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Time use of youth during a pandemic: Evidence from Mexico

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ABSTRACT

Studying how the pandemic affects the education and work of adolescents is a critical question with long lasting implications for well-being of the next generation, particularly in the developing world. The Covid-19 pandemic by mid-March 2020 had led to the closing of most educational institutions in Latin America and the Caribbean, and the region has been one of the worst hit by the pandemic (Sanmarchi et al., 2021). This paper uses the Mexican National Occupation and Employment Survey (ENOE) to provide evidence on the pandemic's effects on school and work of youth. We measure changes in the time use of adolescents comparing patterns just before the pandemic (January to March 2020) with those at the beginning of the following school year (September 2020), controlling for pre pandemic trends and potential seasonality.

Our study finds a sharp reduction in the probability of being engaged in studies during the previous week for youth age 12 to 18 during the pandemic, as well as a reduction of about 30 percent in total hours spent on studies for those who report spending at least one hour on studies in the previous week. Time in work in general shows fewer changes than in time dedicated to studies, with some reductions in the probability of working outside the home for older youth, and a small increase in the number of hours dedicated to work inside the household. Our results overall are suggestive of an important decrease in youth who are engaged with school, who may be at particular risk for abandoning school permanently. It also suggests that even for those who remain engaged, there is a reduction on time spent studying likely to lead to a decrease in learning. Policies to combat potential dropout and negative effects on learning of the pandemic are urgently needed.

1. Introduction

By mid-March 2020 and given the advance of Covid-19 in Latin America and the Caribbean, the vast majority of educational institutions in the region closed their doors, affecting 160 million students (UNESCO, 2020). As of March 2021, only a few countries in the region (Argentina, Chile, Colombia, Nicaragua and Uruguay) had returned, to some degree, to in-person learning (Fernandez, 2021; Infobae, 2021). In Mexico, 36.6 million students have remained home since the beginning of the pandemic through the end of 2020, doing distance learning through the program "Aprende en Casa" (learn at home) which provides classes and broadcasts textbook contents online, through T.V. and the YouTube channel of the Mexican Public Education Secretariat (SEP).

The experience accumulated by previous pandemics have shown that school closures have impacts both in the short run – increase dropout rates, child labor, violence against children, teen pregnancies, deepen socioeconomic disparities (Armitage and Nellums 2020; Rothe et al., 2015; Denney et al., 2015) – and in the long-run, in terms of loss in future income (Ichino & Winter-Ebmer, 2004). For the case of Covid-19, a few studies have begun to report on the learning activities of school aged children during the pandemic in developing countries (Le Nestour et al., 2020; Bosumtwi-Sam and Kabay, 2020; Debenedetti et al., 2020; Kihui, 2020) and in the developed world (Andrew et al., 2020; Bansak and Starr, 2021; Dietrich et al., 2021; Grewenig et al., 2020; Grätz and Lipps, 2021; Reimer et al., 2021). For instance, in Latin America, Asanov et al. (2020) found that during the period of quarantine in Ecuador 74 percent of adolescents were engaging in some

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online or telelearning, and 86 percent have done some schoolwork on the last weekday.

Given the severity and long-lasting nature of the Covid-19 pandemic, a critical question is how the pandemic may affect schooling and work of youth in the short and long run, particularly for developing countries. There are numerous mechanisms through which the pandemic might affect schooling and work of youth, including through health and mortality impacts, through economic impacts on income and employment, and through school closures.

Latin America, and Mexico in particular, have suffered some of the highest excess death rates due to Covid-19 (Sanmarchi et al., 2021) and school closures have been among the longest (UNICEF, 2021). In this paper, we provide a first step to documenting the overall effects of the pandemic on schooling and work of youth in Mexico by measuring how time use of adolescents has changed during the pandemic using rich, nationally representative data from the Mexican National Occupation and Employment Survey (ENOE) for 2018, 2019 and 2020. Specifically, we study time use patterns of youth aged 12 to 18 in three main activities: studies, work outside the home and domestic work, studying both the probability of engaging in each activity as well as the total number of weekly hours. We are fortunate that the ENOE provides continuous monthly and quarterly data over time, and we can thus compare patterns in time use just prior to the pandemic (January to March 2020) with those at the beginning of the following school year (September 2020). We also study changes in time use during the same period in 2019 and 2018, carrying out difference in difference regressions estimates to summarize the likely effects of the pandemic, and to ensure that the changes in 2020 we observe are likely related to the pandemic rather than seasonality or changes in time use patterns over the calendar year.

Our results demonstrate a significant and large decrease in the proportion of youth aged 12–18 who are spending any time on school during the pandemic. This reduction is on average 14 percentage points nationwide, suggesting a very large decrease in the proportion of youth involved in school during the pandemic. Even for those who remain engaged in school activities (as measured by reporting at least one hour studied during the previous week), we observe a significant decrease in time studying of about 10 h per week during the new school year, with respect to pre pandemic March 2020. These patterns are suggestive of very large reductions in time spent in studies due to the pandemic and are likely a risk factor for permanent dropout when in person classes return across Mexico.

School and work are often considered substitute activities (Ravallion & Wodon, 2000). The reductions in time spent studying that we observe might suggest that time spent working of youth would increase during the pandemic. Nevertheless, perhaps due to the increase in unemployment rates during the pandemic, we do not find substantial increases in the probability of working outside the home. Rather, we find decreases in the probability of work outside the home for most age groups. For some groups of youth who do work, we do, however, find some small increases in hours worked outside the home. We also find some small increases in the probability of work inside the home and in the number of hours worked inside the home. While the important reductions in time spent studying were overall not matched by increases in work outside or inside the home, we do find some small and significant increases in time worked by youth. These trends are concerning because work at an early age has been shown to greatly increase the probability of dropout later (Beegle et al., 2009).

What are the potential consequences of the reduction in time spent in studies during the pandemic? Our study has shown a very large decrease in the proportion of youth who spend at least one hour in studies during the pandemic. Potential consequences include both an increased risk of temporary and permanent dropout from school, even when in person classes resume to normal. Even for those youth who continue to dedicate time to their studies, the average time spent in school decreased by about 30 percent during the pandemic, potentially suggesting reductions in learning even for those students who remain connected to school during the pandemic. The reduction in probability of studying is larger for older adolescents (15–18) than for younger ones (12–14), suggesting that the effects of the pandemic on dropout due to the pandemic may be larger for older than younger youth. However, the reductions in time spent studying for those who do spend at least one hour studying were similar across the board, at about 10 h per week for boys, girls, youth in rural areas and youth in urban areas, suggestive of potential generalized reductions in learning. Over the course of a business-as-usual school year, Evans and Yuan (2019) estimate that students learn between 0.15 and 0.21 standard deviations of literacy skills (1 standard deviation is associated with between 4.7 and 6.8 additional years of schooling). When students finally return to in person classes in Mexico then, it will be critical to assess their degree of skills in learning losses.

Our results show across the board reductions in time spent studying, suggesting that few groups may be spared negative education effects of the pandemic. It is likely however that the quality of time in studies varies according to socioeconomic status. For instance, those able to access the educational videos and other materials produced by the SEP on internet versus those only able to watch classes on television are likely to suffer fewer learning losses of the pandemic. Studying the longer run effects of the pandemic on learning and dropout as well as on socioeconomic equities which may arise remain critical areas of study for the future.

The paper is organized as follows. Section II discusses previous literature on the impacts of school closing and a summary of the Mexican education context during Covid-19. Section III presents the data and sample used for the analysis, Section IV provides results and Section V concludes.

