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Scientific articles

**Actividad económica y desigualdad en México durante la
pandemia: TIC y empleo en un análisis con datos panel (2020-
2022)**

***Economic activity and inequality in Mexico during the pandemic: ICT and
employment in a panel data analysis (2020–2022)***

***Atividade econômica e desigualdade no México durante a pandemia: TIC e
emprego em uma análise com dados em painel (2020-2022)***

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Resumen

La crisis COVID-19 impactó la economía global y evidenció las brechas económicas en países en desarrollo como México. El objetivo de esta investigación fue analizar la asociación de las TIC y el empleo en la actividad económica de México bajo el escenario de la crisis sanitaria por COVID-19 durante el periodo 2020–2022. Mediante un modelo panel de efectos fijos con 288 observaciones trimestrales, se analizó si el nivel de ingreso a nivel entidad federativa, amplificó o mitigó los impactos de la crisis sanitaria.



Los resultados del modelo general nacional mostraron que las TIC ($\beta = 0.0053$; $p = 0.0062$) y el empleo ($\beta = 0.0140$; $p = 0.0012$) se asociaron positivamente con la actividad económica, mientras que el COVID-19 tuvo un impacto negativo con rezago de dos periodos ($\beta = -0.0752$; $p < 0.0001$). El análisis por decil de ingreso reveló la magnitud del coeficiente negativo generado por el COVID-19 con rezago de dos periodos ($t-2$) fue mayor en los estados de ingreso bajo ($\beta = -0.1463$; $p < 0.0001$) que en los de ingreso alto ($\beta = -0.0648$; $p = 0.0002$). En conclusión, si bien las TIC y el empleo se vincularon para amortiguar los efectos de la crisis, las disparidades en el nivel de ingreso se asociaron con mayor sensibilidad en los estados con menores ingresos. Estos hallazgos refuerzan la necesidad de diseñar políticas diferenciadas que fortalezcan la digitalización y promuevan el empleo.

Palabras clave: *acceso tecnológico, crecimiento económico, México, pandemia, trabajo.*

Abstract

The COVID-19 crisis impacted the global economy and highlighted structural gaps in developing countries such as Mexico. This research analyzes the association between ICT, employment, and economic activity during the 2020–2022 sanitary crisis. Using a fixed-effects panel model with 288 quarterly observations, the study examines whether income levels at the state level are related to the magnitude of pandemic-related effects. Results for the national model indicate that ICT ($\beta = 0.0053$; $p = 0.0062$) and employment ($\beta = 0.0140$; $p = 0.0012$) were positively associated with economic activity. In contrast, COVID-19 with lag of two periods ($t-2$) showed a significant negative relationship ($\beta = -0.0752$; $p < 0.0001$). Income-based segmentation reveals that the negative coefficient for COVID-19 with lag of two periods ($t-2$) was more pronounced in low-income states ($\beta = -0.1463$; $p < 0.0001$) compared to high-income states ($\beta = -0.0648$; $p = 0.0002$). In conclusion, while ICT and employment were linked to mitigating the crisis's effects, the findings suggest that income disparities are associated with increased sensitivity to sanitary shocks in states with fewer resources. These results underscore the need for differentiated policies that strengthen digitalization and promote formal employment as economic resilience strategies.

Keywords: technological access, economic growth, Mexico, pandemic, labor.

Resumo

A crise da COVID-19 impactou a economia global e evidenciou as desigualdades econômicas em países em desenvolvimento como o México. O objetivo desta pesquisa foi analisar a associação entre as Tecnologias da Informação e Comunicação (TICs) e o emprego na atividade econômica do México, no cenário da crise sanitária da COVID-19, durante o período de 2020 a 2022. Utilizando um modelo de painel com efeitos fixos e 288 observações trimestrais, analisamos se os níveis de renda em nível estadual amplificaram ou mitigaram os impactos da crise sanitária.

