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Resilience and Transformation: Analysis of the Mexican Economy in Times of Pandemic and Post-Pandemic

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Abstract

The emergence of the pandemic has surprised the world, generating a significant impact on macroeconomic variables and impacting the quality of life of citizens. The objective of this research is to analyze economic performance in the pandemic and post-pandemic scenario through the use of segmented regression models in order to formulate political strategies that contribute to improving the living conditions of the citizens of Mexico. Using data from February 2020 to March 2023, it was found that, in the first period, a significant and positive correlation (r=0.9026622) between confirmed cases of COVID-19 and deaths. In the second period, only the IGAE showed a significant relationship with confirmed cases and deaths. From the above, the need arises to strengthen the mechanisms and programs for access to regulated credit for micro and small businesses, access to social security, access to public health services, as well as the incorporation of women into the formal labor market.

Keywords: *Wellbeing, Growth, Disease, Employment; Segmented Regression.*

Introduction

The emergence of the pandemic has surprised the world, generating a significant impact on macroeconomic variables and impacting the quality of life of citizens (Niembro and Calá, 2021; Matailo Pinta; Romero Ramon and Dávila Herrera, 2022). This phenomenon has transcended the field of health and has affected growth rates globally. According to Mejía Reyes, Reyes Hernández, and Vergara Gonzalez (2022), the world has experienced the worst health crisis in the last hundred years during the years 2020 and 2021. During the first months, confinement and mobility restriction measures were implemented with the objective of containing infections, which has caused a drastic contraction in the world economy and strong distortions in the supply and demand of products, affecting the balance in various markets. However, by 2022, a gradual normalization of economic activities and a rebound in the global economy has been observed.

In Mexico, the arrival of the health crisis has caused humanitarian, economic and health losses. According to Santamaría Velasco, Montañez Moya and Gutiérrez Olvera (2021, pp. 1886-4171), 93.2% of companies in the country have experienced some type of impact on their economic activity and labor market. The decrease in income has had the most notable impact, with 91.3% of companies reporting it, while 41.4% have had to carry out temporary closures or technical stoppages. Other adverse effects include reduced sales, reduced staff, and reduced wages.

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However, with the total reopening of different economic activities in 2022, a growing recovery of the economy in Mexico has been observed. According to the OECD (2022), the country experienced a solid rebound in economic activity in the first part of 2021, although it has been weakened due to supply pressures and new outbreaks of the SARS-CoV-2 virus. It is estimated that the Mexican economy will grow 2.3% in 2022 and 2.6% in 2023, after having experienced an increase of 5.3% in 2021.

The analysis of the two crucial moments mentioned reveals the importance of two different stages: the pandemic (February 2020 - February 2022), in which countries were forced to develop resilience to understand and effectively address the abrupt situation; and the post-pandemic stage (March 2022 to May 2023), in which governments have transformed with the aim of adapting to the new normal. In light of the previously mentioned events, the objective is to analyze economic performance in the pandemic and post-pandemic scenario through the use of segmented regression models. The fundamental purpose of this analysis is to formulate political strategies that contribute to improving the living conditions of the citizens of Mexico. The development of this research will allow us to test the hypothesis that resilience and transformation capacities have been the determining factors that have allowed the Mexican economy to overcome the effects caused by the pandemic and the post-pandemic.

After the introduction, the first section of this study is dedicated to exhaustively detailing the evolution of the Mexican economy during the pandemic and post-pandemic periods. Next, the second section focuses on the detailed description of the methodology used in this research. The third section is intended to present the results obtained and carry out a detailed discussion of them. Finally, the conclusions reached in this study are presented. It is worth highlighting the importance of the model used as a valuable contribution to research, providing a solid analytical basis and facilitating a deeper understanding of the economic phenomena studied.

Resilience and Transformation of the Mexican Economy During the Pandemic and Post-Pandemic

Since the declaration of a health emergency by the World Health Organization (WHO), the SARS-CoV-2 virus has been recognized as a public problem with consequences for both health and the economy, both globally as well as in the specific context of Mexico. In this section, the relationship between the health crisis and the Mexican economy is addressed in two stages: the first covering the period from February 2020 to February 2022, and the second covering the period from March 2022 to May 2023. In the analysis, examines the behavior of key variables such as deaths, positive cases, the Global Indicator of Economic Activity (IGAE), unemployment rate, National Consumer Price Index (INPC), Price and Quotations Index (CPI), Monthly Consumption Indicator Private in the Internal Market (IMCPMI) and the exchange rate. Through a gamma regression model, we seek to identify the relationship between these variables, demonstrating how an increase in deaths and a decrease in cases of contagion contribute to the changes observed in the country's economic activity.

