible cohorts by approximately 0.8 additional years from a population mean of 8.7, with the effect being statistically significant at the 1% level (Column 5), representing a 9% increase.

The event studies in Figure 2a show that the treatment effects are statistically and economically significant among individuals younger than age 12 at the first telesecundaria construction in their locality. The effects are also larger in magnitude for younger treated

[31] Figures B.1 and B.2 in the appendix show similar event studies for all outcomes when using the binarized treatment measure.

Table 2: Effects of telesecundaria construction on educational attainment

	Junior Secondary		**Higher Education**		**Years of Education**
	Enrollment (1)	Graduation (2)	Upper Secondary (3)	Tertiary (4)	(5)
Panel A. Treatment: Density of telesecundarias, TS_{lc}					
TS density (50 ch.)	0.133	0.123	-0.001	-0.018	0.793
	(0.006)	(0.006)	(0.005)	(0.002)	(0.044)
Observations	874496	874496	874496	874496	874496
Panel B. Treatment: Above median density of telesecundarias, $AboveTS_{lc}$					
Above Median TS Density	0.180	0.170	0.003	-0.023	1.073
	(0.009)	(0.009)	(0.009)	(0.003)	(0.066)
Dependent Mean	0.63	0.60	0.34	0.14	8.65
Observations	874496	874496	874496	874496	874496

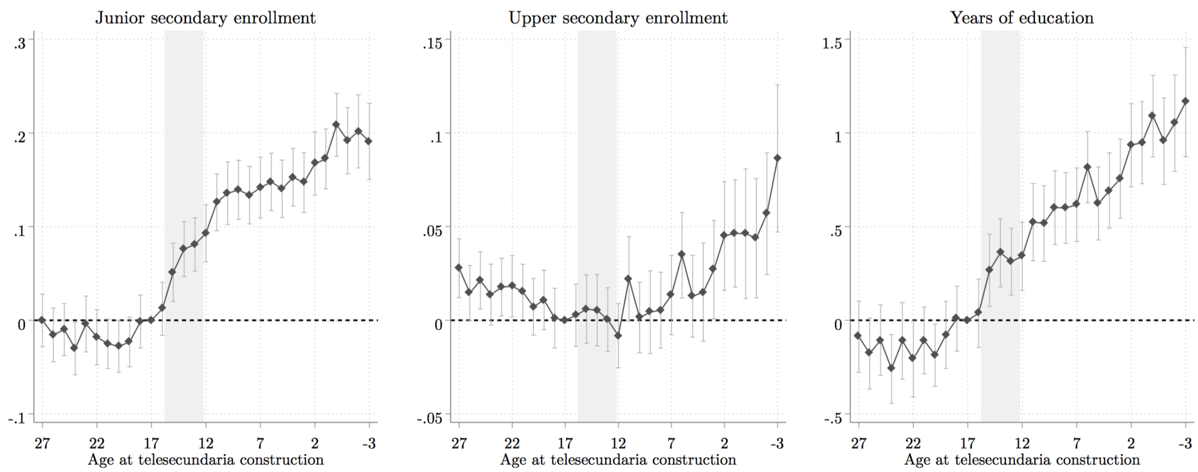
Notes: This table illustrates the reduced-form effects of telesecundaria exposure on educational attainment. The table reports the estimated coefficients of β from the estimation of the two-way fixed-effects DiD equation (1). It uses as dependent variable an indicator for enrollment and graduation in junior secondary education (Columns 1-2), for enrollment in upper secondary and tertiary education (Columns 3-4), and total years of education (Column 5). See Section 3 for a description of the outcome variables. Panel A uses as treatment the telesecundaria density, the number of telesecundarias open in locality l when individuals from cohort c were 12 years-old scaled by the total population of individuals targeted by the program. Panel B uses as treatment the above median telesecundaria density, an indicator identifying the locality-cohort observations with above median telesecundaria density. See Section 4 for details on the treatment variable. All regressions use sampling weights and include cohort and locality fixed effects. Individual controls include female, age and age^2 and interactions between them. Robust standard errors are shown in parentheses and clustered at the locality level.

cohorts, suggesting that students were systematically more likely to pursue secondary education some years after telesecundaria was first introduced in an area compared to the cohorts first exposed to the program. Note that the estimated effects of telesecundaria for individuals ages 13 to 16 are smaller but statistically distinguishable from zero and gradually increasing for the younger cohorts. These partially treated individuals are classified as untreated in the reduced-form effects, so the single-coefficient estimates are lower bounds of the true effects. The fact that the estimated effects are statistically indistinguishable from zero for individuals aged 17 to 27—too old to attend the telesecundaria after its construction—provides additional evidence that the parallel trends assumption is likely to be satisfied in this setting.

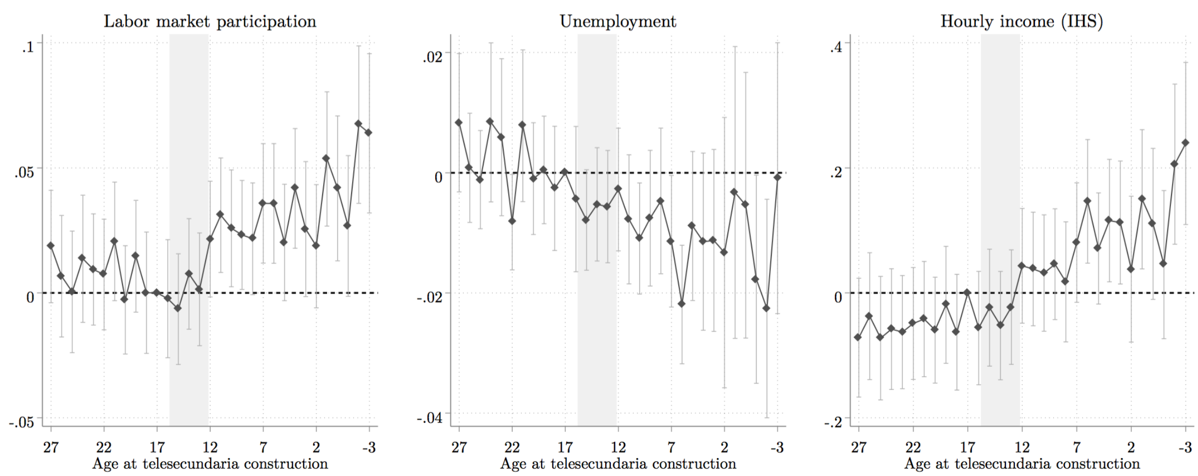
Besides the sizeable increase in attending the targeted educational level, there are no detectable spillover effects on enrollment in education levels higher than those targeted by the program, contrasting with those documented in Duflo et al. (2017) and Akresh et al. (2018). In particular, having access to a higher density of telesecundarias per 50 children does not significantly increase the likelihood of pursuing upper secondary education (Column 3), with a quite precisely estimated zero. Estimates also show a *decrease* of 1.8 percentage points on tertiary education enrollment rate (Column 4). It is unlikely that a lack of access to higher educational institution is driving the results, given that over 60% of individuals in

Figure 2: Impacts of telesecundaria construction

(a) Education outcomes



(b) Labor market outcomes



Notes: This figure presents the reduced-form estimates of the difference-in-differences specification for different outcomes, computed by age at the year of telesecundaria construction. See equation (2) for details. Coefficient estimates are shown with a solid line, and 95% confidence intervals with a vertical line. All effects are computed with respect to age 17.

the sample had access to upper secondary institutions within 10 km of their locality.[32]

I investigate the impacts of telesecundaria density on the individual's terminal academic degree—the highest degree completed—to shed light on the effects to higher achievement level enrollment, finding that telesecundaria graduates have a higher probability of com-

[32] A previous version of this manuscript, Navarro-Sola (2019), included detailed data on differential access to higher secondary education institutions in nearby localities to investigate whether spillover effects to higher educational levels could be responsible for the positive labor market returns to telesecundarias, and concluding that this heterogeneity in access did not drive the results in a significant way.

pleting a vocational training degree afterwards, and a lower probability to receive a college degree.[33] Although the overall impacts on upper secondary education enrollment are insignificant, there is a 1.1 percentage point increase in the probability of having a lower technical degree among those with the possibility of attending telesecundarias, representing a substantial 36% increase from the baseline, whereas the impact on having a preparatoria degree—equivalent to a high school diploma in the US—is much smaller and barely significant. Regarding tertiary education, there is a highly significant 2.4 percentage point decrease in the probability of having college as a terminal degree, a 18% drop, whereas there are small increases in the likelihood of having a higher technical or a teacher college degree. The negative effects on college degree completion combined with no significant impacts on upper secondary enrollment point out to the presence of switchers among the individuals attending the telesecundarias—students that would have attended a brick-and-mortar school, and later pursued college degrees, had the telesecundarias not been constructed in their localities. Section 6.2 further investigates the counterfactuals of attending telesecundarias.

5.2 Impacts on adult labor market outcomes

In this section, I report the estimated results from the DiD specification (1) on labor market outcomes. The estimates indicate that having access to a high density of telesecundarias raises the labor market participation rate, decreases the unemployment rate, increases the probability of receiving some economic compensation and raises the average hourly income. Figure 3 provides evidence in favor of two channels for the earnings increase: a sectoral shift away from subsistence agriculture towards the services sector, and less engagement in informal occupations with vulnerable working conditions.

Table 3 shows that the construction of an additional telesecundaria per 50 children increases the labor market participation rate by 1.9 percentage points. The effects are larger for younger cohorts among those eligible to attend telesecundarias, whereas they are indistinguishable from zero for cohorts too old to have benefited from them (Figure 2b). Among individuals participating in the labor market, the increase in telesecundaria density is associated with a 0.9% percentage point lower probability of unemployment, representing a 22.5% decrease. Note that the new workers are likely not a random sample of the population.[34] This endogenous compositional change of the workers' pool makes the estimates for the subsample of workers not causally interpretable. Because of that, I report the effect estimates of telesecundaria exposure on labor market outcomes for all individuals in the sample, with

[33] Table B.1 in the appendix reports these reduced-form effects on the probability of completing these terminal degrees.

[34] Following the ENOE definition, I identify as a worker any individual conducting some type of work in the formal or informal market and either receiving or not receiving economic compensation for it.

zeros for individuals not engaged in an economic activity.

Table 3: Effects of telesecundaria construction on labor market outcomes

	(1)	(2)	(3)	(4)
		Labor market supply		
	Active	Unemployed	Hours Worked (log)	Hours Worked (IHS)
	Panel A. Treatment: Density of telesecundarias, TS_{lc}			
TS density (50 ch.)	0.019	-0.009	0.084	0.099
	(0.003)	(0.002)	(0.013)	(0.015)
Observations	874496	582448	874496	874496
	Panel B. Treatment: Above median density of telesecundarias, $AboveTS_{lc}$			
Above Median TS Density	0.030	-0.011	0.120	0.142
	(0.006)	(0.004)	(0.022)	(0.026)
Dependent Mean	0.67	0.04	2.26	2.67
Observations	874496	582448	874496	874496
		Labor market income		
	Wage Earner	Hourly Wage (MXN)	Hourly Wage (log)	Hourly Wage (IHS)
	Panel C. Treatment: Density of telesecundarias, TS_{lc}			
TS density (50 ch.)	0.009	1.953	0.098	0.110
	(0.004)	(0.159)	(0.012)	(0.015)
Observations	874496	874496	874496	874496
	Panel D. Treatment: Above median density of telesecundarias, $AboveTS_{lc}$			
Above Median TS Density	0.006	2.482	0.121	0.134
	(0.007)	(0.250)	(0.020)	(0.025)
Dependent Mean	0.49	12.73	1.46	1.77
Observations	874496	874496	874496	874496

Notes: This table illustrates the reduced-form effects of telesecundaria exposure on labor market supply and on labor market income. It reports the estimated coefficients of β from the estimation of the two-way fixed-effects DiD equation (1). It uses as dependent variables an indicator for labor market participation (Column 1), unemployment (Column 2) the log and inverse hyperbolic sine transformations of weekly hours worked (Columns 3-4), an indicator for earning a wage (Column 1), and hourly wage in Mexican pesos, and its log and inverse hyperbolic sine transformations (Columns 2-4). See Section 3 for a description of the outcome variables. Panel A uses as treatment the telesecundaria density, the number of telesecundarias open in locality l when individuals from cohort c were 12 years-old scaled by the total population of individuals targeted by the program. Panel B uses as treatment the above median telesecundaria density, an indicator identifying the locality-cohort observations with above median telesecundaria density. See Section 4 for details on the treatment variable. All regressions use sampling weights and include cohort and locality fixed effects. Individual controls include female, age and age^2 and interactions between them. Robust standard errors are shown in parentheses and clustered at the locality level.

There is a statistically significant increase of 8.4–9.9% in the hours worked among individuals with access to telesecundarias, mostly coming through the increase in labor force participation. Within the subsample of workers, there are no changes in the hours worked, likely due to the fact that the hours are highly clustered around 40. The absence of treatment effects for older cohorts on labor market outcomes (Figure 2b) mitigates the concerns related to the systematic construction of telesecundarias in localities prioritizing economic development, or in regions gradually improving the labor market prospects of their inhabitants.

There are also substantial increases in adult hourly income: An additional telesecundaria per 50 children increases the average probability of being a wage earner by 0.9 percentage points. The main income variable is the inverse hyperbolic sine transformation of hourly income.[35] For completeness, I also report the estimated hourly income effects in Mexican pesos (MXN) and using the logarithmic transformation. An additional telesecundaria per 50 children increases the average hourly income of the exposed cohorts between 9.8–11%, depending on the income measure used. Note that these are long-run labor market effects, captured on average 20 years after the potential enrollment in junior secondary education, so the effects are highly persistent over time.[36]

These income effects are partially due to an extensive margin increase in the labor market participation and a decrease in unemployment probability, with some individuals going from receiving zero to positive income. However, the small 1.9 percentage point increase in the share of active population implies they are not solely drivers of the income increase. Figure 3 reports the estimated effects on outcomes related to two mechanisms that contribute to the positive labor market effects: A shift in labor market occupational sectors, and a decrease in the informal sector participation.[37]

Individuals with access to an additional telesecunaria per 50 eligible children experience a 2 percentage point net decrease in the probability of working in agriculture, and a 4 percentage point net increase in the probability of working in the services sector, representing sizeable changes of 16.7% and 17.4% respectively.[38] There is also a small increase in the likelihood of working in construction of 0.6 percentage points. Hence, having access to additional telesecundarias causes a sectoral shift in workers' occupations, decreasing the proportion of individuals working in subsistence agriculture and shifting them towards the secondary and tertiary sectors. This sectoral shift is consistent with evidence that large primary school construction programs raise the likelihood of being employed outside the agricultural sector (Karachiwalla and Palloni, 2019). In contrast, Delesalle (2019) provides evidence of an *increased* likelihood of working in agriculture.

A relevant indicator for understanding the working conditions is the type of economic unit individuals work for. Among individuals with access to an additional telesecundaria per 50 children, there is an average 1.9 percentage point increase in the probability of working for

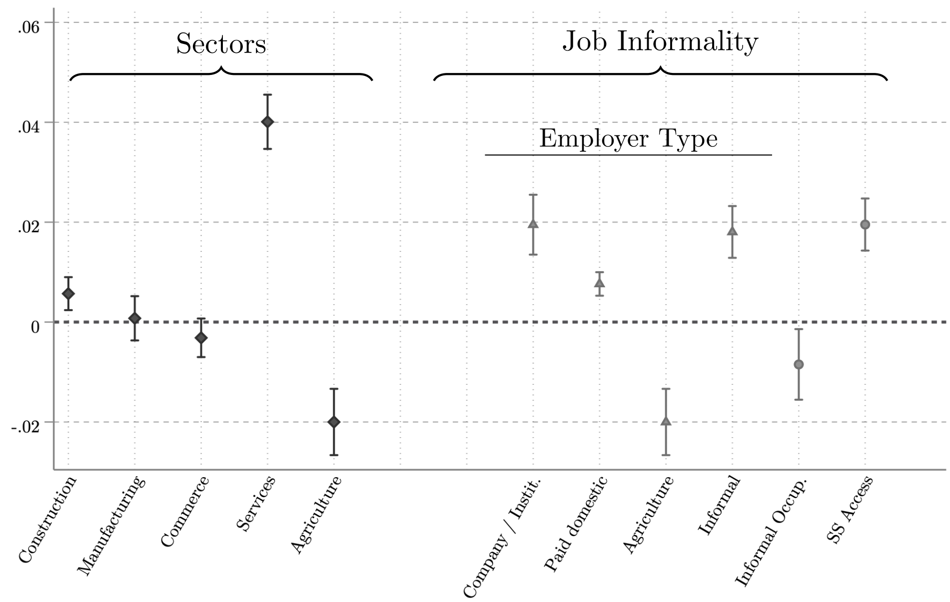
[35]The hourly income variable displays a long thick upper tail, common in wealth data, which would skew the estimates due to extreme values. With an average labor market participation of 67%, the income variable also has many zeros, making the logarithmic transformation an imperfect choice. I address both issues by using the inverse hyperbolic sine transformation (IHS). The inverse hyperbolic sine transformation is $log(y + (y^2 + 1)^{1/2}$ (Burbidge et al., 1988), deals with extreme values and solves the problem of $log(0)$ being undefined.

[36]The median age in the sample is 33 years-old, with an interquartile range of 24 to 43 years-old.