Os resultados do modelo nacional mostraram que as TICs ($\beta = 0,0053$; $p = 0,0062$) e o emprego ($\beta = 0,0140$; $p = 0,0012$) apresentaram associação positiva com a atividade econômica, enquanto a COVID-19 teve um impacto negativo com uma defasagem de dois períodos ($\beta = -0,0752$; $p < 0,0001$). A análise por decil de renda revelou que a magnitude do coeficiente negativo gerado pela COVID-19, defasado em dois períodos ($t-2$), foi maior nos estados de baixa renda ($\beta = -0,1463$; $p < 0,0001$) do que nos estados de alta renda ($\beta = -0,0648$; $p = 0,0002$). Em conclusão, embora as TIC e o emprego estivessem interligados na mitigação dos efeitos da crise, as disparidades de renda estiveram associadas a uma maior sensibilidade nos estados de baixa renda. Esses achados reforçam a necessidade de se elaborarem políticas diferenciadas que fortaleçam a digitalização e promovam o emprego.

Palavras-chave: acesso à tecnologia, crescimento econômico, México, pandemia, trabalho.

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Introduction

In 2020, a pandemic broke out, caused by an infectious disease called coronavirus (COVID-19). The first case of this disease was reported in late December 2019 in Wuhan, China (World Health Organization [WHO], 2020). Following this event, the number of cases began to increase around the world, until, in March 2020, the WHO declared the outbreak a pandemic.

Following the declaration of the pandemic, a series of drastic measures were issued to try to stop the spread of the virus. These measures included national quarantines, population isolation, and physical distancing, especially among vulnerable groups (World Bank, 2020). These measures were comparable only to those applied in war situations

(Economic Commission for Latin America and the Caribbean [ECLAC], 2020) , which caused severe economic consequences for businesses and employment.

In this context, ICTs emerged as a solution to address the requirements of social distancing, serving as a central platform for teleworking, distance education, administrative procedures, social interaction, and leisure (ECLAC & Development Bank of Latin America [CAF] , 2020) . However, despite the fact that ICTs helped businesses and companies continue their regular activities, companies were forced to lay off staff (National Institute of Statistics and Geography [INEGI], 2020a) . The pandemic evolved in such a way that the incidence rate started at 0.3% and reached peak figures of 9.15% and 12.94% in record-breaking times, with deaths occurring in record numbers (General Directorate of Health, 2020b) . Therefore, the objective of this research was to analyze the impact of ICTs, employment (employed population), and the COVID-19 pandemic on Mexico's economic activity during 2020–2022. This study also sought to test the difference in the effects of the pandemic in states with a low income decile by segmenting the federal entities, in order to demonstrate the impact of economic inequality and to determine whether it amplified or mitigated the impacts of the health crisis.

Impacts of COVID-19

The pandemic impacted economic variables such as income and employment. Several studies argue that lockdowns should have been differentiated between developing and developed countries (Alon, Kim, Lagakos, & VanVuren, 2020) . Other research confirms that unemployment resulting from the pandemic maintained average values of 3.8% (Chiatchoua, Lozano, & Macías-Durán, 2020; Mendoza Cota, 2020; Nuñez, 2020) . To obtain more precise estimates regarding the impacts of the pandemic, one of the statistical methods is the panel data model. In fact, given the importance of measuring the impacts of the pandemic, studies were conducted using this methodology. For example, Gagnon, Kamin, and Kearns (2023) analyzed the number of deaths and how these affect the economies of some countries. Among their findings, they highlighted that the impact of COVID-19, as measured by the number of deaths, affected specific sectors of advanced economies more intensely than the overall global economic performance. COVID-19 and its impacts still represent a very broad field of study , especially in the development of studies at the national level in Mexico and its states, grouped by their observable income characteristics.

Theoretical Framework

ICT and COVID-19

To address the research topic, ICTs will be defined as the technological convergence of computing and telecommunications. This definition encompasses all technologies of the information society, such as computing, the internet, cell phones, multimedia, and telecommunications systems . Observatory for the Information Society in Latin America and the Caribbean [OSILAC] & ECLAC, 2004; INEGI, 2020b) .

