Instituto Tecnológico Autónomo de México

TELEWORK IN MEXICO: ESTIMATING AN INDEX AND ITS ECONOMIC IMPACT

THESIS

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PRESENTS

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Telework in Mexico: Estimating an index and its economic impact

Abstract

This thesis investigates the construction and impact of teleworking capacities in Mexico, focusing on creating a telework share index and its economic implications. Using quarterly data from 2012 to 2024 and applying the updated classification system of SINCO 2019, I extend Leyva and Mora's (2021) methodology to construct a comprehensive telework index. This study estimates the key economic associations of telework capacity with labor productivity, GDP growth, labor poverty, and labor inequality. I find three main results. Firstly, significant state-level disparities exist in the telework share. Secondly, in the short run, a 1% increase in teleworking capacity can boost GDP growth by 0.5%, labor inequality by 0.1%, and hinder labor poverty by 0.3%. Lastly, in the medium term, the same increase can boost GDP growth by 0.6% and labor productivity by 0.7%. These findings underscore the share of telework as a potential driver of economic growth and transformation in the labor market while highlighting the need for targeted policy interventions to ensure that its benefits are evenly distributed across Mexico's diverse economic landscape.

Contents

Introduction

The COVID-19 pandemic dramatically accelerated the adoption of teleworking across the globe. For Mexico, a country where face-to-face interactions were traditionally the norm, the shift to telework or remote work posed a unique challenge and opportunity. The rapid technological adaptation and the realization of telework's potential for certain sectors raised significant questions about its lasting impact on economic outcomes. Understanding the variations in teleworking capacities across states and their broader implications on economic indicators such as productivity, inequality, and poverty has become an essential study area. This thesis is motivated by the need to quantify Mexico's teleworking capacity, and how it might shape its economic landscape in the post-pandemic world.

The central hypothesis of this research is that an increase in the share of teleworkable jobs will have a positive economic impact. Specifically, it is posited that teleworking capacity will drive GDP growth and enhance labor productivity while simultaneously reducing labor poverty and labor inequality. The hypothesis is further examined through econometric analysis that links the share of telework to key economic outcomes, drawing from state-level data on economic outputs. To do so, I build a comprehensive quarterly time series for teleworking on both national and state levels from Q3 2012 to Q2 2024. I begin by replicating the methodology used by Leyva and Mora (2021), where they calculated the potential share of telework using occupation classifications from the Mexican National Employment Survey (ENOE) and the SINCO 2011 occupational codes. This methodology allowed me to estimate telework capacities for 2019. Building on this, I updated the classification system with the most recent SINCO 2019 occupational codes, enabling me to calculate telework shares beyond Q2 2021 and track them quarterly. This approach provides a clearer understanding of the evolution of teleworking shares across different states.

My findings reveal notable disparities in teleworking capacities across states. Certain states, characterized by more urban and service-oriented economies, demonstrated higher telework potential, while others with more industrial or agricultural profiles showed lower capacity. The econometric analysis using panel regressions—drawing from the work of Aguilar, Frost, Guerra, Kamin, and Tombini (2024)—provides further insight. Specifically, panel regressions relate state-level economic activity (GDP growth), labor productivity (local currency per hour worked), labor inequality (Gini coefficient), and labor poverty to lagged levels of these variables, the share of telework, and various controls for endogeneity. I find that the share of telework capacity has a statistically significant positive association with GDP growth, labor productivity, and labor inequality, especially in the short and medium term (one and four quarters ahead). Likewise, teleworking has a statistically significant negative association with labor poverty, particularly in the short term (one quarter ahead), as shown in Table 1. These results suggest that teleworking can catalyze economic growth, though its impact on social outcomes, like labor inequality, remains complex and open to further investigation.

The literature on teleworking has garnered increasing attention, particularly during and after the COVID-19 pandemic. Dingel and Neiman (2020) provided a foundational study in this area, estimating that around 41.6% of jobs in the United States could be performed remotely, based on an analysis of tasks using the U.S. O*NET classification. However, as labor markets differ significantly between countries, their framework did not directly translate to economies with distinct occupational structures, such as Mexico. Leyva and Mora (2021) adapted the methodology to fit the Mexican context, where informality and labor market characteristics resulted in only 10.6% of jobs being teleworkable in 2019, substantially lower than in more developed economies. Their single-year indicator was built on the 2011 National Classification System of Occupations (SINCO), which categorizes jobs as teleworkable or non-teleworkable based on descriptions and tasks that can be performed using information and communication technologies (ICT). This binary classification was pivotal in developing Mexico's first telework capacity indicator, forming the methodological foundation for this thesis.

The COVID-19 pandemic accelerated the adoption of telework globally, prompting studies into its long-term viability. Barrero, Bloom, and Davis (2021) studied post-pandemic teleworking in the U.S. and found that remote work will remain a significant component of the labor market, with approximately 20% of full workdays expected to continue from home, compared to just 5% pre-pandemic. This shift was driven by positive WFH (work from

home) experiences, increased investments in home office infrastructure, and reduced stigma around remote work. However, these benefits were not evenly distributed, as low-income and less-educated workers had fewer opportunities for telework. Similarly, in Mexico, the rapid transition to telework exposed deep inequalities in ICT access, particularly in rural areas and among informal workers, as emphasized by Leyva and Mora (2021). They found that while teleworking benefited women in the formal sector, particularly in urban areas, those in informal and rural settings were left behind. Furthermore, Barrero et al.'s (2021) findings on the uneven distribution of telework benefits highlight the importance of analyzing the broader economic effects, such as productivity gains, which are explored through econometric analysis in this thesis. Our results align with Barrero et al.'s insights by showing that teleworking has a positive medium-term impact on GDP growth and productivity.

This thesis contributes to the growing literature on remote work or teleworking by providing the first comprehensive teleworking capacity index across Mexican states from 2012 to 2024. It also extends the literature by using updated SINCO 2019 classifications and applying robust econometric methods to assess the first empirical analysis of the economic implications of teleworking in Mexico. By exploring state-level variations, this work provides valuable insights for policymakers aiming to maximize the economic benefits of teleworking while mitigating its potential downsides.

The remainder of this thesis is structured as follows. Chapter 1 provides an in-depth discussion of the methodology used to construct the telework share index. Chapter 2 presents the dynamics of the telework share index at national and state levels. Chapter 3 explores the economic implications of telework capacity and presents an econometric specification along with the results, explaining the relationship between telework shares and various economic indicators. The final section concludes.

Table 1: Main findings of this work

- A 1% increase in the **telework share** is associated with a 0.465% increase in **GDP** growth rates over a one-quarter period.
- A 1% increase in the **telework share** is associated with a 0.637% increase in **GDP** growth rates over a one-year period.
- A 1% increase in the **telework share** is associated with a 0.717% increase in **labor productivity** growth rates over a one-year period.
- A 1% increase in the **telework share** is associated with a 0.105% increase in **labor inequality** growth rates over a one-quarter period.
- A 1% increase in the **telework share** is associated with a 0.341% reduction in **labor poverty** growth rates over a one-quarter period.

Note: The table presents only statistically significant results.

Chapter 1

Methodology

This thesis replicates and extends the methodology developed by Leyva and Mora (2021) to estimate the telework capacity for 2019 at a national level in Mexico. The central objective is to construct a quarterly time series of the share of jobs that can be performed remotely at both the national and state levels, thereby capturing teleworking potential across states. Leyva and Mora's approach assigns a binary classification to occupations based on their potential to be teleworked. In this chapter, I will describe the methodology used, explain how it was extended, and discuss the limitations of the analysis.

1.1 Telework Share Estimation

The estimation of telework capacity is based on the classification of occupations according to their telework potential. Following Leyva and Mora (2021), I use employment data from the Encuesta Nacional de Ocupación y Empleo (ENOE) and the Sistema Nacional de Clasificación de Ocupaciones (SINCO 2011) to calculate the share of telework jobs.

For each occupation (job) j in the dataset, a binary variable δ_j is created, where $\delta_j = 1$ if the occupation can be performed remotely and $\delta_j = 0$ otherwise. The share of teleworkable jobs τ is then calculated as a weighted sum of employment shares ω_j for each occupation:

$$\tau = \sum_{j=1}^{468} \delta_j \cdot \omega_j$$

where ω_j is the proportion of total employment in occupation (job) j, derived from ENOE data for 2019.

The ENOE 2019 data provides employment figures for 468 occupations at the 4-digit level. Leyva and Mora manually classified each occupation using job descriptions, focusing on tasks that could reasonably be performed remotely via information and communication technologies (ICT). Jobs that require physical presence or intensive manual labor were typically not classified as teleworkable, whereas occupations in information processing or communication were more likely to be considered teleworkable.