[37]Table B.2 in the appendix reports the point estimates and corresponding standard errors.

[38]The services sector includes jobs in the hospitality industry, government, education, health and professional services, among others.

Figure 3: Mechanisms: Sectoral shifts and job informality



Notes: This figure presents the reduced-form estimates of the difference-in-differences specification of the effects of having access to a high telesecundaria density area on outcomes related to labor market sectors and job informality. See equation (1) for details. The vertical axis shows the point estimates with the associated 95% confidence interval.

formal companies or institutions. Interestingly, there is a 1.8 percentage point net *increase* in the probability of working in informal businesses, representing a 10% change against the baseline of 18%. Informal occupations are defined in the ENOE as "those operating using household resources without being a formal business, so that income and economic resources used in the business are not independent from the ones in the household" (INEGI, 2010). Hence, this can be interpreted as a significant increase in the proportion of individuals engaging in entrepreneurial economic activities and in the creation of small informal businesses.

Two outcomes provide suggestive evidence of a decrease in the proportion of individuals working under vulnerable and insecure labor conditions. The construction of an additional telesecundaria per 50 children increases the probability of having health care benefits through their employers by 2 percentage points, which is statistically significant and economically meaningful, representing a 10.5% increase from the baseline. Additionally, there is an overall 0.8 percentage point decrease in individuals working in informal occupations. As opposed to the informal job type mentioned above, these are defined as the occupations "with vulnerable conditions due to the nature of the economic unit they work for, and those whose relationship with the economic unit is not formally recognized by the employer" (INEGI, 2010). Although statistically significant at the 5% level, this effect is economically small and represents only a 2% overall decrease.

Another relevant dimension to interpret the reduced-form effects of expanding access to secondary education is the gender component, given that these schools could be particularly beneficial for females, addressing gender-specific constraints like distance to the nearest school or (non-economic) schooling costs. The heterogeneity analysis by gender suggests that, although they start from similar enrollment baselines, the construction of additional telesecundarias induces females to enroll in junior secondary education to a lesser degree than males, resulting in a lower increase in overall years of education.[39] In terms of pursuing higher educational levels, the expansion of telesecundarias leads to a net *decrease* in upper secondary and tertiary enrollment for females, whereas the changes are not significant for males. Even though females seem to acquire less education than males as a result of the telesecundaria expansion, there are no significant differences in impacts on the main labor market outcomes across genders. All in all, the first-stage educational impacts for females are smaller than for males, but the labor market impacts of having access to a high density of telesecundarias are similar across genders. These two results, and the fact that females have a substantially lower average labor market participation than males (46% compared to 89%), suggest that females that *do* enroll in telesecundarias may get higher labor market returns than males.

6 Labor market returns

One of the purposes of post-primary education is to provide the skills and resources students need to become productive workers. Following the seminal work of Becker (1964) and Mincer (1970), in this section I argue that an important mechanism by which telesecundaria construction affects labor market outcomes is through human capital accumulation, which increases workers' productivity.[40] Although the estimated worldwide return to education is around 10%, this varies considerably across educational levels and settings (Montenegro and Patrinos, 2014). Given that there are few causal estimates of the long-run returns to secondary education in low and middle income countries, there is little evidence of the effectiveness of post-primary education investment in a developing country context.

In this section, I use the variation in telesecundaria density to estimate the income returns to attending junior secondary education through telesecundarias. I find that enrolling in junior secondary education through telesecundarias increases adult labor market income by 74–83%, and that it increases income by 12.5–13.9% for every extra year of education acquired after enrolling in them. A key element when interpreting these returns to secondary

[39]Table B.3 in the appendix reports the reduced-form effects of key outcomes by gender using the density of telesecundarias as treatment measure.

[40]See Heckman et al. (2018) for a recent overview on the evolution of the research studying the relationship between education and human capital accumulation and labor market outcomes.

education is to understand whether they are relative to not pursuing secondary education at all, or whether these are the impacts of attending telesecundarias relative to attending a conventional secondary school. I provide empirical evidence that the compliers come from both counterfactuals. Back-of-the-envelope calculations suggest that between 26% and 70% of telesecundaria students would have not attended secondary school had the telesecundarias not been constructed.

6.1 Estimates of the returns to secondary education

Table 4 reports the estimates from the IV-DiD equation (3) (even columns). For comparison purposes, I also report the estimated returns using an OLS specification (odd columns). The estimates are computed along two margins: The labor market returns of attending junior secondary education, and the returns of an additional year of education. The instruments used are both measures of telesecundaria intensity, $AboveTS_{lc}$ and TS_{lc}, defined in Section 4. The main dependent variable is the inverse hyperbolic sine transformation of hourly income (Columns 5 and 6). For completeness, I also report two additional measures of the returns, in Mexican Pesos, and the corresponding logarithmic transformation.

Enrolling in junior secondary education through telesecundarias increases by 74.2–83% the average hourly income for the complier subpopulation, that is, for those individuals induced to enroll in junior secondary because they had access to a higher density of telesecundarias and who would have not enrolled otherwise. This estimated effect is significant at the 1% level, and the results are similar using the logarithmic transformation of income. An additional year of education after enrolling in telesecundarias increases income by 12.5–13.9%. OLS estimates for Mexico using Mincerian regressions report a return to an extra year of primary education of around 8%, whereas the returns for an extra year of secondary education and of college are around 10% and 11% respectively (Morales-Ramos, 2011).Although the worldwide average return to schooling is around 10%, these tend to be higher in low or middle income economies. For post-primary education, the private rate of secondary education worldwide is around 7.2%, and the rate of return to tertiary education is around 15.2% (Montenegro and Patrinos, 2014).

The estimated returns using the IV-DiD specification are between two and three times larger than the OLS returns. While the OLS specification estimates the return of an additional average year of education, regardless of the educational level, the IV-DiD specification estimates the return of an additional year of education *after* enrolling in telesecundarias. This differential in returns by educational level could contribute to the disparities between the OLS and IV-DiD estimates, but they are not enough to explain all the differences. A reason often used to explain why the LATEs of interventions targeting disadvantaged subpopulations tend to be larger than the corresponding OLS estimates is that the instrument changes

Table 4: Labor market returns to junior secondary education

	Wage (Pesos)		Wage (log)		Wage (IHS)	
	OLS	2SLS	OLS	2SLS	OLS	2SLS
	(1)	(2)	(3)	(4)	(5)	(6)
Treatment: Junior secondary education enrollment						
Panel A. IV: Density of telesecundarias, TS_{lc}						
Enrolled in secondary ed.	7.001	14.737	0.336	0.738	0.378	0.830
	(0.161)	(1.167)	(0.010)	(0.092)	(0.012)	(0.111)
First-stage F-stat.		569.49		569.49		569.49
Panel B. IV: Above median density of telesecundarias, $AboveTS_{lc}$						
Enrolled in secondary ed.	7.001	13.757	0.336	0.668	0.378	0.742
	(0.161)	(1.407)	(0.010)	(0.112)	(0.012)	(0.135)
First-stage F-stat.		442.31		442.31		442.31
Treatment: Years of education						
Panel C. IV: Density of telesecundarias, TS_{lc}						
Years of education	1.165	2.461	0.047	0.123	0.052	0.139
	(0.024)	(0.205)	(0.001)	(0.016)	(0.002)	(0.019)
First-stage F-stat.		324.10		324.10		324.10
Panel D. IV: Above median density of telesecundarias, $AboveTS_{lc}$						
Years of education	1.165	2.313	0.047	0.112	0.052	0.125
	(0.024)	(0.249)	(0.001)	(0.020)	(0.002)	(0.024)
First-stage F-stat.		268.29		268.29		268.29
Dependent mean	12.73	12.73	1.46	1.46	1.77	1.77
Observations	874496	874423	874496	874423	874496	874423

Notes: This table illustrates the labor market returns to junior secondary education through telesecundaria enrollment. The table reports the estimated coefficient β^{LATE} from the estimation of the instrumented difference-in-differences equation (3) in even columns. In odd columns it reports the estimated coefficient β from an Ordinary Least Squares (OLS) regression with the specification: $Y_{ilc} = \alpha + \beta D^S_{ilc} + \mathbf{X}_{ilc}\theta + \varepsilon_{ilc}$, where the parameters are defined as in equation (3). It uses as dependent variable hourly wage in Mexican pesos, and its log and inverse hyperbolic sine transformations. See Section 3 for a description of the outcome variables. The instrumental variable (IV) used in each specification is indicated in the panel title. All regressions use sampling weights and include cohort and locality fixed effects. Individual controls include female, age and age^2 and interactions between them. Robust standard errors are shown in parentheses and clustered at the locality level.

only influence the schooling decision of individuals with high marginal returns (Card, 1995; Ichino and Winter-Ebmer, 1999).[41] The policy of interest in this paper—the telesecundaria expansion—specifically targets areas where it would be unfeasible to construct a conventional school. A potential reason for the disparity is that individuals living in these localities may have larger returns to post-primary education than average due to low competition in the labor market. Another is that, if opportunity costs of schooling in these localities are higher than average, the benefit from attending telesecundarias for the compliers should be bigger than the foregone earnings from work, selecting only the high-return individuals into

[41] However, Oreopoulos (2006) provides a contrasting piece of evidence that LATE estimates of the returns to schooling are similar to the average treatment effects when using compulsory schooling laws as instruments.

secondary education. Part of the differences between the OLS and the IV-DiD estimated returns could also be due to measurement error.

The estimated returns in this section are in line with other instrumental variable estimates in the post-primary education literature in developing countries. Duflo et al. (2017) find that having access to secondary education increases total earnings by 19%, with the effects coming from the increased probability of working, whereas Bianchi et al. (2019) report a 55% increase in earnings due to a computer-assisted learning program with remote lessons, with the main channel being a shift to occupations focusing on analytical and cognitive skills instead of manual and physical skills. In the telesecundaria context, the reduced-form results from Section 5 suggest that a combination of mechanisms may be responsible for the returns to secondary education: There is an increase in labor force participation, moving people along the extensive margin of labor supply and from receiving zero income to positive income, and there is a shift away from subsistence agriculture towards the services sector—either working in formal companies and institutions or becoming entrepreneurs in informal businesses.[42]

6.2 Counterfactuals to attending telesecundarias

This section investigates the counterfactuals for the compliers had the telesecundarias not been constructed. Apppendix D presents a stylized framework of schooling choices under the presence of school substitutes (Kline and Walters, 2016; Mountjoy, 2018) to identify key forces at play in the schooling choice problem. Following Charles et al. (2018), I derive a set of sufficient conditions on the utility functions that guarantee unique thresholds consistent with the empirical patterns. The key implication is that the compliers will be a mixture of individuals (with ex-ante unknown weights) coming from the two potential counterfactuals: not enrolling in secondary education, and attending a brick-and-mortar school. The predictions are that there will be an extensive margin increase in the share of individuals enrolled in junior secondary education, and there might also be a proportion of switchers, i.e., individuals that would have attended a conventional school instead, maybe in a nearby locality.

The ENOE labor market survey only contains information about the last educational level completed, not about the school modality attended. Hence, I use two additional data sources to investigate the counterfactuals: (1) population data from the five-year census for the 1990–2010 period, which contains cohort-level population counts and cohort-level counts on individuals enrolled and not enrolled in school, and (2) school-level annual information

[42]Note that the shift away from subsistence agriculture towards the formal sector could artificially inflate the returns to telesecundarias, since individuals working for formal companies are more likely to be regularly paid a fixed salary. This may improve their record keeping, allowing them to accurately report their earnings during the labor market survey, which could look like an earnings increase.

Figure 4: Share of individuals not enrolled in school

(a) In all localities (b) By access to brick-and-mortar nearby

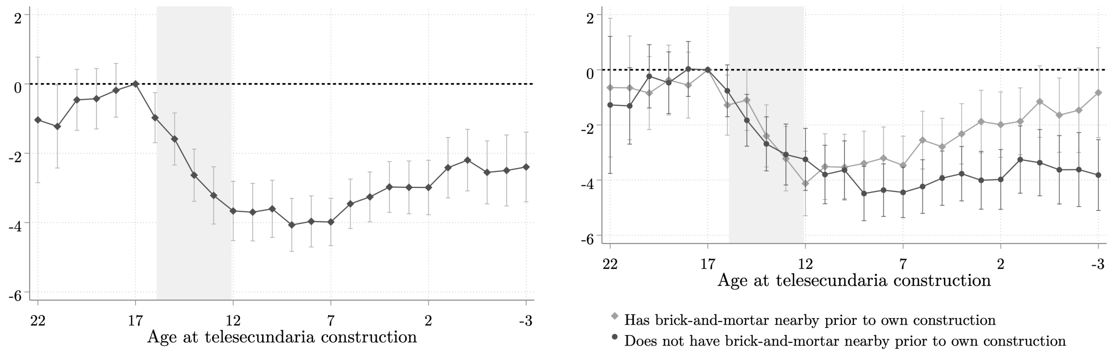
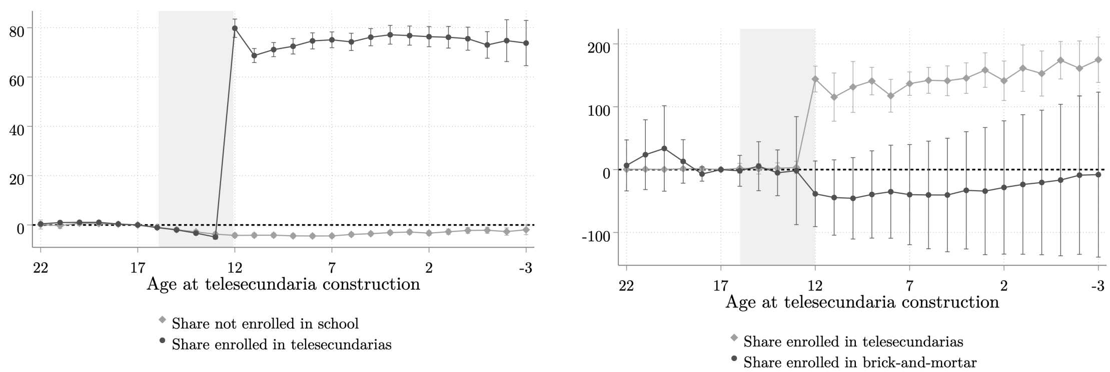


Figure 5: Enrollment shares by educational modalities

(a) In affluent localities (b) In localities with brick-and-mortar prior to telesecundaria construction



Notes: This figure presents the reduced-form estimates of the difference-in-differences specification for different outcomes, computed by age at the year of telesecundaria construction. See equation (2) for details. The denominator for all shares is the number of 12 year-olds registered in the census of the locality with the telesecundaria construction. Coefficient estimates are shown with a solid line, and 95% confidence intervals with a vertical line. All effects are computed with respect to age 17.

on number of students enrolled by grade for the 1990-2010 period.[43]

Figure 4 shows that a relevant proportion of compliers were drawn away from not attending any secondary school. The share of 12 year-old adolescents registered as living in that locality and not attending school decreases by 3.5 percentage points after the telesecundaria construction, from a baseline non-enrollment rate of 30%, representing a 11.6% net decrease. In combination with the results in Section 5.1—which draw from a different sample and use earlier constructions—this provides strong evidence that the telesecundaria construction shifted the school attendance decision on the extensive margin for a relevant share of the complier population.

[43]Enrollment numbers at the school-year level for all schools in Mexico and census data are only available for the 1990-2010 period.

To investigate the presence of intensive margin changes and potential switches from conventional secondary schools, I first look at affluent localities, since they have the highest chance of having potential switchers from brick-and-mortar schools.[44] Figure 6a shows a 65 percentage point increase in the telesecundaria enrollment (dark line), pointing out to a 61.5 percentage point increase unexplained by the extensive margin decrease in the share of non-enrolled individuals for that same cohort (light line).

Although this wedge could be entirely driven by switchers from brick-and-mortar schools, this is unlikely. Descriptive evidence shows it is common in telesecundaria to have students older than the targeted age for a given grade (INEE, 2017), either because of some grade retention or because of late start of school. The gradual increase in treatment effect for individuals aged 13 through 16 in Figure 4 supports this point, hinting at partial treatment effects for slightly older cohorts.[45] Figure 4b provides further evidence that switchers alone are unlikely to be responsible for the unexplained share of telesecundaria enrollment. It decomposes the effects by whether individuals had a nearby brick-and-mortar school before the first telesecundaria construction, showing just a 1.5 percentage point additional decrease in the non-enrollment share among individuals without nearby brick-and-mortar access.[46] A back-of-the-envelope-calculation shows a 11.9 percentage point decrease in the share of 12 to 16 year-olds not enrolled in school, which suggests that around 18% of the compliers in affluent localities are drawn from the counterfactual of not enrolling in secondary education. Given that students from small nearby localities could have attended these newly constructed telesecundarias as well, the 18% is likely a lower bound for the share of extensive-margin compliers.

To further bound the complier proportions, I look at the changes in telesecundaria and brick-and-mortar enrollment in localities that had a brick-and-mortar school prior to the telesecundaria construction (Figure 6b): There is a 140 percentage point increase in the share of individuals enrolled in telesecundarias and a 37 percentage point decrease in the share of eligible individuals enrolled in brick-and-mortar schools—although the latter is imprecisely estimated—suggesting that at most 26% of the compliers switched from a brick-and-mortar school in these localities. It is reasonable to expect that individuals attending brick-and-

[44] Affluent localities are defined as those localities that, the year prior to the telesecundaria construction, had more adolescents enrolled in school than school slots in their own locality. This implies that individuals in the affluent locality were attending schools away from their own locality, becoming likely switchers once a telesecundaria was constructed in their locality of residence.