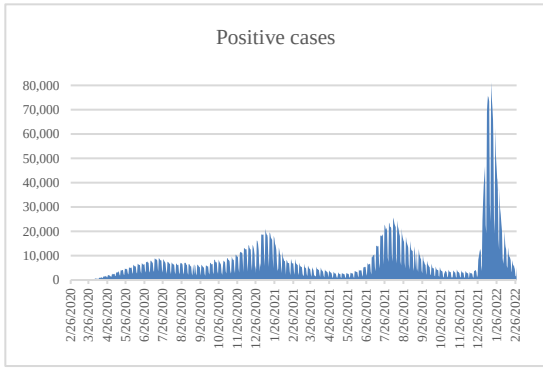
Resilience: February 2020-February 2022

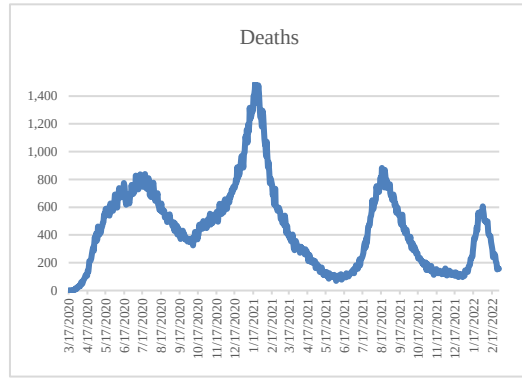
In the first stage, which corresponds to the pandemic period, governments were surprised by the appearance of the disease and had to develop strategies to contain the rapid increase in infections and stabilize the economy, without having previous experience in this situation. The World Health Organization (WHO) recommended the implementation of the "great confinement" as the main measure.

Although confinement was essential to contain the spread of the virus, the temporary closures of activities negatively affected the performance of the country's economy. Due to the increase in positive cases of SARS-CoV-2 (Figure 1a) and deaths (Figure 1b) and the restriction measures on non-essential activities, a significant drop in the Gross Domestic Product (GDP) is observed in the second quarter of 2020, Figure 2.

Figure 1

Impact of the pandemic in Mexico: Confirmed cases and deaths from COVID-19 from 2020 to 2022





1 a) Positive cases from February 2020 to February 2022.

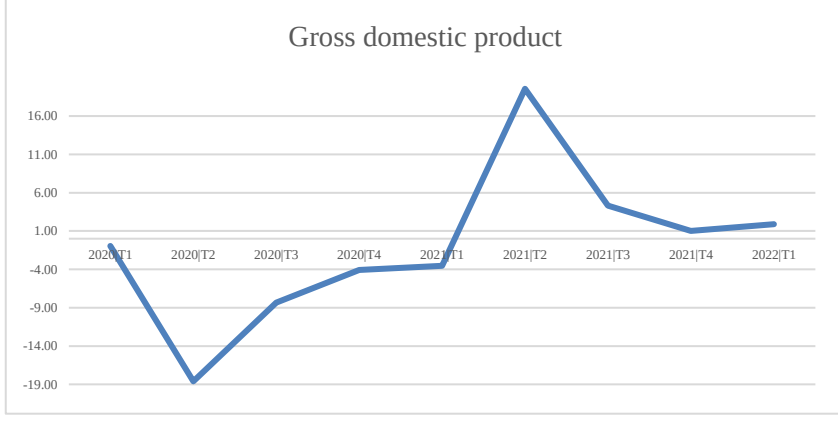
1 b) Deaths from February 2020 to February 2022.

Note: Own elaboration with data from the Ministry of Health (2023).

Furthermore, an increase in the unemployment rate and a decrease in the National Consumer Price Index (INPC) and the consumer price index (CPI) are evident (Figures 3 a, 3 b and 3 c).

Figure 2

The economic impact of the pandemic: variation in Mexico's GDP



Note: Own elaboration with data from Expansión México https://datosmacro.expansion.com/pib/mexico

Finally, in Private Consumption in the Internal Market (IMCPMI) (Figure 3 d).

Figure 3

Key indicators: Unemployment, INPC and CPI in the economic scenario from 2020 to 2022.

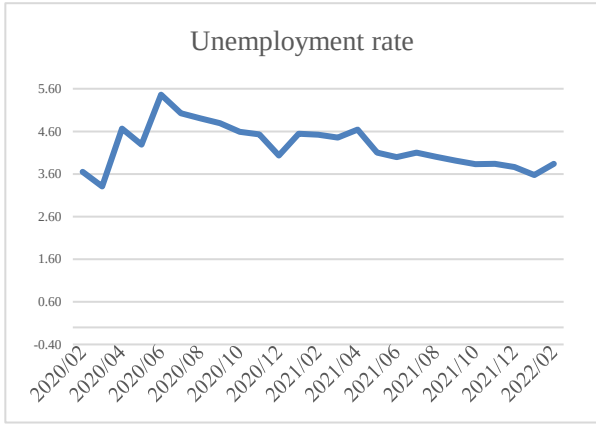


Figure 3 a) Unemployment rate during resilience.

