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Abstract

What is the effect of Covid-19 on labor markets when there is no lockdown? We answer this question using individual-level survey data for Nicaragua from January 2019 to May 2021. We find a negative impact of Covid-19 on the labor force participation right after the pandemic, particularly for young females, but also a quick recovery. We find that female labor force participation is strongly related to school attendance. Using high-frequency smartphone data we find that visits to school areas dropped sharply by 50%, but they recovered soon as with the female labor force participation.

JEL classification: J21, O12
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1 Introduction

The Covid-19 pandemic has impacted our well-being in different dimensions, and sometimes its impact has been affected by how governments responded. To contain the spread of Covid-19 most countries implemented information campaigns, restrictions on international travel and internal movements (lockdowns), testing and contract tracing, school closures, and restrictions on gatherings (Hale et al., 2021). While intended to protect lives, these policies affected economic activity, reduced labor supply, and had negative impacts on livelihoods. For instance, 48% of households in Latin America in 2021 report a reduction in their total income since the onset of the pandemic (Mejia-Mantilla et al., 2021). Aiming to address this income drop, governments implemented another set of policies, such as cash transfers, to mitigate the economic impacts of the pandemic (Gentilini et al., 2021). In these contexts, several studies have been unable to disentangle the impact of different policies from the impact of the pandemic itself.

This paper studies the effect of the Covid-19 pandemic on labor force participation in Nicaragua where no measures were in place to contain the spread of the virus, no cash or in-kind transfers to mitigate negative impacts on livelihoods, and individuals were allowed to keep working as usual, even though more than 85% of the population had a relative or friend infected by the virus by June 2020 (CID/Gallup, 2020). In this context, we can observe the "natural" labor market response to the pandemic and how workers respond to the trade-off between livelihood and health.

Our main contribution is to provide estimates that isolate the impact of the pandemic itself in the short and medium-term. We shed light on the more general question of what would have happened to labor markets had lockdowns would not been implemented by mandate. Second, we use novel high-frequency smartphone data to explore the link between school attendance and female labor market participation. Finally, we provide evidence for a country that does not disclose official microdata, using alternative methods that can be useful for other countries with similar restrictions and are therefore understudied.

Our empirical analysis uses an event study design that compares the labor force participation before and after the pandemic. We use individual-level data from the CID/Gallup survey that gathers systematic information on employment status and covers the period from January 2019

to May 2021. We complement this information with deidentified geocoded smartphone data to construct a measure of school attendance to further understand the dynamics of the female labor market, considering the Latin American context, where the burden of kids is still on women.

A number of studies have documented the impacts of Covid-19 on the labor market and female labor supply in particular. However, the two closest in spirit to ours are the paper by Aum et al. (2021) and Hansen et al. (2022). The first, looks at the change of employment in South Korea at the beginning of the pandemic before lockdowns and find a reduction in employment as infections hiked, but only about half the size compared to studies in the US and UK. Authors concluded that the rising infection itself reduces jobs even in the absence of mandatory lockdowns. However, the government in South Korea closed schools at the start of March 2020 and implemented social distancing later that month. In our case, the government in Nicaragua never closed schools during the pandemic nor implemented any mandatory policy to contain the pandemic. Thus, we have a much longer period to observe private responses and their impact on the labor market. The second study, uses smartphone data to proxy school reopenings in the US after September 2019. The authors find that K-12 school reopenings are associated with significant increases in employment and hours among married women with school-aged children. However, they could not relate school closures to female labor supply because of the near-universal shutdown in the US at the beginning of the pandemic. In Nicaragua, even though there was a *de jure* Covid-19 open school policy, there was instead a *de facto* school closure that allow us to explore this relationship.