[45] As with the ENOE data, this could also be due to data limitations, which may result on an imprecise school construction year. However, the 1990–2010 period used here has better school construction data quality than the 1968–2000 used in the main analysis. Hence, this issue is less likely to be a concern in this section.

[46] The radius length specified by the Ministry of Education when identifying "areas of influence" of brick-and-mortar schools in their guide for schooling construction is 7km (SEP, 2012). Since this cutoff was loosely implemented, I use the 10 km cutoff to identify individuals that had close access to brick-and-mortar schools.

mortar schools outside their locality of residence are more likely to switch to a telesecundaria constructed in their own locality than those already attending brick-and-mortar schools there. Hence, I interpret the 26% as a lower bound for the actual share of switchers.

All these pieces of evidence indicate that individuals attending telesecundarias come from two counterfactuals, and back-of-the-envelope calculations suggest that the share of compliers coming from not enrolling in secondary school is between 26% and 70%.[47] Therefore, the labor market returns estimated in Section 6.1 are a weighted average of the returns to enrolling in secondary education through the telesecundarias instead of finishing primary education—which we would expect to be weakly positive—and the returns to attending a telesecundaria instead of a brick-and-mortar school—with ex-ante unknown direction.

I further investigate the potential differential impacts on switchers by conducting an heterogeneity analysis of the reduced-form effects in the main dataset and sample by whether localities had a brick-and-mortar school nearby prior to the telesecundaria construction.[48] Having access to brick-and-mortar schools nearby *increases* the extensive-margin effect on junior secondary enrollment by 3.1 additional percentage points over the 11.2 baseline effect.[49] Additionally, the positive and significant increase of 0.5 years of education in localities without other schools nearly doubles when there is a brick-and-mortar school nearby. Similarly, the main labor market effects in terms of labor supply and labor market income more than double with prior nearby presence of brick-and-mortar schools. This indicates it is unlikely that switchers are a large proportion of the compliers in the sample of the main analysis, given that this would likely be supported by a smaller junior secondary enrollment rate increase in the presence of nearby brick-and-mortar schools. Although the average effectiveness of each school modality, net of confounders, is ex-ante uncertain,[50] the heterogeneity results by access to brick-and-mortar schools nearby mitigate the concerns that compliers switching from conventional schools may have lower returns to secondary education when they attend the telesecundarias. Combining the school construction data with test score data at the school level from the EXCALE exam could shed light to the average quality of

[47]These bounds are quite conservative, and they could be further sharpened by, for example, including students from nearby localities in the calculations of extensive-margin switchers.

[48]69% of individuals were living in a locality that had a neighboring brick-and-mortar school prior to the telesecundaria construction. Perhaps suprisingly, the share remains quite stable when disaggregated by locality size: 76% of individuals in sub-urbanization localities (between 15,000 and 100,000 habitants) and 60% of individuals in rural localities (less than 2,500 habitants) had access to a brick-and-mortar school nearby prior to the telesecundaria construction.

[49]Table B.4 in the appendix reports the reduced-form effect estimates by whether localities had a brick-and-mortar school within 10 km prior to the telesecundaria construction.

[50]On the one hand, brick-and-mortar schools in principle can provide with instruction tailored at the median level of the classroom, which should lead to better outcomes than lectures with a one-size-fits-all content at a predetermined pace (Banerjee et al., 2007). On the other hand, the telesecundaria standardized lectures are likely of high-quality and delivered in a reliable way, whereas the instruction received by brick-and-mortar students will depend on the teacher's specific quality.

the brick-and-mortar schools that switchers move from, and further assess whether they may be worse off than if they had stayed in the conventional school.

It is also worth mentioning that localities with and without brick-and-mortar schools nearby likely differ in many other dimensions, such as labor market conditions and opportunities, or other economic development and social indicators. Therefore, these differential impacts by presence of nearby brick-and-mortar schools cannot be interpreted as the differential labor market returns between both secondary school modalities. Given that the cost of telesecundarias per student is half the cost of brick-and-mortar schools, understanding the relative benefits of each modality and the degree of substitutability between both is important for shaping optimal school construction policies worldwide.

7 Sensitivity of the results

In this section, I assess the sensitivity and robustness of the results to different specifications and sample restrictions. First, I investigate the sensitivity of the two-way fixed-effect (TWFE) estimates to heterogeneous treatment effects and compute alternative estimators robust to biases generated by heterogeneous and dynamic treatment effects. The diagnostic measures and the alternative estimators show that the results are mostly robust to the potential biases generated by the TWFE. Then, I discuss the concerns regarding migration and provide evidence that migration flows are unlikely to drive the results in a meaningful way. Lastly, I investigate the sensitivity of the results to geographical, period, and cohort restrictions.

Robustness of the two-way fixed effects DiD estimators. To assess the sensitivity of the TWFE results to heterogeneous treatment effects, I use de Chaisemartin and D'Haultfœuille (2020) diagnostic measures.[51] Given the results similarity between the continuous and binarized treatment measures, for ease of implementation and interpretation in this section I use the binarized treatment. Around 7% of treated locality-cohort observations receive negative weights in the estimation of treatment effects, with a total negative weight sum of -0.00266 (0.26%), which implies that the ATTs with associated negative weights have very limited relative importance to the overall weighted average.[52] The robustness of the TWFE estimates is assessed through two diagnostic measures, $\underline{\sigma}_{fe}$ and $\underline{\underline{\sigma}}_{fe}$: The first measure, $\underline{\sigma}_{fe}$, reflects the minimal value under which it would be possible to have a TWFE

[51]Note that I cannot use the alternative approach of Goodman-Bacon (2018) decomposition, since it requires a strongly balanced panel and it is not the data structure of this setting. However, de Chaisemartin and D'Haultfœuille (2020) is a generalization of Goodman-Bacon (2018), which uses a more restrictive set of assumptions.

[52]The weights' calculations are identical if I use the alternative Jakiela (2021) approach.

estimate of the opposite sign of the true ATT. Reassuringly, across all main outcomes, it is at least as large as the estimated effect.[53] In order to invalidate the TWFE estimates, there will need to be a substantial amount of treatment effect heterogeneity across locality-cohort cells. The second measure, $\underline{\underline{\sigma}}_{fe}$, is a proxy for the minimal amount of treatment effect heterogeneity under which it would be possible to obtain an estimate of the opposite sign than the treatment effects in all the treated group and time periods. Given its large values, it is unlikely the estimates could be of opposite signs even under a small amount of treatment effect heterogeneity.

Following de Chaisemartin and D'Haultfœuille (2021), I also compute alternative treatment effects estimates which are unbiased under heterogeneous and dynamic effects. Table C.2 reports the effects of having switched treatment for the first time l periods ago. Compared to the naive TWFE estimates, they show smaller impacts of telesecundaria construction on junior secondary enrollment and years of education, for the first outcome remaining mostly significant, and substantially larger effects on labor market outcomes. In particular, for junior secondary enrollment, the dynamic treatment effects of having switched treatment for the first time l periods ago (net of dynamic treatment effects) oscillate between 3.9-10% increase for the first eighth periods, which are 25-50% of the estimated naive TWFE estimated effects. The impacts on years of education are quite imprecisely estimated, but most are positive and oscillate between 0.1-0.65. For labor market participation, the alternative estimates range between 2–10%, representing up to 3 times larger estimates than with the naive TWFE, none of them statistically significant. For hourly wage, the estimates show positive effects between 15-45%, almost all of them highly statistically significant, implying up to 4 times larger estimates than the TWFE estimates. All in all, the main effects of telesecundarias—increasing both educational outcomes and labor market outcomes—hold when using alternative estimators robust to heterogeneous and dynamic treatment effects. If anything, smaller effect sizes on education outcomes and larger effect sizes on labor market outcomes would suggest even larger returns to secondary education due to attending telesecundarias than those in Section 6.

Robustness to migration decisions. Migration in Mexico is a common phenomenon: Just in the 2005-2010 period, 1.1% of the Mexican population were international migrants, 3.1% intrastate migrants, and 3.5% interstate migrants (CONAPO, 2014). Given dataset limitations, the main results focus on adults living in their state of birth, and assumes they live in the same locality they resided in during their childhood. If migration decisions were uncorrelated with access to secondary schools, this approach would just introduce

[53]The diagnostic of the results' sensitivity to heterogeneous treatment effects are in Table C.1 in the appendix.

measurement error in the estimates, attenuating the effects towards zero. However, education opportunities and schooling choices in the location of origin influence migration decisions, which could bias the estimates in either direction. To investigate whether migration flows are systematically related to the telesecundaria expansion, I use municipality-level migration data from the *Consejo Nacional de Población* (CONAPO), which includes the 5-year average annual migration rate at the municipality level for the 1995-2000 and 2005-2010 periods. Figure C.1 in the appendix shows that a higher density of telesecundarias per 50 children at the municipality level in 1990 is negatively related to the migration rate, supporting the hypothesis that places with higher telesecundaria density experienced higher emigration rates.

The approach I use for dealing with the lack of migration data at the locality level assumes the absence of intrastate migration, and does not account for the fact that there is a lot of mobility between nearby localities. Descriptive evidence also shows the existence of significant rural to urban migration flows, with reports pointing out that localities with more than 15,000 habitants receive around 75% of the total migration within Mexico (CONAPO, 2014). If individuals with the highest returns to education permanently migrate from rural to urban localities—with relatively low density of telesecundarias—they would be incorrectly classified as "untreated". This prevalent migration pattern would lower the average return to education in the locality of origin, underestimating the returns of the telesecundarias, while the average return in the locality of destination would change in an unknown direction, upward or downward biasing the estimates. I investigate the sensitivity of the locality-level results by computing the main results using the telesecundaria density measure defined at the municipality level, i.e., the density of telesecundarias per 50 children in the municipality when the individual was 12 years-old. Panel A and Panel B in the appendix Table C.3 report the main results. Reassuringly, the treatment effects are robust to this alternative treatment aggregation: The impacts on junior secondary education and years of education are larger than when defining the treatment at the locality level, whereas the follow-on effects to further education are not significant. In terms of labor market outcomes, the increase in labor force participation is still positive but becomes insignificant, whereas the drop in unemployment is more pronounced. Overall, this translates to a similar increase in total hours worked, and a slightly larger increase in wages.

The main results also exclude from the analysis international and interstate migrants. If individuals with relatively high returns emigrated internationally or to other states—disappearing from the sample—in order to seek additional education or better work opportunities, the true returns to telesecundarias would be underestimated. Table 1 allows to compare individual characteristics between samples including and excluding inter-state and international migrants, and mitigates the concerns that the analysis sample may exclude individuals with significantly different characteristics. The average years of education among the sample including migrants is only slightly higher, with 1% higher completion rates for all educational levels, and the labor supply variables are almost identical. Inter-state and international migrants tend to have slightly higher wages, are more likely to work in services and less likely to work in agriculture, and hence have higher labor formality rates. Panels C and D in Table C.3 report the main results including in the analysis inter-state and international migrants. In this case, the impacts on junior secondary enrollment and years of education are larger, and the impacts on the extensive margin of the labor force participation become insignificant, while the increases in hourly income still remain. All in all, this section suggest that the data limitations regarding migration are unlikely to affect the results in a substantial way.

Sensitivity along geographical and time dimensions. Although telesecundarias were first designed as a solution to deliver education in rural and marginalized localities, they were later rolled-out to sub-urbanized and urban localities as well due to its lower cost and its lower requirements in terms of teacher training and teacher body composition compared to a brick-and-mortar school. To estimate the average impacts of the program, I include in the main analysis all localities with less than 100,000 habitants. Table C.4 shows that the results are robust to restricting the analysis to smaller localities, both for rural (<2,500 habitants) and for sub-urbanization localities (<15,000 habitants), and are not driven by the inclusion of urban areas.

When interpreting the impacts of a program exploiting a staggered rollout across several decades, it is also important to consider the treatment effects heterogeneity over time which could be due to many factors, from changes in the program design and implementation to differential complementarities with other local development policies. Table C.5 reports the reduced-form effects by decade of the first telesecundaria construction in the locality. They indicate that the impacts of telesecundaria on enrollment for the targeted level have been quite constant over time, with increases in junior secondary enrollment rates oscillating between 11.3 and 13.6 percentage point increases. For higher educational levels, the impacts are positive for those individuals in localities with telesecundarias constructed in the earlier decades, whereas they are insignificant or even negative among those living in late adopter localities. The overall impact on years of education acquired is positive and increasing over time, ranging between 0.36 and 0.83 increase.[54] In terms of labor market income, the impacts have also remained positive and significant across the decades, although they are larger among the late adopters. In particular, there is a 7.1% increase in wages for those living

[54]Note that most of the telesecundarias were constructed after 1980. Hence, the impacts of those constructed in the first decade are quite imprecisely estimated.

in localities that adopted telesecundarias in the 1980–1989 period, which jumps to 13.1% for those localities that first constructed them in the 1990–2000 period. Note that most of the average effects on labor market supply are driven by individuals in late adoption localities. Hence, these two results together suggest that the long-run impacts of telesecundarias on income are not entirely explained by a mechanical increase in labor market participation.

A potential confounder for the telesecundaria impacts could be the Progresa/Oportunidades program, a large conditional cash transfer (CCT) program that began in 1997. It targets poor households in rural communities and, among other things, it conditions monetary transfers on children regularly attending schools.[55] Given that most of the CCT program beneficiaries are telesecundaria students,[56] there could be concerns about which program—telesecundarias or Progresa/Oportunidades—is driving the positive impacts. However, the main results exploit school constructions during the 1968–2000 period. Hence, the Progresa/Oportunidades program does not account for the estimated effects.

Lastly, another margin of interest is whether the individual-level impacts of telesecundarias are persistent over time or have differential effects along the life-cycle. Figure C.2 reports the reduced-form effects by age group at the time of the ENOE survey. The impacts of telesecundarias on junior secondary enrollment and years of education are positive for all cohorts, mostly significant, and a bit larger for younger cohorts.[57] The effects on upper secondary enrollment are insignificant for all cohorts, with quite precise zeros, whereas the impacts on tertiary enrollment seem positive for the 18-24 age group but extremely small, and negative and significant for the 25-45 age range. In terms of labor market participation and hourly income, the effects are positive and significant or almost significant for most of the cohorts, without a differentiated pattern in terms of magnitude between older and younger cohorts.

8 Discussion and conclusions

The use of non-traditional methods to solve challenges and constraints in the provision of education often raises concerns about educational quality. One such method is the telesecundarias, schools using televised lessons as an alternative to face-to-face instruction in rural areas. Descriptive evidence—with telesecundaria students consistently performing worse

[55] This program has been widely studied due to its randomized implementation during the early years. See Parker and Todd (2017) for a recent review of the evidence of the program effects.

[56] In 2015, almost 60% of telesecundaria students benefited from the CCT program, compared to 23% of brick-and-mortar junior secondary students (INEE, 2016).

[57] Note that the telesecundaria impacts are highly imprecise for the older cohorts, given that there were few telesecundaria constructions they could attend.

than brick-and-mortar students in standardized assessments[58]—is often used to argue that telesecundarias provide low-quality education, without taking into account the socioeconomic differences across student populations.

The findings in this paper provide evidence that expanding access to junior secondary education in developing countries has large positive returns, even if it requires resorting to non-traditional methods to solve provision challenges. The policy evaluation of the telesecundaria expansion indicates positive and persistent average educational and labor market effects for individuals with access to a high telesecundaria density. These reduced-form results are robust to different specifications, and there is convincing evidence supporting the parallel trends assumption on the outcomes. I estimate average increases in hourly income of 12.5–13.9% for every extra year of education acquired after enrolling in telesecundarias. As argued above, the estimates for compliers are larger than the corresponding average estimates, likely because individuals induced to change their behavior by the instrument had high marginal returns. However, the return estimates in this paper are policy-relevant treatment effects, since they are the returns for individuals who enrolled in secondary education induced by the school construction, which are the returns policymakers should take into account when considering the construction of additional schools.

Interpreting the instrumental variable estimates as the income returns to attending junior secondary education requires assuming that there are no externalities or general equilibrium effects. If there are spillovers during the provision of education or later in the labor market, the estimated impacts might be biased in an unknown direction. First, if the telesecundarias and brick-and-mortar schools are imperfect substitutes, the telesecundaria expansion may raise the competition of existing brick-and-mortar schools. This could improve the overall school productivity in nearby localities (Hoxby, 2000), crowd-out public investment to existing education institutions, or induce selective sorting of students switching school modalities (Hsieh and Urquiola, 2006; Imberman, 2011), which could upward- or downward-bias the estimates of the true effects. Second, if workers with different educational levels are imperfect substitutes in production (e.g., Katz and Murphy, 1992), a significant increase in the supply of junior secondary school graduates in the local labor market could lower average wages of post-primary graduates through conventional supply effects. In contrast, the existence of human capital spillovers—with the presence of educated workers making other workers more productive—could increase overall wages (Moretti, 2004; Ciccone and Peri, 2006). There is limited empirical evidence supporting significant human capital spillovers (e.g., Lange and Topel, 2006), which limits the magnitude of the estimates attributed to general equilibrium effects.