The classification takes into account factors such as:

1. Decision-making frequency: Jobs requiring frequent daily decisions are less suitable for telework than those involving more sporadic decisions.
2. Physical presence: Occupations requiring physical interaction with people or objects (e.g., healthcare, construction) are generally not classified as teleworkable.
3. ICT reliance: Jobs relying heavily on ICT are considered more likely to be performed remotely.

1.2 Modification and Extensions

To extend Leyva and Mora's methodology, I updated the binary classification system to incorporate the most recent SINCO 2019 classification. This update added 22 new occupational classifications, bringing the total to 490 occupations at the 4-digit level. The new classifications primarily involve more granular distinctions within previously aggregated occupations, forming residual groups. For instance, the 'Medical Specialists' category, which was a single classification in SINCO 2011, was subdivided into distinct roles such as Anesthesiologists, Surgeons, Gynecologists and Obstetricians, Intern Doctors (Resident Physicians), Pathologists, Pediatricians, Psychiatrists, and Radiologists.

This extension avoids discrepancies between Leyva and Mora's telework share calculations of 2019 and the updated series, as the sub-occupations in SINCO 2019 were assigned the same binary telework classification as their counterparts in SINCO 2011.

The motivation for updating the classification stems from the ENOE's transition from SINCO 2011 to SINCO 2019 in Q3 2021. To maintain consistency,

the telework share index is calculated separately for the SINCO 2011 period (Q3 2012 to Q2 2021) and the SINCO 2019 period (from Q3 2021 onward). It is crucial to point out that the ENOE began classifying occupations using the SINCO 2011 system in Q3 2012, which means the index can only be calculated starting from that quarter.

This update enabled the telework share index to be extended to the most recent data available. Using both binary classification systems, I constructed a quarterly time series for telework capacity spanning from 2012 to 2024 at both national and state levels.

It is important to notice that, to estimate the share of teleworkable jobs for Q2 2020, I used the average of the ENOE Q1 2020 and ENOE Q3 2020 data. This approach was chosen to mitigate potential statistical and methodological errors associated with the ETOE (Encuesta Telefónica de Ocupación y Empleo), which was implemented as a telephonic survey during Q2 2020. Reliance on the ETOE observations could lead to inaccuracies due to its limited sample of just over 75,000 responses, compared to an average of approximately 350,000 responses in the ENOE in all of the other quarters. By averaging Q1 and Q3 of 2020, this estimate maintains consistency with the ENOE methodology and enhances the reliability of the share of telework for Q2 2020.

The national share of teleworkable occupations was calculated as follows:

For every quarter from Q3 2012 to Q2 2021, a binary variable δ_j is created for each occupation (job) j, where $\delta_j = 1$ if the occupation can be performed remotely and $\delta_j = 0$ otherwise. The share of teleworkable jobs τ_t for quarter t is then calculated as:

$$\tau_t = \sum_{j=1}^{468} \delta_{j,t} \cdot \omega_{j,t}$$

where $\omega_{j,t}$ is the proportion of total employment in occupation (job) j in quarter t.

Similarly, for the period from Q3 2021 onward, a similar approach is followed with the SINCO 2019 classification system, which includes 490 occupations:

$$\tau_t = \sum_{j=1}^{490} \delta_{j,t} \cdot \omega_{j,t}$$

1.3 State-Level Telework Share Estimation

The methodology employed for constructing the telework share index not only allows for a national-level analysis but also provides the flexibility to explore the heterogeneity of telework capacity at the state level. As explored in Chapter 2, these disparities reveal significant variations in telework capacity across different states, highlighting Mexico's regional diverse economic conditions and telework potential.

Using ENOE data, I filtered the data by state, allowing the telework share index to be calculated at the state level. For every quarter from Q3 2012 to Q2 2021, the share of teleworkable jobs $\tau_{i,t}$ in state i is calculated as follows:

$$\tau_{i,t} = \sum_{j=1}^{468} \delta_{j,i,t} \cdot \omega_{j,i,t}$$

where $\omega_{j,i,t}$ is the proportion of total employment in occupation (job) j in state i and quarter t. Similarly, from Q3 2021 onward, the state-level telework share is calculated using the SINCO 2019 classification:

$$\tau_{i,t} = \sum_{j=1}^{490} \delta_{j,i,t} \cdot \omega_{j,i,t}$$

It is crucial to highlight that this analysis involved manipulating and analyzing more than 17 million observations from the ENOE, covering responses from 2012 to 2024, to construct both national and state-level indices, ensuring a comprehensive representation of telework capacity across Mexico.

1.4 Limitations of the Analysis

While this methodology provides a robust estimate of telework capacity, several limitations exist:

1. Subjectivity in classification: The binary classification of occupations is subjective and may not fully capture the nuances of each job. Leyva and Mora (2021) acknowledge this limitation, noting that job titles alone cannot fully determine telework potential, and job descriptions often leave room for interpretation.

Nonetheless, the SINCO 2019 provides a comprehensive revision of the 2011 version, aimed at improving the classification's accuracy and applicability across sectors. SINCO's 2019 update involved systematically reviewing each division, addressing ambiguities, and integrating clearer definitions for hard-to-classify occupations. Key changes include the introduction of previously unrecognized occupations, the addition of residual groups to enhance categorization flexibility, and adjustments to distinguish between overlapping unit groups.

The revision process was guided by data from the National Employment Survey (ENOE) and insights from expert users, particularly those involved in the Specialized Technical Committee on Labor and Social Welfare Statistics. The SINCO 2019 is a crucial tool for employment planning and decision-making across employment, education, occupational health, and in this case, economics research.

2. Lack of detailed occupational data: Unlike more detailed classifications, such as the O*NET used in the United States, the SINCO 2011 and SINCO 2019 classifications provide somewhat limited information on job characteristics beyond their title, a basic description, and a few practical examples, constraining their accuracy.

3. Regional disparities: The index may not fully account for regional differences in infrastructure, such as varying levels of ICT access across states. Although regional adjustments were made, these disparities likely affect telework capacity in ways not captured by the model.

The methodology outlined in this chapter provides a solid foundation for estimating telework capacity in Mexico. By replicating and extending Leyva and Mora's approach, this thesis creates a comprehensive time series of telework capacity across states and over time. However, the limitations discussed highlight the need for further research and more granular occupational data to improve the accuracy of telework estimates.

Chapter 2

Evolution of the share of teleworking in Mexico

This chapter analyzes the evolution of teleworking capacities in Mexico from both national and state perspectives. It is structured into two main parts: Dynamics at the national level telework and dynamics at the state level.

2.1 Dynamics at national level

The national share of telework in Mexico experienced significant fluctuations between Q3 2012 and Q2 2024, as illustrated in Figure 2.1. During this period, the proportion of total employment that could be performed remotely started at 11.94% and ended at 11.38%, reflecting both external shocks and the evolving nature of work in Mexico.

The sharp increase in teleworking share in 2020 could be directly related to the COVID-19 pandemic, which forced many businesses to shift to remote work. However, after a peak in mid-2020, in Q3 2020, the national teleworking share began to stabilize, fluctuating between 11.6% and 11.22% in the following four quarters. However, this national trend masks substantial variation at the state level. In the following section, we delve into the state-level analysis, where telework capacities differ widely across regions due to potential factors such as urbanization, economic structure, and digital infrastructure. The long-term sustainability of telework remains a key point of interest, particularly given the structural changes in the labor market.

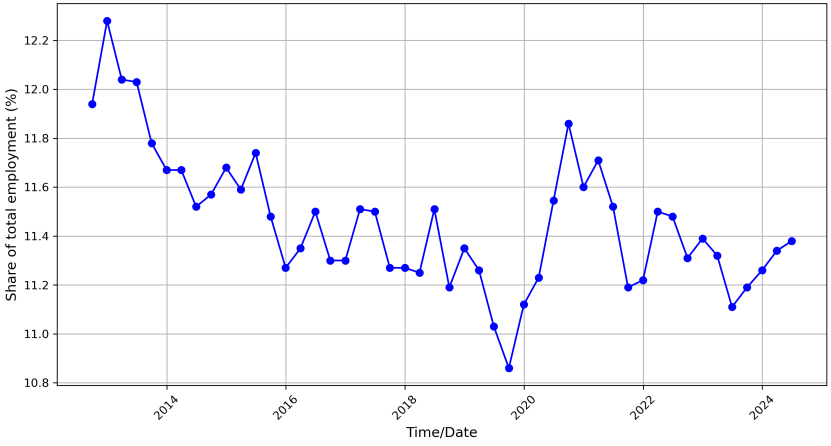

Figure 2.1: National teleworking share at quarterly frequency (Q3 2012 - Q2 2024). Own elaboration with data from the ENOE.

2.2 Dynamics at state level

The state-level analysis provides further insights into the disparities in telework capacities. Figure 2.2 ranks states by their average share of telework from the highest to the lowest, with the national average of 11.57% indicated by a dashed line. This comparison highlights the wide variability in teleworking capacities between states. Ciudad de México, unsurprisingly, leads the ranking with an average telework share significantly higher than the national average, driven by its large service-based economy and ICT penetration. On the other end of the spectrum, states like Guerrero and Tlaxcala exhibit much lower telework capacities, reflecting their more industrial and agricultural economic structures.