Figure 3 b) Variation of the INPC rate

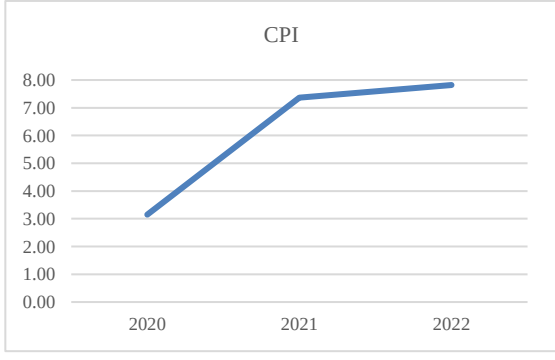


Figure 3 c) Variation of the CPI rate

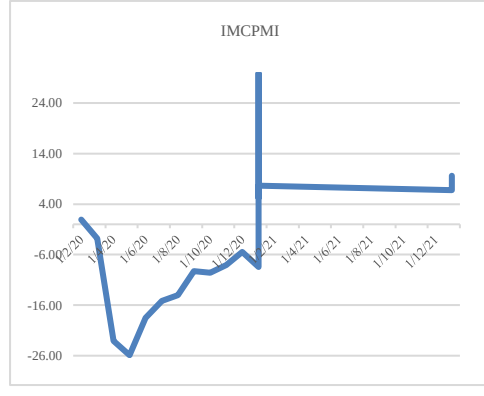


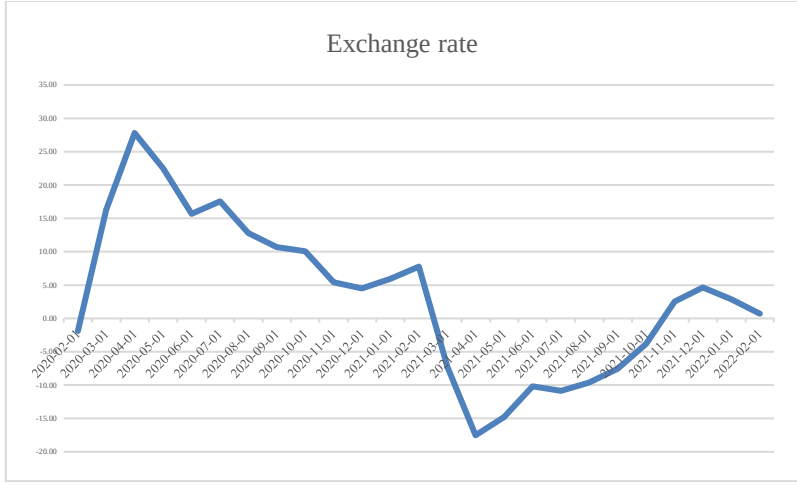
Figure 3 d) Variation of the IMCPMI rate

Note. Own elaboration with data from INEGI (2023).

For its part, an increase was obtained in the peso-dollar exchange rate (Figure 4).

Figure 4

Evolution of the peso-dollar exchange rate from February 2020 to February 2022.



Note: Own elaboration with data from Banco de México (2023).

In summary, during this pandemic stage, the negative impacts on various economic indicators are evident as a consequence of the confinement measures implemented to contain the spread of the virus.

The global economic outlook for 2021 presented a significant challenge related to access to vaccines, as the vaccination process became a crucial factor in restoring mobility and economic reactivation. This advance allowed a rebound in the Gross Domestic Product (GDP) worldwide, with a growth of 5.9 %, being 5.3% for advanced economies and 6.7% for emerging markets, according to the World Bank (2023).

However, despite these advances, uncontrolled risks persisted, including the emergence of new strains of the virus, problems in supply chains, difficulties in accessing vaccines, virus mutations, and continued wear and tear on health systems. These factors contributed to the imminent prolongation of the pandemic and a growing loss of purchasing power in various contexts.

In the case of Mexico, the Organization for Economic Cooperation and Development (OECD, 2022) noted a solid rebound in economic activity during the first part of 2021. However, this growth has been weakened due to pressures in the supply and the appearance of new outbreaks of the SARS-CoV-2 virus. So, despite the advances in vaccination and economic recovery observed in certain periods, the persistence of risks and challenges related to the pandemic has significantly impacted the global economic scenario, including Mexico.

The economic recovery observed in 2021 has been the result of the gradual reopening of essential activities in various sectors. Furthermore, the public policies implemented have sought to promote sustained growth and strengthen the domestic market with the aim of minimizing the negative effects of the economic crisis.

In this sense, various actions have been implemented by the government. Hernández (2020) highlights the implementation of a fiscal policy of austerity and the search to avoid incurring excessive debt to maintain the sustainability of public finances. For their part, Mejía Reyes, Reyes Hernández and Vergara González (2022) mention the implementation of a monetary policy through the Bank of Mexico, which has included measures such as accelerating the cut of the reference interest rate with the objective to boost the economy.

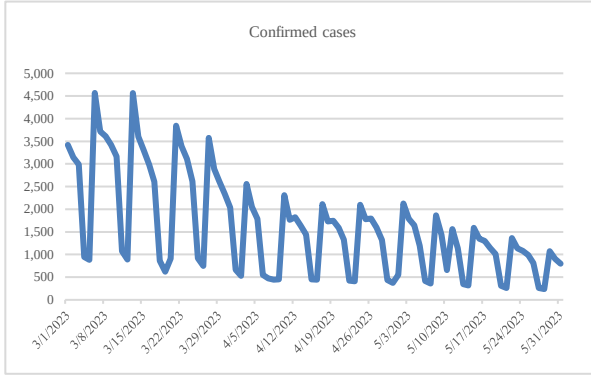
These policies and actions by the government have sought to generate an environment conducive to economic reactivation, stimulate investment and promote consumption. However, it is important to mention that the effectiveness of these measures has been the subject of analysis and debate, and their impact may vary depending on various economic and contextual factors.