ICTs are a catalyst that drives economic growth (World Bank, 2014) , as they have the potential to affect many aspects of a state's or country's economic and social activities, such as Gross Domestic Product growth and employment (Jiménez, Matus, & Martínez, 2014; Martínez Domínguez, 2018; Palvia, Baqir, & Nemati, 2018) . The use of and access to ICTs is known as technological change, which is integrated into the Solow model for study. This model has been the basis for various studies that determine the impact of ICTs on economic growth (Solow, 1957) . Extensive evidence exists to explain the relationship between ICTs and economic growth, which consistently demonstrates a direct and positive correlation between the variables (Díaz Rodríguez, 2017) .

It has become clear that ICTs play a significant role in economic activity when analyzed directly, without any external factors. However, in late 2019, an external factor emerged in Mexico: COVID-19. This led to lockdowns and closures of schools, offices, and businesses, which evolved proportionally to the number of infections (Government of Mexico, 2020) . As a consequence of the prolonged closure of establishments, and as a measure to avoid paralyzing either education or the economy, the use of ICTs intensified. These technologies became essential and allowed for the continuation of essential activities while also acting as a critical determinant for preserving employment (ECLAC & Development Bank of Latin America [CAF] , 2020) . Therefore, it was crucial to study how economic activity was affected during the COVID-19 pandemic and how ICTs helped to increase or mitigate this impact (World Bank, 2020) .

Employment and COVID-19

The effects of containment measures and restrictions on social contact forced some people to work from home or even stop working altogether. These effects of the COVID-19 pandemic triggered an economic slowdown, resulting in a drop in income, according to economic theory (World Bank, 2020; Mejía Reyes, Reyes Hernández, & Vergara González,

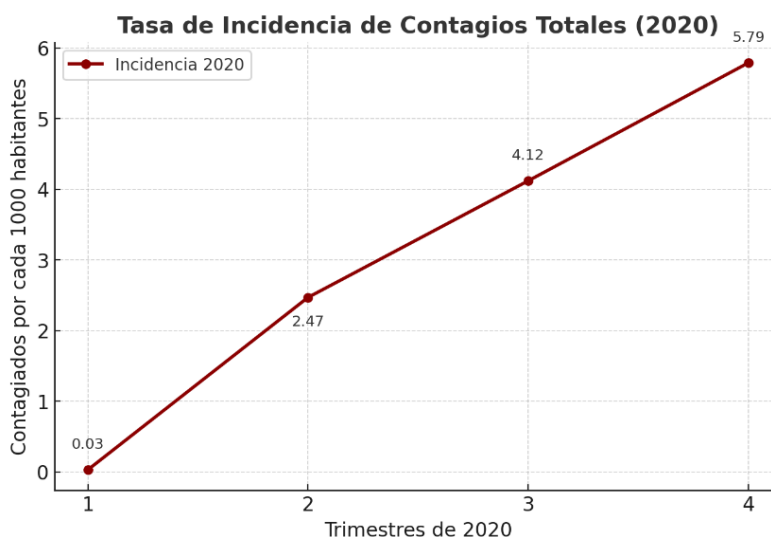
2022) . In Mexico, the National Institute of Statistics and Geography (INEGI) estimated that 93% of the country's businesses experienced at least one type of impact due to the COVID-19 health crisis, with at least 91.3% of businesses reporting a significant decrease in revenue. Although most companies prioritized avoiding layoffs over reducing salaries and/or benefits (with national percentages of 19.1% and 15.4%, respectively), in many cases, employee retention became unsustainable, as revenues decreased while salary and benefit payments remained constant (INEGI, 2020a) . Despite all efforts to contain the pandemic's impact on employment, indicators show that approximately 130,593 jobs were lost between February and March 2020 (Chiatchoua, Lozano, & Macías-Durán, 2020) . The job losses resulted in a severe supply shock due to workplace closures and a reduction in the workforce, which simultaneously triggered a demand shock stemming from the decline in income (Mejía Reyes et al., 2022) . Therefore, including the employment variable in an equation that explains the impact of COVID-19 during the pandemic is relevant to having a more complete picture of the economic effects of the health crisis.

