Broadcasting Education:

The Long-Term Effects of Mexico's Telesecundarias*

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Abstract

Every year over 1 million children in rural or marginalized areas of Mexico attend *telesecundarias*, middle schools with classes transmitted through satellite television. *Telesecundarias* substitute on-site subject-specialized teachers with televised content, substantially reducing the costs of education delivery in remote places. This paper estimates the educational and labor market outcomes of adolescents living in areas with limited access to middle schools who were exposed to a telesecundaria expansion policy in 1993. I obtain causal estimates by exploiting geographical differences in the intensity of school openings and differences in cohort exposure induced by the timing of the policy. The estimates suggest that an additional telesecundaria per 1,000 adolescents led to an average increase of 0.2 years of education for both men and women, and a decline in fertility for women. However, I do not find conclusive evidence that this increase in access to schooling improved the long-term labor market outcomes of affected cohorts.

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1 Introduction

Over the last few decades, there has been a dramatic rise in the enrollment rates of primary school children across the developing world. As countries move towards increased levels of education, the next challenge will be to find ways to improve and expand educational opportunities, especially at the post-primary level. Offering post-primary services to students in remote and marginalized rural communities creates logistical and financial challenges, especially since this might require burdensome commutes for students or attracting specialized teachers to these areas.

Distance education delivered through information and communication technologies (ICTs) offers a low-cost alternative to schooling expansion through traditional means. Recently, with the increased penetration of wireless internet and mobile platforms, computer-based programs have generated excitement about the potential to increase access to education to under-served students and researchers have only recently begun to study the impact of these types of technologies (Escueta et al., 2017; Bulman and Fairlie, 2016). Yet, distance education programs operated through radio and television, have been already widespread in several countries. Surprisingly, we know little about whether these programs can affect educational attainment and long-run labor market outcomes. This paper is the first to examine the long-run effects of a national program of distance education aimed at students in rural areas: Mexico's telesecundarias.

Today over 20% of all middle school-aged children in Mexico, approximately 1.3 million, attend a telesecundaria. Telesecundarias are middle schools that operate in rural or marginalized communities and that substitute regular classes with televised content. Telesecundaria students attend school every day and cover the same subjects and curriculum as traditional public middle schools. However, the content is broadcast via television and students complete exercises under the supervision of a single generalist teacher instead of the usual eight or nine subject-specific teachers that other middle schools employ per grade. Therefore, the per-pupil costs of operating these schools in areas with low-student density are much lower relative to operating regular middle school.

The telesecundaria system was created in the late 1960s, with subsequent expansions. Surprisingly, we have little causal evidence of their effectiveness. The discourse around telesecundarias has been mixed. On the one hand, they have now operated for half a century and have offered

an educational option to millions of children who otherwise might have dropped out of school. In addition, since the scheme is less reliant on local teachers, it is possible that they are less prone to low-quality teaching and other problems in public service delivery, such as teacher absenteeism. On the other hand, telesecundarias have been widely perceived as a lower-quality option for students, and criticized for being ineffective, counterproductive and for accentuating existing inequalities (Santos, 2001). Critics of the model often highlight how telesecundaria students are consistently outperformed in standardized tests by those who attend traditional schools. Yet, this fails to account for a range of unobservable socio-economic characteristics that are likely to affect student outcomes. Furthermore, it is unclear how much children would learn in a setting where lectures cannot adjust for learners' level and pace.[1]

This paper examines the impacts of a telesecundaria expansion policy on the long-term educational and labor market outcomes of individuals who were exposed to these schools as adolescents. To establish causal effects, I use a difference-in-differences framework that exploits geographical differences in telesecundaria expansion intensity and variation in cohort exposure induced by the timing of the policy. Since a potential challenge to this identification strategy is the possibility that telesecundaria growth might be correlated with some unobserved determinants of education and earnings, I employ municipal and state-by-cohorts fixed effects. I also address concerns around pre-existing earnings trends by controlling for pre-treatment levels in demographic, economic and educational characteristics of municipalities and let the associated coefficients vary by cohorts.

This paper provides evidence on the impacts of expanding telesecundarias in areas that did not have regular middle schools nearby. Existing evidence suggests that distance to school can severely hamper enrollment and attendance (Burde and Linden, 2013), yet a school expansion is not guaranteed to improve labor market outcomes, particularly if the television-based instruction model is ineffective or if opportunities in rural labor markets are limited.

Telesecundarias are also complementary to one of the most important poverty-reduction strategies in the country: the Progresa conditional cash transfers (CCT) program.[2] Today over 50% of middle school-age children in households who receive CCTs attend telesecundarias and in

[1] See Banerjee et al. (2016) for recent evidence on the value of teaching to the right level.
[2] I refer to the Progresa/Oportunidades/Prospera program as Progresa.

the original randomized study of CCTs over 85% of children only had access to a telesecundaria. The extent to which the CCT program can be successful at increasing the human capital of the next generation, depends on the quality of the educational services children have access too. Recent evidence on the long-term impacts of Mexico's CCTs suggests positive labor market effects: increasing labor market participation and labor income for early beneficiaries (Parker and Vogl, 2018; Kugler and Rojas, 2018). However, these estimates conflate the effects of higher household income in childhood and that of increased educational attainment.

The results of the analysis provide evidence that the telesecundaria expansion had a positive impact on educational outcomes. I find a robust long-run education effects of the telesecundaria expansion. Each additional telesecundaria per 1,000 adolescents, increases education by 0.13 years for mean and 0.23 years for women. I also find that the expansion increased the completion of primary and middle school, but it had no additional impacts on high school attainment. However, I am unable to find any evidence of improvements in labor market outcomes.

This project therefore contributes to the body of work on the effects of schooling infrastructure on educational attainment and labor market outcomes (Berlinski and Galiani, 2007; Duflo, 2001; Burde and Linden, 2013), and to the more recent literature that investigates the effectiveness of distance education through ICTs (Brown and Liedholm, 2002; Cavanaugh et al., 2004; Kearney and Levine, 2015; Ksoll et al., 2014). Overall, we have less evidence on the effects for marginalized communities and the overall impacts at the national level. Importantly, I am able to reconcile this differences by showing that I can obtain similar returns to education, by restricting the sample to areas.

While most of the recent literature has focused on the role of MOOCs and other computer-based educational technologies, we know little about other distance systems, such as radio and television, which are common in many developing country contexts.[3] There are two interesting features of this program. First, while there are a number of new randomized control trials testing different educational technologies, that evidence tells us little about the effects of ICT-based systems when they are operated by the government and offered at scale. Second, this paper focuses on the role of schools in marginalized and rural areas.

[3]One exception is Kearney and Levine (2015) who report on the effects of sesame street broadcast via television on student outcomes in the US. However, in that setting, this was delivered at home.

The results also contribute to the literature studying Mexico's CCTs by providing evidence on the effects of supply side intervention for a similar population. An economic rationale for conditioning a cash transfer is that the returns to education are high but that due to imperfect information, myopia, or incomplete altruism, investments in human capital might be inefficiently low.[4] Therefore, a first step to understanding the adequacy of CCTs is to explore the labor market effects of education in these rural settings.

The rest of the paper is structured as follows. In section 2, I present some background on educational television systems broadly and on telesecundarias particularly. Section 3 presents the data and empirical strategy and section 4 present the main results. Section 5 discusses threats to validity. Finally, section 6 concludes this study.