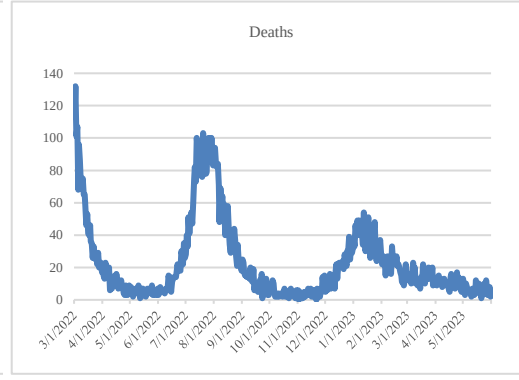
Transformation: March 2022-May 2023

By 2022, the outlook will undergo a substantial transformation with the complete resumption of economic activities and a high rate of immunization in the population, which translates into greater mobility and a notable decrease in the incidence of infections and mortality, as is evident in Figure 5. In this sense, Ugalde, Hellmann and Homedes (2022) recognize that the progress achieved in the development of vaccines is undeniable, although it should be noted that their global distribution has been marked by notable inequalities.

Figure 5

Impact of the pandemic in Mexico: Confirmed cases and deaths from COVID-19 from 2022 to 2023





5 a) Positive cases from March 2022 to May 2023.

5 b) Deaths from March 2022 to May 2023.

Note: Own elaboration with data from the Ministry of Health (2023).

Of course, here's a rewritten form of the idea:

The values presented in Table 1 show the evolution of the Gross Domestic Product from the second quarter of 2022 to the first quarter of 2023. According to the OECD (2022), Mexico's economic recovery is due to a solid macroeconomic policy supported by innovative management of debt, an adequate monetary policy and a flexible exchange rate that allowed macroeconomic stability to be protected and the economy to quickly return to the path of recovery, although challenges still exist.

Quarter	Percentage
Q2 2022	18.30
Q3 2022	18.47
Q4 2022	18.58

Q1 2023	18.76

Table 1: Gross Domestic Product (GDP) Of Mexico from the 2nd Quarter of 2022 to the 1st Quarter of 2023 (In Billions of Mexican Pesos)

Note: INEGI. (May 15, 2023). Gross domestic product (GDP) of Mexico from 1st quarter 2010 to 1st quarter 2023 (in trillion Mexican pesos).

Furthermore, an increase in the unemployment rate and a decrease in the National Consumer Price Index (INPC) is evident (Figures 6 a, 6 b and 6 c). The consumer price index (CPI) during 2022 had a rate of 7.82%, while in 2023 it was 5.03%. All these events allowed the OECD (2022) to estimate that Mexico will grow 2.3% in 2022 and 2.6% in 2023.

Figure 6 d shows an evolution of the dollar-peso exchange rate, a historical appreciation of the currency and a record collection of remittances is observed. For the Center for Public Finance Studies (2023), the wide differential between the interest rates of Mexico and the United States is a factor that has contributed to the exchange rate appreciation, by increasing demand for the national currency. This fact has placed the national currency in one of the most valued in the world and has made it the favorite of operators, or *traders* , who want to bet for or against emerging countries around the world according to Suárez (January , 2023).

Figure 6

Key indicators: Unemployment, INPC and CPI in the economic scenario from 2022 to 2023