Descriptive Analysis of the COVID-19 Variable

In Mexico, the first case of COVID-19 was detected on February 27, 2020 (Suárez, Suarez Quezada, Oros Ruiz, & Ronquillo De Jesús, 2020) . By March 8, 2020, a total of seven cases had been registered nationwide, prompting the General Directorate of Health Promotion to announce measures to prevent the spread of the virus (General Directorate of Health, 2020a) . Some of the immediate measures implemented to prevent the spread of COVID-19 included social distancing, quarantine, and the suspension of various activities and establishments, such as museums, gyms, schools, and other services deemed non-essential. (Government of Mexico, 2020) . However, after the first diagnosed case, the number of cases increased rapidly, following an exponential growth trend (Suárez et al., 2020) . In just the first month , cases had increased by 80%, officially reaching 3,181 cases with 174 deaths (General Directorate of Health, 2020b) . According to data collected in 2020, a total of 1,559,967 infections were registered in Mexico, distributed across all states of the Mexican Republic. The cumulative incidence rate of COVID-19 cases in Mexico varied depending on the quarter and year analyzed.

In Mexico throughout 2020 the incidence rate increased; at the beginning of this year the rate was 0.03 per thousand inhabitants and at the end of the same year it reached 5.79 (see Figure 1).

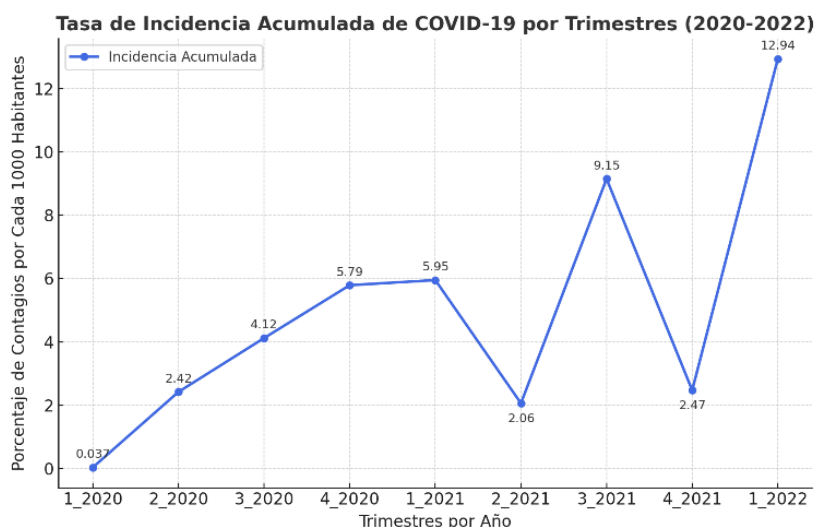
Figure 1 Incidence rate of COVID-19 cases by quarters 2020 .



Source: Own elaboration

The upward trend in the incidence rate continued until the first quarter of 2021. By the second quarter of that year, the rate had decreased from 5.95 to 2.06, and finally, by spring of 2022, the highest rate of the entire series was reached: 12.94 per thousand inhabitants (see Figure 2).