We find a negative impact of Covid-19 on the labor force participation right after the pandemic, but also a quick recovery starting in the third quarter of 2020. We confirm the differential impacts by gender found in the literature (Amuedo-Dorantes et al., 2020; Heggeness, 2020; Olmstead and Tertilt, 2020; Collins et al., 2021; Croda and Grossbard, 2021; Del Boca et al., 2021; Fabrizio et al., 2021; Lofton et al., 2021; Sarker, 2021; Higa et al., 2022; Hoehn-Velasco et al., 2022). Nationwide, the possibility of being in the labor force drops by 7.2 percentage points for females immediately after the pandemic. This negative effect is driven by young females who are more likely to bear childcare responsibilities. We find results in the same direction for Managua, the capital and also the largest city in Nicaragua.

We find that female labor force participation is strongly related to school attendance. The negative effect on young females is consistent with the decrease in visits to schools. Although schools remained open, we find that school visits dropped sharply and reached the bottom in May where visits to school areas were 50% below the levels at the beginning of the school year in February. Interestingly, the school visits recovered soon, just like the female labor force participation.

The following sections are organized as follows: Section 2 describes the context in Nicaragua, Section 3 describes the labor and mobility data used for the study, Section 4 shows our empirical approach, Section 5 presents the results, and Section 6 concludes.

2 Background

The first confirmed Covid-19 case was reported on March 19th, 2020 in Nicaragua, followed by the first wave of infection between May and July 2020, and a second wave between August and October 2021. The extent of the spread of the Covid-19 in Nicaragua and its effects on the population are unknown since the management of the pandemic in Nicaragua has lacked transparency. Official figures from the Ministry of Health (MINSA) indicate 17,243 confirmed cases of Covid-19 and 210 accumulated deaths as of November 16, 2021. However, figures from the Independent Citizen Observatory over the same period indicate 31,140 suspected cases of Covid-19 and 5,928 deaths. The public opinion survey conducted by CID Gallup in June 2020 indicates that Nicaragua is the country in Central America where the most respondents say that they know someone who has been infected with Covid-19 (87%), followed by the Dominican Republic (69%) and Honduras (54%). However, according to Our World in Data in June 2020 Nicaragua reported officially just 7.4 cases per million (0.19 deaths per million), while Honduras 79.4 cases per million (1.31 deaths per million) and Dominican Republic 60.4 cases per million (0.94 deaths per million). The figures from the Independent Citizen Observatory and the Gallup Survey point out that the official Covid-19 reported cases and deaths are significantly underestimated.

Nicaragua's response to the pandemic was unlike any other in Latin America. First, it did not implement officially mandated lockdowns. According to the Covid-19 Stringency Index, Nicaragua had the lowest stringency index in the world, rating 8.3 out of 100, where 100 means the strictest

measures in terms of school closures, workplace closures, and travel bans (Hale et al., 2021). Second, while Latin America has been the region that has kept schools closed for the longest period in the world, according to UNESCO's Global School Closure Monitor, Nicaragua's schools remained open or partially open all through 2020 and 2021. Third, while in Latin America 38% of households received emergency transfers to cope with the reduction of total income during the pandemic, only 5% of households in Nicaragua did (Mejia-Mantilla et al., 2021). In sum, there were no measures in place to contain the spread of the virus, no cash or in-kind transfers to mitigate negative impacts on livelihoods, and workers were allowed to keep working as usual.

Access to key official statistics in Nicaragua is limited. The last national census dates to 2005, the most recent Living Standard Measurement Survey, which is key to measuring poverty, dates from 2014, and the most recent Demographic and Health Survey dates from 2011, to name a few examples. This has limited the possibility to analyze the impacts of the pandemic on employment, living standards, and firms. Although the national statistical agency (INIDE) has continued to gather the *Encuesta Continua de Hogares* (ECH) every quarter, just a few aggregated indicators are publicly available and there is no access to microdata.