2 Background

2.1 Education Television Systems

Many countries have experimented with television to solve the problem of teaching children in places where the cost of recruiting teachers would be prohibitive.[5] In the 1950s and 1960s France, Great Britain, Portugal, Italy and Romania experimented with televised schools (Unwin and McAleese, 1988). Portugal's *telescolas* operated until 2003 and at their peak reached over 60,000 students in rural areas (Barros, 2012) and in Italy, over 20,000 students attended one of 2,000 *telescuolas* (Paulu, 1967). In developing countries, three early large-scale efforts to use television to delivery education stand out. An ambitious project in Ivory Coast rolled-out televised-based instruction in all primary classrooms in the country between 1970 and 1980. The program stopped when it faced implementation problems and opposition from teachers (Koné and Jenkins, 1990). In El Salvador television sets were installed in over 80% of all secondary schools in 1971. In the 1960s the entire American Samoa education system relied on television as a core instruction method (Young et al., 2010). Later both these systems were abandoned.

[4] Another rationale is that even if the level of investment is privately optimal, it might be socially optimal to increase education.

[5] There might be other reasons to use televised instruction, for instance during the teacher strikes in Oaxaca, Mexico televised primary education programs were broadcast. These systems have also been discussed for displaced and refugee populations.

There are striking similarities between the way television was discussed in the 1960s and 1970s to the way computers and massive online courses (MOOCs) have been pushed as a way to scale education. In 1966, Lyndon B. Johnson spoke about the system of televised schools in American Samoa, stating that: *"The pilot program of education [...] is truly a remarkable experiment. This technique [...] has the power to spread the light of knowledge like wildfire, to spread it all across the wide areas of our earth"*.[6]

Today, at the pre-college level, two television scale systems operate at scale in Latin America: Mexico's telesecundarias and Brazil's Telecurso. Brazil Telecurso was launched in 2010 and has reached approximately 5,000 students in the state of Amazonas and 17,000 students in the state of Acre. This system is operated by several non-governmental organizations and they offer a shorter curriculum than regular public schools. In contrast, Mexico's telesecundarias are completely integrated into the national education strategy. In 1996 the telescundaria broadcasting signal became available in all of Latin America and the South of the USA. While much smaller in scale, Costa Rica, El Salvador, Colombia, Guatemala, Honduras and Panama also operate a number of telesecundaria schools. Pilot programs in the USA have used the telesecundaria signal to target hispanic migrants who do not speak English but want to continue their education (SEP, 2010).

2.2 Mexico's Telesecundarias

Basic education in Mexico is comprised of primary school (grades 1st to 6th) and middle school (grade 7th to 9th). Middle school is offered in three different modalities: regular (*secundaria general*), technical (*secundaria tecnica*) and telesecundaria.[7]

Created in 1968 as an educational model for rural and marginalized areas, telesecundarias are formal establishments, where televised lessons are transmitted to groups of students who listen and take notes in the presence of a facilitator. Lessons are broadcast on a daily basis and follow a national morning and afternoon schedule. Each televised lesson is approximately 15 minutes in duration and students, with support from the telesecundaria teacher, are required to complete

[6] Remarks upon arrival to Tafuna International Airport, Pago Pago, American Samoa. October 18, 1966. http://www.presidency.ucsb.edu/ws/?pid=27945

[7] In addition, there are middle schools for workers (*secundaria para trabajadores*) that usually cater for students over 16 years of age who work.

exercises on their own after each module. Once the session is over, the next class begins.[8] The curriculum takes its contents from the nationwide study plans, which emphasize Spanish and mathematics competency. In addition, learners take courses in physics, chemistry, biology, English, geography, history, art, physical and technological education. Today telesecundarias constitute 66% of Mexican public middle schools and enroll about 20% of the students at that level. Appendix Figure A1 shows a map of all telesecundarias against other types of middle schools in the country.

In order to operate, telesecundarias require a school building, at least three television sets (one for each grade), along with satellite dishes and signal decoders. All these expenses are generally financed by the federal government through state budgets (Calderoni, 2007). School costs are roughly similar to those of regular schools in urban areas, though operating a regular school in a rural area would be much more expensive, since it would require hiring many more teachers. As the demand for further education continues to grow, the government of Mexico has recently decided to expand television-based services to the high school level (telebachillerato).

2.3 Telesecundaria Expansion in the 1990s

In 1993 the constitution was amended to make middle school mandatory. This guaranteed the right of children to access middle school across the country. With a vast number of dispersed rural communities, this was not an easy task: in 1990, there were over 200,000 communities with less than 2,500 people. Therefore, the proposed solution to bring educational services to some of these areas was to increase the number of telesecundarias.

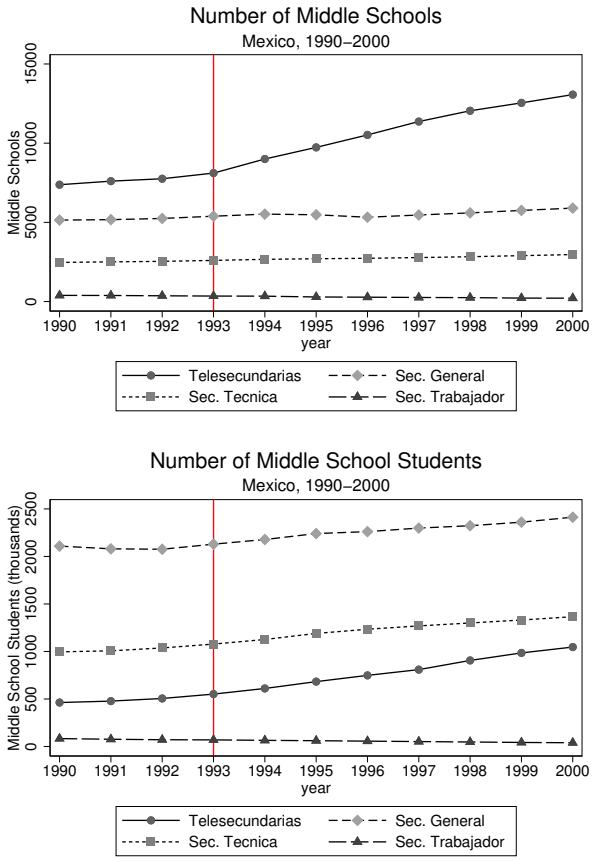
In the President's Education Plan of 1996 it was stated that *"[...] by 2000 [there will be an] increase of at least 50% in the number of telesecundarias relative to the 1994 school cycle"* (DOF, 1996). The expansion was driven by federal and state government and officially followed a compensation policy, aiming to have students no farther than 4 km from a middle school.[9] Minimum demand to establish a telesecundaria was 30 children for the first year.

[8] There is only one channel that serves 3 different grades. Therefore, once the first 15 minutes lesson has finished, a different lesson targeting a different grade starts.

[9] In 1992 the education system was decentralized to the 31 states. This reform has been largely deemed as administrative in nature, since the federal government still transfers most of the funds to the states and is responsible for the academic curriculum, but state governments were allowed to determine the location of schools.