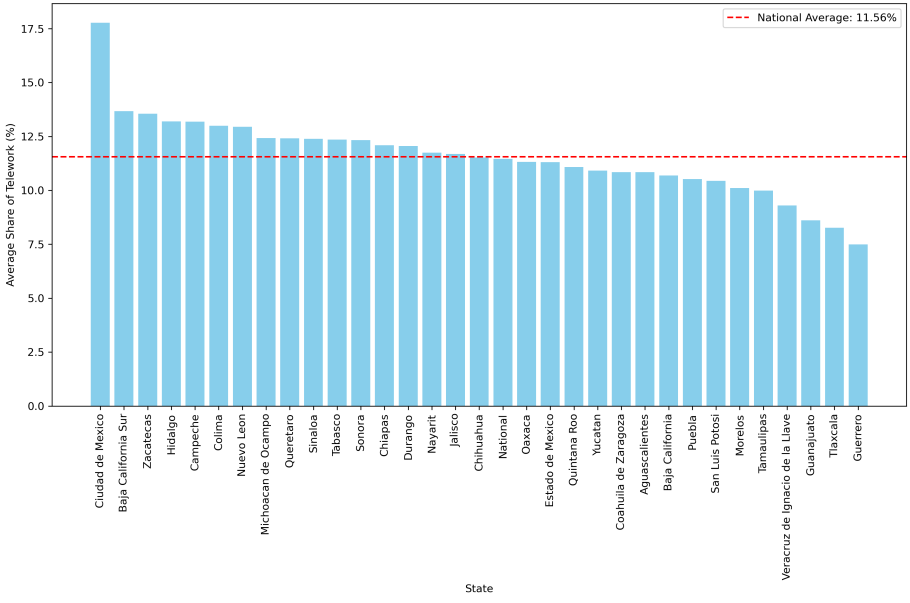

Figure 2.2: Average national teleworking share ranked from highest to lowest. Own elaboration with data from the ENOE.

As shown in Figure 2.2, there is significant variability in the teleworking share across states over time. While states like Ciudad de México consistently maintain higher telework shares, other states, particularly those with lower shares, show a more volatile trajectory.

To offer a clearer picture of these disparities, Figure 2.3 highlights the top three states (Ciudad de México, Nuevo León, and Colima) and the bottom three states (Guerrero, Tlaxcala, and Guanajuato) in terms of their telework shares. The national telework index is included for comparison, showing how these states deviate from national trends. The top three states demonstrate a more stable and higher share of telework, while the bottom three lag significantly behind the national average.

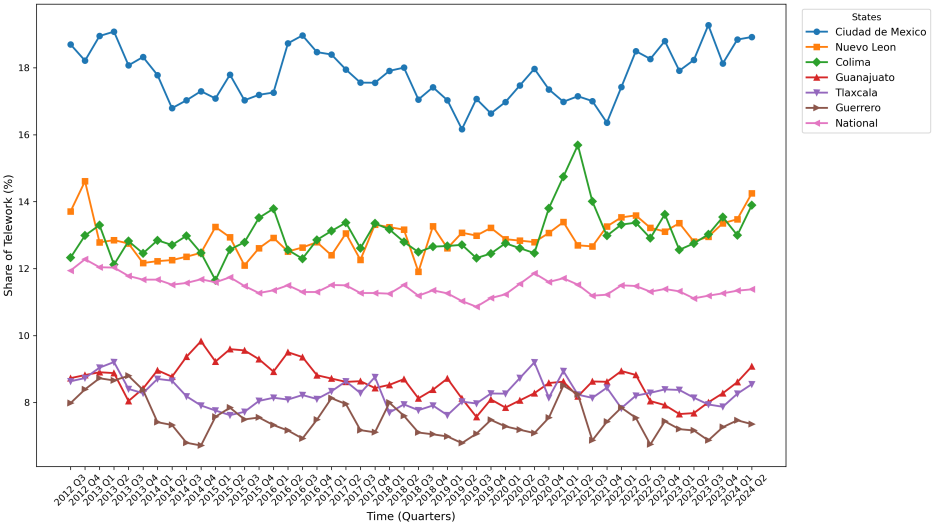

Figure 2.3: Top and bottom three states by share of telework capacity (including the national share). Own elaboration with data from the ENOE.

The Appendix, which shows individual graphs for each of the 32 states, provides further details on each state's specific teleworking trends.

The rise in teleworking is not uniform across states. Figure 2.4 identifies the top 10 states with the highest percentage increase in teleworking since Q4 2019, showcasing the regions that have adapted most significantly to teleworking. Ciudad de México, Durango and Estado de México stand out as the leaders, suggesting that certain states have capitalized more on the pandemic-driven shift to remote work.

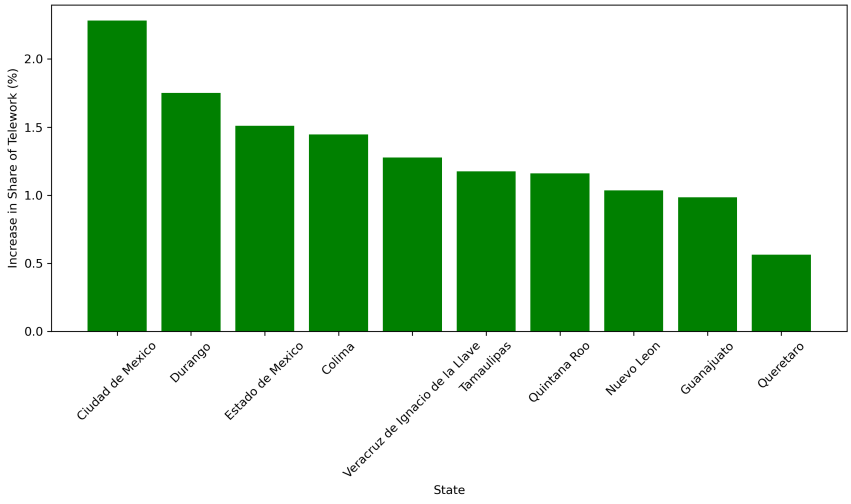

Figure 2.4: Top 10 states with the highest increase in telework share since Q4 2019. Own elaboration with data from the ENOE.

Figure 2.5 illustrates the relationship between the share of telework across Mexican states in Q2 2019 and Q2 2024. The scatter plot includes a red dashed 45-degree line. States above the line, such as Ciudad de México, Nuevo León, Querétaro, Jalisco, and others, show a larger-than-average increase in telework share between 2019 and 2024, while those below the line, including Zacatecas, Oaxaca, and Tlaxcala, exhibit smaller growth or even stagnation relative to the national trend.

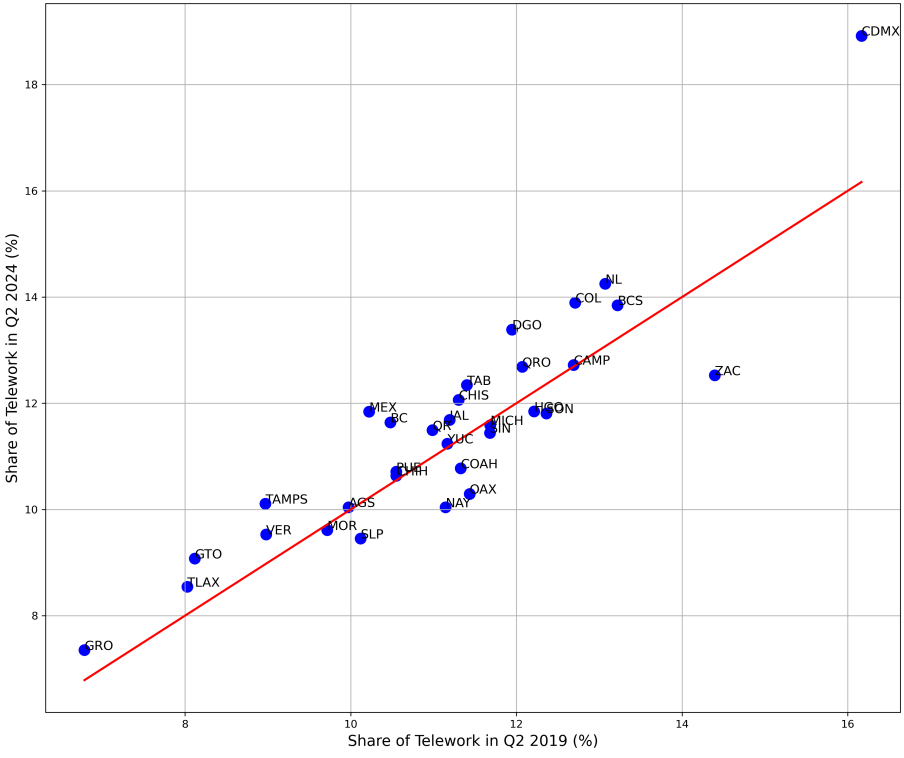

Figure 2.5: Q2 2019 vs Q2 2024 telework share by state scatter plot. Own elaboration with data from the ENOE.