3 Data

In our context of limited access to official statistics, it is important to identify alternative sources of information and data to monitor changes in living standards. To study the impact of Covid-19 on labor market outcomes we use individual-level data from the CID/Gallup survey in Nicaragua for the period between January 2019 and May 2021. Although the main goal of the CID/Gallup survey is to monitor political sentiment, socioeconomic attitudes, and trends, it also gathers systematic information on employment status together with other relevant demographic variables such as gender, age, education, marriage, and household income.[1] This is a nationally representative survey conducted every year in January, May, and September, and has been used in several other studies (Olson, 2002; Deaton, 2008; Kleiner and Krueger, 2013; Rezende Machado de Sousa et al., 2019; Rojas, 2019; Fabian et al., 2020; Melnikov, 2021). In every round, CID/Gallup interviews

[1]Summary statistics can be found in Table C.1 in the appendix.

around 1200 individuals that are 16 years old or more. Note that we complement this information with official reports about quarterly labor market indicators based on the *Encuesta Continua de Hogares* (ECH) from 2019 to 2021.

We also use high-frequency deidentified and geocoded smartphone data to further understand the dynamics of the labor market. This data registers the location of smartphone devices whenever some applications are activated and request such information. We combine this information with maps with geocoded school locations to identify mobility patterns around 458 schools[2] and to analyze visits to areas containing schools before and after the start of the pandemic. We do this analysis only for Managua, the capital city, given that smartphone data works better in high-density areas and that the geocoded school map is only available for this city.

4 Empirical approach

We study the effect of the Covid-19 pandemic on labor force participation over time using an event study design that compares outcomes before and after the beginning of the Covid-19 pandemic. We estimate the following liner probability model using OLS with robust standard errors:

$$y_{it} = \alpha X_{it} + \sum_{\tau=1}^{5} \beta_\tau D_{it}^{\tau} + \epsilon_{it} \quad (1)$$

y_{it} is the dummy indicating whether individual i is in the labor force at month-year t. X_{it} is a set of control variables including age, gender, education level, and month and region fixed effects. D_i^{τ} is an indicator variable equal to one if the individual was interviewed in period τ. For instance, $\tau = 1$ indicates the period May 2020, the first period after the pandemic hit, while $\tau = 5$ refers to May 2021. The reference period is $\tau = 0$, corresponding to January 2019-January 2020. Hence, β_τ measures the difference in labor force participation in various post-pandemic periods relative to the pre-pandemic period. Note that we focus on labor force participation since the survey does not allow us to distinguished unemployed individuals from those employed in 'other occupations" which correspond to categories not listed in the survey.

[2]See map in Figure B.3 displaying elementary and high schools that are either private or public.

5 Results

Table 1 shows our main results for Nicaragua. In general, there seems to be a negative impact of Covid-19 on the labor force participation right after the pandemic, albeit not statistically significant, but also a quick recovery after that according to column (1). This coincides with the official statistics based on the *Encuesta Continua de Hogares* (ECH) that reports a drop in labor force participation in the second quarter of 2020, and an immediate recovery starting from the third quarter of 2020 (see figure B.2 in the appendix). However, this contrasts with other studies (Casarico and Lattanzio, 2022; Higa et al., 2022) that find persistent negative effects of Covid-19 on the labor market even a year after the start of the pandemic. One key difference compared to the contexts studied previously is that Nicaragua did not impose any restrictions as a response to the pandemic.[3]

Table 1: Main Results

	Labor force participation				
	(1)	(2)	(3)	(4)	(5)
May 2020	-0.021	-0.072***	0.035**	-0.097***	0.006
	(0.016)	(0.028)	(0.017)	(0.033)	(0.054)
Sep 2020	0.072***	0.149***	-0.001	0.209***	0.035
	(0.017)	(0.028)	(0.018)	(0.034)	(0.055)
Jan 2021	0.073***	0.165***	-0.019	0.201***	0.039
	(0.015)	(0.024)	(0.016)	(0.028)	(0.049)
May 2021	0.043***	0.052*	0.040**	0.057*	0.089
	(0.017)	(0.028)	(0.018)	(0.033)	(0.059)
Mean outcome (pre-pandemic)	0.632	0.402	0.866	0.404	0.398
Observations	9,625	4,857	4,768	3,622	1,235
R-squared	0.262	0.077	0.179	0.050	0.054

Notes: Regressions control for indicators of gender, educational level, and age, as well as month and region fixed effects. Column (1) includes all 15+ age individuals. Column (2) includes females only. Column (3) includes males only. Column (4) includes only females less than 45 years old. Column (5) includes only females 45 or more years old. Robust standard errors in parentheses, * denotes significant at 10%, ** significant at 5%, and *** significant at 1%.