Figure 1 shows the number of middle schools buildings and students from the 1990 onwards by type of school. The first panel shows the overall increase in public middle schools during the 1990-2000 period. From 1993 to 2003 the number of telesecundarias grew by 111% whereas technical schools by 35% and general schools by 15%. Overall there was an increase of approximately 7,400 middle schools in the country during this period, 6,000 of which were telesecundarias. They accounted for 90% of the school growth in rural municipalities.[10]

Figure 1: Growth of Middle Schools and Student Enrollment 1990-2000



Notes: The first panel shows the total number of middle schools during the 1990-2000 period. The second panel shows the number of middle school students enrolled in public middle schools during the 1990-2000 period. Constructed with data reported by SEP.

We use the schooldistrict boundaries that prevailed in 1969 to link school districtsto counties

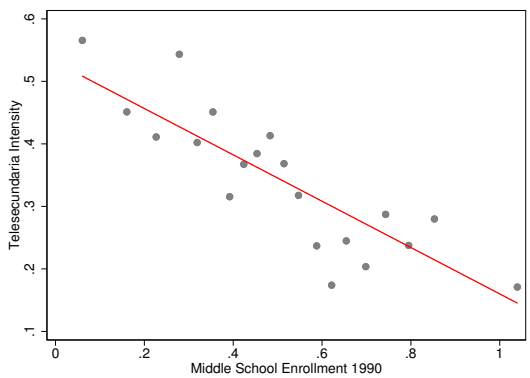
[10] I define rural municipalities as those where over 50% of the population lived in a rural community of 2,500 people or less.

and pull county-level median family income data fromthe 1970 census home environment during childhood, we average parental incomeand education variables over the ages of 12 and 17 and measurefamily structure at birth. se finding parallel those of Card and Kruegers influ-ential 1992 study of males born between 1920 and 1949 and recentstudies that link adult outcomes to quasi-experimental variation inschool inputs (Fredriksson et al. 2012).

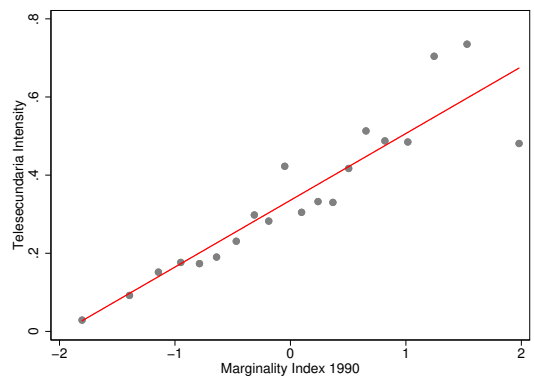
Figure 2 confirms the compensatory nature of the telesecundaria placement. The panels show a strong positive correlation between the increase in the number of telesecundarias per 1,000 children with the marginality index (poverty index) of a municipality in 1990 and a negative correlation with middle school enrollment rates in 1990.

Figure 2: Correlates of Telesecundaria Intensity

a. Middle School Enrollment 1990



b. Marginality Index



Notes: The graphs show correlates (binscatter plots) of telesecundaria intensity at the municipal level.

3 Empirical Strategy

3.1 Data

I use three sources of data. First, the outcome data is obtained from the 10 percent subsample of the 2000 and 2010 Mexican census and the 2015 inter-censal survey, which was accessed through the Integrated Public Use Microdata Series (IPUMS) project. This contains information on age, years of schooling, municipality of residence, state of birth, migration status, employment status, hours worked, industry and monthly earnings. I restrict the primary sample to 11 cohorts of

individuals, who were young around the time of the policy but who would have already entered the labor market in 2010 (aged 24-34 in 2010 and 29-39 in 2015).

The census data is merged with administrative data on the cumulative number of new middle schools in each municipality obtained from the Mexican Secretariat of Education (SEP). The school database contains the address of all secondary schools in the country by type of service offered. I collapse the number of schools-shifts by school type at the municipal level to merge with the census data.[11] Since telesecundarias target marginalized areas, I restrict the sample to rural municipalities categorized as poor in 1990 (high or very high in the marginality index).[12] Since the variation is at the municipal level, I collapse the individual level data at the level of cohort and municipality and work with the cell means. The main sample consists of 999 municipalities.

The measure of school intensity is constructed by calculating the number of new schools built between 1993 and 2000 and normalizing it by the number of people under 15 years of age living in that municipality based on 1990 census data.[13]

Finally, this is merged with municipal level data from the Statistics Office (INEGI) on population size, enrollment rates (constructed by ratio of children in school over school-aged children), and the level of marginality of the municipality in 1990.[14]

To characterize the labor market outcomes of individuals exposed to the telesecundaria expansion I focus on labor force participation, probability of working for a wage, and monthly labor income. I choose these variables both because an important fraction of people work in agriculture and report zero income, and because a large fraction of women report being inactive. Therefore, I do not condition any of my measures on labor force participation. Finally, to look at impacts on demographic variables, I present results for fertility another key outcome that has

[11] In Mexico, many schools have a morning and an afternoon shift. I count these as two separate schools. However, very few telesecundarias operate double shifts since they serve communities with a limited number of students, so the demand is limited

[12] Boundaries are harmonized by IPUMS to account for changes in census geography. For instance, if the boundaries between two census units change from one sample year to another, units are combined to create a single unit.

[13] A number of schools in the data set shifted location over time. In most cases, this appears to be driven by coding errors or by the fact that municipal boundaries changed over time. All estimations reported use the municipal boundaries from 1960 and keep them consistent over time for all data sources. If discrepancies in location of schools could not be resolved, they where coded by using the location reported a 2013 school census conducted by the SEP or by using the first municipality listed in the dataset.

[14] I use the classification used by CONAPO, which relies on an index based on illiteracy, levels of education, access to public services, rurality, and share earning less than twice the minimum wage.

been discussed in the literature of schooling (Osili and Long, 2008).

Table 1 shows summary statistics for the main sample. I report the weighted mean and standard deviations for the group of individuals age 24 to 34 in 2010 to make it representative of the full population. Individuals in this group have, on average, completed about 7 year of schooling. Approximately 24% of women and 84% of men report being employed. However, only 59% of men report a non-zero wage. The mean monthly labor income in pesos is 1,964 pesos for men and 619 pesos for women. In this sample the majority of men work in agriculture, followed by services. Whereas services is the most likely sector for women. On average, during the expansion period 0.39 telesecundarias for every 1,000 youth under 15 years opened in each municipality. This number is much lower for technical (0.02) and general schools (0.02).