[58]For example, in PISA 2003, 94% of telesecundaria students had insufficient competency in math, compared to 58% of brick-and-mortar students and the 21% OECD average (INEE, 2005).

Given that telesecundarias are schools using televised lessons, this paper also provides evidence on the long-run impacts of one of the most primitive versions of technology-aided instruction. Recent surveys report mixed results on the effectiveness of the use of technology in education (Bulman and Fairlie, 2016; Escueta et al., 2017). The interventions with the largest returns use technology to personalize instruction and to teach at the right level (e.g., Banerjee et al., 2007; Muralidharan et al., 2019). In contrast, the content delivery in telesecundarias diverges significantly from these successful programs, being a one-size-fits-all lesson taught by a single remote teacher and simultaneously retransmitted to all schools. An important difference is that the televised lessons in telesecundarias completely substitute face-to-face instruction in a classroom environment, whereas educational technologies have often been evaluated either as complementary tools to face-to-face teaching, or as complete substitutes for formal schooling. The success of telesecundarias could be due to their "blended environment", where the benefits of superstar teachers delivering the content (Acemoglu et al., 2014) are combined with in-class support and peer interactions.[59]

In conclusion, telesecundarias provide significant payoffs in the labor market through low-cost secondary schools using low-tech technology to deliver lessons. This may be because they are able to solve two prevalent barriers to expanding post-primary education in developing countries: The supply constraint of trained secondary education teachers, and high rates of teacher absenteeism (Banerjee and Duflo, 2006; Duflo et al., 2012). With the appropriate infrastructure, telesecundarias offer timely lessons conducted by remote lecturers selected for their professional excellence (Martinez Rizo, 2005). Although the contexts are different, there are still lessons for fully-remote low-tech distance education programs, which have become prevalent during the Covid-19 pandemic: Although the blended environment may be key for the success of the telesecundarias, it is still the case that lessons were delivered using a one-size-fits-all technology that followed the same pace for all students in the country. Hence, in settings where low-tech remote educational interventions may be the only possibility to provide education, they may still provide positive impacts if paired with the right support and learning environments. Additionally, if the success of interventions using technology to personalize instruction replicate to telesecundaria-like settings, the estimated returns in this paper could be a lower bound for similar programs using more sophisticated and personalized educational technologies.

[59]This hypothesis is in line with Escueta et al. (2017), who reports that "the effects of blended learning are generally on-par with those of fully in-person courses. This suggests that appropriate combination of online and in-person learning may be cost effective". However, recent evidence in Setren et al. (2019) cautions against using "flipped classroom" models—where students view a video lecture at home and work on exercises during class time—finding fade-out effects and an increase in the achievement gap.

References

Acemoglu, D., Laibson, D., and List, J. A. (2014). Equalizing superstars: The internet and the democratization of education. *American Economic Review Papers and Proceedings*, 104(5):523–527.

Akresh, R., Halim, D., and Kleemans, M. (2018). Long-term and intergenerational effects of education: Evidence from school construction in Indonesia. *National Bureau of Economic Research*, (Working paper 25265).

Alpert, W. T., Couch, K. A., and Harmon, O. R. (2016). A randomized assessment of online learning. *American Economic Review*, 106(5):378–382.

Assefa, T. (2016). Educational technology implementation in Ethiopian high schools: Benefits and challenges of the instructional plasma TV. *Handbook on Digital Learning for K-12 Schools*, pages 413–427.

Banerjee, A., Cole, S., Duflo, E., and Linden, L. (2007). Remedying education: Evidence from two randomized experiments in India. *The Quarterly Journal of Economics*, 122(3):1235–1264.

Banerjee, A. and Duflo, E. (2006). Addressing absence. *Journal of Economic Perspectives*, 20(1):117–132.

Banerjee, A. and Duflo, E. (2014). Economics education in the digital age: The implications of online technologies and MOOCS. *American Economic Review: Papers and Proceedings*, 104(5):514–518.

Banerjee, A., Glewwe, P., Powers, S., and Wasserman, M. (2013). Expanding access and increasing student learning in post-primary education in developing countries: A review of the evidence. *Post-Primary Education Initiative Review Paper*.

Banerjee, A., La Ferrara, E., and Orozco, V. (2019). Entertainment, education, and attitudes toward domestic violence. *AEA Papers and Proceedings*, 109:133–137.

Barron Rodriguez, M., Cobo, C., Munoz-Najar, A., and Sanchez Ciarrusta, I. (2021). *Remote Learning During the Global School Lockdown: Multi-Country Lessons*. World Bank.

Becker, G. S. (1964). Human capital: A theoretical and empirical analysis, with special reference to education. *The University of Chicago Press*.

Beg, S. A., Lucas, A. M., Halim, W., and Saif, U. (2019). Beyond the basics: Improving post-primary content delivery through classroom technology. *National Bureau of Economic Research*, (Working Paper 25704).

Berg, G. and Zia, B. (2013). Harnessing emotional connections to improve financial decisions. evaluating the impact of financial education in mainstream media. *The World Bank Policy Research Working Paper 6407*.

Bettinger, E. P., Fox, L., Loeb, S., and Taylor, E. S. (2017). Virtual classrooms: How online college courses affect student success. *American Economic Review*, 107(9):2855–2875.

Bianchi, N., Lu, Y., and Song, H. (2019). The effect of computer-assisted learning on students' long-term development.

Borusyak, K., Jaravel, X., and Spiess, J. (2021). Revisiting Event Study Designs: Robust and Efficient Estimation. *arXiv:2108.12419 [econ]*.

Bulman, G. and Fairlie, R. W. (2016). Technology and education: Computers, software and the internet. *National Bureau of Economic Research*, (Working Paper 22237).

Burbidge, J. B., Magee, L., and Robb, A. L. (1988). Alternative transformations to handle extreme values of the dependent variable. *Journal of the American Statistical Association*, 83(401):123–127.

Calderoni, J. (1998). Telesecundaria: Using TV to bring education to rural Mexico. *Education and Technology Technical Notes Series*, (2).

Calixto Flores, R. and Rebollar Albarrán, A. M. (2008). La telesecundaria, ante la sociedad del conocimiento. *Revista Iberoamericana de Educación*, 44(7).

Callaway, B. and Sant'Anna, P. H. C. (2021). Difference-in-Differences with multiple time periods. *Journal of Econometrics*, 225(2):200–230.

Card, D. (1995). Earnings, schooling, and ability revisited. *National Bureau of Economic Research*, (Working Paper No. 4832).

Card, D. (1999). The causal effect of education on earnings. *Handbook of Labor Economics*, 3:1801–1863.

Charles, K. K., Hurst, E., and Notowidigdo, M. J. (2018). Housing booms and busts, labor market opportunities, and college attendance. *American Economic Review*, 108(10):2947–2994.

Chong, A. and La Ferrara, E. (2009). Television and divorce: Evidence from Brazilian "novelas". *Journal of the European Economic Association*, 7(2/3):458–468.

Ciccone, A. and Peri, G. (2006). Identifying human-capital externalities: Theory with applications. *Review of Economic Studies*, 73(2):381–412.

Consejo Nacional de Población (2014). Prontuario de migración interna. *Consejo Nacional de Población*.

de Chaisemartin, C. and D'Haultfœuille, X. (2020). Two-Way Fixed Effects Estimators with Heterogeneous Treatment Effects. *American Economic Review*, 110(9):2964–2996.

de Chaisemartin, C. and D'Haultfœuille, X. (2021). Difference-in-Differences Estimators of Intertemporal Treatment Effects. SSRN Scholarly Paper ID 3731856, Social Science Research Network, Rochester, NY.

de Chaisemartin, C., D'Haultfoeuille, X., and Deeb, A. (2020). TWOWAYFEWEIGHTS: Stata module to estimate the weights and measure of robustness to treatment effect heterogeneity attached to two-way fixed effects regressions. Boston College Department of Economics.

de Chaisemartin, C., D'Haultfoeuille, X., and Guyonvarch, Y. (2021). DID_MULTIPLEGT: Stata module to estimate sharp Difference-in-Difference designs with multiple groups and periods. Boston College Department of Economics.

Delesalle, E. (2019). The effect of the universal primary education program on labor market outcomes: Evidence from Tanzania. *Institut de Recherches Économiques et Sociales de l'Université catholique de Louvain*, (Discussion Paper 2019-10).

Duflo, E. (2001). Schooling and labor market consequences of school construction in Indonesia: Evidence from an unusual policy experiment. *American Economic Review*, 91(4):795–813.

Duflo, E. (2004). The medium run effects of educational expansion: evidence from a large construction program in Indonesia. *Journal of Development Economics*, 74:163–197.

Duflo, E., Dupas, P., and Kremer, M. (2017). The impact of free secondary education: Experimental evidence from Ghana.

Duflo, E., Hanna, R., and Ryan, S. P. (2012). Incentives work: Getting teachers to come to school. *American Economic Review*, 102(4):1231–1278.

Escueta, M., Quan, V., Nickow, A. J., and Oreopoulos, P. (2017). Education technology: An evidence-based review. *National Bureau of Economic Research*, (Working Paper 23744).

Fabregas, R. (2019). Broadcasting education: The long-term effects of Mexico's telesecundarias. *Working Paper*.

Figlio, D. N., Rush, M., and Yin, L. (2013). Is it live or is it internet? experimental estimates of the effects of online instruction on student learning. *Journal of Labor Economics*, 31(4):763–784.

Gentzkow, M. and Shapiro, J. M. (2008). Preschool television viewing and adolescent test scores: Historical evidence from the Coleman study. *The Quarterly Journal of Economics*, 123(1):279–323.

Goodman, J., Melkers, J., and Pallais, A. (2019). Can online delivery increase access to education? *Journal of Labor Economics*, 37(1):1–34.

Goodman-Bacon, A. (2018). Difference-in-differences with variation in treatment timing. *National Bureau of Economic Research*, (Working paper 25018).

Gunderson, M. and Oreopoulos, P. (2010). Returns to education in developed countries. *Chapter for International Encyclopedia in Education (Third Edition), edited by E. Barker, M. McGaw and P. Peterson, Elsevier Publishers, USA*, pages 298–304.

Heckman, J., Humphries, J. E., and Veramendi, G. (2018). Returns to education: The causal effects of education on earnings, health and smoking. *Journal of Political Economy*, 126(Suppl 1):S197–S246.

Hoxby, C. M. (2000). Does competition among public schools benefit students and taxpayers? *American Economic Review*, 90(5):1209–1238.

Hsieh, C.-T. and Urquiola, M. (2006). The effects of generalized school choice on achievement and stratification: Evidence from *chile's* voucher program. *Journal of Public Economics*, 90(8-9):1477–1503.

Ichino, A. and Winter-Ebmer, R. (1999). Lower and upper bounds of returns to schooling: An exercise in IV estimation with different instruments. *European Economic Review*, 43:889–901.

Imberman, S. A. (2011). The effect of charter schools on achievement and behavior of public school students. *Journal of Public Economics*, 95(7-8):850–863.

Instituto Nacional de Estadística y Geografía (2010). Conociendo la base de datos de la ENOE. datos ajustados a proyecciones de población 2010.

Instituto Nacional de la Evaluación de la Educación (2016). Panorama educativo de México. indicadores del sistema educativo nacional. educación básica y media superior. *Indicadores Educativos*.

Instituto Nacional de la Evaluación de la Educación (2017). Panorama educativo de México. indicadores del sistema educativo nacional. educación básica y media superior. *Indicadores Educativos*.

Instituto Nacional para la Evaluación de la Educación (2005). Las telesecundarias mexicanas. un recorrido sin atajos. *Fundación Este País. Conocimiento Útil*.

Jakiela, P. (2021). Simple Diagnostics for Two-Way Fixed Effects. *arXiv:2103.13229 [econ, q-fin]*.

Johnston, J. and Ksoll, C. (2017). Effectiveness of interactive satellite-transmitted instruction: Experimental evidence from Ghanaian primary schools. *Center for Education Policy Analysis Working Paper No. 17-08*.

Karachiwalla, N. and Palloni, G. (2019). Human capital and structural transformation. quasi-experimental evidence from Indonesia. *International Food Policy Research Institute*, (Discussion Paper 01836).

Katz, L. F. and Murphy, K. M. (1992). Changes in relative wages, 1963-1987: Supply and demand factors. *The Quarterly Journal of Economics*, 107(1):35–78.

Kazianga, H., Levy, D., Linden, L. L., and Sloan, M. (2013). The effects of “girl-friendly” schools: Evidence from the BRIGHT school construction program in Burkina Faso. *American Economic Journal: Applied Economics*, 5(3):41–62.

Kearney, M. and Levine, P. (2015a). Early childhood education by MOOC: Lessons from Sesame Street. *NBER*, (Working Paper 21229).

Kearney, M. and Levine, P. (2015b). Media influences on social outcomes: The impact of MTV's 16 and pregnant on teen childbearing. *American Economic Review*, 105(12):3597–3632.

Kline, P. and Walters, C. R. (2016). Evaluating public programs with close substitutes: The case of Head Start. *Quarterly Journal of Economics*, 131(4):1795–1848.

La Ferrara, E., Chong, A., and Duryea, S. (2012). Soap operas and fertility: Evidence from Brazil. *American Economic Journal: Applied Economics*, 4(4):1–31.

Lange, F. and Topel, R. (2006). The social value of education and human capital. *Handbook of the Economics of Education*, 1:459–509.

Martinez Rizo, F. (2005). La telesecundaria mexicana. desarrollo y problematica actual. *Coleccion de Cuadernos de Investigacion*, (16).

Mayo, J. K. (1975). The Mexican telesecundaria: A cost-effectiveness analysis. *Instructional Science*, 4(4):193–236.

Mincer, J. (1970). The distribution of labor incomes: A survey with special reference to the human capital approach. *Journal of Economic Literature*, 8(1):1–26.

Montenegro, C. E. and Patrinos, H. A. (2014). Comparable estimates of returns to schooling around the world. *World Bank Group*, (Policy Research Working Paper 7020).

Morales-Ramos, E. (2011). Los rendimientos de la educación en México. *Banco de México Working papers*, (Nº 2011-07).

Moretti, E. (2004). Human capital externalities in cities. *Handbook of Regional and Urban Economics*, 4:2243–2291.

Mountjoy, J. (2018). Community colleges and upward mobility.

Muralidharan, K., Singh, A., and Ganimian, A. J. (2019). Disrupting education? experimental evidence on technology-aided instruction in India. *American Economic Review*, 109(4):1426–1460.

Navarro-Sola, L. (2019). Secondary School Expansion through Televised Lessons: The Labor Market Returns of the Mexican Telesecundaria. Working Paper.

Oreopoulos, P. (2006). Estimating average and local average treatment effects of education when compulsory schooling laws really matter. *American Economic Review*, 96(1):152–175.

Ozier, O. (2016). The impact of secondary schooling in Kenya: A regression discontinuity analysis. *Journal of Human Resources*.

Parker, S. W. and Todd, P. E. (2017). Conditional cash transfers: The case of Progresa/Oportunidades. *Journal of Economic Literature*, 55(3):866–915.

Santos, A. (2001). Oportunidades educativas en telesecundaria y factores que las condicionan. *Revista Latinoamericana de Estudios Educativos*, XXXI(3):11–62.

Secretaría de Educación Pública (1967). Informe sobre el movimiento educativo en México durante el año escolar 1966-1967. Report.

Secretaría de Educación Pública (2010). La telesecundaria en México: un breve recorrido histórico por sus datos y relatos. *Direccion General de Materiales Educativos*.

Secretaría de Educación Pública (2012). Acciones de planeación regional para programación detallada, 2012-2013. Report 970-18-4172-7.

Secretaría de Educación Pública (2014). Capítulo 1: La educación en México. *Revisiones de la OCDE sobre la Educación en México*.

Setren, E., Greenberg, K., Moore, O., and Yankovich, M. (2019). Does flipping the classroom reduce inequality? Evidence from a randomized trial at the United States military.

Spohr, C. A. (2003). Formal schooling and workforce participation in a rapidly developing economy: Evidence from "compulsory" junior high school in Taiwan. *Journal of Development Economics*, 70(2):291–327.

Sun, L. and Abraham, S. (2021). Estimating dynamic treatment effects in event studies with heterogeneous treatment effects. *Journal of Econometrics*, 225(2):175–199.