2. Context and previous literature

2.1. School disruptions

The study of other pandemics such as the Ebola crisis and the H1N1 pandemic have shown that school closures in the short run increase dropout rates, child labor, violence against children, teen pregnancies – as well as deepen socioeconomic disparities (Armitage and Nellums, 2020; Selbervik, 2020; Rothe et al., 2015; Denney et al., 2015). In the longer run, Ichino and Winter-Ebmer (2004) study the effects of reduced access to schools during WWII comparing Austria and Germany with Sweden and Switzerland, finding an earning loss that in the 1980s translated into 0.8 percent of GDP.

Other events such as strikes or natural disasters have also been used to study the effects of school disruptions. Jaume and Willén (2019) show that in Argentina, being exposed to the average incidence of strikes (88 days) during primary school reduces labor earnings of males and females between the ages of 30 and 40 by 3.2 percent and 1.9 percent, respectively. After Hurricane Katrina in New Orleans in 2005, Harris (2020) estimates that it took children a full two years to recover lost learning. Sacerdote (2012) also studies hurricanes in the United States (both Katrina and Rita) and finds that students show large declines in test scores in the first year following the hurricanes. Perhaps surprisingly, the same study shows that Katrina evacuees who moved to other school districts with better math scores experienced gains of 0.18 standard deviations relative to prehurricane test scores by 2009 (four years after the hurricane). La Mattina (2018) and Akresh and de Walque

(2008) demonstrate significant reductions in schooling attainment following the 1992 Rwandan genocide.

2.2. Covid pandemic

School closures around the world are likely to have long and lasting effects on education. Psacharopoulos et al. (2021) suggest the world could lose as much as $10 trillion over the coming generation as a result of school closures today. School closure is not only associated with reduced learning, but also lack of access to subsidized meal programs, vaccination clinics, and overall safeguarding and supervision (Armitage and Nellums, 2020). Azevedo et al (2021) using data on 157 countries predict that Covid-19 could result in a loss of between 0.3 and 0.9 years of schooling adjusted for quality based on proficiency in international student assessments, reducing the effective years of basic schooling from 7.9 years to between 7.0 and 7.6 years. They also estimate that close to 7 million students from primary through secondary education could drop out due to the income shock of the pandemic alone.

A number of country level studies have begun to document the negative effects of the pandemic on education and learning around the world. Two studies provide evidence of the initial losses in learning from school closures during the pandemic: Engzell et al. (2021) found learning losses of about 0.08 standard deviations after the 8-week lockdown in The Netherlands measured by progress on national examinations, and Kuhfeld et al. (2020) project using data for 3 to 8 graders in the United States who took the MAP Growth™ assessments that students would start the Fall 2020 with 63–68 percent of the gains in reading and 37–50 in mathematics relative to a typical year.

In terms of time spent on studies in developing countries, Le Nestour et al. (2020) show through a multi-country survey conducted at the beginning of the pandemic in April of 2020 that the proportion of children not engaging in any learning activity was 30 percent for Senegal; between 26 and 32 percent in Ghana (Bosumtwi-Sam and Kabay, 2020); and 50 percent in Burkina Faso (Debenedetti et al., 2020). Similarly, Kihui (2020) found in the context of Kenya that only 22 percent of children were engaged in online learning. In the study most similar to our own, Asanov et al. (2020) sampled 1552 students by phone in Ecuador as the pandemic started and found that 74 percent of students between 14 and 18 years old were engaging in some online learning with 86 percent having spent at least 1 h doing schoolwork on the last weekday.

Studies of the education effects of the pandemic based on developed countries have also emerged, with several demonstrating larger negative effects of the pandemic on poorer groups. Andrew et al. (2020) show for the case of England during the pandemic, a new gap in time spent on studies emerged for primary school children between poorer and better off families. Bansak and Starr (2021) for the United States and Dietrich et al. (2021) for Germany found that during the pandemic, parents with lower levels of education spent less time helping children with schoolwork. Also, for Germany, Grewenig et al. (2020) showed that time spent in studies fell from 7.4 h to 3.6 h per day during school closures with gaps in learning time developing between those with higher and lower grades. Grätz and Lipps (2021) for the case of Switzerland demonstrate a drop of 12 h per week in overall time spent studying for students aged 14–26 years old during the pandemic. Finally, Reimer et al. (2021) show using data from a digital reading app in Denmark an increase in inequality in time spent online reading based on parents' education and median income that dissipated over time.

2.3. Education system in Mexico and distance learning during the pandemic

Education in Mexico is mandatory up through ninth grade with "educacion basica" or basic education including preschool, primary (1st through 6th grade) and secondary school (7th through 9th grade). Interestingly, distance education has become a central component of secondary education in Mexico over the past thirty years and was largely implemented to bring secondary level education to remote areas. Over twenty percent of secondary students currently attend telesecondary schools (Fabregas, 2019). Telesecondary schools operate in rural communities and provide televised content for each subject with only one teacher who monitors and assists with exercises. Other types of secondary schools include general secondary schools with traditional academic curriculums, technical secondary schools that are vocational, and private schools. At the high school level or "medio superior" the main options are 1) general high schools with traditional academic programs that prepare students to continue studying at university, 2) technical high schools that have an academic focus but with technical and vocational training, 3) technical professional schools that aim to combine studies with work and 4) private schools. The school year in Mexico runs from August to July of the next calendar year.

The Mexican Public Education Secretariat (SEP) announced on March 20th, 2020, the official suspension of all in person academic activities in the country including all public and private schools from preschool through the end of 12th grade. (Palma et al. 2020; EFE, 2020). Building on experiences with distance education from telesecondary schools, the SEP designed the initiative "Aprende en Casa" following the suspension of classes, which consisted of providing classes and broadcasting contents online and on television for each school grade. All content was virtually stored so that students could review recordings and carry out exercises, and get personalized advice by phone, chat or email.[1]

For the new school year 2020–2021 beginning in August 2020, in person schooling continued to be suspended and the return to classes carried out through distance learning via "Aprende en Casa II" – which built on "Aprende en Casa" by additionally providing classrooms by open cable and cable services, delivery of textbooks and allowing additional online tools, including teachers organizing video sessions. The content of classes became available in 22 indigenous languages, and in remote areas was also broadcast by radio.

Little concrete information on the effects of the pandemic and distance learning on schooling in Mexico exists. The Centro de Estudios Educativos y Sociales (CEES) has estimated that the economic contraction product of pandemic will generate 4.3 million new "ninis" in Mexico – individuals between 15 and 29 years old that neither study nor work (CEES, 2020). A study of "Aprende en Casa" in the state of Aguascalientes for children in primary school between March-June 2020 documents that while a majority of teachers reported a similar number of students enrolled as at the beginning of the school year, 44 percent of parents believe they do not have the appropriate conditions at home for distance learning (CIDE, 2021). Data from the National Survey on Availability and Use of Information Technologies in Households showed in 2017 that the rate of internet usage in rural areas was 39.2 percent, in comparison with 71.2 percent in urban areas (Martínez-Domín guez & Mora-Rivera, 2020), potentially suggestive that rural stu-

[1] Complementary strategies included "Estrategia de educación a distancia: transformación e innovación para México", which offered learning tools through Google for Education and YouTube during the confinement period and the "Jóvenes en casa" initiative, which offered cognitive and emotional support aimed at higher secondary education (Leal et al., 2020).

dents may have added difficulties fully participating in distance learning and "Aprende en Casa". Below, we study the heterogeneous effect of the pandemic on the time use of rural children versus urban children.