Table 1: Summary Statistics

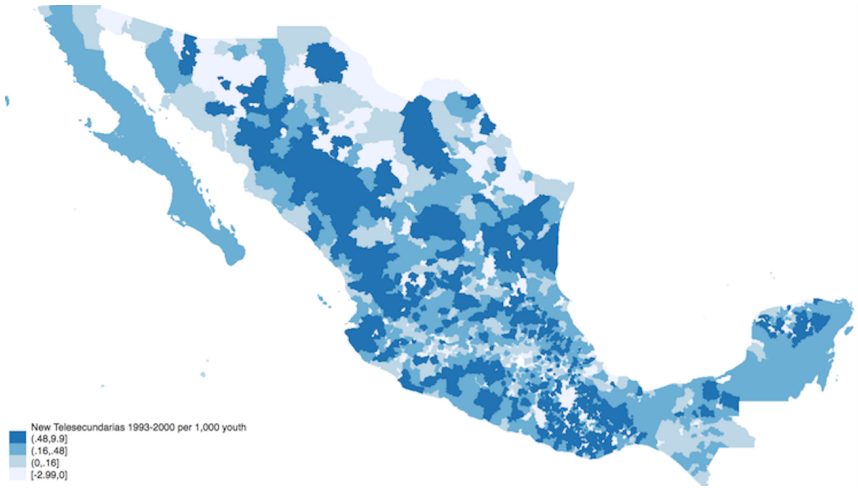
	Mean	Std. Dev.	Mean	Std. Dev.
	Female		*Male*	
Age	29.55	4.97	29.55	5.01
Indigenous	0.45	0.37	0.46	0.38
Years of School	6.66	1.91	7.05	1.64
Primary Complete	0.68	0.20	0.72	0.17
Middle School Complete	0.38	0.21	0.43	0.20
High School Complete	0.15	0.12	0.16	0.12
Any Tertiary Education	0.06	0.07	0.06	0.07
Employed	0.24	0.13	0.84	0.12
Positive Income	0.19	0.12	0.54	0.21
Income (pesos)	619.07	581.03	1,964.08	1,538.60
Agriculture	0.03	0.06	0.46	0.22
Services	0.16	0.10	0.31	0.17
Manufacturing	0.04	0.06	0.17	0.13
Observations	16,866		16,810	
Rural (1990)	1.00	0.00		
High Marginality (1990)	1.00	0.00		
Enrolled children (1990)	0.73	0.10		
Telesecundaria intensity	0.39	0.39		
Tec. secundaria intensity	0.02	0.06		
Gral secundaria intensity	0.02	0.07		
Trabajador secundaria intensity	-0.00	0.01		

Notes: Sample of rural and marginal municipalities in sample. Agriculture, Services and Manufacturing takes the value one if the person is employed in each respective sector. Enrolled children refers to children enrilled in primary and secondary school. All statistics use population weights.

3.2 Estimation

The empirical strategy exploits spatial and temporal variation on the roll-out of telesecundarias following the change in legislation that made middle school compulsory.[15] I use a difference-in-differences specification, where the first difference consists of comparing the labor market outcomes, at a single point in time, for individuals in birth cohorts who were affected by the expansion of telesecundarias against those who were too old to have benefited. I exploit the fact that those students who were 12 years or older in 1993 would not have benefited from the expansion policy, as they were likely to be out of school already. While grade repetition and late enrollment in these areas is possible, such that some students around the 'cut-off' might have been partially exposed, we would expect that the younger the cohort the higher likelihood of full exposure. Later I check the robustness of the results to the exclusion of different cohorts.The second difference, corresponds to the variation in telesecundaria intensity growth at the municipality level during this period.

Figure 3: Telesecundarias Expansion 1993-2000



Notes: The map shows the number of telesecundarias that opened between 1993 and 2000 per 1,000 young adults in the municipality.

Figure 3 depicts this variation. Since the main variable of interest -the roll out of telesecundarias-

[15] A number of studies using television have used signal strength predicted by the Irregular Terrain Model (ITM), to measure exposure. The TV signal was broadcast by satellite, rendering access to it universal. This is one of the reasons Mexico signed agreements with other central American countries to use the same signal.

varied across municipalities and cohorts, I collapse the individual level data at the level of the cohort (c) and municipality of residence (m) and work with cell means (weighted by the corresponding cell sizes). More formally, I regress cohort outcomes on telesecundaria expansions:

$$y_{mc} = \alpha + (I_m \cdot d_c)\beta_1 + \mu_c + \theta_m + \gamma_s c + X_{cm}\delta + \epsilon_{mc} \tag{1}$$

Where y_{mc} represents different educational and labor market outcomes in 2000, 2010 and 2015 for the cohorts born in year c who resides in municipality m.

I_m is a measure of telesecundaria intensity in municipality m, d_c indicates if the cohort was 12 years or younger in 1993. I include cohort effects (μ_c), municipal fixed effects (θ_m) to capture time-invariant differences in outcomes across municipalities, and state-time dummies (γ_{sc}), to capture time-varying changes in outcomes across states, where s indexes the state. X_{cm} represents additional controls to address concerns around mean reversion or convergence across municipalities. First, the model also controls for initial levels of population and primary and middle school enrollment in 1990 interacted with d_c, which would absorb cross-cohort changes that differentially affected municipalities with different populations and higher levels of school enrollment to start with. To rule out that the effects are driven by changes in other types of schools, particularly general and technical schools, I also control for their intensity growth in the municipality. The sample is restricted to those born between 1972 and 1988. Standard errors are clustered at the municipal level and regressions are weighted by cell population. Section 5 discusses additional robustness checks. Since the labor market participation of men and women in Mexico is quite different, I estimate equation 1 separately for each gender.

The simple difference-in-differences specification in equation 1 uses all the regional variation but pools those born before 1981 and those born after 1981. In the results section I also show graphically a multiple cohort difference-in-differences strategy, exploiting exposure to the expansion program for each cohort by interacting the measure of telesecundaria intensity with 10 different cohort dummies and keeping those who are 17 years of age in 1993 as the baseline comparison cohort (the omitted dummy). Where the coefficient of interest is an estimate of the impact of the expansion of telesecundarias for that given cohort c. If the identification strategy is valid, one should observe that the coefficients for those born before 1981 (12 years or older in

1993) are indistinguishable from zero.

To rule out issues around selective migration, one would know the municipality of residence at birth. However, the census data does not record this information. It only asks respondents about current municipality and the municipality they lived five years prior. I deal with this problem in a number of ways. First, I restrict the sample to non-migrants, defined as someone who reports being born in the same state they currently live in. This assumes no differential migration across treated municipalities, and in section 5 I assess this assumption. For the 2010 census, I also re-assign individuals to the municipality they reported living in in 2005. The 2000 census data is also helpful to assess issues of differential migration, since I can assign individuals to their municipality of residence in 1995, around the time when the school roll out started.

Telesecundarias went to areas with low school enrollment. However, if younger cohorts in low-intensity municipalities were already converging towards the outcomes of those in high-intensity municipalities, the parallel trend assumption would be violated. Figures A2 in the Appendix show similar pre-trends across above- and below-median telesecundaria intensity municipalities. Similarly, following Duflo (2001), as a placebo I show results for cohorts that were too old to benefit from program. Finally, my preferred specification controls for the post-rollout variable interacted with middle school enrollment levels and marginality levels in 1990. Any difference in levels across regions should be absorbed by the municipal fixed effects, however, controlling for baseline enrollment rate can address the issue that changes in rates might be correlated with initial conditions in these areas.

4 Results

4.1 Educational Attainment

Table 2 reports the effects of the telesecundaria expansion on the number of years of schooling attained in 2000 (Panel A) and 2010 (Panel B). Additional results for 2015 are shown in Appendix table A2. All specifications control for municipality fixed effects and cohort-state fixed effects. Column 2 and 6 controls for growth of other types of schools during that period and examines whether changes in schooling were related to differential growth of other types of schools by

interacting with the post dummy variable. Column 3 and 6 interacts gross school enrollment rates and marginality index in 1990 with birth cohorts to account for potential endogeneity arising from differential changes across municipalities with different enrollment rates.