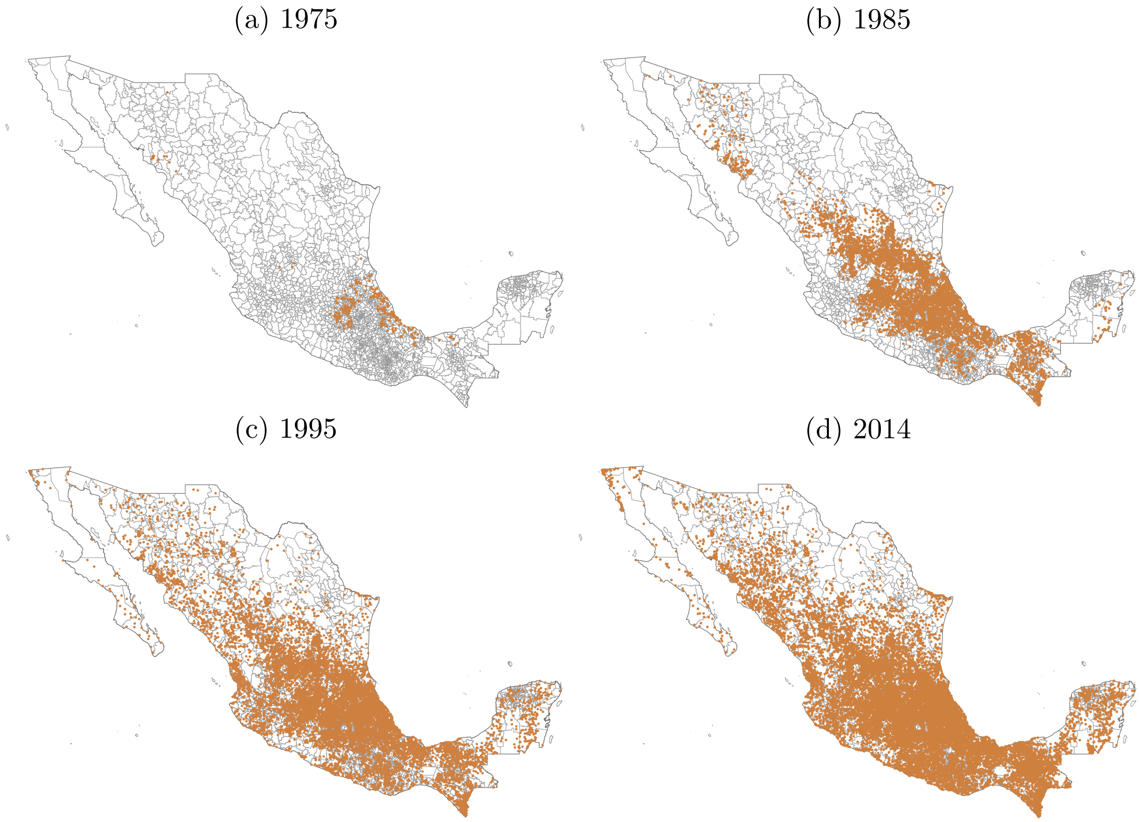
The World Bank (2005). Expanding opportunities and building competencies for young people. a new agenda for secondary education. *World Bank Publications*, (Number 7429).

The World Bank (2019). Indicators retrieved from the world bank indicators webpage on october 2019. .

UNESCO (2017). Global education monitoring report, 2017/8. accountability in education: meeting our commitments.

A Supplementary figures on telesecundaria rollout

Figure A.1: Expansion of telesecundarias (1968-2014)



(a) 1975

(b) 1985

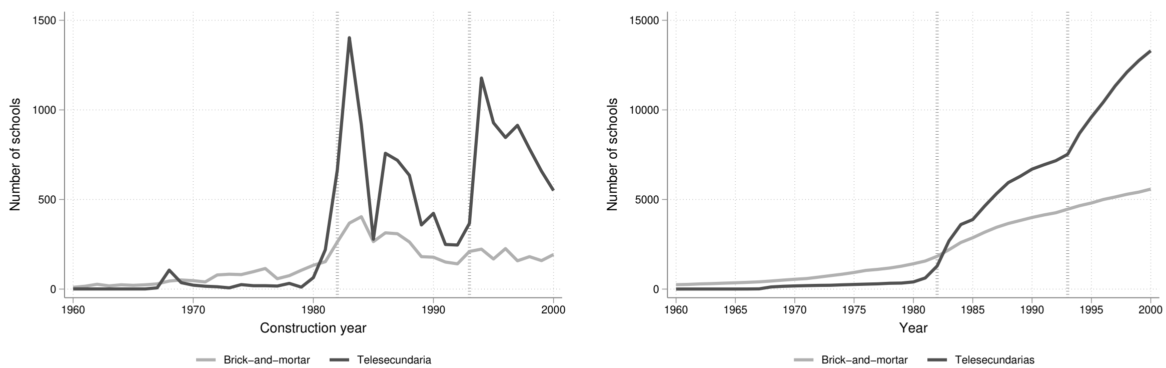
(c) 1995

(d) 2014

Notes: Telesecundaria expansion for the 1968-2014 period. Geographical frontiers correspond to municipalities, and each orange dot to a single telesecundaria. *Source*: Author graphs based on the school registry data from the Ministry of Education in Mexico.

Figure A.2: Secondary school construction rollout in Mexico

(a) School construction dates (b) Number of open schools



Notes: Panel (a) shows the distribution of the imputed construction dates of all junior secondary schools in Mexico, separated by telesecundarias and brick-and-mortar schools. Panel (b) shows the total number of open junior secondary schools in Mexico in a given year, separated by telesecundarias and brick-and-mortar schools. Both panels only include schools constructed in Mexican localities with less than 100,000 habitants during the 1960-2000 period.

Figure A.3: Secondary school construction rollout in the ENOE sample

(a) Date of first school in the locality (b) Number of open schools

Notes: Panel (a) shows the distribution of individuals in the ENOE final sample by dates of the first junior secondary school constructed in their locality, separated by telesecundarias and brick-and-mortar schools. Panel (b) shows the total number of open junior secondary schools in a given year in the ENOE localities, separated by telesecundarias and brick-and-mortar schools. Both panels only include schools constructed in Mexican localities with less than 100,000 habitants during the 1960-2000 period.

B Supplementary reduced-form results

Table B.1: Effects of telesecundaria construction on terminal achievement levels

	Upper Secondary Education		**Tertiary Education**		
	Lower Technical	Preparatoria	Higher Technical	Teacher College	College
	(1)	(2)	(3)	(4)	(5)
TS density (50 ch.)	0.011	0.008	0.001	0.005	-0.024
	(0.001)	(0.004)	(0.000)	(0.001)	(0.002)
Dependent Mean	0.03	0.16	0.01	0.01	0.13
Observations	874496	874496	874496	874496	874496

Notes: This table illustrates the reduced-form effects of telesecundaria access on the terminal academic degree of individuals. The table reports the estimated coefficients of β from the estimation of the two-way fixed-effects DiD equation (1). It uses as dependent variable an indicator for the highest achievement level of the individual: Lower technical degree (Column 1), preparatoria (Column 2), higher technical degree (Column 3), teacher college degree (Column 4) and college degree and beyond (Column 5). See Section 3 for a description of the outcome variables. The treatment measure is the telesecundaria density, the number of telesecundarias open in locality l when individuals from cohort c were 12 years-old scaled by the total population of individuals targeted by the program. See Section 4 for details on the treatment variable. All regressions use sampling weights and include cohort and locality fixed effects. Individual controls include female, age and age^2 and interactions between them. Robust standard errors are shown in parentheses and clustered at the locality level.

Table B.2: Effects of telesecundaria construction on labor market sectors and job informality

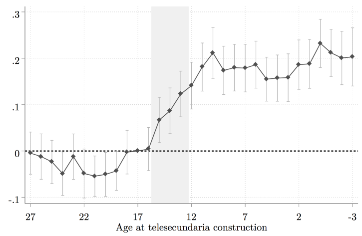
	(1)	(2)	(3)	(4)	(5)	(6)
	Panel A. Labor market sectors					
	Construction	Manufact.	Commerce	Services	Agriculture	
TS density (50 ch.)	0.006	0.001	-0.003	0.040	-0.020	
	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	
Dependent Mean	0.06	0.10	0.11	0.23	0.12	
Observations	874496	874496	874496	874496	874496	
	Panel B. Labor market informality					
	Company/Instit.	Domestic	Agriculture	Informal	Informal Occup.	SS Access
TS density (50 ch.)	0.019	0.008	-0.020	0.018	-0.008	0.020
	(0.003)	(0.001)	(0.003)	(0.003)	(0.004)	(0.003)
Dependent Mean	0.31	0.03	0.12	0.18	0.41	0.19
Observations	874496	874496	874496	874496	874496	874496

Notes: This table illustrates the reduced-form effects of telesecundaria access on the participation on labor market sectors and on labor market informality. The table reports the estimated coefficients of β from the estimation of the two-way fixed-effects DiD equation (1). Panel A use as a dependent variable an indicator identifying whether the individual work in a given labor market sector: Construction (Column 1), manufacturing (Column 2), commerce (Column 3), services (Column 4) or agriculture (Column 5). Panel B, columns 1-4, use as a dependent variable an indicator for whether the individual works for a given type of employer: Formal company or institution (Column 1), paid domestic work (Column 2), subsistence agriculture (Column 3) or informal sector (Column 4). Column 5 uses as a dependent variable an indicator for whether the individual works in an informal occupation, and Column 6 for whether the individual has access to health insurance benefits through their employer. See Section 3 for a description of the outcome variables. The treatment measure is the telesecundaria density, the number of telesecundarias open in locality l when individuals from cohort c were 12 years-old scaled by the total population of individuals targeted by the program. See Section 4 for details on the treatment variable. All regressions use sampling weights and include cohort and locality fixed effects. Individual controls include female, age and age^2 and interactions between them. Robust standard errors are shown in parentheses and clustered at the locality level.

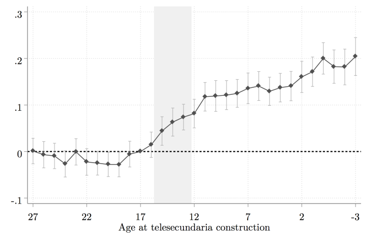
Figure B.1: Comparison of telesecundaria construction effects on education outcomes by treatment measure

(a) **Junior sec. enrollment**
Density treatment

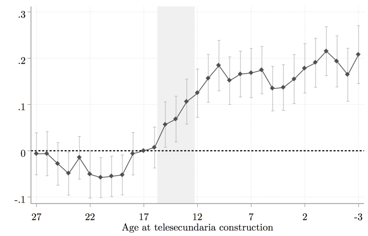
(b) **Junior sec. enrollment**
Binary treatment



(c) **Junior sec. graduation**
Density treatment

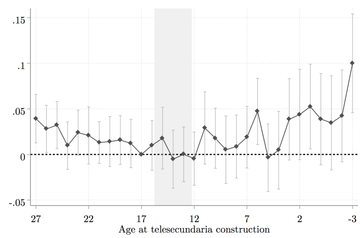


(d) **Junior sec. graduation**
Binary treatment



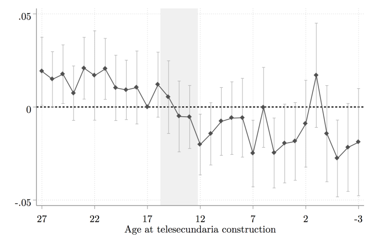
(e) **Upper sec. enrollment**
Density treatment

(f) **Upper sec. enrollment**
Binary treatment

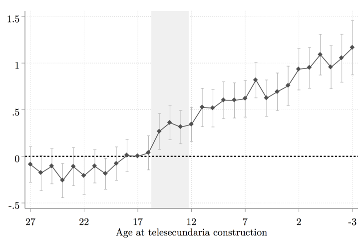


(g) **Tertiary enrollment**
Density treatment

(h) **Tertiary enrollment**
Binary treatment



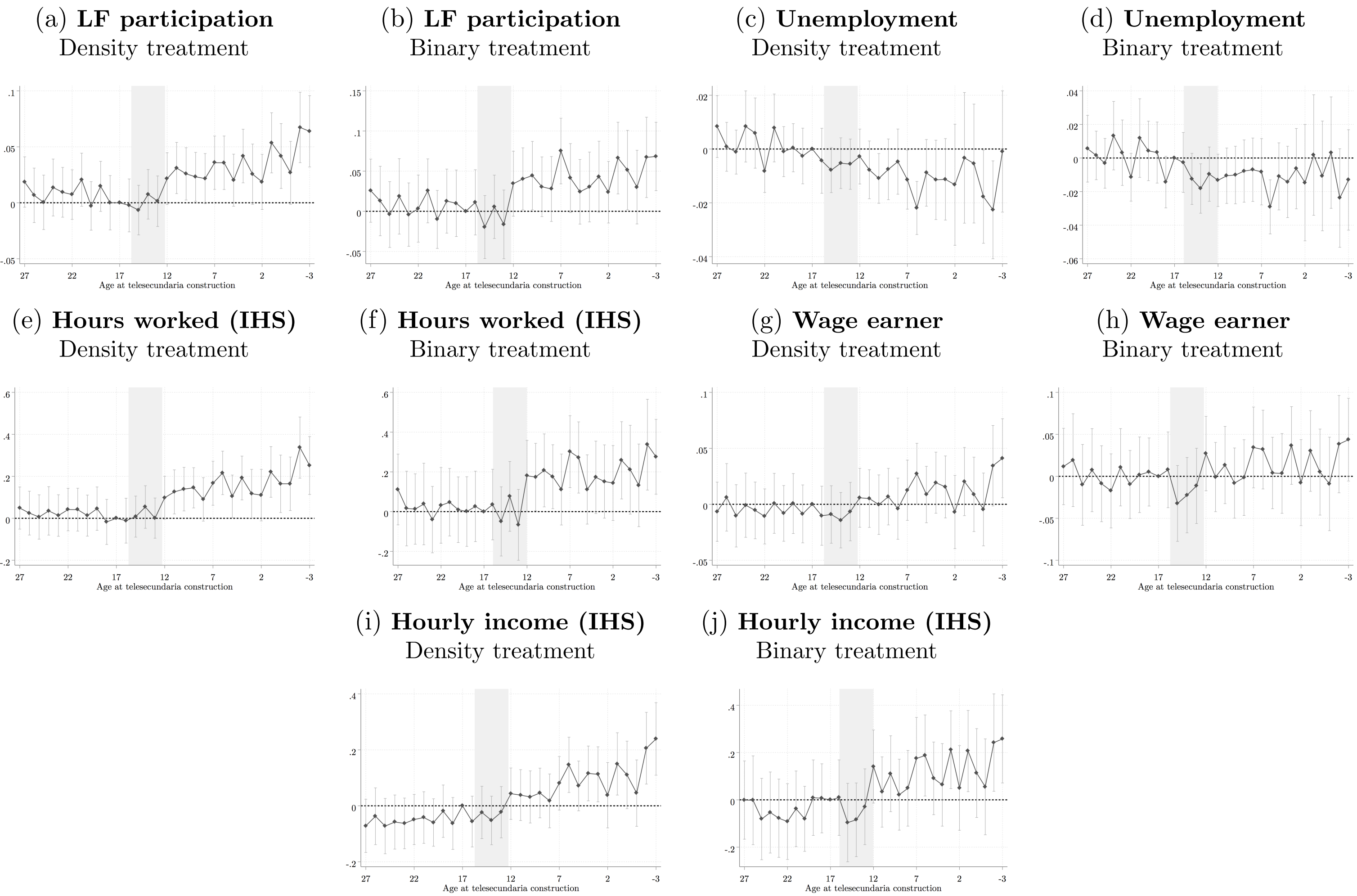
(i) **Years of education**
Density treatment



(j) **Years of education**
Binary treatment

Notes: This figure presents the reduced-form estimates of the difference-in-differences specification for different outcomes and treatment measures, computed by age at the year of telesecundaria construction. See equation (2) for details on the econometric specification. Coefficient estimates are shown with a solid line, and 95% confidence intervals with a dashed line. All effects are computed with respect to age 17, the baseline year.

Figure B.2: Comparison of telesecundaria construction effects on labor market outcomes by treatment measure



Notes: This figure presents the reduced-form estimates of the difference-in-differences specification for different outcomes and treatment measures, computed by age at the year of telesecundaria construction. See equation (2) for details on the econometric specification. Coefficient estimates are shown with a solid line, and 95% confidence intervals with a dashed line. All effects are computed with respect to age 17, the baseline year.

Table B.3: Effects of telesecundaria construction by gender

	(1)	(2)	(3)	(4)
	Panel A: Education outcomes			
	Junior Sec. Enroll.	Upper Sec. Enroll.	Tertiary Enroll.	Years of Education
TS density (50 ch.)	0.146	0.011	-0.006	0.905
	(0.007)	(0.006)	(0.003)	(0.051)
TS density × Female	-0.026	-0.023	-0.024	-0.209
	(0.007)	(0.006)	(0.003)	(0.051)
Dependent Mean: Males	0.64	0.34	0.15	8.74
Dependent Mean: Females	0.62	0.33	0.14	8.56
Observations	874423	874423	874423	874423
	Panel B: Labor market outcomes			
	Active	Unemployed	Hours Worked (IHS)	Hourly Wage (IHS)
TS density (50 ch.)	0.024	-0.008	0.124	0.123
	(0.004)	(0.002)	(0.023)	(0.021)
TS density × Female	-0.009	-0.002	-0.045	-0.026
	(0.006)	(0.005)	(0.029)	(0.024)
Dependent Mean: Males	0.89	0.04	3.67	2.40
Dependent Mean: Females	0.46	0.05	1.76	1.19
Observations	874423	582339	874423	874423
	Panel C: Labor market sectors			
	Manufacturing	Commerce	Services	Agriculture
TS density (50 ch.)	0.002	-0.002	0.041	-0.025
	(0.003)	(0.002)	(0.004)	(0.006)
TS density × Female	-0.002	-0.003	-0.002	0.013
	(0.004)	(0.004)	(0.005)	(0.006)
Dependent Mean: Males	0.13	0.11	0.25	0.23
Dependent Mean: Females	0.08	0.11	0.22	0.02
Observations	874423	874423	874423	874423
	Panel D: Labor market informality			
	Company/Instit.	Informal Employer	Informal Occup.	SS Access
TS density (50 ch.)	0.032	0.023	-0.020	0.027
	(0.005)	(0.004)	(0.006)	(0.004)
TS density × Female	-0.026	-0.009	0.024	-0.015
	(0.005)	(0.006)	(0.007)	(0.004)
Dependent Mean: Males	0.39	0.23	0.55	0.26
Dependent Mean: Females	0.23	0.14	0.28	0.14
Observations	874423	874423	874423	874423

Notes: This table illustrates the reduced-form effects of telesecundaria construction by gender on education and labor market outcomes. The table reports the estimated coefficients of β from the estimation of the two-way fixed-effects DiD equation (1), all regressors interacted with a binary indicator for whether the individual is a female. See Section 3 for a description of the outcome variables. The treatment measure is the telesecundaria density, the number of telesecundarias open in locality l when individuals from cohort c were 12 years-old scaled by the total population of individuals targeted by the program. See Section 4 for details on the treatment variable. All regressions use sampling weights and include cohort and locality fixed effects. Individual controls include female, age and age^2 and interactions between them. Robust standard errors are shown in parentheses and clustered at the locality level.