3. Data and sample

For our analysis of the effects of the pandemic on the time use of youth, we use the micro level data from the 2018, 2019 and 2020 National Occupation and Employment Survey (ENOE) from Mexico's National Institute of Informational Statistics and Geography (INEGI). Similar to the Current Population Survey (CPS), the ENOE is a nationally representative continuous monthly household survey of approximately 120,000 households per quarter and is the source for official employment statistics in Mexico as well as a main source for academic studies of the labor market.[2] Representative at the national level and at the state level as well, the ENOE collects data from the population aged 12 years and over on labor force participation, activities during the previous week, occupation, informality, unemployment as well as socioeconomic characteristics.[3] Importantly for our purposes, the ENOE includes a short section on time use during the previous week in all rounds including time spent in studies, in domestic work and in other unpaid activities. The type of sampling used is a stratified probabilistic two stage cluster design.[4,5]

To study the effects of the pandemic we compare time use just before the pandemic started in January-March 2020 with time use at the beginning of the new school year in September 2020 (classes begin mid-August).[6] However, because there may be seasonal variation in enrollment and time dedicated to work and studies over the months of the calendar year, we also analyze changes in time use over this same time period in 2018 and 2019. This allows us to reason that the pre-post changes we observe in 2020 are likely related to the pandemic rather than reflecting seasonality. We provide a descriptive graphical analysis showing changes in time use between January-March and September for 2020, 2019 and 2018 for school and work. For our empirical estimation, we carry out a difference in difference model that differences out potential seasonality effects in time spent in school and work between January-March and September using the pre pandemic years of 2018 and 2019.

Table 1
Sample summary statistics: ENOE youth aged 12–18.

Variables	2018	2019	2020
Age	15.0 (2.0)	15.0 (2.0)	15.0 (2.0)
Boys	0.5 (0.5)	0.5 (0.5)	0.5 (0.5)
Communities ≥100,000 inhabitants	0.4 (0.5)	0.4 (0.5)	0.4 (0.5)
Education of HH (years of schooling)	8.5 (4.3)	8.6 (4.4)	8.8 (4.4)
Age of HH	46.2 (11.2)	46.5 (11.4)	46.7 (11.3)
Household Size	5.1 (1.8)	5.1 (1.8)	5.0 (1.7)
Proportion in municipality with cell	0.3 (0.2)	0.3 (0.2)	0.3 (0.2)
High or very high marginality municipality	0.3 (0.2)	0.3 (0.2)	0.3 (0.2)
N	52,830	54,232	51,309

Note: Standard deviations in parentheses.
Source: own calculations based on INEGI (2021), Conapo (2021).

We also test for heterogeneous effects of the pandemic by age, gender, area of residence, schooling level of the household head as well as municipal level characteristics including the *marginality index*, taking advantage that the ENOE includes municipality codes that allows us to merge such indicators. The Mexican Population Council (CONPAO) constructs a continuous official poverty index at the municipality level, formed by taking the first principal component of socioeconomic aggregates from 9 variables constructed from census data (for instance proportion of households with electricity) and dividing into five categories of marginality, ranging from very low to very high (Conapo, 2011). As part of our heterogeneity analysis, we test whether impacts vary in municipalities which are considered to be high or very high levels of marginality compared with municipalities with lower levels of marginality. We also control for the proportion of households with cell phones which may proxy access to the internet and the potential to take better advantage of distance learning (data for this variable comes from the 2010 Mexican Census (INEGI, 2010).

Table 1 provides descriptive statistics from our data for the years 2018 through 2020. As expected, about half of the youth in the sample are male and the average age in our sample is age 15. On average, youth live in a household with an average size of five individuals and about 40 percent of youth live in urban areas, defined as communities of 100,000 inhabitants or more. The average youth lives in a household where the household head has close to 9 years of education and an average age of 46 years. Around 30 percent of our sample lives in a high or very high marginalized municipality and the average individual lives in a municipality where about 30 percent of the population has access to a cellphone.[7]

3.1. Descriptive analysis: time use of adolescents before and after the pandemic

We begin by analyzing the changes in the unconditional number of hours in each of the three activities we study in this paper: weekly hours spent studying or taking courses of study; work outside the household (participating in paid work); and work inside the household or domestic work (defined as caring for family members and household or domestic chores). In Table 2, we see a clear reduction between January-March 2020 and September 2020 in the average weekly hours devoted to studying of a little over 11 h, a trend that is clearly not present in 2019 or 2018 (where in these years in fact the number of hours studied increases during the year). For work both inside and outside the household we see overall small changes in 2020 between January-March

[2] Recent studies which use the ENOE include Cano-Urbina (2015), Shapiro and Mandelman (2016), Campos-Vazquez and Lustig (2020), Leyva and Urrutia (2020), Del Valle (2021), and Hoehn-Velasco and Penglase (2021).

[3] Although the indicators that are disseminated monthly and quarterly are generated for the population aged 15 years and over because that is the minimum legal working age, micro data is available for those 12–14 years old.

[4] Like the CPS, the survey has a rotating scheme, in which a fifth of the sample is followed for five trimesters and replaced after five trimesters or when the household exits the sample. Given the pandemic, in person fieldwork was suspended in April 2020, although the INEGI continued to carry out a reduced version of the ENOE by telephone through June 2020. A note from INEGI (Orozco, 2020) documents no differences in response rates for surveys carried out by phone versus in person during the period of Covid-19 in 2020. As of July, the ENOE returned to in person interviews (INEGI, 2021b). While short panels can be constructed where 20 percent of the cross-sectional sample is followed over time, we use the cross-sectional rounds of the ENOE in order to maximize the sample size and to avoid the potentially non-random attrition that occurs using the constructed panels which may vary due to the pandemic.

[5] Probabilistic because the selection units, that is, the housing units, have a known and non-zero probability of being selected. Two-stage because the Primary Sampling Units are selected first and in a second stage the private housing units are selected. Stratified because the Primary Sampling Units with similar characteristics are grouped to form strata, and by conglomerates because the housing units form groups (INEGI, 2021b).

[6] We use only September from the third trimester of the ENOE and do not include the months of July and August for the analysis because the school year by and large had not yet begun.

[7] In the Appendix Table A.1, we show the summary statistics separately for January-March and September of each year.

Table 2
Time use of children – pre and post Covid-19 pandemic.

Average Weekly Hours				
		2020	2019	2018
Studying	Jan to March	28.9 (17.4)	28.8 (17.7)	29.4 (17.2)
	September	17.8 (15.7)	30.0 (17.1)	31.0 (16.6)
Work inside the household	Jan to March	6.9 (7.7)	7.1 (9.1)	7.6 (9.2)
	September	7.7 (9.8)	7.2 (9.0)	7.3. (8.9)
Work outside the household	Jan to March	5.1 (13.9)	5.4 (14.3)	5.2 (14.2)
	September	4.8 (13.5)	5.4 (14.3)	5.3 (14.3)

Note: Standard deviations in parenthesis.
Source: own calculations based on INEGI (2021).

and September, and similarly few changes during the same period in 2018 and 2019. In the Appendix we show the same results by gender, place of residence and age groups (see Table A.2).

Table 2 suggests substantial reductions in time studied of youth during the pandemic with lesser changes in time spent in work, both inside and outside the home. We now disaggregate these overall changes in unconditional time use between the probability of participating in an activity and the number of weekly hours, conditional on participating. For each of the three activities, school, work outside the home and work inside the home, we present a graphical analysis of the probability of spending time during the previous week and the conditional number of hours.