These results indicate that one additional telesecundaria per 1,000 young adults in the municipality increased education by an additional 0.13-0.21 years for males and 0.12-0.23 years for women. As a way of comparison, the results from primary education from Duflo (2001) suggest that the expansion of primary schools in Indonesia increased years of education for men by an additional 0.19 per school constructed for 1000 children.

The next three rows examine the likelihood of completing primary school, middle school and high school education. For men and women, the roll-out increased the likelihood of completing primary school by 2 to 3 percentage points. The effects on the probability of completing middle school increase by 3 percentage points for men and 2 percentage points for women (5 years after roll out) and by 4 percentage points as measured in 2010. The results for high school are indistinguishable from zero once I control for differential enrollment and marginality in 1990. This suggests that the point estimates in previous columns might have been affected by pre-program trends. This lack of results for higher education are perhaps unsurprising as these areas were likely to lack options to continue education at the upper secondary level.

Figure 4 shows the results for the cohort specification. Reassuringly, telesecundaria effects appear to be much smaller and statistically insignificant for all of those who were above age 12 in 1993. Since it is unlikely that older cohorts were affected by the expansion, a positive and significant estimate for this group could suggest that any measured effects are driven by unobserved municipality characteristics that are correlated with the telesecundaria expansion. The coefficients also suggest that the effects are increasing for younger cohorts.

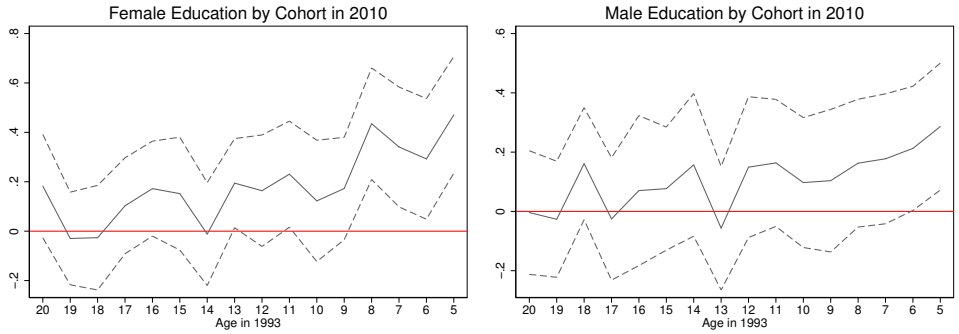
Overall these results provide evidence that the expansion of telesecundarias led to significant gains in schooling at the post-primary level.

Table 2: Educational Attainment

Dependent Variable	Males			Females		
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. 2000 Census						
Years of Education	0.409***	0.277***	0.206***	0.365***	0.233***	0.124**
	(0.073)	(0.064)	(0.063)	(0.070)	(0.055)	(0.053)
Mean	6.01	6.01	6.01	5.74	5.74	5.74
Primary Complete	0.046***	0.036***	0.035***	0.043***	0.034***	0.028***
	(0.010)	(0.009)	(0.009)	(0.009)	(0.008)	(0.008)
Mean	0.64	0.64	0.64	0.62	0.62	0.62
Middle School Complete	0.054***	0.039***	0.032***	0.037***	0.026***	0.015**
	(0.009)	(0.009)	(0.009)	(0.007)	(0.006)	(0.006)
Mean	0.22	0.22	0.22	0.20	0.20	0.20
High School Complete	0.015***	0.004	-0.002	0.014**	0.004	-0.004
	(0.006)	(0.005)	(0.005)	(0.006)	(0.005)	(0.005)
Mean	0.04	0.04	0.04	0.04	0.04	0.04
Panel B. 2010 Census						
Years of Education	0.180***	0.154***	0.132**	0.290***	0.268***	0.238***
	(0.061)	(0.058)	(0.058)	(0.058)	(0.056)	(0.056)
Mean	7.11	7.11	7.11	6.72	6.72	6.72
Primary Complete	0.036***	0.023***	0.019**	0.055***	0.043***	0.032***
	(0.009)	(0.008)	(0.008)	(0.008)	(0.007)	(0.007)
Mean	0.73	0.73	0.73	0.69	0.69	0.69
Middle School Complete	0.048***	0.050***	0.042***	0.038***	0.045***	0.044***
	(0.009)	(0.009)	(0.009)	(0.007)	(0.007)	(0.007)
Mean	0.43	0.43	0.43	0.39	0.39	0.39
High School Complete	-0.016***	-0.007	-0.007	-0.011*	-0.001	0.003
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Mean	0.16	0.16	0.16	0.15	0.15	0.15
School Controls	Y	Y	Y	Y	Y	Y
Enrollment Controls		Y	Y		Y	Y
Mariginality Controls			Y			Y

Notes: Standard errors in parenthesis. ***p<0.01, **p<0.05, *p<0.10. The dependent variables are: years of education, primary school complete, any middle school, middle school completed, and any high school education completed. The telesecundaria intensity variable is measured by the number of new telesecundarias per 1,000 youth in the municipality for the 1993-2000 period. Enrollment controls include the interaction between cohorts treated and school enrollment in 1990. School controls include the interaction between cohorts treated and intensity of the growth of other schools.

Figure 4: Effects on Education by Cohort



Notes: The graphs show the estimated coefficients for each cohort. The regressions control for population in 1990, growth of other schools, enrollment in 1990, and marginality index all interacted with cohort.

4.2 Labor Market Outcomes

The previous section documents increases in education. Table 3 explores subsequent effects on labor market outcomes. If access to a school makes adolescents more likely to substitute time away from work one might detect negative impacts in the labor market in earlier years. However, one would expect positive labor market impacts if there are gains in human capital from the additional education. The first panel reports results measured in 2000. Telesecundaria access reduces the likelihood that exposed teenagers work, consequently reducing their income. The next panel shows results using data from the 2010 census, labor force participation is high for men (84%) and much lower for women (24%). I do not find significant effects of the increase in the number of telesecundarias neither on labor force participation, probability of earning a positive income, number of hours worked or monthly labor income (all results are unconditional on employment).

Appendix figure A3 shows results by cohort. The point estimates for labor income are noisier than those for education, but the patterns suggest that the cohorts that were exposed to the expansion of telesecundarias did not experience substantial gains in their labor market outcomes.

Finally, table A3 in the appendix shows results for the probability of working in services,

Table 3: Labor Market Outcomes

Dependent Variable	Males			Females		
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. 2000 Census						
Labor Force Participation	-0.009	-0.020**	-0.020**	-0.006	-0.013*	-0.014*
	(0.010)	(0.010)	(0.010)	(0.007)	(0.007)	(0.007)
Mean	0.52	0.52	0.52	0.17	0.17	0.17
Monthly Labor Income	-94.201	-135.782	-243.029**	-11.810	-30.876	-42.593*
	(109.977)	(109.855)	(120.587)	(25.652)	(24.465)	(22.882)
Mean	519.50	519.50	519.50	148.88	148.88	148.88
Panel B. 2010 Census						
Labor Force Participation	0.012**	0.009	0.006	0.004	0.002	-0.002
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Mean	0.84	0.84	0.84	0.24	0.24	0.24
Hours of Work	0.836***	0.676**	0.431	0.112	0.050	-0.117
	(0.301)	(0.298)	(0.298)	(0.241)	(0.244)	(0.244)
Mean	36.23	36.23	36.23	9.44	9.44	9.44
Positive Income	0.008	0.003	-0.002	0.007	0.005	-0.000
	(0.006)	(0.006)	(0.006)	(0.005)	(0.005)	(0.005)
Mean	0.54	0.54	0.54	0.19	0.19	0.19
Monthly Labor Income	61.779	25.589	-26.348	33.122	17.354	-11.386
	(67.914)	(67.621)	(72.091)	(26.108)	(26.074)	(25.690)
Mean	1947.87	1947.87	1947.87	615.77	615.77	615.77
Panel B. 2015 Census						
Labor Force Participation	0.002	0.001	0.002	0.001	-0.002	-0.004
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Mean	0.79	0.79	0.79	0.23	0.23	0.23
Monthly Labor Income	67.825	48.854	11.393	29.252	15.134	5.535
	(56.690)	(50.543)	(48.942)	(38.009)	(36.869)	(35.504)
Mean	2336.74	2336.74	2336.74	773.89	773.89	773.89
School Controls	Y	Y	Y	Y	Y	Y
Enrollment Controls		Y	Y		Y	Y
Mariginality Controls			Y			Y