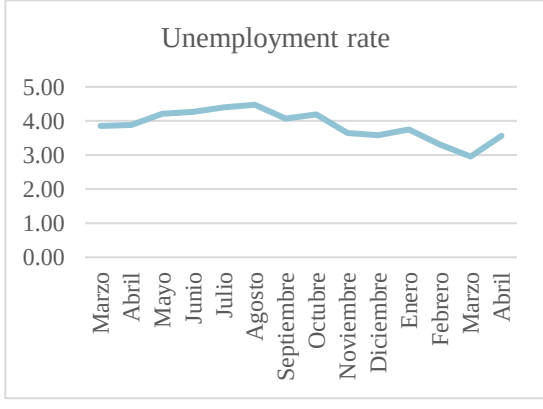


Figure 6 a) Variation of the IMCPMI rate

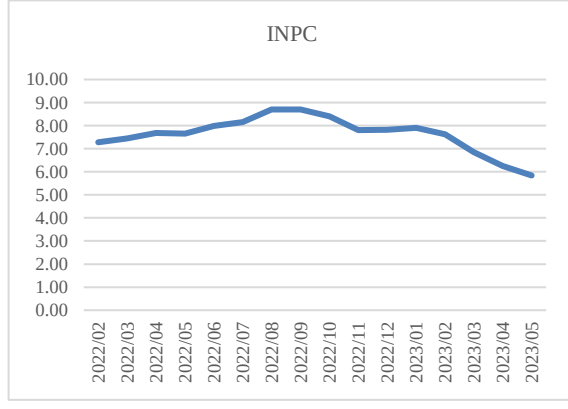


Figure 6 b) Variation of the INPC rate

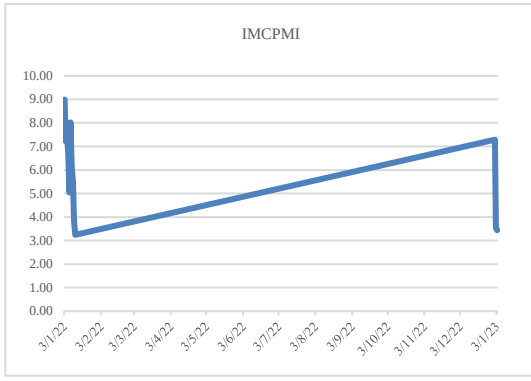


Figure 6 c) Variation of the IMCPMI rate

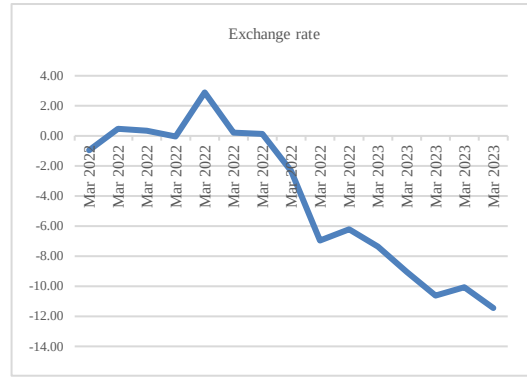


Figure 6 d) Exchange rate.

Note. Own elaboration with data from INEGI (2023).

Materials and Methods

In this research, segmented regression models are proposed with the purpose of describing the behavior of several economic indicators in relation to key variables related to the context of COVID-19 during two different time intervals. The main objective is to examine the existence of relationships between these indicators and the aforementioned variables, as well as to determine the nature of these relationships. In addition, it seeks to analyze the impact of both the emergence of the pandemic and the beginning of the administration of vaccines on these economic indicators. This will allow us to evaluate whether there have been significant changes in the trends of economic indicators when comparing the two time periods.

From a statistical point of view, a change in the trend can be reformulated as a change in the slope of the fitted line by means of a regression model. In the opinion of Chen et al. (2011), segmented regression models are regression models in which the dependence of a response variable on a covariate is piecewise linear. In other words, the dependency can be represented by several straight line segments.

The work considered four variables that describe the impact of the pandemic: the number of confirmed cases (x_1), the number of deaths from COVID-19 (x_2), the number of vaccine doses administered (x_3) and the number of people vaccinated (x_4). In addition to these variables, time $t$measured in months was taken into account.

One of the fundamental assumptions of the multiple linear regression model states that there is no high linear correlation between the independent variables, that is, there is no perfect multicollinearity in the model. If the possible multicollinearity of the regressor variables is not taken into account, an overfitted model could be obtained in which part of the explanation obtained by the coefficients reflects the underlying linear relationship in the independent variables.

Therefore, multicollinearity between the regressor variables was first analyzed. If the correlation is high ($|r| > 0.7$), a dimensionality reduction is carried out through principal components analysis to express the variation of the regressor variables in a way that avoids the problems that arise from multicollinearity. Principal components analysis is extremely useful as a hypothesis-generating tool, summarizing patterns in multivariate data and reducing the number of variables

in analyses. It is suitable for data sets where the dependent variables are linearly related to each other but can still provide useful results even if this condition is not completely met (Syms, 2019).

Several approaches have been proposed to address the challenge of the presence of multicollinearity among the independent variables in the linear regression model, represented by the equation.

$$y_i = \beta_0 + \beta_1 x_{1i} + \cdots + \beta_p x_{pi} + e_i,$$

where $i = 1, 2, \ldots, n$, $y_i$is the output variable, x_{ni} is the value of the nth output variable, $e_i$is the error between the current output and the estimated output $\hat{y}_i$. The method that was applied was regression on principal components (del Valle Moreno & Guerra Bustillo, 2012). That is, in this study, the variables obtained from this analysis were used as the new regressor variables of the model.

The time interval in which the events that were examined take place was divided into two periods in which different linear equations were proposed following a segmented regression model. Said model can be expressed in the following way, for each of the estimated economic indicators $\hat{y}_i, i = 1, \ldots, 7$, we have the following segmented model

$$\hat{y}_i(x_1, x_2, x_3, x_4, t) = \begin{cases} \beta_{1,0} + \sum_{i=1,2,3,4} \beta_{1,i} x_i, & 1 \leq t < 11 \\ \beta_{2,0} + \sum_{i=1,2,3,4} \beta_{2,i} x_i, & 11 \leq t \leq 39 \end{cases}$$

The indicators studied are coded using subscripts i. The summary of the coding of the variables is found in Table 2. The first of the periods (called Period 1) includes from the beginning of the pandemic in February 2020 (corresponding to) until December 2020 when only the variables are available $t = 1$. time t, and $x_1$and x_2 and the second period (named Period 2) is from the first vaccination records in December 2020 (corresponding to $t = 11$) until March 2023.