Fig. 1 shows the proportion of individuals studying at least one hour per week during the Spring (January-March) and Fall (September) of 2020, 2019 and 2018, as well as the conditional density of hours of study for those who study at least one hour per week, during the same period.[8] Beginning with the proportion who report having studied in the previous week, we observe an important drop in the Fall of 2020 compared with the Spring of 2020, with differences post pandemic increasing with age and particularly large at around 10 percentage points for those aged 15 and above, generally corresponding to ages for upper high school. These trends are suggestive of a significant reduction in youth carrying out school activities.

Because the differences in the proportion studying may vary due to seasonality patterns, we carry out a similar analysis for 2019 and 2018, e.g., in the two years prior to the pandemic to observe whether in non-pandemic years, we similarly observe a reduction in the probability of participating in school activities in the Fall versus the Spring. In fact, the reverse is true; for both 2018 and 2019, a higher proportion of adolescents aged 15 and older overall dedicate at least one hour to their studies in the Fall compared to the Spring (with few changes in those between 12 and 14 years old). This implies that the reductions we observe in the probability of participating in school in 2020 may in fact represent an underestimate of the impacts of the pandemic on the probability of dedicating time to school (which we will address in the multivariate estimates below).

Fig. 1 also shows the density of weekly hours studied during the Spring (January-March) and Fall (September) of 2020, 2019 and 2018 for those who report studying at least one hour. During 2020, Fig. 1 shows an important shift in the density of hours studied to the left and an increase in the variance of hours studied in September 2020 compared to January-March of the same year. The figure for 2020 is suggestive of a large reduction in hours studied even for the population that remains active in participating in school. Whereas the average hours studied for youth who study pre pandemic in 2020 was about 40 h per week, this is reduced to a mean of about 27 h per week by September of 2020, a reduction of more than 30 percent. Fig. 1 also shows similar graphs for 2018 and 2019 which show nearly identical densities of hours studied in January-March versus September of each year, suggesting few changes due to seasonality in hours studied between Spring and Fall. The change in the spread or increased variance of the distribution of study hours could reflect differences in availability of resources for distance learning – for example, the number of hours of study of children that have to share a computer or mobile device in larger households may be different than for those who are an only child. Taken as a whole, this graphical analysis of time spent in school is suggestive that the pandemic has led to a large increase in the population aged 12 to 18 that is not engaged in school and a large reduction in time spent in studies even for the population that remains engaged in school.[9]

These reductions in time spent in studies might be associated with increases in work. We are fortunate the ENOE allows us to study both work outside the home and work inside the home. Beginning first with changes in the probability of spending at least one hour during the previous week in work outside of the home, Fig. 2 shows changes in the proportion of individuals reporting working outside the household in the previous week for 2020, 2019 and 2018. Fig. 2 suggests in 2020 much smaller changes in the probability of working than we observed in Fig. 1 in the probability of studying. Overall, rather than increases in the probability of working outside the home, we observe decreases for older children, perhaps reflecting generally higher unemployment rates post pandemic than pre pandemic (INEGI, 2021a). For younger children, we see increases in the probability of working, though they do not appear to be significant. Both in 2019 and 2018 we do not observe significant differences in the probability of working between January-March and September. In short, Fig. 2 does not suggest that the probability of working outside the home increased due to the pandemic.

Fig. 2 also shows the density of hours spent during the previous week working outside the household, conditional on working outside the home. It is interesting to note in the three years under analysis, for those working outside the home, there are two peaks in the density roughly corresponding to part-time and full-time work. Turning now to changes during the pandemic, in 2020, overall, the patterns are similar between January-March and September. However, we see a slight decrease in full-time work e.g., in 40 h per week or more and an increase in the share of youth working between 20 and 40 h per week in 2020. We do not observe however changes in the density of hours worked in 2019 and 2018, suggesting the pandemic may have contributed in addition to a reduction in the probability of working, to a reduction in hours

[8] The proportion of those reporting time dedicated to school during the previous week does not explicitly measure the proportion of students formally enrolled but may be a better measure of the proportion of youth who remain actively involved in their studies. During a school week, to not study even one hour during an entire week suggests a substantial disconnection with studies.

[9] In Appendix Figs. A.1–A.3, we repeat Fig. 1 by gender and place of residence.

worked. However, any changes appear relatively small, particularly in comparison to the changes in hours studied demonstrated in Fig. 1. We will return to the topic of magnitudes of changes in work outside the home, and in particular which groups of youth experimenting these effects, through the multi variate regression analysis below.

Finally, Fig. 3 shows the proportion of youth engaging in work inside the household, and the conditional hours devoted to such activity in 2020, 2019 and 2018. Fig. 3 is suggestive of few overall changes in both the probability of participating in work inside the household and in hours participating in domestic work, conditional on carrying out domestic work. Fig. 3 for 2020 is suggestive of perhaps some small increases in the proportion of youth above age 15 carrying out domestic work with the pandemic. However, no changes in conditional hours spent in domestic work are apparent between January-March 2020 and September 2020. For the pre pandemic years of 2018 and 2019, there are few changes in both the probability of engaging in work inside the household and the