Figure 2 Incidence rate of COVID-19 cases by quarter 2020 – 2022

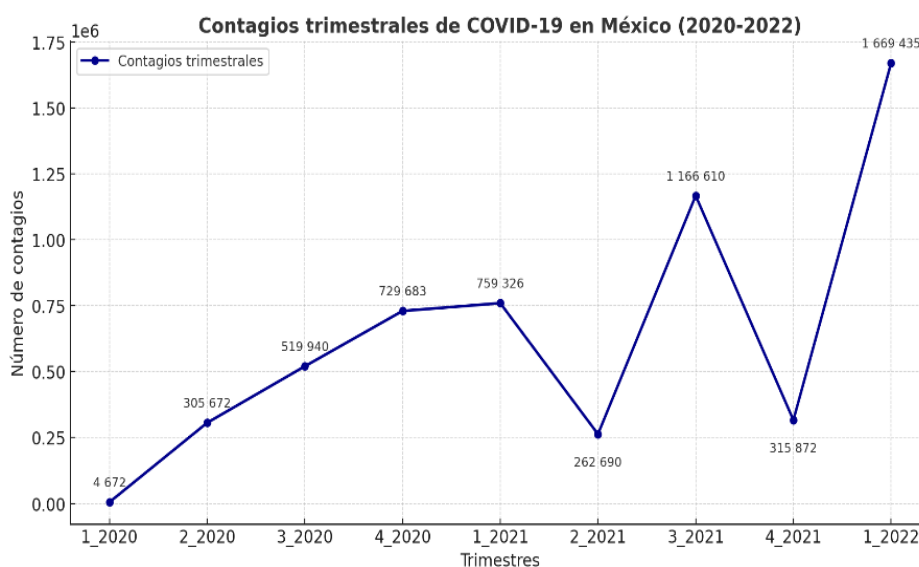


Source: Own elaboration

When analyzing the COVID-19 infections quarterly in absolute terms, we see that the series begins in the first quarter of 2020 with 4,672 infections; for the second quarter of that year, infections marked their first major increase to 305,672, in the third quarter the figure

rose to 519,940 and in the fourth quarter there were 729,683 infections. In 2021, the behavior was more variable. In the first quarter, 759,326 cases were registered (a higher figure than any quarter of 2020). For the second quarter, a fairly encouraging decrease was observed with 262,690 infections, but this did not last long as infections rebounded exponentially in the third quarter, reaching 1,166,610 infections (the highest period of 2021). Finally, in 2022, the strongest rebound of the entire series analyzed in this research occurred with 1,669,435 infections (see Figure 3).

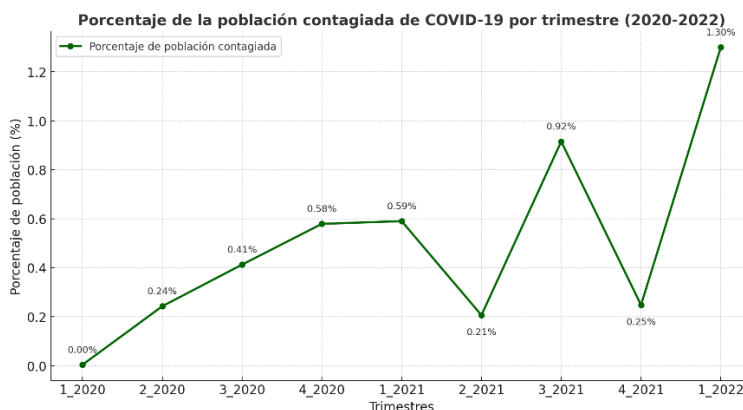
Figure 3. Absolute COVID-19 infections by quarters 2020 – 2022.



Source: Own elaboration

While the absolute figures are relevant, it is also important to analyze what these numbers meant in relation to Mexico's total population. In 2020, the percentage of the population infected rose from 0.0037% during the first quarter to 0.58% at the end of the year, a small proportion since it still did not reach one percent. However, near the end of 2021, the figure reached 0.92%, and in 2022 it finally climbed to 1.3% (see Figure 4).

Figure 4. Percentage of the population infected with COVID-19 by quarters 2020-2022.



Source: Own elaboration

The analysis of the behavior of infections showed a lot of variability without a clear trend, which raises the need to determine how this phenomenon affected the economy. Based on the literature, it is worth verifying whether ICTs and employment in Mexico continue to have a positive behavior in the pandemic years of 2020, 2021 and the first quarter of 2022 and whether these effects are the same in the states with lower incomes.

Methodology

Data collection and variables

The methodology was exploratory and quantitative, based on the estimation of a model using balanced panel data. Thirty-two federal entities and a nine-quarter time series were used, resulting in a database of 288 observations.

The data were obtained from three official public sources: INEGI, the Federal Telecommunications Institute (IFT), and the General Directorate of Epidemiology. The databases consulted were: 1) Employed Population (people over fifteen years of age with formal and informal employment), 2) Quarterly Indicator of State Economic Activity, 3) Total fixed broadband service accesses by technology (coaxial cable and fiber optic), and 4) COVID-19 infections in Mexico (daily at the state level). The data were compiled for the 2020–2022 period and disaggregated at the state level.

Table I details the variables used, their type, their description, and their construction for the model.