Notably, Ciudad de México stands out with the highest telework share in both periods, indicating a consistently strong capacity for remote work, likely driven by its highly urbanized environment and concentration of sectors conducive to teleworking, such as professional services and IT. In contrast, states with more rural or industrial economies, such as Guerrero, exhibit significantly lower telework shares, reflecting the economic structure and limited availability of jobs that can be performed remotely.

This comparative analysis underscores the persistent regional disparities in telework capacity evolution across Mexico. States with higher initial telework shares in 2019 tended to experience greater increases by 2024, suggesting that pre-existing infrastructure and economic conditions play a crucial role in shaping telework capacity over time. These findings have important implications

for understanding the uneven distribution of telework opportunities and highlight the need for policies aimed at reducing regional inequalities in teleworking potential.

These disparities are explored further in Chapter 3, where I examine how telework capacity correlates with key economic indicators such as GDP growth, labor inequality, and labor productivity.

Chapter 3

Economic Implications of the Share of Telework

3.1 Data and simple correlations

This subsection explores the relationships between the average telework share and several key economic indicators, explaining potential economic drivers or implications and providing visual insights into how teleworking capacities might influence broader economic outcomes.

At the outset of this subsection, it is important to acknowledge that the quarterly state-level series for all the economic indicators used in this thesis were generously provided by *México, ¿Cómo Vamos? (MCV)*, enabling a comprehensive analysis.

MCV provides valuable state-level economic indicators to monitor the performance of States around Mexico. MCV's methodology involves collecting data from reliable sources, such as INEGI, CONEVAL, and Banco de México, and applying rigorous statistical techniques to construct indicators that reflect various aspects of economic performance, including labor conditions, poverty, and productivity. MCV offers quarterly state-level data that is crucial for this study. The economic indicators from MCV are described below and were used to assess the economic correlations with telework capacities in Mexico.

Table 3.1: Variable Description

Variable	**Description**
GDP Growth Rate (%)	Economic growth rate, measured as the change relative to the immediate previous quarter. Source: *México, ¿Cómo Vamos? (MCV)*
Labor Poverty (%)	Percentage of the population that cannot acquire the basic food basket with the labor income of their household. Source: *México, ¿Cómo Vamos? (MCV)*
Labor Informality (%)	Percentage of the non-agricultural employed population in informal employment. Source: *México, ¿Cómo Vamos? (MCV)*
Labor Inequality (Gini Coefficient)	Gini coefficient of labor income, where 1 is perfect inequality and 0 is perfect equality. Source: *México, ¿Cómo Vamos? (MCV)*
Labor Productivity (Mexican pesos per hour worked)	Amount of local currency (LC), in Mexican pesos, produced per hour worked. Source: *México, ¿Cómo Vamos? (MCV)*

Scatter plots have been used to examine these relationships, which are summarized below.

GDP Growth Rate (%): As shown in Figure 3.1, the correlation between the average telework share and the GDP growth rate is weak and slightly negative. This suggests that teleworking capacities do not have a strong direct relationship with economic growth, at least regarding the states' GDP growth rates. Interestingly, outliers such as Campeche and Zacatecas exhibit higher telework shares but lower GDP growth rates, while states like Guanajuato show moderate telework capacities but slightly above-average growth. This result underscores the complexity of the relationship between telework and broader economic outcomes. It indicates that teleworking may not be a dominant factor influencing GDP growth in the Mexican context. Other structural factors, such as industrial composition and investment patterns, likely play a more significant role in shaping economic growth trajectories across states. As noted by Leyva (2021), the integration of telework into certain industries has been slower in Mexico due to the nature of the labor market and the pre-existing economic structure, limiting its influence on GDP growth (Leyva, 2021).

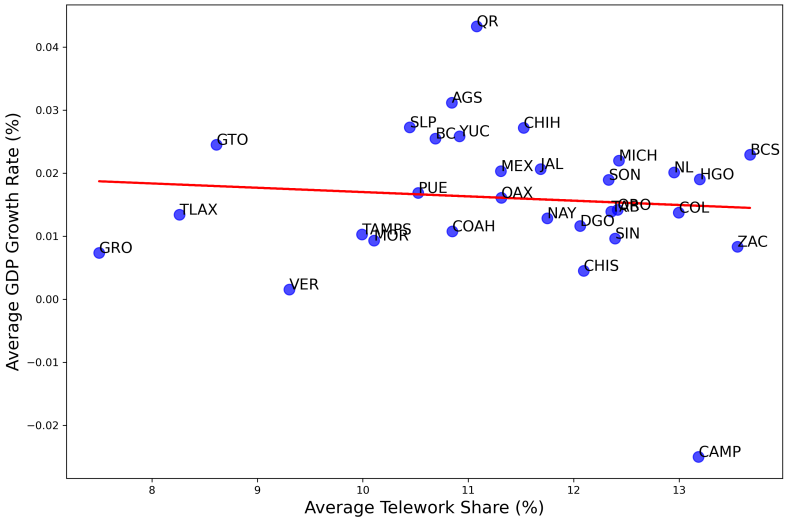

Figure 3.1: Average telework share versus average GDP growth rate (%). Own elaboration with data from MCV and the ENOE (2012-2024).

Labor Poverty: The negative correlation between telework share and labor poverty is more pronounced in Figure 3.2. States with higher telework capacities tend to have lower levels of labor poverty, indicating that telework might play a role in reducing poverty, particularly in urbanized regions with strong ICT infrastructures. This finding is consistent with Barrero, Bloom, and Davis (2021), who observe that teleworking can improve access to better-paying, formal employment opportunities, especially in high-productivity sectors and urbanized states like Nuevo León. (Barrero et al., 2021).

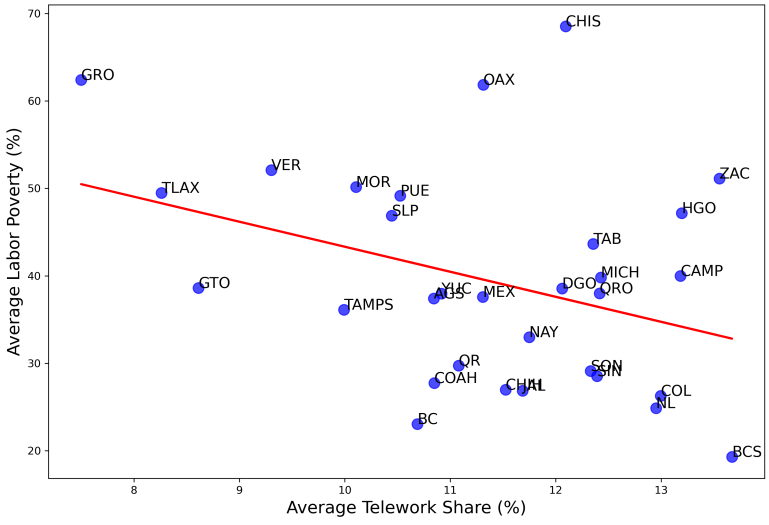

Figure 3.2: Average telework share versus average labor poverty. Own elaboration with data from MCV and the ENOE (2012-2024).

Labor Informality: Figure 3.3 reveals a negative correlation between telework share and labor informality. States with higher telework shares tend to exhibit lower levels of labor informality. This suggests that teleworking might be contributing to a formalization of the workforce, particularly in more urbanized areas where remote work is more feasible. This result echoes the findings of Leyva and Mora (2021), who highlight that access to information and communication technologies (ICT) is crucial in reducing labor informality. Their study emphasizes that teleworking can foster formal employment in states with robust digital infrastructure (Leyva and Mora, 2021)

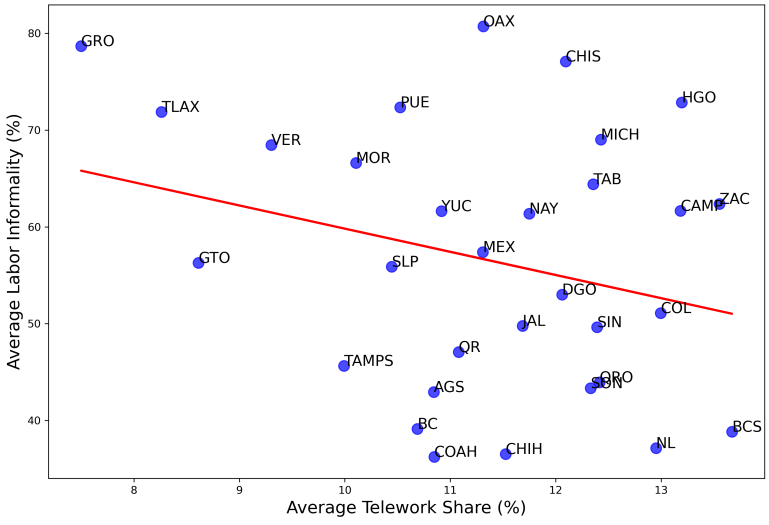

Figure 3.3: Average telework share versus average labor informality. Own elaboration with data from MCV and the ENOE (2012-2024).