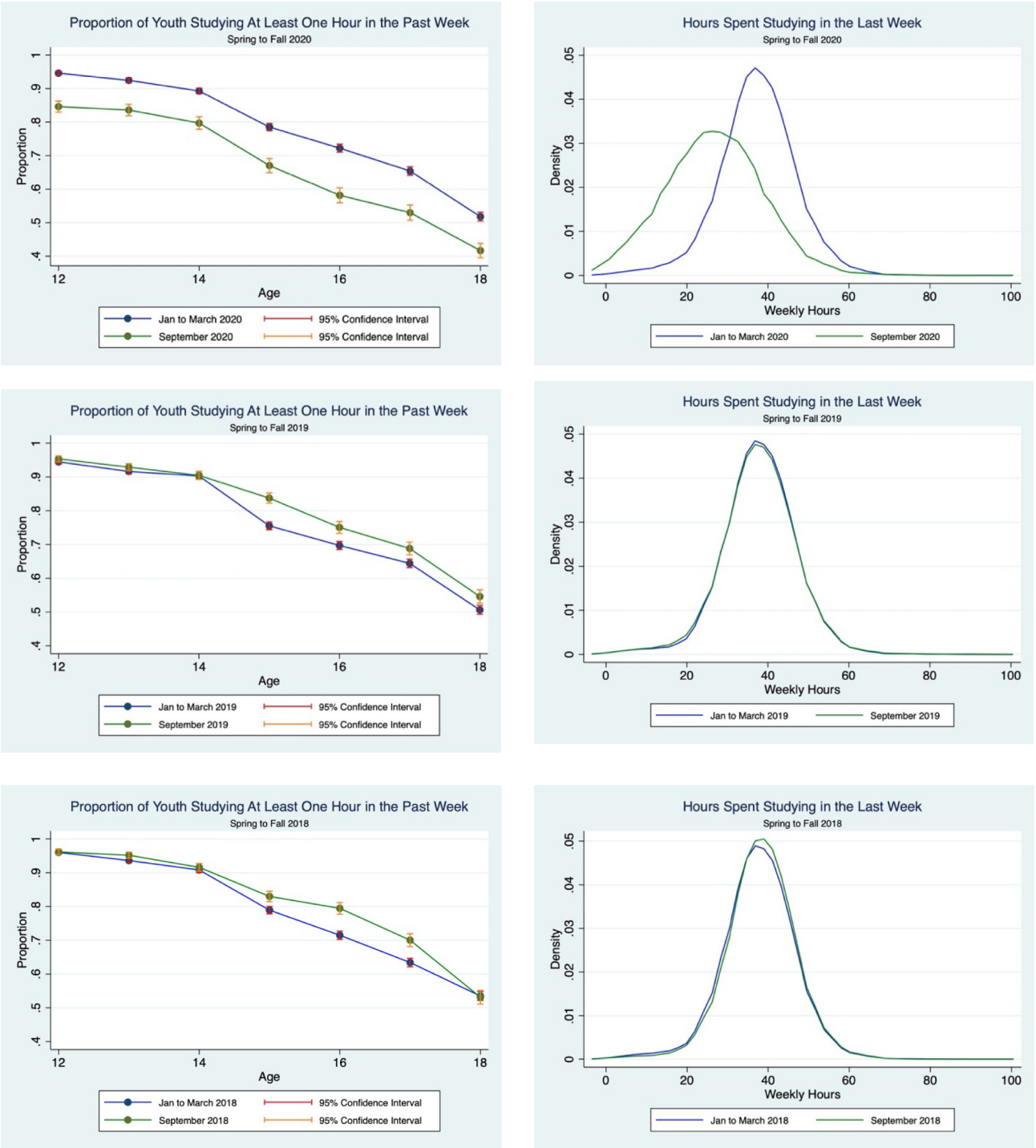

Fig. 1. Proportion of teenagers who study between 12 and 18 and weekly hours spent studying for teenagers who study.
Source: own calculations based on INEGI (2021).

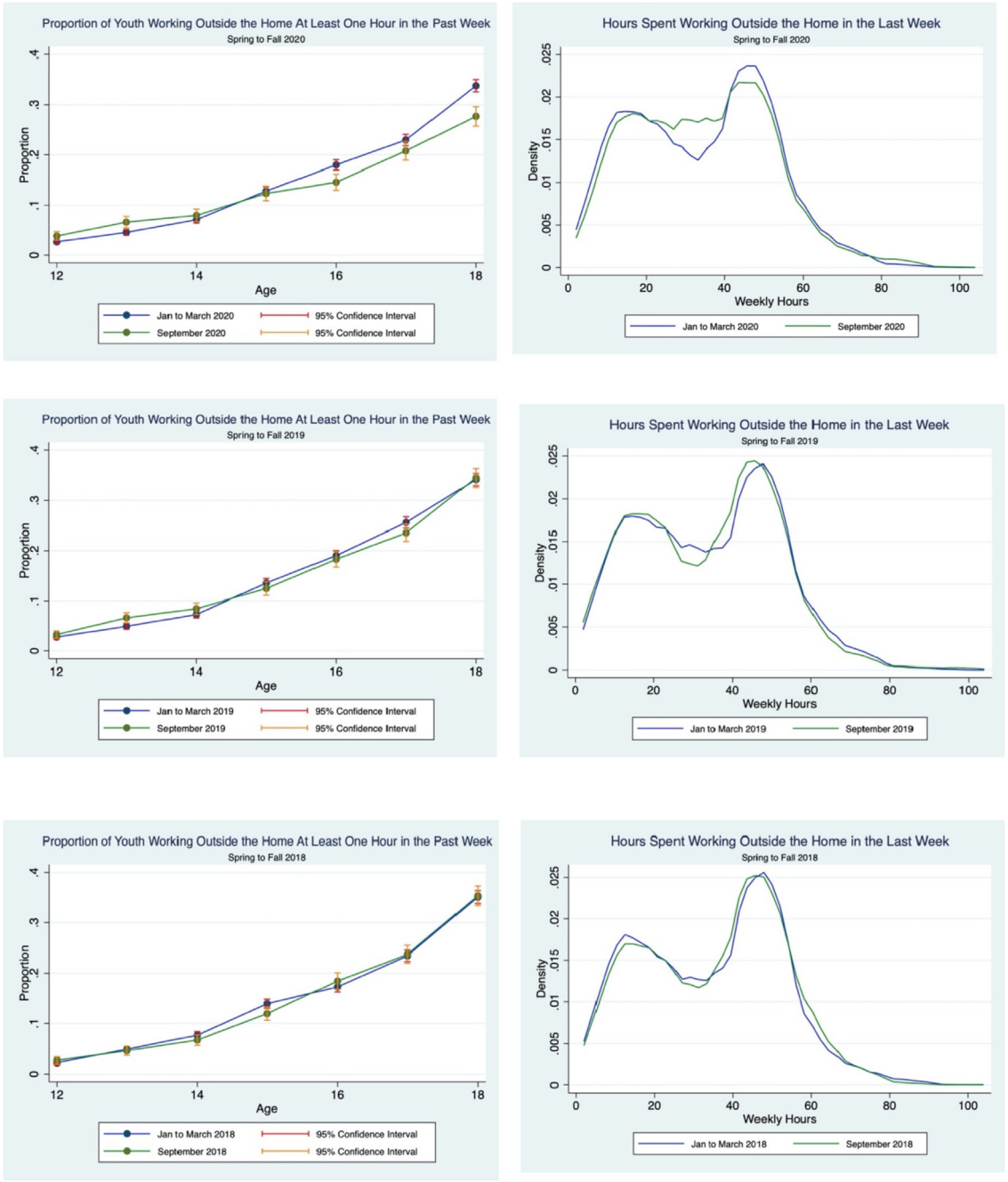

Fig. 2. Proportion of teenagers who work outside the house between 12 and 18 and weekly hours spent working outside the household for teenagers who work. Source: own calculations based on INEGI (2021).

number of weekly hours. As was seen for work outside the home, these descriptive graphs do not suggest substantial changes or increases in work inside the home due to the pandemic. We now turn to multivariate analysis to test the significance of changes in school and work during the pandemic.

4. Multivariate results

Our descriptive analysis on time use above was suggestive of some important overall changes in the time use of youth during the first year of the Covid-19 pandemic, particularly in the area of participation in study activities. We now turn to multivariate analysis to provide more evidence on the size and significance of these changes during the pandemic and to explore heterogeneity in these changes by gender, urban rural residence and socioeconomic status.

We estimate the following difference in difference equation:

$$y_i = \beta_0 + \beta_1 September_i + \beta_2 PYEAR_i + \beta_3 September_i x PYEAR_i + \sum_{j=1} \delta_j X_i + \sum_{j=1} \gamma_j W_i + \alpha_s + \varepsilon_i \quad (1)$$

where y_i represents our indicator of interest which, following our descriptive analysis, includes the proportion of individuals participating and the conditional weekly hours spent in three main activities a) studies b) work outside the home and c) work inside the home the home in the week before the survey; $September_i$ is a dummy variable that takes the value of 1 for observations in September (the beginning of a school year) and 0 for January-