There is a differential impact by gender. In column (2), we observe a negative and statistically significant effect of Covid-19 on female labor force participation immediately after the pandemic.

[3]Note that Nicaragua had a contraction of its GDP per capita starting in 2017. Between 2017 and 2019, the rate of labor force participation dropped approximately 3 percentage points. However, in the second quarter of 2020, it dropped 4.5 percentage points compared to the average in 2019.

However, we observe the opposite for males in column (3). Moreover, female participation in the labor market recovers quickly.

The negative effect on females is driven by young females (i.e. aged 44 or less) who are more likely to have children in school age and bear childcare responsibilities. In column (4), the possibility of being in the labor force drops by 9.7 percentage points for young females, as compared to no effect of Covid-19 on females over 45 in column (5).

We find similar results for Managua, the capital city, although we lose statistical significance due to lack of power. Table C.2 shows that the pandemic seems to strike less hard for people in Managua compared to other parts of the country. However, if we look at females under age 44, there is little difference between the estimates for Managua and the whole nation. In both cases, the point estimates show that the possibility of females under 44 being in the labor force decreased by 9 to 10 percentage points and that recovery also follows soon.

The negative effect on young females is consistent with the decrease in school attendance soon after the pandemic hit. Although schools remained open, according to UNESCOâs Global School Closure Monitor, we can explore school attendance in Managua combining the high-frequency smartphone data with the location of schools. Figure 1 displays the daily evolution of visits to areas containing schools for the first half of 2020.[4] We can observe that school visits dropped sharply and reached the bottom in May where visits to school areas were 50% below the levels at the beginning of the school year in February.[5] Interestingly since schools remained open, school visits recovered soon, just like the female labor force participation we observed earlier.

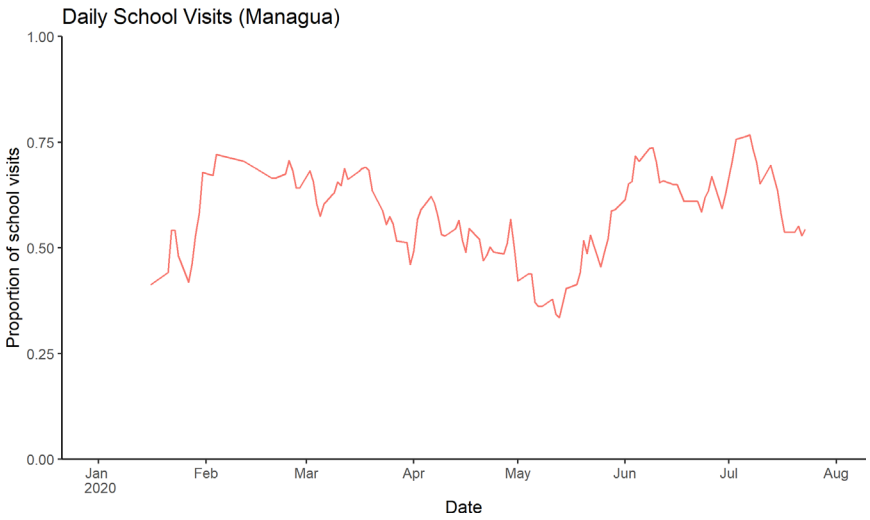
Figure 1 also provides evidence that the *de jure* Covid-19 open school policy was instead a *de facto* school closure at least right after the beginning of the pandemic. Some private schools move from in-person to online, and despite public schools remaining open by mandate, parents were not sending their kids to school and teachers were discouraging students to attend (El Pais, 2021). Note that this "voluntary lockdown" was not exclusive to schools as can be seen in Figure B.4.

Robustness. To the extent that young mothers may have different labor market dynamics

[4]See the appendix for a methodological note about the estimation of visits to schools.