Labor Inequality: As depicted in Figure 3.4, a slight positive correlation exists between the average telework share and labor inequality, though the relationship is weak. States with higher telework capacities, such as Baja California Sur and Zacatecas, tend to have higher labor inequality, suggesting that, while teleworking has expanded, it may not necessarily be reducing inequality in certain regions, possibly reflecting disparities in access to telework opportunities among different socioeconomic groups. This observation slightly aligns with the findings of Barrero, Bloom, and Davis (2021), who suggest that the benefits of teleworking are often concentrated among higher-income workers, further widening the inequality gap as lower-income groups face barriers to accessing remote work opportunities (Barrero et al., 2021)

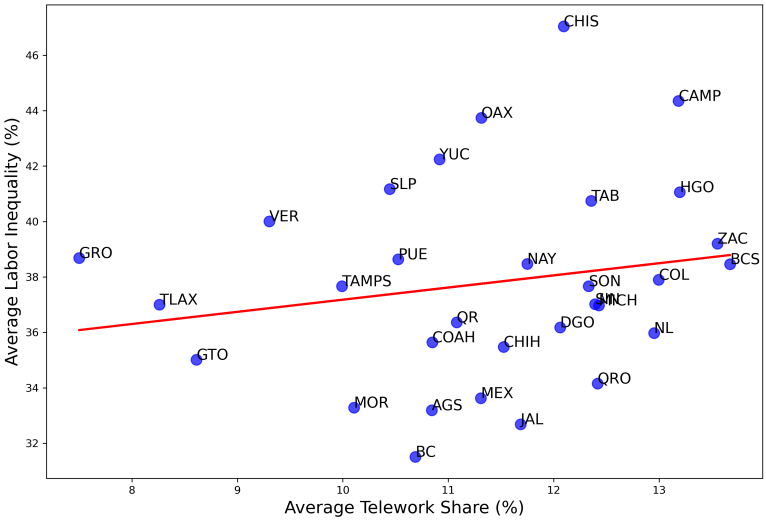

Figure 3.4: Average telework share versus average labor inequality. Own elaboration with data from MCV and the ENOE (2012-2024).

Labor Productivity: Figure 3.5 shows a positive relationship between telework share and labor productivity. States with higher telework shares, such as Campeche, exhibit significantly higher productivity levels, further supporting the notion that telework can drive economic efficiency. This relationship highlights the potential of teleworking to enhance economic efficiency and labor outcomes, especially in sectors conducive to remote work. As Barrero et al. (2021) point out, the flexibility of teleworking arrangements can contribute to productivity gains by allowing workers to optimize their schedules and reduce commuting times, factors that are particularly relevant in more developed or urbanized states (Barrero et al., 2021)

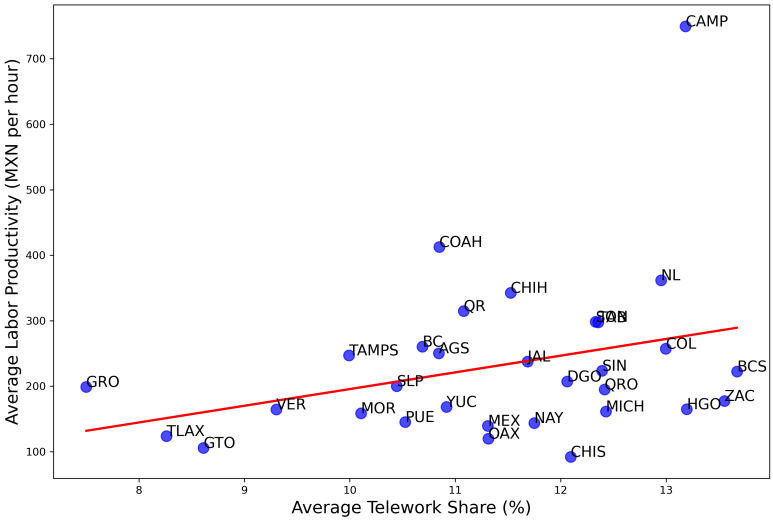

Figure 3.5: Average telework share versus average labor productivity. Own elaboration with data from MCV and the ENOE (2012-2024).

These correlations shed light on how telework capacity might influence various economic indicators, providing a nuanced understanding of how teleworking can shape Mexico's labor market and broader economic development. Moreover, they align with previous literature, such as the studies by Barrero et al., Leyva and Mora, and Dingel and Neiman), suggesting that teleworking can positively affect labor inequality and productivity and negatively affect labor poverty and informality. However, the impact on GDP growth is mixed, with differences among different regions and some short-term benefits but more complex long-term dynamics that require further investigation.

3.2 Identification Strategy

This analysis draws from the methodology in Aguilar, Frost, Guerra, Kamin, and Tombini (2024) to reduce endogeneity issues. They examined, the use of digital payments on economic growth, productivity, and informality through an endogeneity-controlled panel regression framework. By applying a fixed-effects

model, we aim to address the unique characteristics of our dataset, allowing for the precise estimation of telework's economic impacts across Mexican states. The fixed-effects specification accounts for state-level heterogeneity and isolates stable, state-specific factors (e.g., structural economic characteristics or telework culture) that might influence telework adoption, while time-fixed effects control for national trends that could affect all states (such as economic cycles or policy shifts).

Endogeneity concerns are addressed by using lagged levels of explanatory variables, as in Aguilar et al. (2024), which helps minimize potential reverse causality and confounding influences. The model assumes that lagged levels of telework adoption affect future growth rates of economic outcomes, such as labor productivity, GDP growth, and labor inequality.

The model is built on the following key assumptions:

1. Time-invariance of unobserved characteristics: The fixed-effects model assumes that unobserved factors influencing telework adoption remain constant over time within each state, allowing these to be differenced out to focus on within-state temporal variations.

2. Lagged levels for causality: Following Aguilar, Frost, Guerra, Kamin, and Tombini (2024), we assume that lagged levels of telework adoption capture causal relationships with future growth rates of economic outcomes by separating past telework levels from current economic fluctuations.

3.3 Econometric Specification

To assess the economic implications of the share of teleworking in Mexico, we estimate a series of panel regressions using quarterly state-level data. This specification follows closely the approach taken by Aguilar, Frost, Guerra, Kamin, and Tombini (2024). The baseline equation is structured as follows:

$$\Delta y_{i,t:t+h} = \alpha_i + \beta_1 y_{i,t} + \beta_2 \text{Teleworking}_{i,t} + \beta_3 \text{DevelopmentControls}_{i,t} + \gamma_t + \epsilon_{i,t}$$

Where:

- $\Delta y_{i,t:t+h}$ represents the change in the dependent variable (e.g., GDP growth, productivity, labor inequality, or labor poverty) from period t to $t+h$ for state i.

- $y_{i,t}$ is the level of the dependent variable in state i and time t.
- $\text{Teleworking}_{i,t}$ is the share of teleworkable jobs in state i and time t, constructed based on the methodology by Leyva and Mora (2021).
- $\text{DevelopmentControls}_{i,t}$ is a vector of economic controls related to each state's level of development.
- α_i and γ_t are state and time fixed effects, respectively.
- $\epsilon_{i,t}$ is the error term.

This specification allows us to isolate the effect of telework share on various economic outcomes while controlling for state-specific and time-specific factors. The inclusion of state fixed effects (α_i) captures any unobservable factors that are unique to a particular state, such as long-standing infrastructure or regional policies, while the time fixed effects (γ_t) account for macroeconomic shocks that could affect all states in a given quarter.

Additionally, clustered standard errors are used in the estimation to account for heteroscedasticity and ensure the validity of statistical inference. This approach is well-suited to our data, which spans multiple quarters and exhibits significant variation across both time and space.

3.4 Empirical results

The key findings from the econometric analysis are as follows:

3.4.1 GDP Growth

The share of telework has a positive and statistically significant effect on GDP growth in the short and medium term (one and four quarters ahead). Specifically, the results show that a 1% increase in telework share is associated with a 0.465% increase in GDP growth one quarter ahead and a 0.637% increase four quarters ahead (see Table 3.2, columns 3 and 6). These findings suggest that telework can have an immediate and a delayed but substantial positive impact on economic growth, possibly reflecting the time it takes for digital transformations and remote work setups to influence broader economic performance.