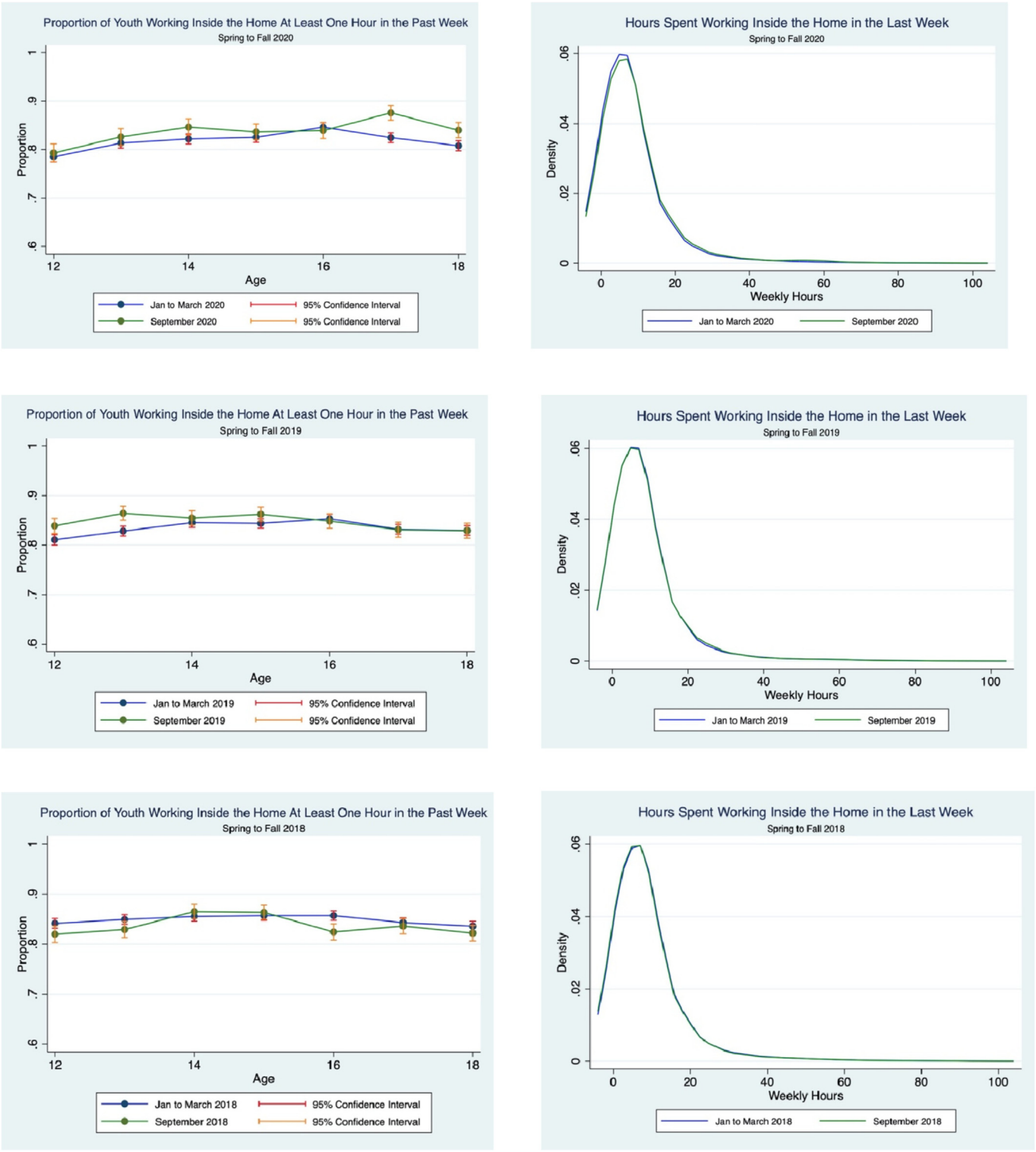

Fig. 3. Proportion of teenagers who work inside the house between 12 and 18 and weekly hours spent working inside the household for teenagers who perform domestic chores. Source: own calculations based on INEGI (2021).

March; $PYEAR_i$ is a dummy variable that takes the value of 1 for observations in 2020 (the year of the pandemic) and 0 for 2018 and 2019[10]; $September_i xPYEAR_i$ is our double difference estimator measuring impacts of the pandemic which takes the value of 1 for those observations in September 2020; X_i are a series of individual controls which include age, gender, place of residence, household size and household head variables including age, education (a dummy that represents having complete high school or more) and being the only parent present; W_i are a series of geographic level variables including proportion of individuals with cell phones and the Margination Index andε_i is the error term which is clustered at

[10] We use both 2018 and 2019 as potential pre pandemic comparison years. Our results are quite similar however if we use only 2019 as a pre pandemic year.

the municipality level. Estimations also include fixed effects by state, represented by α_s.

Because time use patterns for studies and work may vary by month due to seasonality issues (for instance if school enrollment is higher in the Fall or work outside the home is more common in the Spring), we include pre pandemic years in our regression estimation to potentially control for differences in participation which may occur due to seasonality separately from the effects of the pandemic. To test for heterogeneous effects of the pandemic, we carry out equation (1) for different subgroups including by age, gender, and area of residence. We report in the main text only the coefficients on the interaction e.g. ($September_i xPYEAR_i$), which captures the change in time use between January-March and September of 2020, differencing out changes in these patterns in the pre pandemic years of 2018 and 2019. The full regression results are provided in the online Appendix (see Tables A.3 and A.4). We divide our sample between youth aged 12 to 14, ages which correspond approximately to middle school and youth 15 to 18, which correspond to youth in ages to attend high school. In all tables, we provide the pre pandemic means (average of 2018 and 2019) of our dependent variables.

Table 3 reports coefficients estimates of the pandemic on the probability of studying and working (inside and outside the household) at least one hour per week for the complete sample and separately by age group, gender and urban rural residence. Panel A in Table 3 suggests a large and significant reduction of 14 percentage points in the probability of dedicating time to studies during the previous week (corresponding to a reduction of nearly 20 percent), with generally larger effects for youth aged 15 to 18 and smaller effects for youth aged 12 to 14. This reduction is statistically significant for girls and boys and both youth in less urban and more urban communities, demonstrating a significant reduction nationwide across these different groups. The magnitude of the reduction for those 15 to 18 years old is similar across groups, ranging from 15 to 19 percentage points, which corresponds to a substantial decrease in about 25 percent in the probability of studying from the pre pandemic mean. The magnitude of the reduction for the age group 12 to 14 ranges from 7.4 percentage points for those in less urban areas, to 14 percentage points for those in more urban ones. By gender we also observe a difference for youth 12–14: a decrease of 8.3 percentage points for girls and of 12 percentage points for boys. In summary, these estimates suggest important declines in the proportion of youth who spend time on studies during the previous week during the first year of the Covid-19 pandemic.

We now turn to changes in the probability of working outside the home (Panel B of Table 3). For the overall sample, there is a significant decrease of 1.1 percentage points in the probability of working at least one hour outside the home during the previous week. The effects however are concentrated on older youth aged 15 to 18 with no significant changes in the probability of working outside the home for youth aged 12 to 14 (with the exception of a small increase (2.1 percentage points) for those in less urban areas). The reductions in the probability of working for older youth are concentrated on the group of girls and for youth in more urban areas. Other groups show no significant effects of the pandemic on participation in work outside the home.

Finally, Panel C in Table 3 shows effects of the pandemic on the proportion of youth participating in domestic work in the household. Here we observe an interesting small but significant increase in the overall proportion of boys aged 15 to 18 carrying out domestic work as well as an increase in urban areas overall of participation in work inside the household. While there is no overall increase in the proportion of girls participating in work inside the home, it is worth noting that a larger proportion of girls (94 percent) aged 15 to 18 pre pandemic participate in work in the household versus 75 percent of boys aged 15 to 18.