The validity of the model was measured first by reviewing the values $p$of the test $t$applied to the coefficients and the value p of the Fischer test performed on the set of coefficients. Finally, it was verified whether or not there is cointegration between the variables by applying the Dickey -Fuller test to the residuals of the regression model obtained (Chiapinotto, 2021). It should be noted that the values $p$are important in determining the statistical significance of the results in the context of the model. In this case, test $t$values are being calculated $p$to evaluate the model coefficients (Stella, et al., 2023).

Variable	Coding	Variable type	Units
Time	t	Returner	Months
confirmed_cases	x_1	Returner	People
Deaths	x_2	Returner	People
Administered_doses +	x_3	Returner	People
Vaccinated_people	x_4	Returner	People
GDP	y_1	Answer	
IGAE	y_2	Answer	
Unemployment rate	y_3	Answer	
INPC	y_4	Answer	
CPI	y_5	Answer	

IMCPMI	y_6	Answer	
Exchange rate	y_7	Answer	

To carry out the test, the imputation of 11/18/2022 was carried out with the previous value 22315899.

Results

First Period

The first period is from February 2020 to December 2020 (10 months). Initially, linear models were proposed with regressor variables number of confirmed cases and deaths. However, they were found to be correlated with a correlation coefficient of $r = 0.9026622$, with a $p < 0.0003487$significance value for hypothesis testing with alternative hypothesis $\rho \neq 0$. Therefore, a linear combination was carried out with both variables using principal components.

In principal component analysis one of the key steps is to calculate the covariance matrix and then find its values and eigenvectors (eigenvalues and eigenvectors). The covariance matrix of the regressor variables for Period 1 is given in Table 3.

	Confirmed cases	Deaths
Confirmed cases	6717.7805	619.90052
Deaths	619.90052	70.20495

The values and eigenvectors associated with the covariance matrix of the data that represent the variance explained by each principal component were calculated following the principal components method. The eigenvalues and eigenvectors associated with the covariance matrix are $\lambda_1 = 6775.09343$with associated vector $\vec{v} = (0.99575324, -0.09206237)$ corresponding to more than 99 % the variation. The remaining percentage corresponds to the value $\lambda_2 = 12.89204$with associated eigenvector $\vec{v} = (0.09206237, 0.99575324)$. Considering these results, the transformation was applied.

$$x_5 = 0.9957x_1 - 0.0920x_2$$

This new variable was then used for the Gaussian regression model. Table 4 summarizes the results obtained for this model. It should be noted that for the positive variables, Gaussian and gamma distribution regression models were used without finding clear differences in the results. Gamma regression is a type of regression analysis that is used when the response variable follows a gamma distribution, that is, instead of using the normal density function for errors, the gamma density function is used (Brown, Griffin, 2010). This allows modeling response variables that are non-negative and asymmetric.

Variable	Intercept	x_5	Cointegration (value p)
GDP	17441426*	-2614	0.7273
IGAE	-8,980**	-0.0007	0.3971
Unemployment rate	3.82***	0.0059**	0.89
INPC	3.0268**	0.003	0.99
CPI	37054.584**	4,870	0.97
IMCPMI	-8.07*	0.0351**	0.10

Exchange rate	14.79**	-0.009	0.01

Table 4: Linear Regression with Gaussian

Significance level * less than 0.1, ** less than 0.05, *** less than 0.01.

From the regression analysis it was concluded that for Period 1 only in two economic indicators did the presence of the variable $x_5$result in a significant contribution. This means that in this period the variable x_5 had a significant impact on these two economic indicators, while it did not have a significant impact on the others. As a result, the models of these equations were obtained after replacing the variable $x_5$with its definition:

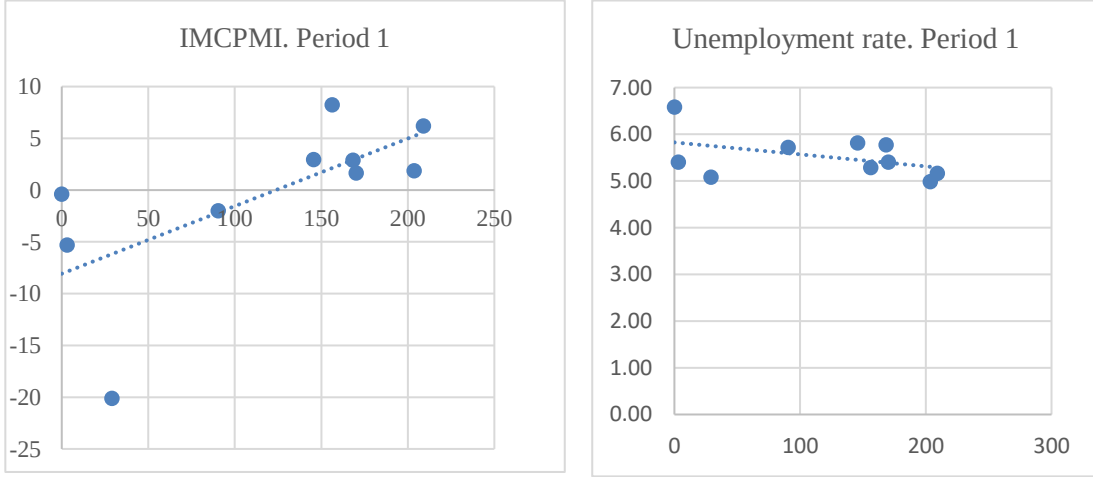
$$Unemployment\ rate = 3.82 + 0.0058\ Confirmed\ cases - 0.0005\ Deaths$$

$$IMCPMI = -8.07 + 0.034\ Confirmed\ cases - 0.0032\ Deaths$$

Figure 7 shows the linear regression graph for the IMCPMI and unemployment rate for the first period.