[5]Note that this is close to the 60% reduction in public school attendance announced by the Officials in August 2020 (El Pais, 2021).

Figure 1: Evolution of School Visits, 2020.



Notes: Figure depicts the daily evolution of school visits. The daily visits are aggregated using a rolling average of 10 days. We count the number of cellphone devices visiting a school during "school time", from 6:30am to 2:30pm, weekends are excluded. Note that "visiting" means that the device visiting a school area does not correspond to a resident of the zone. Visits are estimated based on anonymized high-frequency smartphone data. See the appendix for a methodological note.

due to household size optimization or human capital accumulation, we replicate our main results excluding all individuals under the age of 25. Results presented in Table C.3 show the same pattern we found when considering all female workers in the labor market.

Limitations. Even though the context favors the identification of the impact of the pandemic itself without confounding factors such as lockdowns or other government interventions, time-variant unobservables may bias our results. Unfortunately, we cannot include time trends given that our empirical approach relies on time variation. Second, systematic attrition due to the pandemic could have changed the composition of respondents. However, Figure B.1 shows that the number of observations before and after the pandemic remains stable. Third, the CID/Gallup is not intended to monitor labor market outcomes. However, the patterns on the survey coincide with the official reports about quarterly labor market indicators.

6 Conclusion

This paper examines the effect of Covid-19 on labor force participation in Nicaragua where no measures were in place to contain the spread of the virus, no cash or in-kind transfers to mitigate negative impacts on livelihoods, and individuals were allowed to keep working as usual, even though more than 85% of the population had a relative or friend infected by the virus by June 2020. In this context, we observe the "natural" labor market response to the pandemic and how workers respond to the trade-off between livelihood and health.

We document a negative impact of Covid-19 on the labor force participation right after the pandemic, particularly for females, but also a quick recovery. We find that the gender gap in labor force participation increases at the onset of the pandemic. However, the widening gap lasts for a very short period since from the third quarter of 2020 we observe a recovery of female labor force participation and little change in male labor force participation.

We find that the negative effect on female labor force participation is driven by young females (i.e., aged 44 or less) who are more likely to bear childcare responsibilities. We find that female labor force participation is strongly related to school attendance. Using high-frequency smartphone data we find that visits to school areas dropped sharply after the start of the pandemic, but they recovered soon as with the female labor force participation. Hence the quick recovery of female participation in the labor market seems to be a result of children returning to school, which is consistent with the Latin American context, where the burden of kids is still on women.

We also document that the *de jure* Covid-19 open school policy was instead a *de facto* school closure. On the one hand, private schools were allowed to switch from in-person to online classes. On the other hand, even though public schools were open by mandate, around 60% of students did not attend by august 2020 according to official records (El País, 2021). This is corroborated by the smartphone data that shows a drop of close to 50% in visits to schools during the beginning of the pandemic. One implication of this finding is that parents with less economic resources that need to send their kids to public schools were in a situation where they did not send their kids to avoid getting infected, but they were not offered an alternative by the government since public schools were kept open in principle. Hence, this situation may be an amplifier of inequality in general, and

the gap between private and public school educational outcomes. Further research in this direction is needed.

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ONLINE APPENDIX

A School visits

In this section, we explain the approach we followed to estimate the school visits before and after the pandemic in Managua.

Sample of devices. We use smartphone devices that always report their location with a GPS horizontal accuracy of less than 50 metres. In addition, we restrict our sample to devices that have been observed for more than a week to avoid tourists or sporadic users.

Home location. We infer home locations based on the night activity of devices following an algorithm similar to Kreindler and Miyauchi (2019) and Blanchard et al. (2021). First, we only consider pings observed between 9pm and 5am. Second, we identify clusters based on the proximity of pings using a DBSCAN clustering algorithm. Note that one device may have more than one cluster between 9pm and 5am. Third, a cluster is considered a home location if that cluster is where the device spent most of the nights and for 4 hours (i.e. 50% of the 8 hours window between 9pm and 5am) or more.