Notes: Standard errors in parenthesis. ***p<0.01, **p<0.05, *p<0.10. The dependent variables are: employed (=0 if inactive of unemployed), a dummy variable for having a positive income, monthly income, hours work and formal health. The telesecundaria intensity variable is measured by the number of new telesecundarias per 1,000 youth in the municipality for the 1993-2000 period. Enrollment controls include the interaction between cohorts treated and school enrollment in 1990. School controls include the interaction between cohorts treated and intensity of the growth of other schools.

manufacturing or agriculture. I estimate equation 1, with a dependent variable taking value of one if the person is employed in each sector. This provides evidence on whether there were any changes in the sector where people work. I do not detect a change in the probability of working in each of these sectors.

4.3 Demographic outcomes

More educated women may have a higher opportunity cost of bearing children, have a higher household bargaining to determine their preferred sample size or have better information to avoid unplanned pregnancies. I find that exposure to the telesecundaria expansion decreased the average number of children that women had by by 0.05 from an average of 2,71 (Table 4). These effects appear to be important in adolescence and persist until adulthood. I do not find an effect on child mortality.

Table 4: Fertility

	(1)	(2)	(3)
Panel A. 2000 Census			
Number of Children	-0.142***	-0.108***	-0.058*
	(0.038)	(0.033)	(0.033)
Mean	1.83	1.83	1.83
Child Mortality	-0.012	-0.002	0.010
	(0.015)	(0.014)	(0.014)
Mean	0.11	0.11	0.11
Panel B. 2010 Census			
Number of Children	-0.204***	-0.151***	-0.058**
	(0.039)	(0.033)	(0.029)
Mean	2.71	2.71	2.71
Child Mortality	-0.011	-0.003	0.004
	(0.007)	(0.007)	(0.007)
Mean	0.10	0.10	0.10
School Controls	Y	Y	Y
Enrollment Controls		Y	Y
Mariginality Controls			Y

Notes: The dependent variable is the number of children alive women report. The sample is restricted to females. Standard errors in parenthesis. ***p<0.01, **p<0.05, *p<0.10. The telesecundaria intensity variable is measured by the number of new telesecundarias per 1,000 youth in the 1993-2000 period. The Age 12 or younger is a dummy that takes value 1 for those 8 to 12 years of age. Enrollment controls include the interaction between cohorts treated and school enrollment in 1990. School controls include the interaction between cohorts treated and intensity of the growth of other schools.All regressions control for gender and age squared.

5 Robustness Checks

A key concern is that the effects are driven by selective migration. Two potential issues may arise if there is endogenous migration. The first has to do with treatment assignment and the second with differential attrition. Ideally, one would like to know the municipality of birth of

each individual to assign them to their corresponding treatment exposure. However, the census data only reports municipality of residence. Therefore an additional identifying assumption of the analysis is that the municipality of residence is a good proxy for that of birth. If parents moved to municipalities with more telesecundarias to enjoy the benefits of the program or if more educated young adults migrated in search for better job opportunities, the estimates will capture the effects of this regional sorting instead of the casual effect of the telesecundaria expansion. The census questionnaire contains information in what state the individual was born and whether they had lived in the same municipality in the last 5 years. In the sample, 94% of individuals report living in the same municipality as in 2005 and 84% live in the same state that they were born.

Tables 5 shows treatment effects on migration using these variables as outcome measures in equation 1. I do not find a differential likelihood of moving states (from the one they are born), and only a one percentage point decrease in the probability of changing municipalities in last 5 years for women in the 2010 census round.

Table 5: Reported Migration

	Males		Females	
	(1) State Born	(2) Municipal	(3) State Born	(4) Municipal
Panel A. 2000 Census				
Age 12 or younger*telesec. intensity	0.005	0.006	0.002	-0.003
	(0.005)	(0.005)	(0.005)	(0.005)
Mean	0.06	0.93	0.07	0.92
Panel B. 2010 Census				
Age 12 or younger*telesec. intensity	-0.001	-0.002	0.008	-0.011**
	(0.006)	(0.007)	(0.005)	(0.005)
Mean	0.07	0.90	0.08	0.93
Panel C. 2015 Census				
Age 12 or younger*telesec. intensity	-0.002	0.007	0.000	-0.004
	(0.004)	(0.005)	(0.004)	(0.004)
Mean	0.06	0.93	0.07	0.95

Notes: Standard errors in parenthesis. ***p<0.01, **p<0.05, *p<0.10. The dependent variable corresponding to "State Born" takes value one if person is residing in a different state than where they were born. The dependent variable in "Municipal" takes value one if person changed municipality in last 5 years. The telesecundaria intensity variable is measured by the number of new telesecundarias per 1,000 youth in the 1993-2000 period. The Age 12 or younger is a dummy that takes value 1 for those 8 to 12 years of age. Enrollment controls include the interaction between cohorts treated and school enrollment in 1990. School controls include the interaction between cohorts treated and intensity of the growth of other schools.

6 Conclusion

Improving access to education has been a major concern for policymakers in the developing world. This has led to the development of programs that use non-traditional methods to reach students who live in remote areas. In this paper I present evidence of the effects of the expansion of television-based middle schools in Mexico. Specifically, I explore whether this expansion had significant impacts on educational attainment and individual labor market outcomes. An extra telesecundaria per 1,000 youth led to an increases in education of 0.2 years, as well as reductions in fertility. The affected cohorts do not appear to have experienced different underlying trends

earlier in life. However, I do not find that labor market outcomes improved, despite also experiencing increases in their educational attainment. Better understanding the mechanisms behind this result, requires further consideration.

The analysis does not directly speak to the question of how telesecundarias compare to regular schools. This is a difficult question to answer since telesecundarias and regular schools serve very different populations. However, at a fundamental level I show that relative to not having a school, telesecundarias had positive effects on individuals' educational outcomes. A next step would be to compare this model of educational delivery with others to better understand their cost-effectiveness.