Dependent Variable:	GDP growth rate windows (%)					
	(1) 1q ahead	(2) 1q ahead	(3) 1q ahead	(4) 4q ahead	(5) 4q ahead	(6) 4q ahead
Share of teleworking$_{i,t}$ (%)	0.139***	0.228	0.465**	0.325**	1.028***	0.637**
	(0.0524)	(0.159)	(0.182)	(0.143)	(0.344)	(0.273)
GDP$_{i,t}$ (index)	-0.144***	-0.220***	-0.356***	-0.348***	-0.459***	-0.499***
	(0.0384)	(0.0509)	(0.0754)	(0.0756)	(0.0947)	(0.0960)
Labor poverty$_{i,t}$ (%)	0.0611***	0.128***	0.0919	0.0905**	0.140	-0.0157
	(0.0164)	(0.0445)	(0.0581)	(0.0392)	(0.106)	(0.0944)
Informality$_{i,t}$ (%)	-0.0139	-0.331***	-0.327***	-0.0320	-0.542***	-0.245**
	(0.0135)	(0.0448)	(0.0579)	(0.0284)	(0.119)	(0.111)
Inequality$_{i,t}$ (index)	-0.0724**	-0.178*	0.0209	-0.104	-0.149	0.194
	(0.0360)	(0.101)	(0.0985)	(0.0717)	(0.176)	(0.150)
Productivity$_{i,t}$ (logarithm)	0.00517*	0.0427	0.180***	0.00147	-0.0338	0.100*
	(0.00265)	(0.0305)	(0.0499)	(0.00700)	(0.0561)	(0.0556)
Constant	11.14**	16.67	-56.79**	32.63***	82.60*	-8.719
	(4.536)	(19.34)	(25.89)	(9.403)	(40.60)	(37.25)
State fixed effects		Y	Y		Y	Y
Quarter fixed effects			Y			Y
Year fixed effects			Y			Y
Observations	1,472	1,472	1,472	1,376	1,376	1,376
R-squared		0.131	0.256		0.260	0.472
Number of states	32	32	32	32	32	32

Clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3.2: GDP Growth Rate (%) - Panel Regression Results

3.4.2 Productivity

Teleworking has a significant positive effect on labor productivity, particularly over longer time horizons. After four quarters, a 1% increase in telework share is associated with a 0.717% increase in productivity (see Table 3.3, columns 3 and 6). These results align with the literature on remote work improving flexibility and efficiency, as outlined by Barrero et al. (2021), who found similar productivity gains in the U.S. post-pandemic period.

Dependent Variable:	Productivity growth rate windows (%)					
	(1) 1q ahead	(2) 1q ahead	(3) 1q ahead	(4) 4q ahead	(5) 4q ahead	(6) 4q ahead
Share of teleworking$_{i,t}$ (%)	-0.0467	0.210	0.0776	-0.122	0.805*	0.717**
	(0.0482)	(0.182)	(0.216)	(0.141)	(0.423)	(0.334)
GDP$_{i,t}$ (index)	-0.0243**	0.0162	0.0540	0.0509**	0.224***	0.204**
	(0.0117)	(0.0393)	(0.0587)	(0.0238)	(0.0670)	(0.0909)
Labour poverty$_{i,t}$ (%)	-0.0577***	-0.166***	-0.159***	-0.156***	-0.282***	-0.124
	(0.0140)	(0.0417)	(0.0498)	(0.0465)	(0.0974)	(0.0952)
Informality$_{i,t}$ (%)	0.0233**	0.290***	0.127	0.0207	0.583***	-0.0856
	(0.0112)	(0.0908)	(0.108)	(0.0333)	(0.150)	(0.139)
Inequality$_{i,t}$ (index)	0.0457*	0.174**	0.0342	0.153**	0.550***	0.0273
	(0.0266)	(0.0834)	(0.0906)	(0.0752)	(0.151)	(0.158)
Productivity$_{i,t}$	-0.00982***	-0.213***	-0.301***	-0.0369***	-0.514***	-0.624***
	(0.00219)	(0.0387)	(0.0492)	(0.00780)	(0.0702)	(0.0883)
Constant	7.236***	93.06***	154.4***	14.92***	200.3***	315.6***
	(1.737)	(23.73)	(27.35)	(4.336)	(37.55)	(44.83)
State fixed effects		Y	Y		Y	Y
Quarter fixed effects			Y			Y
Year fixed effects			Y			Y
Observations	1,472	1,472	1,472	1,376	1,376	1,376
R-squared		0.127	0.245		0.313	0.488
Number of states	32	32	32	32	32	32

Clustered standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 3.3: Productivity (LC units x hour) - Panel Regression Results

3.4.3 Inequality

The relationship between telework and labor inequality is weaker but still of interest. The model shows a slight negative effect of telework on labor inequality one quarter ahead, with this effect diminishing over time. The positive sign, albeit weak, suggests that after one quarter, a 1% increase in telework share is associated with a 0.105% increase in inequality (see Table 3.4, columns 3 and 6). Suggesting that remote work opportunities might be skewed toward higher-income workers, as discussed by Barrero et al. (2021), who highlighted how the benefits of remote work tend to favor more educated and higher-income workers.

Dependent Variable:	Inequality growth rate windows (%)					
	(1) 1q ahead	(2) 1q ahead	(3) 1q ahead	(4) 4q ahead	(5) 4q ahead	(6) 4q ahead
Share of teleworking$_{i,t}$ (%)	0.106***	0.220***	0.105*	0.148***	0.176**	0.0304
	(0.0230)	(0.0501)	(0.0536)	(0.0441)	(0.0676)	(0.0749)
GDP$_{i,t}$ (index)	-0.00326	-0.0240***	0.00278	0.0102	-0.0210**	0.0117
	(0.00328)	(0.00748)	(0.00847)	(0.00776)	(0.0101)	(0.0114)
Labour poverty$_{i,t}$ (%)	0.0154*	0.0148	0.0466**	0.0230	0.0110	0.0477
	(0.00825)	(0.0166)	(0.0179)	(0.0143)	(0.0303)	(0.0299)
Informality$_{i,t}$ (%)	0.0152**	0.107***	0.0161	0.0201**	0.157***	0.0306
	(0.00708)	(0.0266)	(0.0279)	(0.0102)	(0.0338)	(0.0515)
Inequality$_{i,t}$ (index)	-0.115***	-0.355***	-0.466***	-0.181***	-0.526***	-0.693***
	(0.0201)	(0.0277)	(0.0415)	(0.0337)	(0.0385)	(0.0417)
Productivity$_{i,t}$	0.00289**	0.0270***	-0.00299	0.00357**	0.0428***	-0.00163
	(0.00120)	(0.00616)	(0.00955)	(0.00180)	(0.0120)	(0.0169)
Constant	0.315	-7.906**	16.40***	-0.192	-12.56**	23.56**
	(0.644)	(2.895)	(5.543)	(0.932)	(5.719)	(10.41)
State fixed effects		Y	Y		Y	Y
Quarter fixed effects			Y			Y
Year fixed effects			Y			Y
Observations	1,504	1,504	1,504	1,408	1,408	1,408
R-squared		0.174	0.243		0.266	0.353
Number of states	32	32	32	32	32	32

Clustered standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 3.4: Inequality (index) - Panel Regression Results

3.4.4 Poverty

Interestingly, the share of telework is negatively correlated with labor poverty, particularly in the short term. The results show a 1% increase in telework share is associated with a 0.341% reduction in labor poverty one quarter ahead, with the effect diminishing over time (see Table 3.5, columns 3 and 6). This result suggests that teleworking might offer immediate poverty-reduction benefits by enabling access to better-paying jobs or formal employment, especially in urban areas with better digital infrastructure, as highlighted by Dingel and Neiman (2020).