School location. We use a map of schools for Managua with geocoded locations. This map contains elementary, secondary, public, and private schools.

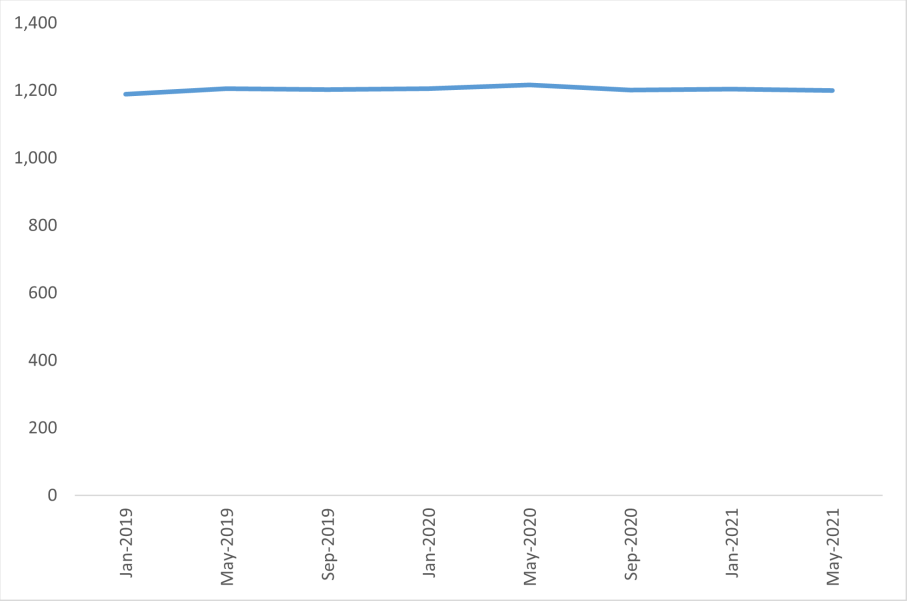
School visits. We count the number of cellphone devices visiting a school during the day. Note that "visiting" here implies that the device visiting an school area do not correspond to a resident of the zone. These counts are done during "school time", namely from 6:30am to 2:30pm, and with pings observed between Monday and Friday. In this window of time we can capture the time when parents usually drop their kids to school up to the time when parents pick their kids up.

Our main indicator for school visits is estimated using equation 2. V_t is the proportion of devices that visit school zones at day t. This indicator is calculated as the ratio of the number of devices i visiting school areas S and the total number of devices outside residential areas.