We now turn to changes in weekly hours dedicated to studying, working outside the home and working inside the home during the pandemic, conditional on participation in these activities (Table 4). Panel A shows that for those who dedicate time to studying, the average time dedicated falls significantly by 10–11 h per week, representing about a 30 percent decrease from the pre pandemic study hours of about 37 to 38 h per week. This is similar to the drop of a little more than 12 h per week in the hours students spent studying that Grätz and Lipps (2021) found in Switzerland comparing data from the September 2019-March 2020 to May-June 2020. The decrease occurs for all age groups and is similar in magnitude for boys and girls and in less urban and more urban areas. That is, even for children engaged in studies, the pandemic has led to a general and important decrease in time spent on studies.

Panel B in Table 4 shows the impacts on hours spent working outside the home. While Table 3 demonstrated that the pandemic has not in general led to an increase in the probability of working for the 12- to 14-year-old group, Table 4 demonstrates there have been some changes in the number of hours of work for those who do work in this group. In particular, youth aged 12 to 14 in less urban areas who work (who as shown in Table 3 experience an increase in the probability of working), are now working 6.7 more hours per week during the pandemic, an increase of almost 30 percent relative to pre pandemic levels. In less urban areas, older youth see a reduction of 2.4 h, conditional on working. Panel B also shows that for those in more urban areas, the opposite is true: the increase in time spent working outside the household with the pandemic is seen for older children who work (recall however this group experienced a general decline in the probability of working as seen in Table 3): almost 3 h, conditional on working. In more urban areas, younger youth experience a reduction in the number of hours per week working of 6.6 (although the overall proportion of youth 12–14 in more urban communities who work is relatively low at 3 percent).

Finally, Panel C in Table 4 shows changes in the hours spent in domestic work, conditional on carrying out domestic work during the pandemic. It demonstrates a general and statistically significant increase in time spent in domestic work of between 0.6 and 2.3 h per week, statistically significant for all groups aged 15 to 18. Overall, for youth aged 12-18, the increases in time spent in domestic work correspond to increases in about 13 percent versus pre pandemic, for those who carry out work inside the household.

The ENOE datasets contain limited information on socioeconomic status outside of labor income. To further explore how the effects of the pandemic may vary by socioeconomic status, we performed the same estimations dividing the sample by education level of the household head and by the margination index in the municipality of residence as well as by the proportion of individuals with cellphone access, which in addition to socioeconomic status may proxy for potential access to internet to facilitate attending classes. These tables (found in the online Appendix, see Tables A.5 and A.6) show limited evidence for significant differences in the effects of the pandemic by socioeconomic status, using the indicators of time use studied in this paper. While more longer-term evidence is needed on indicators that directly measure learning, our evidence suggests that there may be significant negative effects of the pandemic on learning and enrollment nationwide in Mexico. This differs somewhat from initial evidence from developed countries, where the pandemic has appeared to have more negative effects on time spent studying over those with lower socioeconomic status (Andrew et al., 2020; Dietrich et al., 2021; Grätz and Lipps, 2021; Reimer et al., 2021) and lower pre program achievement (Grewenig et al., 2020). However, we would also caution that students in higher resource families may be able to learn

Table 3
Proportion of teenagers who study, work outside the household and work inside the household (Difference-in-Difference).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Total	Girls		Boys		Communities ≥ 100,000 inhabitants		Communities < 100,000 inhabitants	
		12–14 y.o.	15–18 y.o.	12–14 y.o.	15–18 y.o.	12–14 y.o.	15–18 y.o.	12–14 y.o.	15–18 y.o.
A. Study									
September × PYEAR	−0.14***	−0.083***	−0.17***	−0.12***	−0.16***	−0.14***	−0.19***	−0.074***	−0.15***
	(0.013)	(0.019)	(0.019)	(0.017)	(0.018)	(0.023)	(0.021)	(0.017)	(0.019)
Mean pre-pandemic	0.79	0.94	0.69	0.93	0.66	0.96	0.75	0.91	0.62
	(0.411)	(0.243)	(0.460)	(0.256)	(0.474)	(0.194)	(0.432)	(0.281)	(0.486)
B. Work outside the household									
September × PYEAR	−0.011*	0.0067	−0.041***	0.016	−0.0043	−0.00090	−0.048***	0.021*	−0.0028
	(0.0061)	(0.0073)	(0.013)	(0.012)	(0.013)	(0.0077)	(0.0092)	(0.011)	(0.014)
Mean pre-pandemic	0.15	0.03	0.14	0.07	0.31	0.03	0.18	0.07	0.26
	(0.359)	(0.163)	(0.346)	(0.261)	(0.463)	(0.157)	(0.386)	(0.254)	(0.439)
C. Work inside the household									
September × PYEAR	0.014	−0.013	0.0071	0.012	0.033*	−0.0019	0.034**	0.0043	0.013
	(0.011)	(0.016)	(0.011)	(0.023)	(0.017)	(0.024)	(0.014)	(0.021)	(0.013)
Mean pre-pandemic	0.84	0.90	0.94	0.78	0.75	0.83	0.86	0.85	0.83
	(0.365)	(0.294)	(0.244)	(0.416)	(0.433)	(0.374)	(0.352)	(0.360)	(0.373)
Observations	158,371	32,497	45,430	33,848	46,596	35,928	51,821	30,417	40,205
Clusters	273	260	263	261	269	73	73	268	270

Note: Standard errors in parentheses. Estimations include Fixed Effects by state.
Mean pre-pandemic is calculated as the average for 2018 & 2019.
September is a dummy variable that takes the value of 1 for observations in September (the beginning of a school year) and 0 for Jan-March, and *PYEAR* is a dummy variable that takes the value of 1 for observations in 2020 (the year of the pandemic) and 0 for 2018 and 2019.
Source: own calculations based on INEGI (2021) and Conapo (2021).
* $p < 0.10$.
** $p < 0.05$.
*** $p < 0.01$.

Table 4
Conditional hours spent studying, working outside the household and working inside the household (Difference-in-Difference).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Total	Girls		Boys		Communities ≥ 100,000 inhabitants		Communities < 100,000 inhabitants	
		12–14 y.o.	15–18 y.o.	12–14 y.o.	15–18 y.o.	12–14 y.o.	15–18 y.o.	12–14 y.o.	15–18 y.o.
A. Study									
September x PYEAR	−11.0***	−10.7***	−10.6***	−11.3***	−11.0***	−11.6***	−11.2***	−10.5***	−10.4***
	(0.42)	(0.51)	(0.60)	(0.54)	(0.60)	(0.70)	(0.85)	(0.56)	(0.70)
Mean pre-pandemic	37.9	37.4	38.8	37.1	38.2	37.8	39.0	36.7	38.1
	(8.17)	(7.01)	(9.27)	(6.92)	(9.09)	(7.22)	(9.53)	(6.73)	(8.84)
Observations	123602	30334	31407	31210	30651	33742	37152	27802	24906
Clusters	273	258	250	259	252	73	73	267	264
B. Work outside the household									
September x PYEAR	−0.26	6.81	−0.43	2.36	−0.51	−6.59*	2.90**	6.65***	−2.36**
	(0.95)	(4.28)	(1.52)	(2.38)	(1.06)	(3.50)	(1.36)	(2.42)	(1.18)
Mean pre-pandemic	34.6	21.5	33.9	24.0	37.4	23.7	37.2	23.3	35.9
	(17.94)	(14.85)	(17.71)	(17.11)	(17.32)	(17.21)	(17.49)	(16.39)	(17.50)
Observations	21872	762	5983	1985	13142	898	9281	1849	9844
Clusters	256	141	212	192	244	63	72	196	252
C. Work inside the household									
September x PYEAR	1.10***	0.31	2.26***	0.63***	0.41*	0.61**	1.66***	0.45	1.40***
	(0.19)	(0.28)	(0.47)	(0.20)	(0.22)	(0.24)	(0.39)	(0.31)	(0.41)
Mean pre-pandemic	8.7	7.7	13.4	5.4	6.2	6.0	8.8	7.1	11.2
	(9.30)	(6.37)	(13.12)	(4.50)	(5.41)	(5.29)	(9.67)	(5.91)	(11.86)
Observations	133384	29059	42375	26395	35555	29826	44225	25628	33705
Clusters	273	259	263	258	263	73	73	267	268