Dependent Variable:	Labour Poverty growth rate windows (%)					
	(1) 1q ahead	(2) 1q ahead	(3) 1q ahead	(4) 4q ahead	(5) 4q ahead	(6) 4q ahead
Share of teleworking$_{i,t}$ (%)	-0.0609	-0.271**	-0.341***	-0.122	-0.322	-0.199
	(0.0394)	(0.116)	(0.117)	(0.0803)	(0.205)	(0.181)
GDP$_{i,t}$ (index)	-0.0206***	-0.110***	-0.0624***	0.0386*	-0.0644**	-0.0397*
	(0.00723)	(0.0154)	(0.0139)	(0.0202)	(0.0244)	(0.0234)
Labour poverty$_{i,t}$ (%)	-0.0814***	-0.434***	-0.448***	-0.157***	-0.740***	-0.693***
	(0.0151)	(0.0369)	(0.0357)	(0.0338)	(0.0521)	(0.0495)
Informality$_{i,t}$ (%)	0.0633***	0.179***	0.235***	0.101***	0.340***	0.197**
	(0.0151)	(0.0539)	(0.0535)	(0.0290)	(0.0670)	(0.0722)
Inequality$_{i,t}$ (index)	0.0230	-0.0130	-0.000909	0.0744	0.146*	-0.0447
	(0.0326)	(0.0498)	(0.0551)	(0.0601)	(0.0772)	(0.0685)
Productivity$_{i,t}$	0.000241	0.0506***	0.00192	-0.00385	0.0362*	-0.0182
	(0.00256)	(0.0153)	(0.0166)	(0.00429)	(0.0212)	(0.0281)
Constant	1.212	-5.805	13.49	-2.947	-5.319	33.50**
	(0.990)	(8.594)	(9.370)	(2.482)	(12.07)	(14.59)
State fixed effects		Y	Y		Y	Y
Quarter fixed effects			Y			Y
Year fixed effects			Y			Y
Observations	1,504	1,504	1,504	1,408	1,408	1,408
R-squared		0.235	0.311		0.340	0.452
Number of states	32	32	32	32	32	32

Clustered standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 3.5: Labour Poverty (%) - Panel Regression Results

The econometric analysis supports the hypothesis that telework has a positive impact on GDP growth and labor productivity. As expected, higher telework capacities mean stronger economic performance. However, the relationship between telework and labor inequality, and labor poverty is less significant and more complex. While some states with high telework shares exhibit lower labor poverty, as shown in Figure 3.2, the econometric result appears less significant than expected. Similarly, the correlation and econometric results between telework and labor inequality seem even less substantial.

Main Remarks and Conclusions

At the outset of this research, it was hypothesized that teleworking capacities—measured by the share of jobs that can be performed remotely—would have a significant positive impact on economic outcomes. Specifically, the hypothesis posited that telework would drive GDP growth and enhance labor productivity, while also reducing labor poverty and labor inequality. To test this hypothesis, an econometric analysis was conducted using panel data at the state level, which captured variations in teleworking capacities across Mexico's regions from 2012 to 2024. Based on the panel regression model, the empirical strategy allowed for identifying the relationships between telework share and key economic indicators, controlling for regional heterogeneity.

The results provide robust evidence supporting part of the initial hypothesis. The findings reveal a statistically significant positive impact of teleworking capacity on GDP growth, labor productivity, and labor poverty. States with higher shares of teleworkable jobs demonstrated stronger economic growth and higher productivity levels. This outcome suggests that telework is an important driver of economic efficiency, potentially enabling workers to contribute more effectively to economic activity while reducing the constraints of traditional in-office employment.

On the social front, the findings were more nuanced. Telework appears to have a short-term positive impact on labor poverty, with higher telework shares correlating with reductions in poverty levels. However, this effect diminishes over time, suggesting that while telework may provide immediate relief regarding access to formal, better-paying jobs, its longer-term impact on poverty is less certain and likely requires complementary social policies to sustain progress.

In contrast, the hypothesized reduction in inequality was not fully supported. The relationship between telework share and labor inequality showed mixed results. While some states with higher telework capacity saw improvements in income distribution, this effect was inconsistent across all regions. In fact, in certain areas, telework contributed to widening inequality, potentially due to unequal access to telework opportunities across different socioeconomic groups. This outcome underscores the complexity of teleworking as a tool for social equity and highlights the need for policies that ensure broader access to remote work across diverse populations.

In sum, the results of this thesis suggest that teleworking can be a powerful catalyst for economic growth and productivity gains. Still, its social impacts, particularly poverty and inequality, are more complex and require further investigation. Telework has the potential to improve labor market outcomes, but its ability to drive inclusive growth will likely depend on addressing the structural barriers that prevent widespread access to remote work opportunities.

Future research should delve deeper into understanding the long-term social impacts of teleworking, with a particular focus on regional disparities and access to ICT. Additionally, further analysis could explore the role of complementary policies—such as education, training, and digital inclusion programs—in maximizing the benefits of telework for all segments of the workforce. As remote work continues to evolve in the post-pandemic world, policymakers must leverage its potential to drive growth while ensuring that its benefits are equitably distributed across Mexico's diverse regions.

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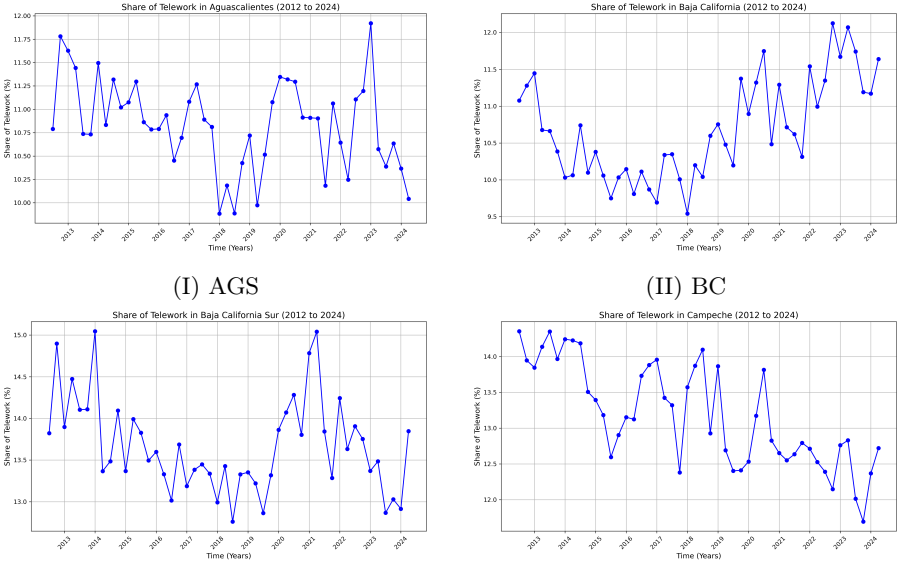
Appendix A

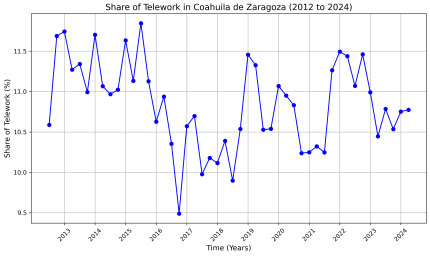
Telework share per state



(I) AGS (II) BC

(III) BCS (IV) CAMP

Figure A.1: Share of Telework by State



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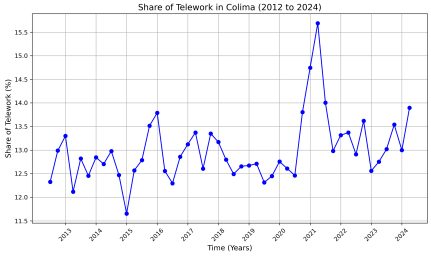

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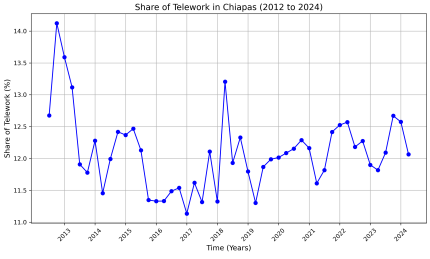
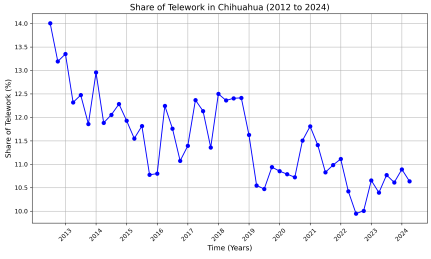


(III) CHIS



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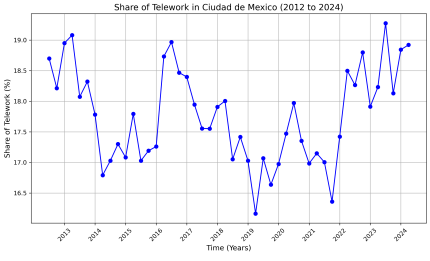

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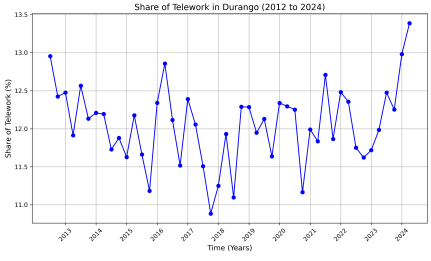
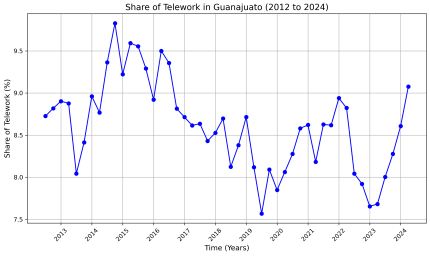