$$V_t = \frac{\sum_{i \in S} i_t}{\sum_{i} i_t} \tag{2}$$

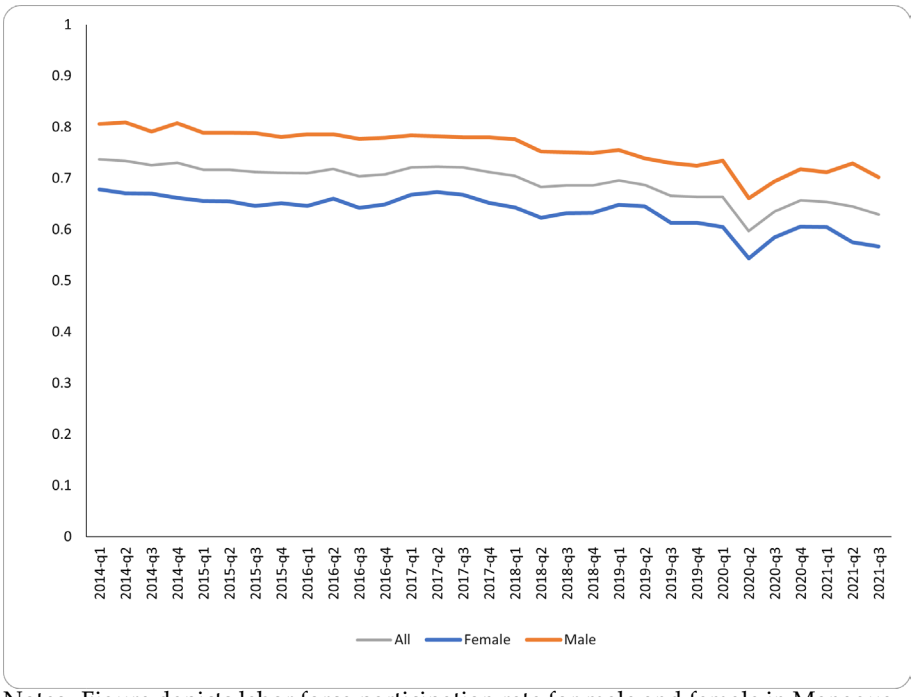
B Additional Figures

Figure B.1: CID/Gallup survey: sample size



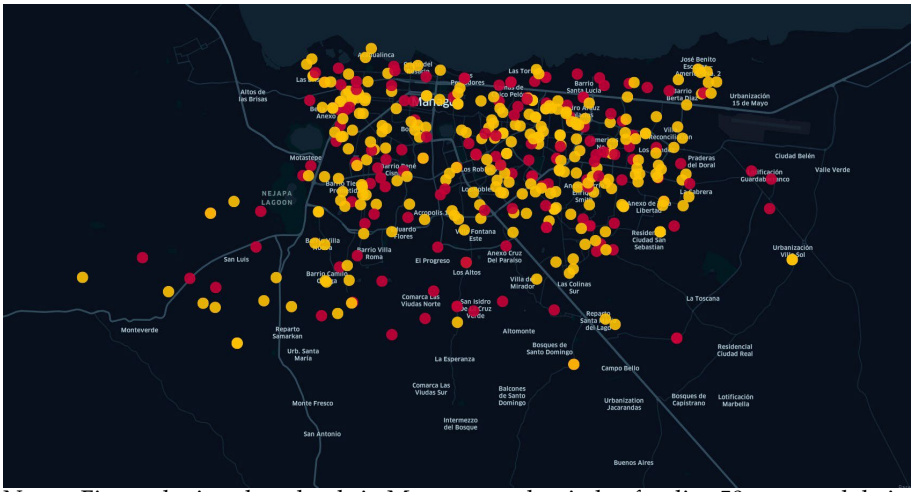
Notes: Figure depicts the number of observations per CID/Gallup survery during January 2019-May 2021.

Figure B.2: Male and female LFP in Managua: 2014-2021



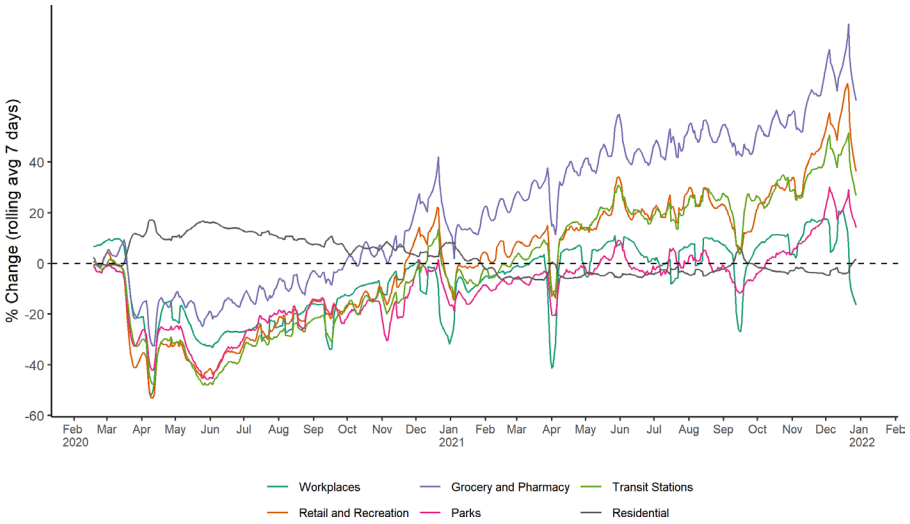
Notes: Figure depicts labor force participation rate for male and female in Managua from January 2010 to January 2021. Source: Encuesta Continua de Hogares.