Table B.4: Effects of Telesecundaria Construction,
by brick-and-mortar access nearby prior to telesecundaria construction

	(1)	(2)	(3)	(4)
	Panel A: Education outcomes			
	Junior Sec. Enroll.	Upper Sec. Enroll.	Tertiary Enroll.	Years of Education
TS density (50 ch.)	0.112	0.010	-0.011	0.511
	(0.010)	(0.008)	(0.003)	(0.085)
TS density × BM nearby at constr.	0.031	-0.013	-0.008	0.412
	(0.012)	(0.011)	(0.005)	(0.104)
Dependent Mean	0.63	0.34	0.14	8.65
Observations	874423	874423	874423	874423
	Panel B: Labor market outcomes			
	Active	Unemployed	Hours Worked (IHS)	Hourly Wage (IHS)
TS density (50 ch.)	0.009	-0.005	0.052	0.051
	(0.005)	(0.004)	(0.024)	(0.023)
TS density × BM nearby at constr.	0.017	-0.006	0.080	0.095
	(0.007)	(0.004)	(0.031)	(0.030)
Dependent Mean	0.67	0.04	2.67	1.77
Observations	874423	582339	874423	874423
	Panel C: Labor market sectors			
	Manufacturing	Commerce	Services	Agriculture
TS density (50 ch.)	-0.002	-0.003	0.019	-0.007
	(0.004)	(0.003)	(0.005)	(0.006)
TS density × BM nearby at constr.	0.006	-0.000	0.031	-0.019
	(0.005)	(0.004)	(0.006)	(0.007)
Dependent Mean	0.10	0.11	0.23	0.12
Observations	874423	874423	874423	874423
	Panel D: Labor market informality			
	Company/Instit.	Informal Employer	Informal Occup.	SS Access
TS density (50 ch.)	0.011	0.005	-0.007	0.013
	(0.004)	(0.004)	(0.006)	(0.004)
TS density × BM nearby at constr.	0.015	0.019	-0.002	0.011
	(0.006)	(0.005)	(0.007)	(0.005)
Dependent Mean	0.31	0.18	0.41	0.19
Observations	874423	874423	874423	874423

Notes: This table illustrates the reduced-form effects of telesecundaria construction by brick-and-mortar access nearby on education outcomes (Panel A) and labor market outcomes (Panel B), as well as labor market sectors (Panel C) and labor market informality (Panel D). The table reports the estimated coefficients of β from the estimation of the two-way fixed-effects DiD equation (1), all regressors interacted with a binary indicator for whether the locality had a brick-and-mortar school within 10 km the year prior to the telesecundaria construction. See Section 3 for a description of the outcome variables. The treatment measure is the telesecundaria density, defined as the number of telesecundarias open in locality l when individuals from cohort c where 12 years-old, scaled by the total population of individuals targeted by the program. See Section 4 for details on the treatment variable. All regressions use sampling weights and include cohort and locality fixed effects. Individual controls include female, age and age^2 and interactions between them. Robust standard errors are shown in parentheses and clustered at the locality level.

C Heterogeneity and sensitivity results

Table C.1: Diagnostic of the results' sensitivity to heterogeneous treatment effects, following de Chaisemartin and D'Haultfoeuille (2020)

	Number of ATTs with:				
	Positive weight	Negative weight	Sum negative weights	$\underline{\sigma}_{fe}$	$\underline{\underline{\sigma}}_{fe}$
	(1)	(2)	(3)	(4)	(5)
Enrolled in secondary ed.	8,070	593	-0.00266	0.29	14.61
Years of education	8,070	593	-0.00266	1.65	82.11
Labor force participation	8,070	593	-0.00266	0.04	2.20
Hourly income (IHS), all	8,070	593	-0.00266	0.20	10.09

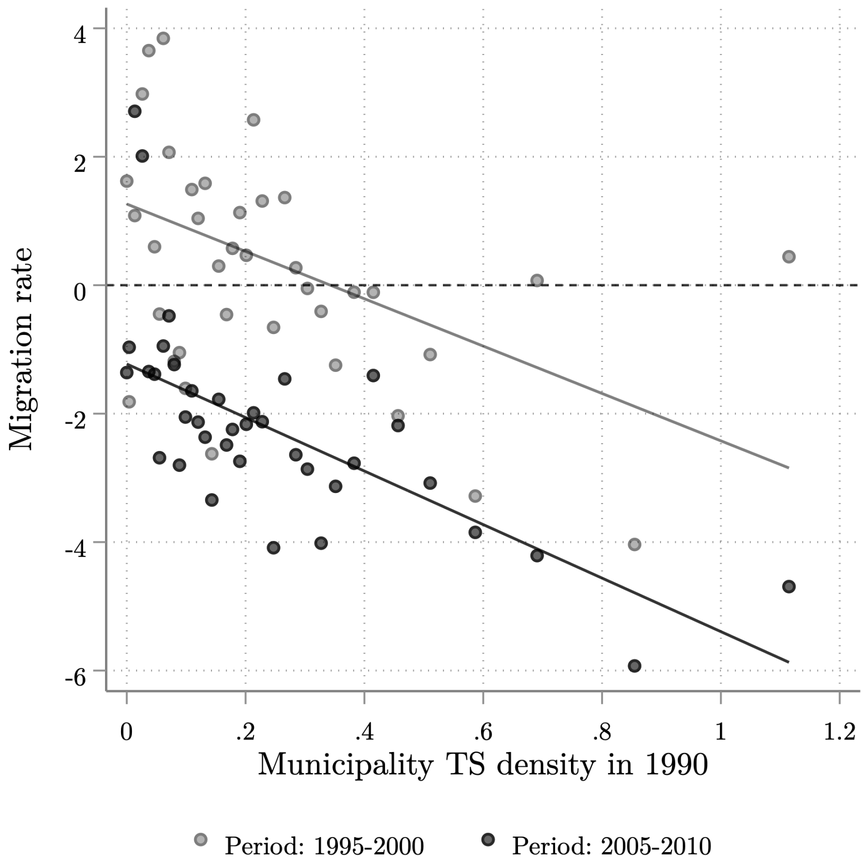
Notes: This table presents diagnostic measures of the sensitivity of the main results to heterogeneous treatment effects, following de Chaisemartin and D'Haultfœuille (2020). It shows the number of ATTs with associated positive weights (Column 1) and negative weights (Column 2), and the sum of the negative weights (Column 3). It also presents two diagnostic measures: $\underline{\sigma}_{fe}$, a proxy for the degree of heterogeneity in ATEs across treated groups and time periods,(Column 4), and $\underline{\underline{\sigma}}_{fe}$ (Column 5), a proxy for the minimal amount of treatment effect heterogeneity under which it would be possible to obtain a β_{fe} of the opposite sign of all the ATEs. See de Chaisemartin and D'Haultfœuille (2020) for details on the construction of these diagnostic measures and their interpretation. These diagnostics have been computed with the twowayfeweights package (de Chaisemartin et al., 2020).

Table C.2: Alternative dynamic treatment effects estimators following de Chaisemartin and d'Haultfoeuille (2020, 2021)

	Junior Sec. Enrollment (1)	Years of Education (2)	Active (3)	Hourly Wage (IHS) (4)
Period l = 0	0.039	-0.029	0.064	0.223
	(0.009)	(0.399)	(0.071)	(0.012)
Period l = 1	0.072	0.350	0.056	0.151
	(0.037)	(0.270)	(0.030)	(0.044)
Period l = 2	0.073	0.104	0.020	0.189
	(0.005)	(0.174)	(0.006)	(0.013)
Period l = 3	0.062	0.189	0.057	0.138
	(0.086)	(0.446)	(0.011)	(0.064)
Period l = 4	0.058	0.307	0.105	0.287
	(0.002)	(0.173)	(0.042)	(0.146)
Period l = 5	0.086	0.544	0.124	0.368
	(0.045)	(0.480)	(0.029)	(0.009)
Period l = 6	0.078	0.650	0.108	0.458
	(0.045)	(0.534)	(0.023)	(0.114)
Period l = 7	0.045	0.310	0.062	0.266
	(0.018)	(0.248)	(0.031)	(0.156)
Period l = 8	0.098	0.579	0.088	0.293
	(0.044)	(0.602)	(0.032)	(0.005)
Period l = 9	0.015	0.252	0.101	0.452
	(0.035)	(0.314)	(0.039)	(0.070)
Period l = 10	0.053	0.474	0.104	0.426
	(0.071)	(0.162)	(0.117)	(0.192)

Notes: As alternative estimators to those coming from the two-way fixed-effects difference-in-differences equation (1) and the associated event study specifications, this table presents estimators robust to heterogeneous and dynamic treatment effects, following de Chaisemartin and D'Haultfœuille (2020) and de Chaisemartin and D'Haultfœuille (2021). Columns present the l^{th} dynamic treatment effect, DiD_l, for $l = 0, \ldots, 10$ for the main outcomes of the paper. See Section 3 for a description of the outcome variables. The alternative estimators were computed using did_multiplegt Stata package (de Chaisemartin et al., 2021). Above median TS density is an indicator capturing the intensity of telesecundaria exposure, and identifies the locality-cohort observations with above median telesecundaria density. The telesecundaria density, TS_{lc} is defined as the number of telesecundarias open in locality l when individuals from cohort c where 12 years-old, scaled by the total population of individuals targeted by the program. See Section 4 for details on the treatment variable. The sample includes individuals living in localities with less than 100,000 habitants. Robust standard errors are shown in parentheses and clustered at the locality level. 100 bootstrap replications. See de Chaisemartin and D'Haultfœuille (2020) and de Chaisemartin and D'Haultfœuille (2021) for details on the construction and interpretation of these alternative dynamic treatment effect estimators. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Figure C.1: Telesecundaria density and migration rates



Notes: This figure presents a binned scatterplot of the relationship between the telesecundaria density at the municipality level in 1990 and the 5-year annual migration rate for the 1995-2000 and 2005-2010 periods.

Table C.3: Effects of telesecundaria construction at the municipality level

	(1)	(2)	(3)	(4)
Sample: Excludes inter-state and international migrants				
Panel A: Education outcomes				
	Junior Sec. Enroll.	Upper Sec. Enroll.	Tertiary Enroll.	Years of Education
Municipality TS density (50 ch.)	0.177	0.010	-0.041	1.444
	(0.030)	(0.012)	(0.012)	(0.241)
Dependent Mean	0.63	0.34	0.14	8.65
Observations	873496	873496	873496	873496
Panel B: Labor market outcomes				
	Active	Unemployed	Hours Worked (IHS)	Hourly Wage (IHS)
Municipality TS density (50 ch.)	0.006	-0.022	0.072	0.130
	(0.007)	(0.005)	(0.034)	(0.036)
Dependent Mean	0.67	0.04	2.67	1.77
Observations	873496	581800	873496	873496
Sample: Includes inter-state and international migrants				
Panel C: Education outcomes				
	Junior Sec. Enroll.	Upper Sec. Enroll.	Tertiary Enroll.	Years of Education
Municipality TS density (50 ch.)	0.189	0.019	-0.034	1.612
	(0.031)	(0.011)	(0.011)	(0.256)
Dependent Mean	0.64	0.35	0.15	8.75
Observations	1057065	1057065	1057065	1057065
Panel D: Labor market outcomes				
	Active	Unemployed	Hours Worked (IHS)	Hourly Wage (IHS)
Municipality TS density (50 ch.)	0.002	-0.023	0.059	0.113
	(0.007)	(0.005)	(0.034)	(0.034)
Dependent Mean	0.67	0.04	2.70	1.81
Observations	1057065	710149	1057065	1057065

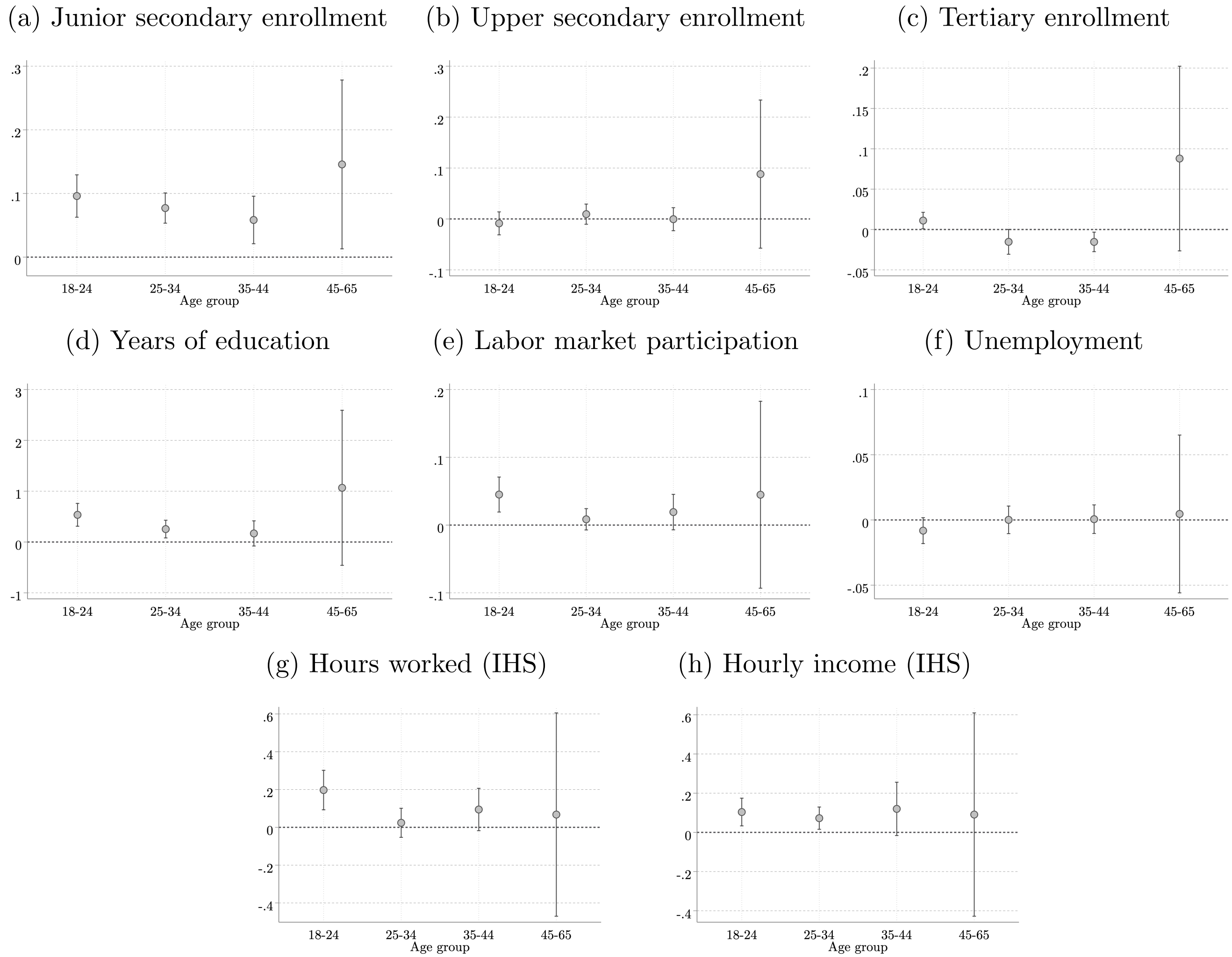
Notes: This table illustrates the reduced-form effects of telesecundaria construction on education and labor market outcomes. The table reports the estimated coefficients of β from the estimation of the two-way fixed-effects DiD equation (1). See Section 3 for a description of the outcome variables. The treatment measure is the telesecundaria density, the number of telesecundarias open in the municipality when individuals from cohort c were 12 years-old scaled by the total population of individuals targeted by the program. See Section 4 for details on the treatment variable. All regressions use sampling weights and include cohort and municipality fixed effects. Individual controls include female, age and age^2 and interactions between them. Robust standard errors are shown in parentheses and clustered at the municipality level.