Figure 7

Result of the linear regression for the Monthly Indicator of Private Consumption in the Internal Market (IMCPMI) and unemployment rate



Note: Own elaboration based on the results.

In these models, the coefficients 0.0058, 0.0005, 0.034 and 0.0032 represent how the economic indicator changes in response to changes in the predictor variables (Confirmed Cases and Deaths). The constant values 3.82 and -8.07 represent the base level of the economic indicators when all predictor variables are equal to zero. These models allow predictions to be made about the Unemployment Rate and IMCPMI based on the values of Confirmed Cases and Deaths. If the values of these variables change, the models provide an estimate of how economic indicators will change accordingly.

Period 2

For the second period (starting in December 2020), in addition to the number of confirmed cases and deaths, the number of doses applied and the total number of vaccinated people, regressor

variables were used as regressor variables. For this case, with the objective of detecting multicollinearity, the correlation matrix shown in Table 5 was first constructed.

	Confirmed cases in thousands	Deaths.thousands	Administered doses	Vaccinated people
Confirmed cases in thousands	1,0000000	0.34609706	-0.09544956	-0.05653765
Deaths.thousands	0.34609706	1,0000000	-0.7385928	-0.7303022
Administered doses	-0.09544956	-0.7385928	1,0000000	0.97855647
Vaccinated people	-0.05653765	-0.7303022	0.97855647	1,0000000

Table 5: Correlation Matrix

From this table it is obtained that the variables corresponding to deaths, doses administered, and people vaccinated have a high correlation. Due to this and to avoid the effects of collinearity, similar to the previous case, two variables were proposed that are a linear combination of the previously mentioned ones obtained from the principal components' method. Table 6 a shows the covariance between all possible combinations of the three mentioned variables (Deaths.thousands, Doses.administered.millions and People.vaccinated.millions). For example, the value in the row " Deaths.thousands " and the column " Doses.Administered.millions " is -61.06935, suggesting a negative relationship between the number of deaths and the number of doses administered; That is, as the doses administered increase, the number of deaths tends to decrease.

	Deaths.thousands	Doses administered in millions	People.vaccinated.millions
Deaths.thousands	93.62600	-61.06935	-25.30519
Doses administered in millions	-61.06935	73.01970	29.94434
People.vaccinated.millions	-25.30519	29.94434	12.82383

Table 6a: Covariance Matrix

Table 6 b shows the eigenvalues (eigenvalues) and eigenvectors (eigenvectors) of the covariance matrix. As mentioned above, principal component analysis involves decomposing the variability of the original variables into its principal components, namely the eigenvalues and eigenvectors.

Eigenvalue	Eigenvector	Variability percentage
155.7351790	$(-0.7287879, 0.6847358, -0.002236796)$	86.77%
23.2692305	$(0.6327843, 0.6747351, 0.379890247)$	12.96%
0.4651154	$(-0.2616337, -0.2754440, 0.925028863)$	0.005%

Because the first two eigenvectors represent more than 99% of the variability of the information provided by these three variables, the following two new variables were proposed.

$$x_5 = -0.7287x_2 + 0.6847x_3 - 0.002x_4$$

$$x_6 = 0.6327x_2 + 0.6747x_3 + 0.3798x_4$$

Using as regressor variables x_1, x_5 and $x_6$regression models were proposed for economic indicators. Table 7 summarizes the regression model for the second period and provides information on how the predictor variables $x_1$affect $x_5$the $x_6$response variables GDP, IGAE, Unemployment Rate, INPC, CPI, IMCPMI and Exchange Rate.

Variable	Intercept	x_1	x_5	x_6	Cointegration (value p)
GDP	7.07e+06	1.56	2.404e+05	-1.87e+05	-
IGAE	0.004**	0.945	0.036**	0.037**	0.01**
Unemployment rate	4,047***	-3.99e-07	9.37e-02	-1.43e-01	0.17
INPC***	5.37***	1.89e-07	-3.60e-01	5.11e-01	0.78
CPI**	4.602e+04***	-1.33e-03	-2.63e+03	2.99e+03	0.2703
IMCPMI	4.19e-02	-5.58e-07	-4.31e-01	4.68e-01	0.072*
Exchange rate	-7,304	4.3e-06	-2.38	2.58	0.8017

Significance level * less than 0.1, ** less than 0.05, *** less than 0.01.

The coefficients x_1, $x_5$and $x_6$indicate how much the dependent variable changes for each unit change in the corresponding predictor variable, holding the other predictor variables constant. For example, for the IGAE, the coefficient for "Confirmed Cases" is 0.945, which means that an increase of one unit in "Confirmed Cases" is associated with an increase in 0.945the value of IGAE, holding the other variables constant.