(VI) DGO

Figure A.2: Share of Telework by State



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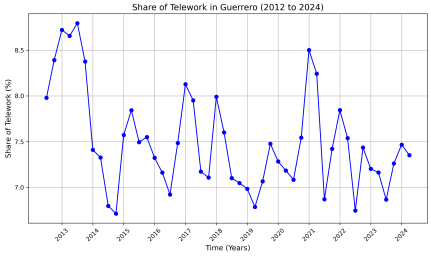

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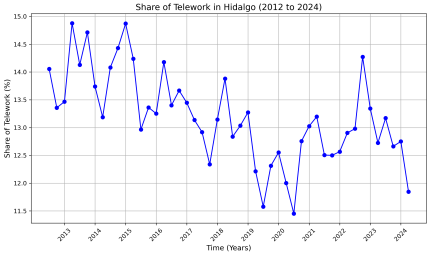

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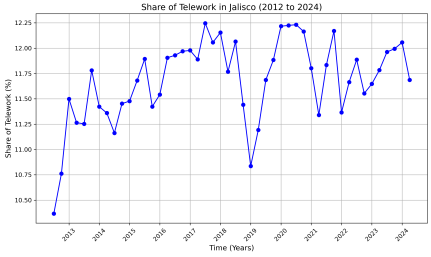

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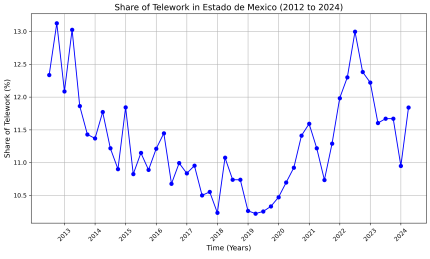

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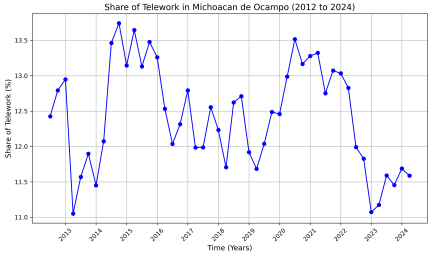
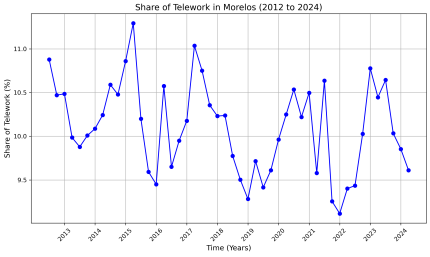


(VI) MICH

Figure A.3: Share of Telework by State



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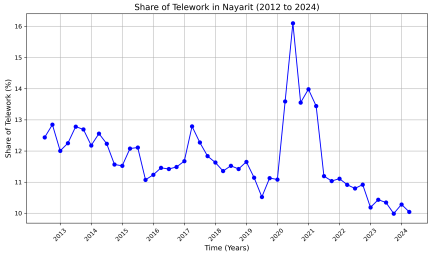

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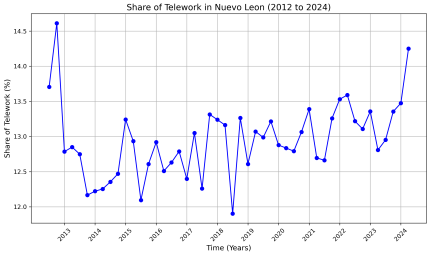
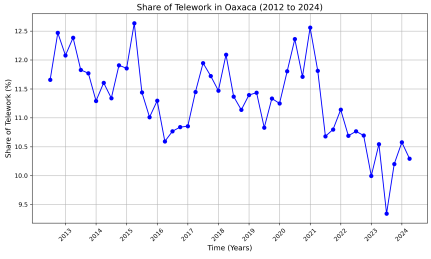
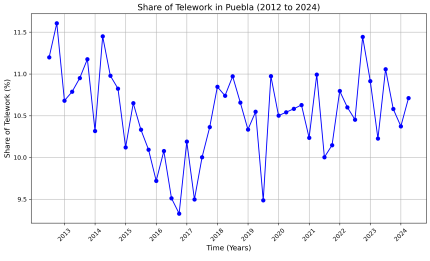


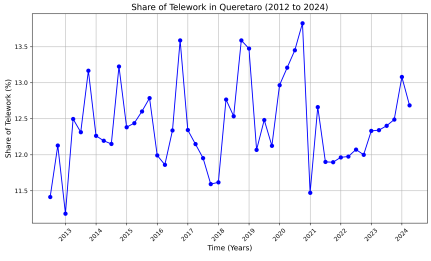
(III) NL



(IV) OAX

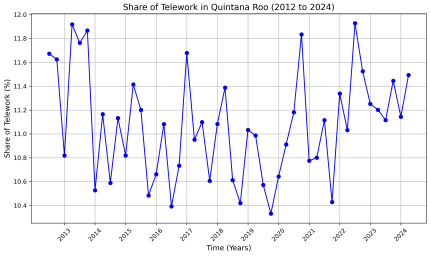


(V) PUE

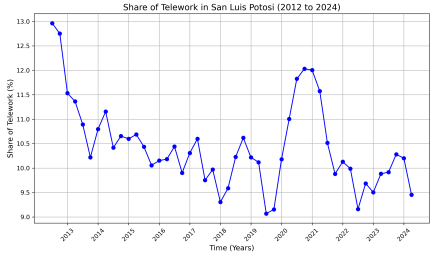


(VI) QRO

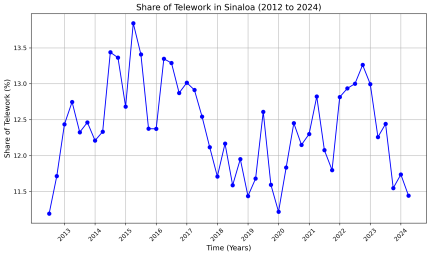
Figure A.4: Share of Telework by State



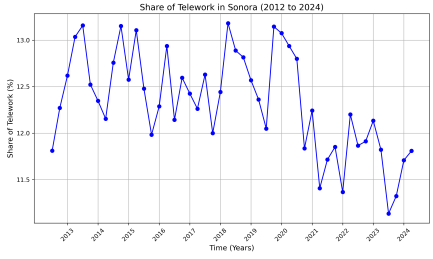
(I) QR



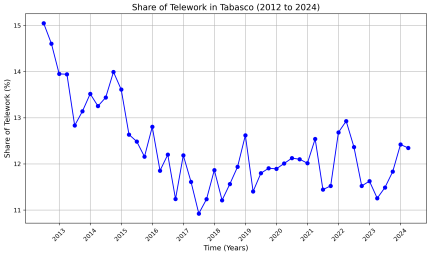
(II) SLP



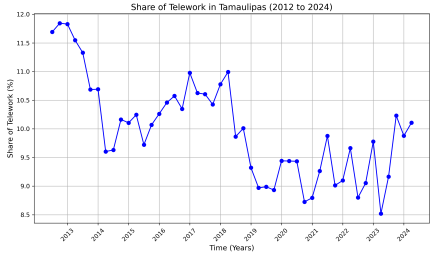
(III) SIN



(IV) SON

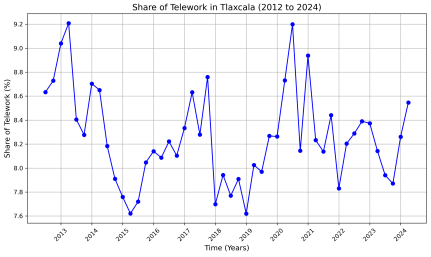


(V) TAB

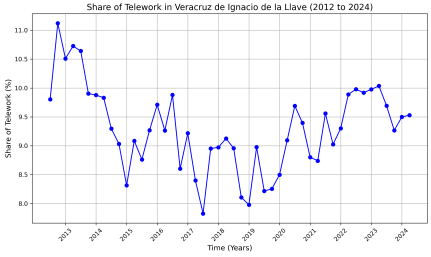


(VI) TAMPS

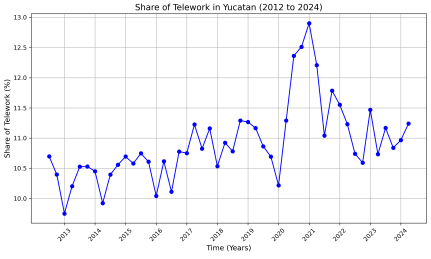
Figure A.5: Share of Telework by State



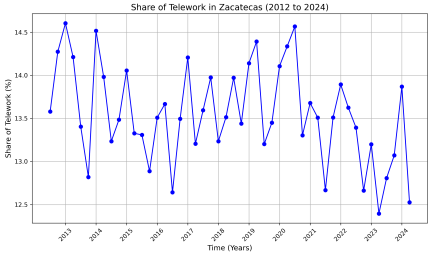
(I) TLAX



(II) VER



(III) YUC



(IV) ZAC

Figure A.6: Share of Telework by State