Table C.4: Reduced-form effects of telesecundaria construction, by locality size

	Junior Secondary		Higher Education			Labor Supply				Labor Income			
	Enrollment	Graduation	Upper Sec.	Tertiary	Years Educ.	Active	Unemployed	Hours Worked		Wage Earner	Hourly Wage		
								(log)	(IHS)		(Pesos)	(log)	(IHS)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Panel A: Rural localities (less than 2,500 habitants)													
TS density (50 ch.)	0.085	0.081	0.003	-0.008	0.328	0.006	-0.002	0.021	0.025	0.001	0.457	0.026	0.029
	(0.005)	(0.005)	(0.005)	(0.002)	(0.039)	(0.003)	(0.002)	(0.012)	(0.015)	(0.004)	(0.149)	(0.012)	(0.014)
Dependent Mean	0.50	0.47	0.20	0.06	7.26	0.63	0.04	2.14	2.53	0.45	9.99	1.29	1.56
Observations	344391	344391	344391	344391	344391	344391	216918	344391	344391	344391	344391	344391	344391
Panel B: Rural and low urbanization localities (less than 15,000 habitants)													
TS density (50 ch.)	0.109	0.103	-0.005	-0.014	0.566	0.015	-0.006	0.060	0.071	0.007	1.361	0.074	0.083
	(0.005)	(0.005)	(0.005)	(0.002)	(0.040)	(0.003)	(0.002)	(0.013)	(0.015)	(0.004)	(0.154)	(0.012)	(0.014)
Dependent Mean	0.57	0.53	0.27	0.10	7.94	0.65	0.04	2.21	2.61	0.47	11.45	1.39	1.68
Observations	589219	589219	589219	589219	589219	589219	383149	589219	589219	589219	589219	589219	589219
Panel C: Rural and urban localities (less than 100,000 habitants)													
TS density (50 ch.)	0.133	0.123	-0.001	-0.018	0.793	0.019	-0.009	0.084	0.099	0.009	1.953	0.098	0.110
	(0.006)	(0.006)	(0.005)	(0.002)	(0.044)	(0.003)	(0.002)	(0.013)	(0.015)	(0.004)	(0.159)	(0.012)	(0.015)
Dependent Mean	0.63	0.60	0.34	0.14	8.65	0.67	0.04	2.26	2.67	0.49	12.73	1.46	1.77
Observations	874496	874496	874496	874496	874496	874496	582448	874496	874496	874496	874496	874496	874496

Notes: This table illustrates the reduced-form effects of telesecundaria exposure on educational attainment and labor market outcomes. The table reports the estimated coefficients of β from the estimation of the two-way fixed-effects DiD equation (1). It uses as dependent variable an indicator for enrollment and graduation in lower secondary education (Columns 1-2), for enrollment in upper secondary and tertiary education (Columns 3-4), and total years of education (Column 5). It also uses as dependent variable an indicator for labor market participation (Column 6), unemployment (Column 7) the log and inverse hyperbolic sine transformations of weekly hours worked (Columns 8-9), an indicator for earning a wage (Column 10), and hourly wage in Mexican pesos, and its log and inverse hyperbolic sine transformations (Columns 11-13). See Section 3 for a description of the outcome variables. The treatment variable is the telesecundaria density, the number of telesecundarias open in locality l when individuals from cohort c were 12 years-old scaled by the total population of individuals targeted by the program. See Section 4 for details on the treatment variable. All regressions use sampling weights and include cohort and locality fixed effects. Individual controls include female, age and age^2 and interactions between them. Robust standard errors are shown in parentheses and clustered at the locality level.

Figure C.2: Effects of telesecundaria construction by cohort



Notes: This figure presents the reduced-form estimates of the difference-in-differences specification for education and labor market outcomes, disaggregated by age group at the time of the ENOE survey. The treatment measure used is the density of telesecundarias per 50 children. The vertical axis shows the point estimates with the associated 95% confidence interval.

Table C.5: Effects of telesecundaria construction by construction period

	Education				Labor Market			
	Junior Sec.	Upper Sec.	Tertiary	Years Education	Active	Unemployed	Hours Worked (IHS)	Hourly Wage (IHS)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Construction Period 1968-1979								
TS density (50 ch.)	0.113	0.117	0.058	0.364	-0.003	0.013	-0.187	-0.024
	(0.055)	(0.052)	(0.040)	(0.482)	(0.047)	(0.017)	(0.226)	(0.205)
Dependent Mean	0.62	0.33	0.13	8.53	0.67	0.04	2.68	1.81
Observations	510762	510762	510762	510762	510762	341422	510762	510762
Panel B: Construction Period 1980-1989								
TS density (50 ch.)	0.124	0.004	-0.016	0.728	0.002	-0.001	0.017	0.071
	(0.008)	(0.008)	(0.003)	(0.064)	(0.005)	(0.003)	(0.023)	(0.024)
Dependent Mean	0.62	0.33	0.13	8.52	0.67	0.04	2.67	1.79
Observations	634556	634556	634556	634556	634556	422160	634556	634556
Panel C: Construction Period 1990-2000								
TS density (50 ch.)	0.136	-0.002	-0.019	0.833	0.026	-0.015	0.137	0.131
	(0.007)	(0.007)	(0.003)	(0.057)	(0.004)	(0.003)	(0.019)	(0.017)
Dependent Mean	0.62	0.33	0.13	8.49	0.67	0.04	2.68	1.81
Observations	633402	633402	633402	633402	633402	424373	633402	633402

Notes: This table illustrates the heterogeneity of the reduced-form effects of telesecundaria exposure on educational attainment and labor market outcomes by the decade of the first telesecundaria constructed in the locality. The table reports the estimated coefficients of β from the estimation of the two-way fixed-effects DiD equation (1). It uses as dependent variable an indicator for enrollment in junior secondary education (Column 1), for enrollment in upper secondary and tertiary education (Columns 2-3), and total years of education (Column 4). It also uses as dependent variable an indicator for labor market participation (Column 5), unemployment (Column 6) the inverse hyperbolic sine transformation of weekly hours worked (Column 7) and of hourly wages (Column 8). See Section 3 for a description of the outcome variables. The treatment variable is the telesecundaria density, the number of telesecundarias open in locality l when individuals from cohort c were 12 years-old scaled by the total population of individuals targeted by the program. See Section 4 for details on the treatment variable. All regressions use sampling weights and include cohort and locality fixed effects. Individual controls include female, age and age^2 and interactions between them. Robust standard errors are shown in parentheses and clustered at the locality level.

D Stylized framework of educational choices

This section outlines a simple model of schooling choices, based on models with choices between schooling substitutes (e.g., Kline and Walters, 2016; Mountjoy, 2018). Its purpose is to identify forces at play in the schooling decision problem. Following Charles et al. (2018), I derive a set of sufficient conditions on the utility functions that guarantee unique thresholds consistent with the empirical patterns.

Individuals indexed by $i = 1, \ldots, I$ have completed primary education choose whether to stop studying and enter the labor force or stay at home (N) or to attend junior secondary education by enrolling into a brick-and-mortar school (B) or into a telesecundaria (T). Let $D_i^S \in \{N, B, T\}$ identify the choice between these three alternatives.

Individuals choose the alternative that maximizes their long-run utility. In the model, I assume that the benefits of all alternatives are homogeneous across all individuals, $B_i^s = B^s$, for every $s \in \{N, T, B\}$.[60] I additionally assume that attending a brick-and-mortar school has higher benefits than attending a telesecundaria for all individuals. With the benefit of not studying normalized to zero ($B^N = 0$), B^B and B^T are the income premium of attending each type of school compared to just finishing primary education.[61]

The direct cost of attending a brick-and-mortar is the distance to the nearest school, which is constant for all individuals in a given locality l, k_l^B. The direct cost of telesecundaria is zero. However, individuals only consider attending a telesecundaria if it is built in the same locality they live in.[62] The indirect cost of post-primary education is a stochastic cost, $c_i \sim U[0, 1]$, and reflects the individual opportunity cost of enrolling in school. In this setting, it may capture whether students are required to help in the fields or in the family business, or social norms and family pressures to stay at home.

Individuals optimally choose the option that provides the highest long-run utility:

$$D_i^S(c_i) = \begin{cases} \underset{s \in \{N,B,T\}}{\arg\max} \quad U_i^s(k_l^B, c_i) & \text{if } TS \text{ in locality} \\ \underset{s \in \{N,B\}}{\arg\max} \quad U_i^s(k_l^B, c_i) & \text{otherwise} \end{cases}$$

When individuals only have access to brick-and-mortar schools, a single-crossing condi-

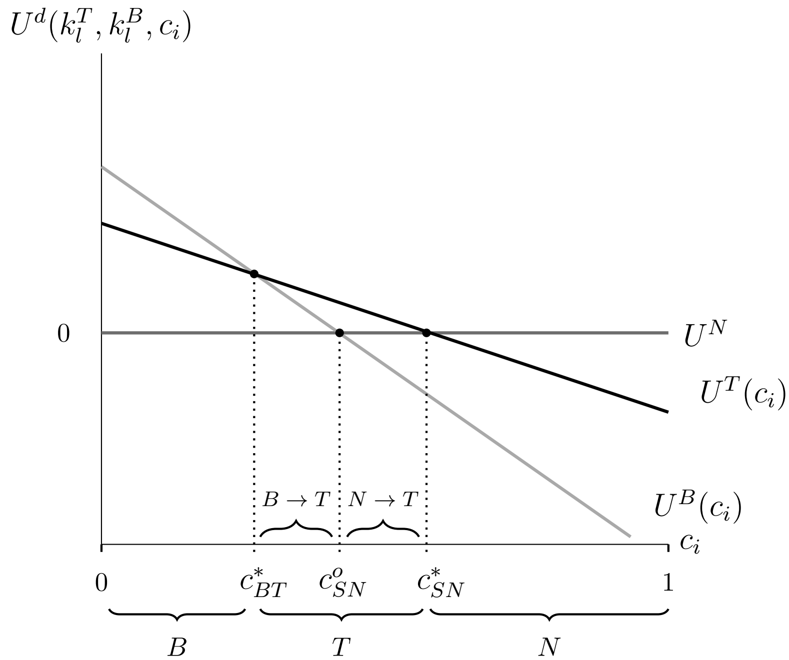
[60] This simplification, which rules out a mechanism of selection based on underlying ability or motivation, is not needed for the empirical estimation, but it facilitates the illustration of the model dynamics.

[61] Following other literature investigating returns to education in partial equilibrium settings, I assume there are no general equilibrium effects or externalities. This implies assuming that the benefits of attending T, B do not change when a telesecundaria is constructed, i.e., $B^m[A^T = 0] = B^m[A^T = 1]$, for $m \in \{T, B\}$, where $A^T \in \{0, 1\}$ indicates the telesecundaria availability.

[62] This assumption is based on the fact that telesecundarias are schools with very limited capacity (between 15-30 students), mainly serving individuals from the same locality. I assume distance to schools is the only direct cost, ruling out tuition costs and other schooling expenses, since private schools are not common in the period of interest.

tion between U_i^B and U_i^N is a sufficient condition to obtain a unique threshold of opportunity cost identifying the individual indifferent between attending a brick-and-mortar school or not studying (c^o_{SN}), which separates individuals into two groups: Those with lower opportunity costs ($c_i < c^o_{SN}$) will choose to attend brick-and-mortar schools, whereas those with higher opportunity costs ($c_i > c^o_{SN}$) will prefer not not enroll in secondary education. See Figure D.3 for a stylized example displaying the threshold c^o_{SN}.[63]

Figure D.3: Stylized model of schooling choices



Notes: This figure displays the utility functions of attending a brick-and-mortar school (B), a telesecundaria (T) or not to study (N). It shows the opportunity cost cutoffs and the complier shifts when a telesecundaria is constructed in the locality.

After telesecundarias are constructed in the individual's locality, attending them becomes a feasible option and they can derive utility from them. Two sufficient conditions are needed to obtain two unique thresholds of opportunity costs (c^*_{BT}, c^*_{SN}): (1) Single-crossing conditions between U_i^N and U_i^T and between U_i^N and U_i^B, and (2) U_i^B and U_i^T crossing only once in the positive utility area.[64] These generate positive shares in the three post-primary alternatives (see Figure D.3 for the stylized example). Among those children enrolled in junior secondary education, students with moderate opportunity costs ($c_i \in [c^*_{BT}, c^*_{SN}]$), will choose to attend telesecundarias, whereas those with lower stochastic costs ($c_i < c^*_{BT}$) will choose to

[63]For the stylized example, we can parametrize the utilities as: $U_i^B(k_l^B, c_i) = B^B - k_l^B - \eta c_i$, $U_i^T(k_l^B, c_i) = B^T - c_i$ and $U_i^N(k_l^B, c_i) = 0$. The parameter $\eta > 1$ captures the fact that the opportunity cost for attending brick-and-mortar secondary schools is higher than for attending telesecundarias, consistent with the setting where brick-and-mortar schools only have a full-time option, whereas telesecundarias offer a more concentrated schedule.

[64]Following the same parametrization, $U_i^B(c_i = 0) > U_i^T(c_i = 0) > 0$ and $U_i^T(c_i = 1) < U_i^T(c_i = 1) < 0$.

attend brick-and-mortar schools.[65] Shifts in the opportunity cost of the individual indifferent between attending junior secondary education and not studying (c^*_{SN}) reflect changes in the extensive margin of secondary education enrollment, whereas shifts in the opportunity cost of the individual indifferent between enrolling in a brick-and-mortar or a telesecundaria (c^*_{BT}) reflect changes in the trade-off between junior secondary school modalities.

The key implication of the model is that compliers come from two counterfactuals. The construction of telesecundarias only affects the individual optimization problem by adding an additional choice without affecting the utility of the other alternatives. Hence, it results in an increase of the binding opportunity cost between working and attending junior secondary school, $c^*_{SN} > c^o_{SN}$, leading to an increase in the share of individuals enrolled in junior secondary education, and a decrease of children out of school. Individuals enrolling in junior secondary education with a relatively high opportunity cost ($c_i \in [c^*_{BT}, c^*_{SN}]$), will choose to attend the telesecundaria, whereas those with lower stochastic costs ($c_i < c^*_{BT}$) will choose to attend a brick-and-mortar school.[66] The empirical prediction steming from this shift is a net increase in the share of individuals enrolled in junior secondary education. Under the assumptions above, there are two types of compliers (i.e., individuals choosing to enroll in telesecundarias after they are constructed): Those that would have attended brick-and-mortar schools otherwise (with $c_i \in (c^*_{BT}, c^o_{SN}]$) and those that would not have studied secondary education otherwise (with $c_i \in [c^o_{SN}, c^*_{SN})$).

If these two conditions are satisfied, the equilibrium parameters are:

$$c^*_{SN} = \begin{cases} B^T & \text{if } h = 0 \\ B^T + \rho(B^{HS} - k_l^{HS}) & \text{if } h = 1 \end{cases}$$

$$c^*_{BT} = \frac{B^B - B^T + k_l^B}{\eta - 1}$$

[65] I assume that individuals at the thresholds will choose to attend telesecundarias. This assumption is without loss of generality because tiebreaking happens with probability zero.

[66] Note that the model assumes that the benefits of telesecundaria are constant between these two groups of compliers, since the only difference explicitly modeled are differences in opportunity costs.

E Data details: FOR ONLINE PUBLICATION

E.1 Education and labor market outcomes

The individual outcome level data comes from the *Encuesta Nacional de Ocupación y Empleo* (ENOE, Employment and Occupation National Survey), administered by the *Instituto Nacional de Estadística y Geografía* (INEGI, Statistics and Geography National Institute). It is a quarterly household survey on the labor market characteristics of the population, and it is constructed as a five-quarter rotating panel. I use all waves from the 2005-2016 period, keeping only the first observation for each unique individual to avoid non-random attrition in subsequent survey waves. The survey is representative at the national level, state level, and for each of the following locality size groups: Localities with 100,000 and more habitants, localities with between 15,000 and 99,999 habitants, localities with between 2,500 and 14,999 habitants and localities with less than 2,500 habitants. All economic characteristics correspond to the week previous to the interview, except income, which refers to the previous month. Below I define the education and labor market outcomes used in the analysis and describe their construction.

Achievement levels. I construct the achievement level variables using the ENOE variables education level (CS_P13_1) and years of education ($ANIOS\_ESC$). The education levels are preschool, primary, junior secondary, upper secondary (preparatoria or bachillerato), teacher's degree (escuela normal), technical degree, profesional degree (licenciatura), master or PhD.

Junior secondary education. I define junior secondary enrollment as having completed at least some years in junior secondary education, either in lower general secondary school or in technical junior secondary school, which is equivalent at completing at least 7 years of education.[67] I define junior secondary graduation as having completed at least junior secondary school or lower technical secondary school, which is equivalent to at least 9 years of education.

Upper secondary enrollment. I define upper secondary enrollment as having completed at least some courses of *preparatoria* or *bachillerato*, or some courses of upper technical education, equivalent of having completed at least 10 years of education.

[67]There are three types of technical education: A 3 year degree (9 total years of education), a 3+3 year degree (12 total years of education) and a 3+3+3 years degree (15 years of education). I classify the 3 year degree as technical secondary education, the 3+3 years as lower technical education, and the 3+3+3 as higher technical education.

Tertiary education enrollment. I define tertiary education enrollment as having completed at least some courses of tertiary technical education, a teacher's degree (*ecuelas normales* or *licenciatura*) or a college degree (either a full degree or a technical degree). It also includes individuals later pursuing a master or a PhD.