In this second period, only in the IGAE was a significant effect of the regressor variables shown. The equation obtained after substituting $x_5$and $x_6$by its definitions is.

$$IGAE = 0.0040 + 0.945\ Confirmed\ cases\ - 0.0028\ Deaths + 0.0496\ Doses\ administered + 0.0139\ Vaccinated\ people$$

This equation represents how the IGAE relates to the specific predictor variables in the second period.

Below is a summary of the results. In the first period, which covers from February 2020 to December 2020, a significant and positive correlation was found $r = 0.9026622$between confirmed cases of COVID-19 and deaths. This suggests that as confirmed cases increased, deaths also increased, as Mejía Reyes, Reyes Hernández, and Vergara Gonzalez (2022) point out, the world has experienced the worst health crisis in the last hundred years during the years 2020 and 2021.

To address multicollinearity between variables, principal components analysis was applied. The

first principal component, termed x_5, captured more than 99% of the variability of the original data. This component was used in linear regression models with Gaussian distribution. Among these models, only two economic indicators, namely, the Unemployment Rate and the IMCPMI, showed significant relationships with the variable x_5. The resulting regression equations indicate how the Unemployment Rate and IMCPMI change in response to changes in confirmed cases and deaths during the first period.

The above translates according to Santamaría Velasco, Montañez Moya, and Gutiérrez Olvera (2021, pp. 1886-4171), 93.2% of companies in the country have experienced some type of impact on their economic activity and labor market. The decrease in income has had the most notable impact, with 91.3% of companies reporting it, while 41.4% have had to carry out temporary closures or technical stoppages. Other adverse effects include reduced sales, reduced staff, and reduced wages.

In the second period, starting in December 2020, two new predictor variables, x_5 and x_6, were introduced to overcome the problem of multicollinearity between the variables related to deaths and vaccination. The correlation matrix revealed a high correlation between these variables. Principal components analysis was again applied, and the variables x_5y $x_6$captured more than 99% of the variability of the original data. However, in this second period, only the IGAE showed a significant relationship with the predictor variables. x_1, $x_5$and x_6. The resulting regression equation for the IGAE provides information on how this economic indicator relates to confirmed cases, deaths, doses administered, and people vaccinated during the second period.

The above denotes two things. One, the application of vaccines and the reduction of deaths. For Ugalde, Hellmann and Homedes (2022) the progress achieved in the development of vaccines is undeniable. And two, the reopening of economic activities. The economic recovery in Mexico is due, according to the OECD (2022), to a solid macroeconomic policy supported by innovative debt management, an adequate monetary policy and a flexible exchange rate that made it possible to protect macroeconomic stability and quickly return to economic stability. road to recovery, although challenges still exist.

Conclusions, Recommendations, and Final Considerations

In this analysis, economic performance was studied in the pandemic and post-pandemic scenario using segmented regression models with the purpose of formulating political strategies that contribute to improving the living conditions of the citizens of Mexico. Therefore, data from February 2020 to March 2023 were used. This research was developed in two different stages: the pandemic (February 2020 - February 2022), in which countries were forced to develop resilience to understand and effectively address the abrupt situation; and the post-pandemic stage (March 2022 to May 2023), in which governments have transformed with the aim of adapting to the new normal.

The results show that, in the first period, a significant and positive correlation ($r = 0.9026622$) was found between confirmed cases of COVID-19 and deaths. This suggests that as the thousands of confirmed cases increase, the deaths of thousands of people also increased. In the second period, starting in December 2020, only the IGAE showed a significant relationship with the predictor variables. x_1, $x_5$and x_6(confirmed cases, deaths, doses administered, and people vaccinated). The resulting regression equation for the IGAE provides information on how this economic indicator relates to confirmed cases, deaths, doses administered, and people vaccinated.

Thus, in the first period, as confirmed cases increased, deaths also increased and, consequently, an increase in the unemployment rate and a fall in the Monthly Index of Household Private Consumption. Faced with this problem, the Mexican government applied certain measures (support to older adults, the construction of the Santa Lucia airport, the Maya Train and the Dos Bocas refinery, the cancellation of ten undersecretaries, support for 2.1 million MyPES), in addition to confinement to reduce the rate of infections, as financial support to micro and small businesses, progressive reopening of essential activities, generation of temporary and permanent jobs, construction of infrastructure, debt freezing, among others.

In a second period, the results show that the application of vaccines allowed the reduction of cases of infections on the one hand and the reduction of the number of deaths. The direct consequence was the economic recovery through a solid macroeconomic policy supported by innovative debt management, an adequate monetary policy and a flexible exchange rate that allowed macroeconomic stability to be protected, although there are still challenges such as inflation, stagnant wage bill, informality and underemployment. Additionally, this recovery has not been the same in all states of the republic, nor does it translate into greater well-being.

The results of this study allow us to suggest some public policy interventions. One of the main recommendations revolves around the need to strengthen mechanisms and programs for access to regulated credit for micro and small businesses, access to social security, access to public health services, as well as the incorporation of women into the market. formal work. Other mechanisms and programs for access to education, mainly basic education (preschool, primary and secondary), gender parity, the use of mobile phones and homes with internet connection, access to the rule of law, as well as encouraging investment to generate jobs and decent wages.

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