Table 1. Variables used

Variable name	Variable type	Description of the variable	Unit	Construction for the study
Total economic activity of the states	Endogenous	Quarterly economic activity indicator 2020 to first quarter 2022.	Thousands of pesos	
Information and communication technologies	Exogenous	Quarterly broadband subscriptions 2020 to first quarter 2022.	Thousands of subscriptions	
Employment	Exogenous	Population over 15 years old with formal and informal employment from 2020 to the first quarter of 2022.	Thousands of people	
COVID-19	Exogenous	Total SARS-CoV-2 infections per quarter in Mexico from 2020 to the first quarter of 2022.	Thousands of infections	Lag of two periods (t-2)

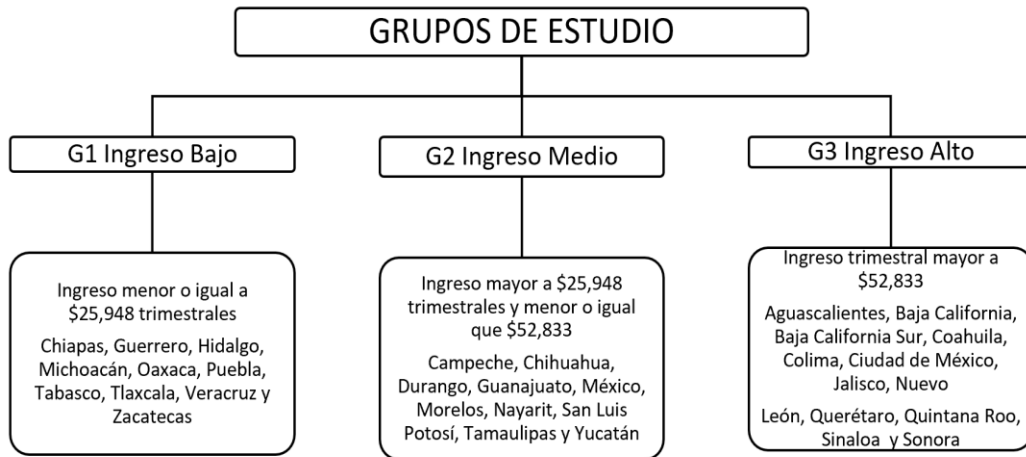
Source: Own elaboration

Data segmentation strategy

Following the collection and organization of data, three analysis groups were constructed based on segmentation by income decile, under the methodology of the document *Adoption of ICTs and Internet Uses in Mexico IFT, (2018)* . The inclusion criteria in the groups were as follows: Group G1: Mexican states with an income less than or equal to \$25,948 quarterly; Group G2: States with an income greater than \$25,948 and less than or equal to \$52,833 quarterly; and Group G3: States with a quarterly income greater than \$52,833 (Federal Telecommunications Institute [IFT], 2018) .

Figure 5 shows in detail the groups with the states belonging to each group, while Figure 6 presents the same information, but geographically.

Figure 5. Study Groups According to the IFT.



Source: Own elaboration

Figure 6. Map of state distribution according to income level



Source: Own elaboration

Data analysis

After data processing, a panel data model with fixed effects was estimated, allowing for the capture of variations in state economic activity both over time and between entities. To ensure the model's validity, the assumptions of linearity and absence of autocorrelation were verified, using robust standard errors to correct for heteroscedasticity. Furthermore, to determine the appropriateness of using fixed effects versus random effects, the Breusch-

Pagan and Hausman tests were performed using SAS 9.4 software ($p < 0.001$ and $p = 0.005$, respectively). These results confirmed the suitability of the fixed effects model. The proposed model does not consider time effects and is expressed as follows (see formula 1).

$$Y_{it} = \alpha_1 + \beta_1 TIC_{it} + \beta_2 Empleo_{it} + \beta_3 COVID - 19_{it-2} + u_{it} + \varepsilon_{it}(1)$$

Where

Y_{it} = Actividad Económica Trimestral del estado i en el tiempo t

TIC_{it} = Indicador TIC de estado i en el tiempo t

$Empleo_{it}$ = Población ocupada en el estado i en el tiempo t .