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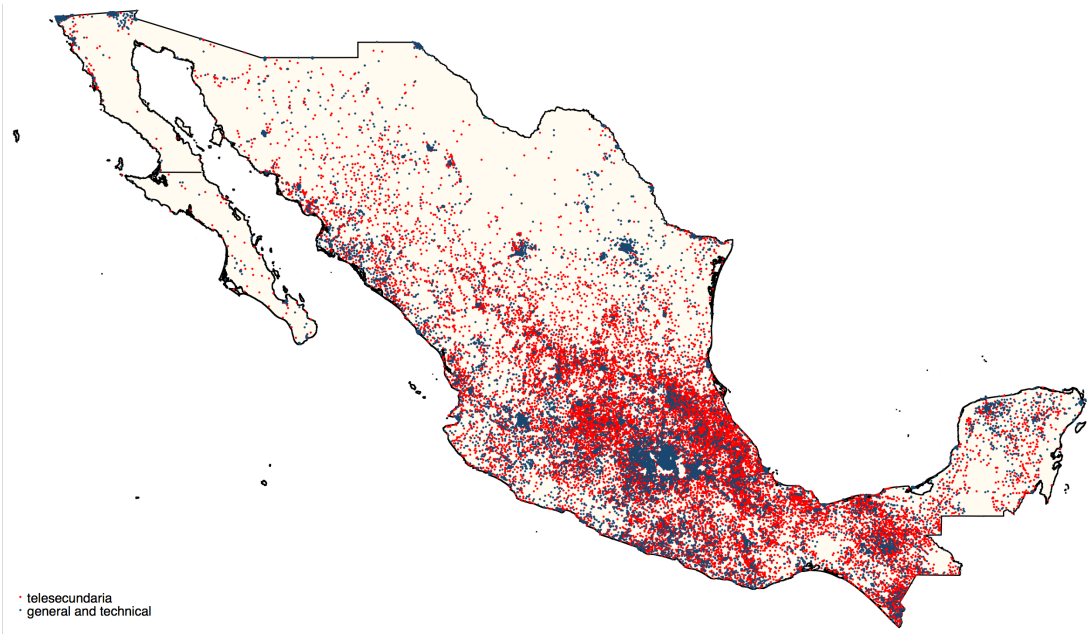
Appendix

Figures

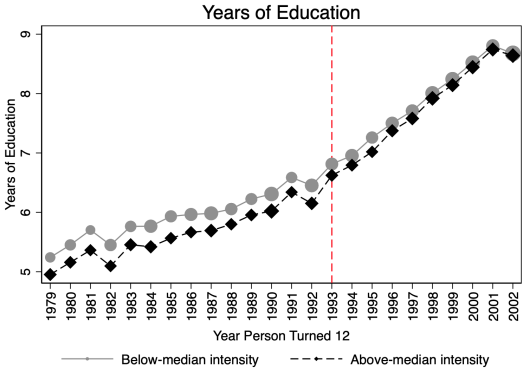
Figure A1: Middle Schools in Mexico in 2013



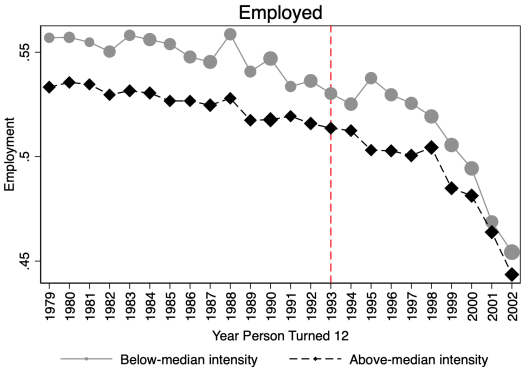
Notes: The map shows all public middle schools in Mexico in 2013. The red dots represent telesecundarias and the blue dots all other types of middle schools (*secundarias tecnicas and generales*).