Labor market participation. The labor market participation is a binary variable classifying the individual as economically active or not. The ENOE defines the economically active population as the sum of working population and the non-working individuals actively looking for a job in the month prior to the interview. The workers are defined as individuals engaged in an economic activity in the week prior to the interview, either working in a formal job, earning some income informally, helping in land work or family business, and individuals temporarily not working (e.g., for a strike) or absent but with a secured job after the temporality finishes. I construct the labor market participation directly using the variable *CLASE1* from the ENOE dataset *SDEMT.dbf*, which classifies the population in Economically Active Population (EAP) and Non-Economically Active Population (NEAP). There are no missing values associated with this variable.

Unemployment. Unemployment is a binary variable that indicates whether an individual that actively participates in the labor market (see above) was not involved in an economic activity during the week prior to the interview but was actively looking for work during the last month. The unemployment variable is only defined for the individuals actively participating in the labor market, and has missing values for individuals not participating in the labor market. I construct it using the variable *CLASE2* from the ENOE dataset *SDEMT.dbf*. *CLASE2* classifies the population in employed, unemployed (for those economically active), and available and not available (for those not economically active because, for example, they perform houskeeping duties or are studying).

Weekly hours worked. Hours worked are the number of hours worked in a week. I obtain this information from the ENOE variable *HRSOCUP*, constructed from the survey question *P5C_THRS*. As in the ENOE, I define this variable for all individuals in the sample, with a zero value if the individual is either unemployed or not in the labor force. I winsorize the hours worked at the 99th percentile to exclude extreme and unreasonably large values that could drive the results. Due to its nature, the variable has a highly left-skewed distribution. I minimize the incidence of large values by using two variable transformations. First, I apply a logarithmic transformation of the weekly hours worked, adding a 1 to avoid the logarithm not being defined. Second, I apply an inverse hyperbolic sine transformation of the weekly hours worked.[68] Both transformations result with a smoother distribution with a spike at 0, with very similar distributions between variables. Two supplementary variables identify the weekly hours worked only for the employed individuals.

Hourly income. The hourly income variable identifies the average income per hour worked. I use the ENOE variable ING_X_HRS, constructed by dividing the monthly income with the weekly hours worked following the formula $ING\_X\_HRS = INGOCUP/(HRSOCUP * 4.3)$. I define the variable for all individuals in the sample, imputing a 0 if the individual is not employed. Due to its nature, the variable has a highly left-skewed distribution. I minimize the incidence of large values by using two variable transformations. First, I apply a logarithmic transformation of the weekly hours worked, adding a 1 to avoid the logarithm not being defined. Second, I apply an inverse hyperbolic sine transformation of the weekly hours worked.[69] Both transformations result with a smoother distribution with a spike at 0, with very similar distributions between variables. Two supplementary variables identify the hourly income only for the employed individuals.

Labor market informality. The ENOE includes several variables that provide complementary information on the worker's informality level. I define individuals working in informal occupations as the individuals that are working in vulnerable conditions due to the nature of the economic unit they work for, and those whose relationship to the economic unit is not formally recognized by the employer.[70] I construct a supplementary variable on labor market informality based on whether the individual receives health care benefits through the job. I consider the individual to be in the informal sector if the job doesn't provide health care benefits ($P6D = 6$) or they are provided by other medical institutions ($P6D = 5$). Lastly, I follow the ENOE classification of occupations by type of employers: Companies or institutions, subsistence agriculture, paid domestic work, and informal sector. Hence, the workers in the informal sector are the employed population that works in a non-agricultural economic unit that operates using household resources but without being a formal business, so that the income, materials and equipment used for the business are not independent from the ones in the household.[71]

Labor market sectors. The ENOE specifies five labor market sectors: Agriculture, construction, manufacturing industry, commerce and services. The agricultural sector includes

[68] $log(w\_hours\_worked + sqrt(w\_hours\_worked^2 + 1))$

[69] $log(hourly\_income + sqrt(hourly_income^2 + 1))$

[70] This definition corresponds to the $TIL1$ variable in the ENOE dataset (see (INEGI, 2010), page 30 for the explanation on the definitions)

[71] This definition corresponds to the $TOSI1$ variable in the ENOE dataset (see (INEGI, 2010), page 30 for the explanation on the definitions)

economic activities related to agriculture, farming, logging, fishing and hunting. The services sector includes occupations in restaurants and lodging; transportation, communication and storage; professional, financial and corporative services; social services and government and international organisms.

E.2 Secondary school construction

The information on secondary school data comes from the *Secretaría de Educación Pública* (Ministry of Education). I use two different sources for junior secondary school data, the 2015-2016 school directory, and yearly school records for the 1990-2014 period. The 2015-2016 school directory is a database of all junior secondary schools in Mexico. Among other information, for each school it includes its unique identifier, address, geographical coordinates, school type, foundation date, date it was registered into the system, and closing and reopening dates, when appropriate. The registration system was created in 1981. All schools that existed prior to 1981 have the same date of registration, which makes the distinction between the foundation date and registration date relevant. The yearly school records are yearly databases of all junior secondary schools opened in a given academic year in Mexico. Among other information, for each school they include the unique school code, address, geographical coordinates, school type and total number of enrolled students by grade.

Creation of the school construction date. I combine three different sources of information to construct the school construction date: The foundation date and the registration date from the 2015-2016 school directory, and the yearly records, from which I extract the years the schools were actually operating. Although these three variables should result with the same school opening years, they don't always match, and the discrepancy levels between them widely vary depending on the state. I impute the school construction date by combining the three data sources with the following procedure: I first use the foundation year from the school registry as the school construction date. If it doesn't exist, I use the registration year from the same database. Lastly, if neither exist, I assign as the school construction date the first date the school was open according to the yearly records.[72] Since the registry was created in 1981, any schools constructed prior to this date will have assigned 1981 or

[72] I specify eight alternative criteria to check that the results are robust to the criteria used for imputing the school construction date: (1) use the foundation, closure and re-opening dates derived from the yearly records, (2) use the foundation year from the school registry, (3) use the foundation year, closure and re-opening dates from the school registry, (4) use the registration year from the school registry, (5) use the registration year, closure and re-opening dates from the school registry, (6) use the foundation year and, if it doesn't exist, use the registration year from the school registry, (7) use the registration year and, if it doesn't exist, use the construction date derived from the yearly records, and (8) use the foundation year and, if it doesn't exist, use the construction date derived from the yearly records. The main results are quite robust to the criteria used to assign the school construction dates, and are available upon request.

1982 as the construction date. Similarly, since the yearly records started in 1990, any schools constructed prior to this date will have assigned 1990 as the first year the school was opened. When constructing the binary indicator for whether the school was open in a given year, I assign a missing value to all years prior to 1982 or 1990 depending on the case if I use either of these sources. Note that the yearly records are only valid starting in 1990, and the registration dates are only valid starting in 1982.[73] Hence, depending on the data source used, some localities or states will have different sample sizes in the analysis. Any schools without an imputed construction year at the end of the construction date assignment procedure will be categorized as never opened (with a zero for all the sample period), and are not dropped from the sample. Figure E.1 shows the number of schools opened each year by state depending on the data source used to construct the variable. I combine these three sources to impute the school construction date used in the analysis. As a empirical test, I look at school construction trends for telesecundarias and brick-and-mortar schools. The relatively smooth increase of brick-and-mortar schools during the 1993 expansion suggests that the imputed telesecundaria construction dates are capturing real telesecundaria constructions. However, there is a jump in brick-and-mortar schools in 1982 (Figure A.3), which raises measurement concerns related to the construction dates around 1982. Additionally, the school registry officially opened in 1982, which could have caused to include backdated information in 1982 as well, causing this artificial jump in school construction.

Construction of the treatment of telesecundaria exposure. I identify the schools with unknown start dates, either because either the date is 1990 from the yearly records source, or the date is 1982 from the registration date source. I aggregate the junior secondary school construction dates at the locality and cohort level, also separating them by school type. The year that separates the cohorts as treated or untreated is the year the first telesecundaria was constructed in the locality. I identify the locality as having an unknown start date if at least one school in the locality has an unknown start date. For the difference-in-differences specification by age at telesecundaria introduction, I compute the average number of schools after the first telesecundaria is constructed, and I assign random construction years to localities that never had a telesecundaria. I assign the random construction dates following the distribution of the real construction dates across time. I do not assign a random construction year to localities with telesecundarias with unknown construction dates. I

[73] If I use the registration date, I categorize as not usable any school constructed in 1982. Note that this is restrictive, since in 1981-1982 there was a telesecundaria construction boom with the introduction of this modality to new states. As a robustness check, I identify states that have reliable pre-1982 based on the coincidence between the three sources along the years and smoothness of the number of schools pre and post 1982 (see Figure E.1). The states with reliable pre-1982 dates are Aguascalientes, Hidalgo, Mexico, Morelos, Sonora and Veracruz. and use the 1982 construction dates. Results are robust to this modification and available upon request.

winsorize at 99 percent the extreme values of the average density of telesecundarias per 50 children.

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

E.3 Supplementary variables

Aggregate enrollment shares. To construct the aggregate enrollment shares, I combine yearly secondary school enrollment data from the *Secretaría de Educación Pública* (Ministry of Education) for the period 1990-2014, and population counts from the census. The school records are yearly databases of all junior 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).[74] 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, I 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, I divide the population groups into five equally-sized cohorts. I obtain yearly population counts using a cubic spline interpolation across census years.

I aggregate the school-level enrollment data by separately computing the total number of brick-and-mortar and telesecundaria students in a given locality and year. Assuming no individuals leave their locality to attend a school, I use the cohort size from the imputed population data to compute the enrollment shares in brick-and-mortar and telesecundaria students, and proportion of individuals not enrolled in secondary education. I exclude from the aggregate analysis 17% of the ENOE localities, which have a total number of enrolled students exceeding the total cohort population.

[74]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*.

Figure E.1: Number of open schools by data source

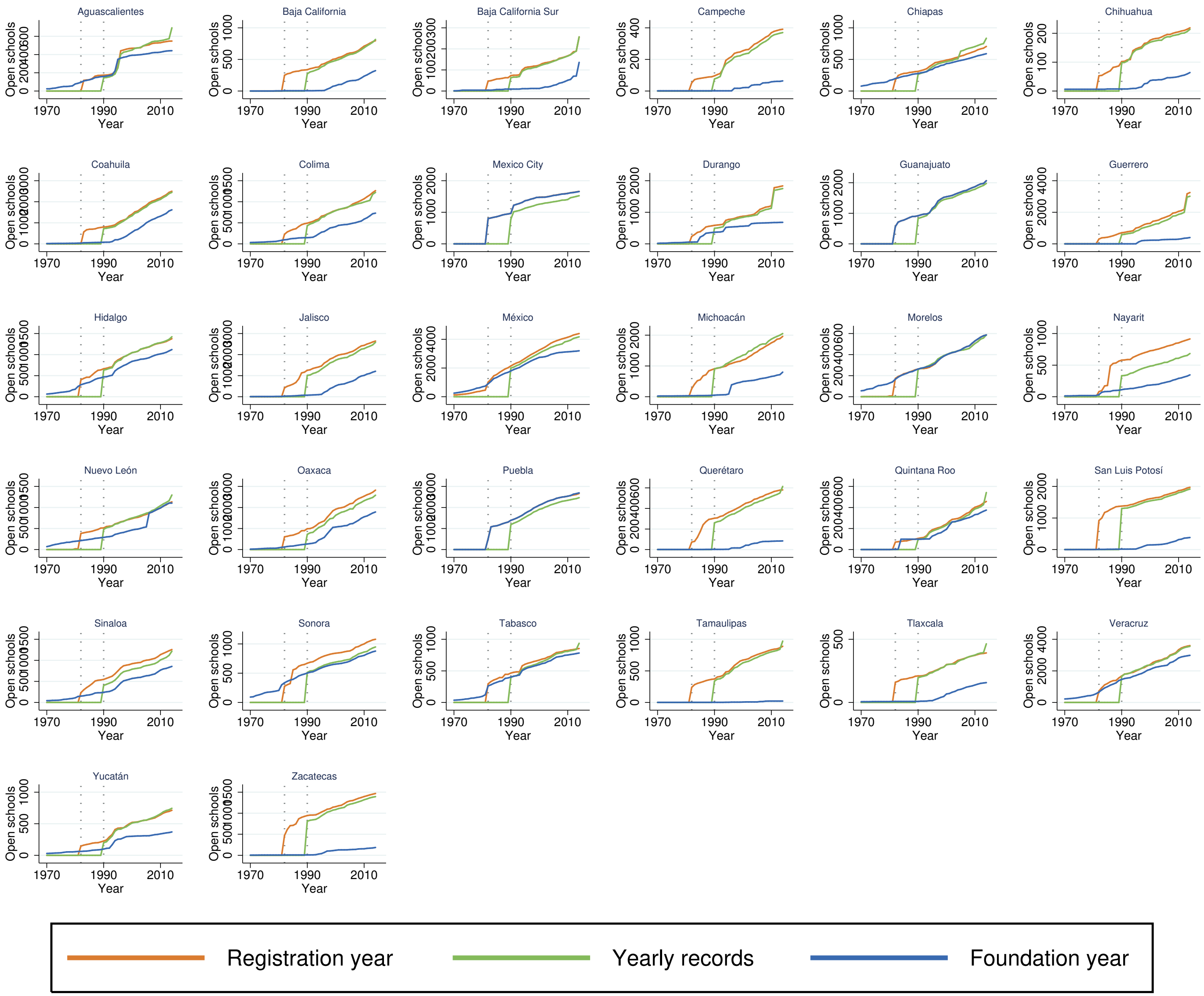


Figure E.2: Final school creation dates (I)

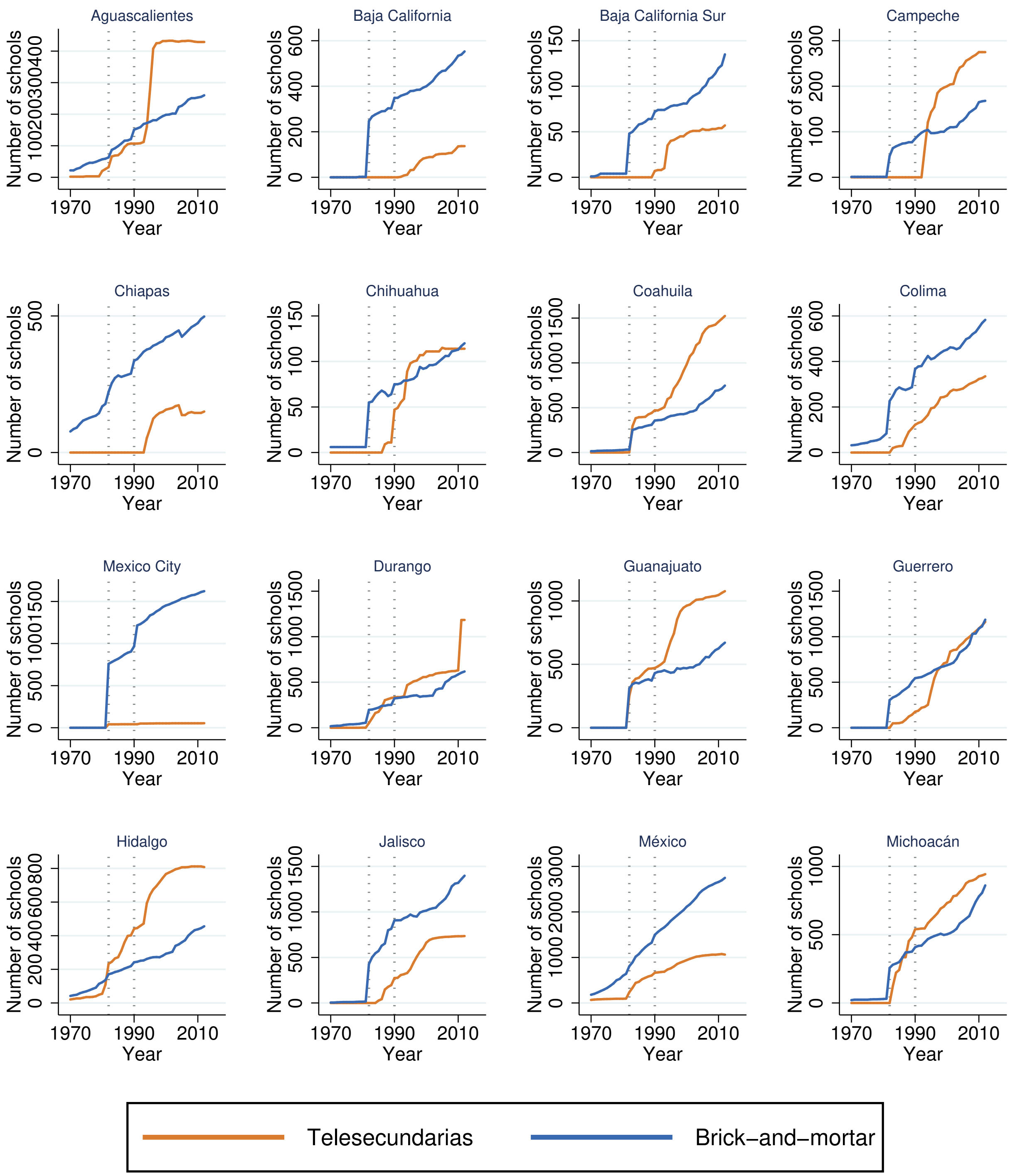


Figure E.3: Final school creation dates (II)