$Covid 19_{it}$ = Contagios de COVID 19 en el estado i , con un rezago de dos periodos

u_{it} = Efectos fijos no observados invariables en el tiempo

ε_{it} = Término de error

The model specification includes a two-period (t-2) lag for the COVID-19 infection variable. This lag is justified because the impact of health restrictions is not immediately reflected in the economic activity indicator (ITAE E), but rather appears with a time delay. The variables were integrated into the model at their original levels.

Results

The model estimation was performed using SAS 9.4 software through the PROC PANEL procedure. The estimated coefficients are presented in Table II.

Table 2. Estimation of Fixed Effects with COVID delayed by 2 periods

Fixed Effects Panel Procedure				
Cross Sections 32				
Time Series Length 9				
Variable	Coefficient	Standard error	T	p -value
Intercept	90.17759	3.4787	25.92	< 0.0001
TIC	0.005321	0.00193	2.76	0.0062
COVID-19 with a lag of two periods (t-2)	-0.07521	0.0135	-5.57	< 0.0001
Employment	0.014021	0.00427	3.29	0.0012
$R^2 = 0.7476$				
$F = 20.05$				

Source: Prepared by the author using SAS 9.4 output

The model showed a good fit ($R^2 = 0.7476$; $F = 20.05$) in explaining the behavior of economic activity variation between states and over time. At the national level, these results

confirm that ICTs and employment were key variables for sustaining the economy during the pandemic. The estimated coefficient for ICTs (0.005321; $p = 0.0062$) suggests that an increase in connectivity services is associated with a positive variation in state economic activity. This phenomenon was replicated for the employment variable, but with greater magnitude (0.014021; $p = 0.0012$), highlighting the importance of preserving jobs as a factor associated with the resilience of state economic activity during the pandemic.

In contrast, the COVID-19 variable, explained by the number of infections with a two-period lag, showed a negative and highly significant effect (-0.07521; $p < 0.001$). This suggests that the impact of the pandemic was not immediate, but rather manifested itself with a delay.

Once it was confirmed that these variables had a national impact, the analysis was segmented by the previously described groups. Independent models were estimated for each income group. The results are shown in Table III.

Table 3. Model estimates by income decile

Variables	High income	Average income	Low income	Mexico
Intercept	71.79978 *** (< 0.0001)	108.3074 *** (< 0.0001)	70.27481 *** (< 0.0001)	90.17759 *** (< 0.0001)
TIC	0.0094 ** (0.0080)	0.0050 (0.0863)	0.0101 * (0.0179)	0.0053 ** (0.0062)
COVID-19 two-period lag (t-2)	-0.0648 ** (0.0002)	-0.1575 ** (0.0028)	-0.1463 *** (< 0.0001)	-0.0752 *** (< 0.0001)
Employment	0.0204 * (0.0179)	0.0066 (0.2507)	0.0427 *** (0.0001)	0.0140 ** (0.0012)
R ²	0.52	0.85	0.68	0.74
F	6.85	43.92	16.66	20.05
Note: Asterisks indicate statistical significance based on tests under the following criteria: ***significant at the 1% level, **significant at the 5% level, and *significant at the 10% level				

Source: Prepared by the author using output from SAS 9.4 software

The results suggest that the negative association of COVID-19 (with a two-period lag) was not uniform across the analyzed groups. A higher magnitude in the coefficient (β) was observed in the lower-income states. = -0.1463, $p < 0.0001$) compared to the high income

group ($\beta = -0.0648$, $p = 0.0002$). This disparity suggests that although ICTs and employment were positively associated with economic performance at all income levels, sensitivity to the health crisis was greater in the most vulnerable states.

Discussions

The results suggest that ICTs and employment had a positive association with economic activity during the health crisis. These findings are consistent with existing literature that identifies ICTs as a fundamental driver of economic growth (Jiménez, Matus, & Martínez, 2014; Díaz Rodríguez, 2017). From the perspective of Solow's theory, ICTs act as a driving force that shifts the production function, directly impacting economic growth and maintaining their relevance even in a crisis context. In this sense, ICTs and employment not only boost growth in stable times but also play a significant role as a resilience mechanism, helping to mitigate the negative effects of the health crisis.