Figure B.3: Map of Schools in Managua



Notes: Figure depicts the schools in Managua and a circle of radius 50m around their centroid. Private schools are yellow, and public school are red.

Figure B.4: Mobility Changes: Managua area.



Notes: Figure depicts visit changes to places in Managua area (e.g. workplaces, grocery stores, transit stations, parks among others) compared to pre-pandemic levels. Changes for each day are compared to a baseline value (median during the 5-week period from Jan 3 to 6 February 2020) for that day of the week. They are estimated based on anonymized location history data collected by Google. The daily changes in visits are aggregated using a rolling average of 7 days. Source: Google Community Mobility Reports.

C Additional Tables

Table C.1: Summary Statistics.

	All	Pre-pandemic	Post-pandemic
	(1)	(2)	(3)
Labor force participation rate	0.66	0.63	0.69
% female	0.50	0.50	0.50
% under 45	0.73	0.75	0.71
% complete high school	0.41	0.36	0.45
Observations	9,625	4,802	4,823

Notes: Table displays mean values. Column (1) uses all sample from January 2019 up to May 2021. Column (2) uses only observations from January 2019 to January 2020. Column (3) uses only observations from May 2020 to May 2021.

Table C.2: Main results (Managua only)

	Labor force participation				
	(1)	(2)	(3)	(4)	(5)
May 2020	0.017	-0.047	0.071*	-0.099	0.126
	(0.035)	(0.059)	(0.038)	(0.075)	(0.116)
Sep 2020	0.103***	0.204***	0.024	0.300***	-0.015
	(0.036)	(0.059)	(0.041)	(0.072)	(0.124)
Jan 2021	0.018	0.038	-0.007	0.030	0.099
	(0.030)	(0.050)	(0.033)	(0.060)	(0.093)
May 2021	0.008	0.016	0.024	-0.015	0.400***
	(0.038)	(0.061)	(0.043)	(0.072)	(0.151)
Mean outcome (pre-pandemic)	0.622	0.421	0.825	0.434	0.385
Observations	2,125	1,053	1,072	789	264
R-squared	0.287	0.123	0.278	0.055	0.126

Notes: Sample is restricted to only observations in Managua. Regressions control for indicators of gender, educational level, and age, as well as month and region fixed effects. Column (1) includes all 15+ age individuals. Column (2) includes females only. Column (3) includes males only. Column (4) includes only females less than 45 years old. Column (5) includes only females 45 or more years old. Robust standard errors in parentheses, * denotes significant at 10%, ** significant at 5% and *** significant at 1%.

Table C.3: Main results (excluding individuals < 25 years-old)

	Labor force participation				
	(1)	(2)	(3)	(4)	(5)
May 2020	-0.022	-0.062*	0.028**	-0.095**	0.006
	(0.018)	(0.033)	(0.013)	(0.041)	(0.054)
Sep 2020	0.058***	0.125***	-0.006	0.177***	0.035
	(0.018)	(0.033)	(0.014)	(0.043)	(0.055)
Jan 2021	0.035**	0.130***	-0.044***	0.188***	0.039
	(0.016)	(0.029)	(0.016)	(0.036)	(0.049)
May 2021	0.043**	0.053	0.046***	0.038	0.089
	(0.018)	(0.033)	(0.015)	(0.040)	(0.059)
Mean outcome (pre-pandemic)	0.688	0.448	0.939	0.474	0.398
Observations	7,123	3,560	3,563	2,325	1,235
R-squared	0.285	0.067	0.155	0.052	0.054

Notes: Sample is restricted to only individuals older than 25. Regressions control for indicators of gender, educational level, and age, as well as month and region fixed effects. Column (1) includes all 25+ age individuals. Column (2) includes females only. Column (3) includes males only. Column (4) includes only females less than 45 years old. Column (5) includes only females 45 or more years old. Robust standard errors in parentheses, * denotes significant at 10%, ** significant at 5% and *** significant at 1%.