Note: Standard errors in parentheses. Estimations include Fixed Effects by state.
Mean pre-pandemic is calculated as the average for 2018 & 2019.
September is a dummy variable that takes the value of 1 for observations in September (the beginning of a school year) and 0 for Jan-March, and *PYEAR* is a dummy variable that takes the value of 1 for observations in 2020 (the year of the pandemic) and 0 for 2018 and 2019.
Source: own calculations based on INEGI (2021) and Conapo (2021).
* $p < 0.10$.
** $p < 0.05$.
*** $p < 0.01$.

more during the pandemic per hour studied if for instance, their families have internet and a greater supply of education resources in the household. Differences in study time is only one input to the education process and it is possible that greater inequities by socioeconomic status than what we have observed here may appear in studies of academic learning and achievement.

5. Discussion and conclusion

We have studied the changes in time use of adolescents aged 12 to 18 in Mexico that occurs during the first year of the Covid-19 pandemic. We have found strong evidence of a reduction in time dedicated to studies, including both a generalized reduction in the probability of studying (with greater decreases for older children) and a reduction in the time spent on studies by all enrolled students. The decrease in the proportion of youth 12-18 who report studying at least one hour during the previous week of nearly 20 percent from 79 percent to 65 percent) suggests a large increase in youth who are disconnected from studies at the time of the survey. Such figures are lower than the proportion of children not engaging in any learning activity at the beginning of the pandemic in countries like Burkina Faso and Kenya (Debenedetti et al., 2020; Kihui, 2020), as well as Senegal and Ghana for the younger cohorts (Bosumtwi-Sam & Kabay, 2020). However, they are similar to the 74 percent of students between 14 and 18 years old are engaging in some online learning in Ecuador (Asanov et al., 2020). Our evidence thus suggests an important decrease in the number of students who are engaged with school, vis a vis pre pandemic. These students would seem to be at particularly high risk for abandoning school permanently when in person classes resume.

Those students who do dedicate time to school show an important reduction in time spent on studies of about 30 percent relative to pre pandemic. Such reduction is larger than what was observed in Germany in June 2020 (Grewenig et al., 2020), but of a similar magnitude to a comparable before-after study conducted in Switzerland (Grätz & Lipps, 2021). Of course, a reduction in time spent studying is not necessarily consequential if students are still learning the same amount of material as pre pandemic. While we do not have direct measures of learning, this seems unlikely. A review performed by Escueta et al. (2020) suggests that students taking courses exclusively online experience negative learning outcomes compared to those who have some degree of in-person teaching. For example, Heppen et al. (2012) found through an experimental study in 15 high schools in the Chicago Public Schools system that students in a face-to-face summer credit recovery algebra course outperformed those in the online version of it. Moreover, existing evidence from the pandemic in other contexts shows a significant reduction in learning, as measured by standardized tests (Kuhfeld, Tarasawa, Johnson, Ruzek, & Lewis, 2020; Engzell et al., 2021). With few exceptions, schools in Mexico have been closed during the first year of the pandemic. When students return to in person classes in Mexico, an urgent matter will to be evaluate the extent of learning that occurred during the pandemic.

Our work also suggests a decrease in the proportion of youth aged 15 to 18 working outside the home with the pandemic, and a significant increase in the number of hours younger youth aged 12 to 14 in less urban communities and those aged 15 to 18 in more urban communities who are employed devote to work. It is concerning to observe such increase that might later on lead to lower school attachment. There is also a small increase in the time dedicated to work inside the household with larger increases for older youth.

As of March 2021, all schools in Mexico had been closed for a full year, with few exceptions. Our results which include study of only the initial effects in the new school year following the start of the pandemic point to sharply decreased time spent studying. Further study is needed to document how enrollment, learning and studying evolves as disruptions in learning continue in Mexico. Earlier literature suggests that school closures tend to lead to early dropout, for instance the recent H1N1 pandemic led to increases in the probability of permanently dropping out of school in a number of developing countries (Selbervik, 2020).

There are a number of other potential mechanisms, besides school closures, through which the pandemic may have also affected the school and work of youth. These mechanisms include health and mortality effects, as well as economic effects for instance due to unemployment of parents or other members of the household . While it is beyond the scope of this paper to isolate the impact of each these mechanisms on schooling and work patterns, it is interesting to note that while there was little variation in school closures nationwide (e.g., all schools were closed), there was wide variations in mortality and health effects by states. In particular, Mexico City suffered the highest level of excess deaths per capita nationwide (Dahal et al., 2021). Appendix Table A.7 and A.8 compare the effects of the pandemic on schooling for Mexico City versus the rest of Mexico and demonstrates higher reductions in the proportion of youth studying in Mexico City versus nationwide, suggestive that impacts on schooling and work may derive not only from school closures but from health and economic effects of the pandemic.

Even for students who remain in school, a loss in learning seems probable with potentially long-lasting effects on youth and adult well-being. Promising programs in other contexts might be pursued in Mexico to try to combat the reduction in learning. Summer school, a national tutoring program, as well as measures to increase learning feasible in distance learning models, such as distributing tablets and investing in internet networks in rural areas should be considered. Nickow et al. (2020) for instance summarize the effects of tutoring in 96 different contexts, the vast majority of which showed positive effects. Carlana and La Ferrara (2021) show tutoring can work to improve learning during the pandemic using online tutoring in Italy whereas Angrist et al. (2020) show positive effects on learning through text messaging of math problems in Botswana. Effective measures to reduce and offset learning losses in Mexico are urgently needed.

Our results then demonstrate substantial initial effects for Mexican youth on their time use with the pandemic. More research is needed to look at the effects of these reductions in time studying on learning and other educational indicators, as well as the effects of the pandemic on other variables related to schooling such as early fertility, marriage and adolescent risk behaviors - issues that were reported in the study of other pandemics like the Ebola crisis and the H1N1 pandemic (Armitage & Nellums, 2020; Rothe et al., 2015; Denney et al., 2015).

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Data Statement

Data used for this study, as well as codes can be found in the open access repository: Boruchowicz, Cynthia; Parker, Susan Wendy; Robbins, Lindsay (2021), "Time Use of Youth during a Pan-

demic: Evidence from Mexico", Mendeley Data, V1, doi: 10.17632/hpgzxcfsds.1

CRediT authorship contribution statement

Cynthia Boruchowicz: Conceptualization, Data curation, Methodology, Formal analysis, Visualization, Writing - original draft, Writing - review & editing. **Susan W. Parker:** Conceptualization, Data curation, Methodology, Formal analysis, Visualization, Writing - original draft, Writing - review & editing. **Lindsay Robbins:** Data curation, Formal analysis, Methodology, Visualization.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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