The employment findings are consistent with what the World Bank (2020) and other authors, such as Chiatchoua et al. (2020) and Mejía Reyes et al. (2022), have documented regarding the impact of the pandemic on the labor market. The positive association observed in the employment variable suggests the importance of job continuity during crises. In this sense, job stability is linked to a greater capacity to sustain economic activity during the analyzed period.

A key finding from the segmentation is the lack of statistical significance in the middle-income group. Unlike the extremes, the impact of COVID-19 was not significant in this segment, which, combined with a higher coefficient of determination ($R^2 = 0.85$), suggests that these entities have economic structures that absorbed the shock differently.

R^2 values between the groups reinforces the need for segmented analysis to understand the model's explanatory power. While the model explains 85% of the variance in the middle-income group and 62% in the low-income group, this value drops to 52% in the high-income group. This difference suggests that, in higher-income states, economic activity is more influenced by exogenous factors or variables not included in this analysis, whereas in middle- and low-income states, ICT and employment variables have a more direct explanatory impact.

Analysis of the COVID-19 variable with a two-period lag ($t-2$) revealed that the pandemic's impacts on the economy were not immediate, but rather manifested in subsequent quarters. This offers a window of opportunity for governments to prepare for the effects of future crises.

The most significant finding of this research was that inequality between groups was linked to the magnitude of the crisis's impact. Unlike the findings of Gagnon, Kamin, and Kearns (2023), who found a greater impact in advanced economies, this disaggregated analysis underscores the importance of segmentation to understand the reality of each group.

This result is consistent with research by the World Bank (2020) and ECLAC and the Development Bank of Latin America [CAF] (2020), organizations that emphasize how crises disproportionately affect the most vulnerable. In this context, segmentation proved to be an effective tool for identifying the differential effect that was otherwise unobservable in the aggregate model. This reinforces the recommendations of Alon et al. (2020) regarding the need for differentiated policies in developing economies.

The strengths of this research lie in its panel methodology and its disaggregated approach by state, which allowed for the identification of variations between groups that aggregated models do not show. However, it is important to acknowledge that the study has limitations, especially regarding the availability of official data, a factor that restricted the analysis to the period under consideration. While this limitation affects the continuation of the study, it also points to a future line of research to update the model as new quarterly data are published.

Conclusions

This study addresses the stated objectives and thus contributes to the literature analyzing the behavior of the economy in response to external factors. The results suggest that employment and ICTs were positively associated with economic activity during the health crisis in Mexico, allowing them to be identified as mitigating mechanisms. Furthermore, the analysis revealed that the COVID-19 variable with a two-period lag ($t-2$) showed a negative association with economic performance, indicating that the effects of the crisis were not immediately apparent but rather manifested themselves over time.

The central finding of this study is that income level is linked to the magnitude of the economic impact of the crisis. States with lower incomes experienced a stronger impact, while those with higher incomes experienced less severe impacts. This result provides a basis

for creating differentiated public policies for lower-income economies. This finding reinforces the idea of improving connectivity and employment conditions in less developed states, thereby increasing their resilience to crises.

In summary, this study suggests that Mexico's capacity to respond to the COVID-19 health crisis depended largely on access to ICTs and job preservation, but also that structural inequality disproportionately affected the least developed states. The evidence presented serves as a basis for designing differentiated policies that consider regional income gaps. It is crucial to promote public and private investment in digital infrastructure in lagging regions. Likewise, the creation of teleworking training programs should be encouraged. These measures would allow lower-income groups to better cope with future crises.

Future lines of research

A future line of research would focus on analyzing the estimated individual effects by state using the same sample from the study. This would allow for quantifying each state's capacity to respond to the crisis. By establishing a reference state for the estimation (for example, the largest or smallest state), and classifying states not only by their income decile but also by their actual performance, it would identify which low-income states performed better and which performed worse. This analysis provides a solid foundation for designing public policies with greater geographical precision. However, it is pertinent to replicate the analysis for the 2023-2024 period as soon as the information becomes available in order to determine whether the pandemic's aftereffects persist at the regional level.

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