Figure A2: Correlates of Telesecundaria Intensity

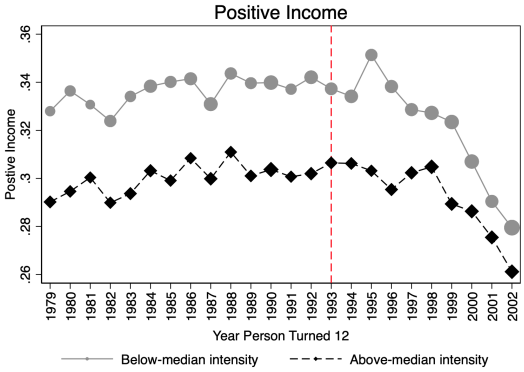
a. Years of Education



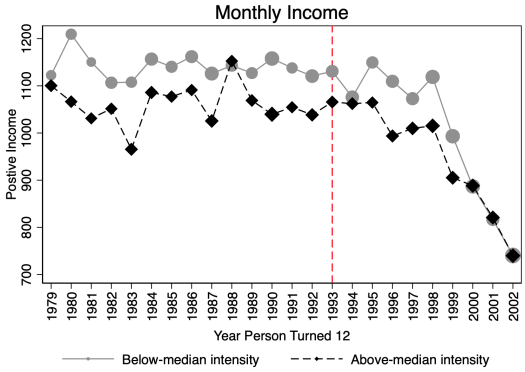
b. Employed



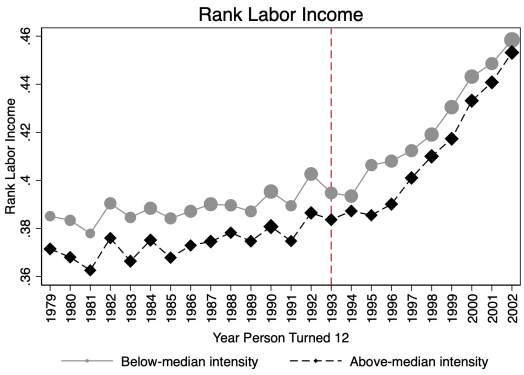
c. Positive Income



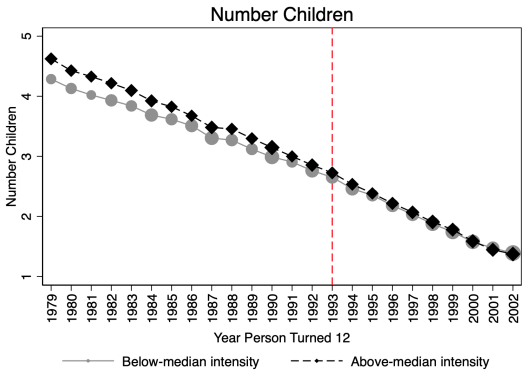
d. Monthly Labor Income



e. Labor Income Rank

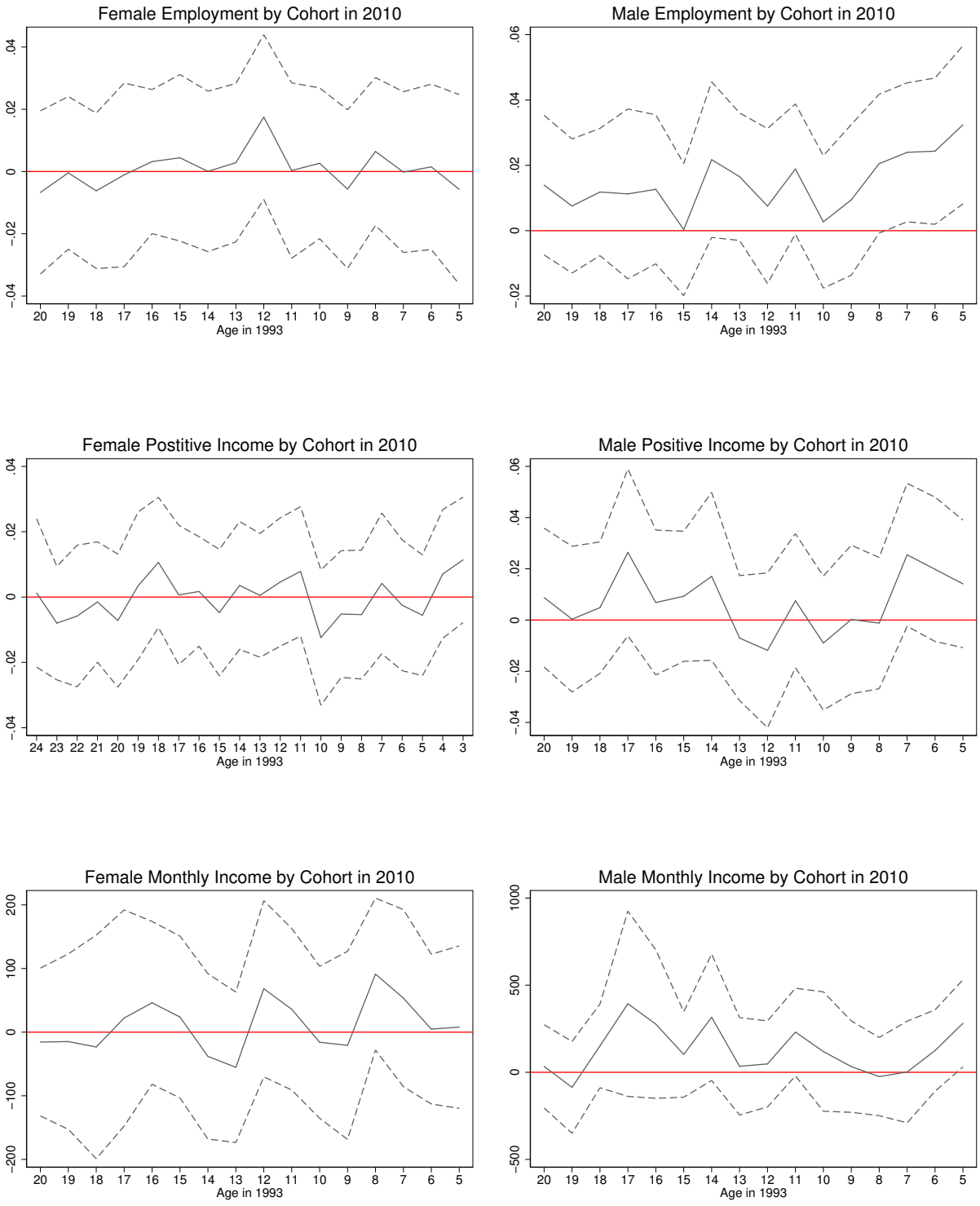


f. Number of Children (Females)



Notes: The graphs show cohort averages for above and below-median telesecundaria intensity. The size of each dot represents number of observations in the sample.

Figure A3: Effects on Labor Market Outcomes by Cohort



Notes: The graphs show the estimated coefficients for each cohort, as per equation **??**.

Tables

Table A1: Cohorts Included in the Analysis

Year of Birth	Year Age 6 (primary)	Year Age 12 (secondary)	Age in 1990	Age in 1993	Anticipated Grade 1995	Anticipated Grade 2000	Age in 2010	Age in 2015
1968	1974	1980	22	25	HS Grad	HS Grad	42	47
1969	1975	1981	21	24	HS Grad	HS Grad	41	46
1970	1976	1982	20	23	HS Grad	HS Grad	40	45
1971	1977	1983	19	22	HS Grad	HS Grad	39	44
1972	1978	1984	18	21	HS Grad	HS Grad	38	43
1973	1979	1985	17	20	HS Grad	HS Grad	37	42
1974	1980	1986	16	19	HS Grad	HS Grad	36	41
1975	1981	1987	15	18	HS Grad	HS Grad	35	40
1976	1982	1988	14	17	HS Grad	HS Grad	34	39
1977	1983	1989	13	16	HS Grad	HS Grad	33	38
1978	1984	1990	12	15	12	HS Grad	32	37
1979	1985	1991	11	14	11	HS Grad	31	36
1980	1986	1992	10	13	10	HS Grad	30	35
1981	1987	1993	9	12	9	HS Grad	29	34
1982	1988	1994	8	11	8	HS Grad	28	33
1983	1989	1995	7	10	7	12	27	32
1984	1990	1996	6	9	6	11	26	31
1985	1991	1997	5	8	5	10	25	30
1986	1992	1998	4	7	4	9	24	29

Table A2: Educational Attainment Measured in 2015

Dependent Variable	Males			Females		
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. 2015 Census						
Years of Education	0.232***	0.197***	0.167**	0.262***	0.229***	0.223***
	(0.069)	(0.068)	(0.069)	(0.074)	(0.072)	(0.071)
Mean	7.36	7.36	7.36	7.00	7.00	7.00
Primary Complete	0.038***	0.027***	0.021***	0.058***	0.047***	0.039***
	(0.007)	(0.006)	(0.006)	(0.008)	(0.007)	(0.007)
Mean	0.74	0.74	0.74	0.70	0.70	0.70
Middle School Complete	0.052***	0.054***	0.048***	0.038***	0.043***	0.043***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Mean	0.44	0.44	0.44	0.41	0.41	0.41
High School Complete	-0.005	0.001	0.002	-0.012**	-0.004	0.002
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Mean	0.16	0.16	0.16	0.15	0.15	0.15

Notes: Standard errors in parenthesis. ***p<0.01, **p<0.05, *p<0.10. The dependent variables are: years of education, primary school complete, any middle school, middle school completed, and any high school education completed. The telesecundaria intensity variable is measured by the number of new telesecundarias per 1,000 youth in the municipality for the 1993-2000 period. Enrollment controls include the interaction between cohorts treated and school enrollment in 1990. School controls include the interaction between cohorts treated and intensity of the growth of other schools.

Table A3: Sector of Employment in 2010

	Males				Females			
	(1) Agriculture	(2) Services	(3) Manufacturing	(4) Formal	(5) Agriculture	(6) Services	(7) Manufacturing	(8) Formal
*Intensity*Young*	0.007	0.001	0.004	-0.001	-0.000	0.001	-0.002	-0.003
	(0.005)	(0.006)	(0.005)	(0.004)	(0.002)	(0.004)	(0.002)	(0.004)
Observations	13,850	13,850	13,850	13,850	13,896	13,896	13,896	13,896
R-squared	0.830	0.750	0.717	0.803	0.719	0.605	0.701	0.833
Municipal FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cohort*State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
School Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Enrollment Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean Control	0.46	0.30	0.17	0.13	0.03	0.16	0.04	0.13

Notes: Standard errors in parenthesis. ***p<0.01, **p<0.05, *p<0.10. The dependent variable takes value one if person works in that sector and zero otherwise. The telesecundaria intensity variable is measured by the number of new telesecundarias per 1,000 youth in the 1993-2000 period. The Age 12 or younger is a dummy that takes value 1 for those 8 to 12 years of age. Enrollment controls include the interaction between cohorts treated and school enrollment in 1990. School controls include the interaction between cohorts treated and intensity of the growth of other schools.All regressions control for gender and age squared.