

Analysis of Mexico's economic growth, unemployment, interest rate and its influence on inflation for the period 2019-2022**Análisis del crecimiento económico, desempleo, tasa de interés y su influencia en la inflación de México del periodo 2019-2022**

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Abstract

The following investigation was carried out through an analysis of inflation in Mexico in the period 2019-2022, using the viable unemployment and economic growth, finding that inflation is related to; where the macroeconomic models will be used, which are Okún's law, which is an empirical observation proposed in 1962 in the United States by the economist Arthur Okun and the Phillips curve, an operation created by William Phillips 1958, where he describes the relationship between inflammation and unemployment; With these methods, the sensitivity that unemployment generates to the economic and expansion will be observed; in order to analyze the impact it generates and establish the effects of the Economy. These effects were caused by the events of the start of COVID-19, approval of new laws, increase in remittances, growth in unemployment, and end of the pandemic in Mexico. It will also be observed if unemployment can be an economic stabilizer for the country because it generates on economic growth and inflation.

Inflation, Correlation, Sensibilisation**Resumen**

La siguiente investigación se realizó a través de un análisis de la inflación en México en el periodo 2019-2022, utilizando las viables desempleo y crecimiento económico, encontrando que relación tienen con la inflación; donde se utilizara los modelos macroeconómicos que son la ley de Okún que es observación empírica propuesta en 1962 en Estados Unidos por el economista Arthur Okun y curva de Phillips operación creada por William Phillips 1958 donde describe qué relación tiene la inflación y el desempleo; con estos métodos se observara la sensibilidad que genera el desempleo ante el crecimiento económico e inflación; con el fin de analizar el impacto que genera y establecer los efectos de la Economía. Estos efectos fueron causados por los acontecimientos del inicio del COVID-19, aprobación de nuevas leyes, aumento de remesas, crecimiento del desempleo y termino de la pandemia en México. También se observará si el desempleo puede ser un estabilizador económico para el país, debido a las afectaciones que genera en el crecimiento económico e inflación.

Inflación, Correlación, Senbilidad

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Introduction

Inflation is a monetary phenomenon that affects the prices of products, decreasing the purchasing power of people and affecting economic growth, high inflation can weaken the growth of economic activity and employment, to avoid these effects the Bank of Mexico implements actions to reduce inflation, one action is to establish inflationary targets that are set by central banks for price stability of products and services (Hanel, 1997), the Bank of Mexico aims to reduce the inflation rate to 3%, with a range of variability of 1%; Mexico closed 2021 with a headline inflation rate of 7.36% higher than last year (Banco de México, 2021).

Economic growth can be used as a proxy for human development, investment, trade openness to new markets and increased profits within the country (Ranis, 2002). The National Institute of Statistics and Geography (INEGI) indicates that during the period from July to September 2021 economic growth had an increase of 4.5%, around 600 billion pesos leaving an increase after a fall of 8.1% in 2020 (INEGI, 2022).

The Bank of Mexico applied a Restrictive Monetary Policy which aims to maintain sustained economic growth, allowing it to achieve stable and significantly low inflation levels. The Bank of Mexico injects or withdraws daily liquidity shortages or surpluses from the system through Open Market Operations, which affect the level of inflation. By using the interest rate on overdrafts as the basis for its Open Market Operations, the Bank provides incentives for funding operations between banks to be conducted at rates close to the target rate (Banco de México, 2022).

In 2021, Banco de México recorded an increase in inflation that was reflected in the increase in the cost of the basic food basket, raw materials and fuels, which generated a reduction in the population's purchasing power. Other elements that affected inflation in Mexico were the fall in employment, wage increases, the approval of the reform reducing remittances, the approval of the energy reform and the approval of the use of international reserves (Banco de México, 2021).

The (Bank of Mexico, 2021) recorded an increase in the unemployment rate that was caused by the pandemic, closing the first semester with 17.9% and the second with 14.3%, reducing by 3.6% later with the reactivation of the economy. Unemployment has a financial impact on productivity, generating a decrease in GDP, which leads to low interest rates (Adame, 2022).

In the same year, the Senate of the Mexican Republic approved an increase in salaries, which affected inflation by causing an increase in prices and a decrease in purchasing power, resulting in a deficit in the population's salaries. This increase was 1.4% of salaries in 2021 and 2022, which represented an approximate increase of \$38 pesos in 2022 (CONEVAL, 2023).

In 2021 the Senate of the Republic approved the reform of articles 20 and 34 of the Banco de México law, regarding the collection of foreign currency in cash or remittances (Diario Oficial de la Federación, 2021). In recent years, there has been an increase in income to the country due to private transfers generated by migrants to the country in the form of remittances, which incite consumption, generating a greater circulation of money within the country and consequently generating inflation (Arévalo, 2010). This reform increased to 32% of the money received in remittances in 2021, generating an amount of \$50 billion pesos in the same year (Clavellina, 2021).

To determine the cause of inflation and the variables that affect it, it is necessary to analyse the 3 types of inflation that exist (UNAM, 2022); it measures the increase in prices of a subset of goods and services in the national consumer price index (INPC) whose prices are not subject to administrative decisions, seasonality or high volatility (Grünwald, 2004); core inflation increased 0.65 % at a monthly rate and 8.35 % at an annual rate in 2021 (INEGI, 2022). Non-core inflation measures the increase in goods and services whose prices do not directly affect market conditions, but are highly influenced by external conditions such as weather or government regulations. Non-core inflation increased by 0.40 % monthly and 6.27 % at annual rate (INEGI, 2022).

In 2021, aggregate demand for goods and services reported a real annual increase of 7.1 %, caused by the acquisition of services for communication and entertainment at home, which led to an increase in the demand for money greater than that recorded in 2020, this phenomenon not only occurred in the country, but also globally (Government of Mexico, 2022). Productivity is a factor that influences inflation, this is due to the demand for a product or service and the supply it has, according to the global index of labour productivity of the economy (IGPLE) recorded a decrease of 1.2% in the fourth quarter of 2021, this result is divided into 3 sectors; the primary sector increased 1.3%, the secondary sector increased 0.3% and the tertiary sector decreased by 1.9% (Government of Mexico, 2023).

To analyse the impact of the inflation that occurred in 2021 and to establish the effects it caused such as the increase in unemployment and decrease in economic growth, to express the relationships that inflation has, a correlational comparison was made using as a basis what is described in Okun's law where and Phillips curve showing the sensitivity that unemployment has to inflation in Mexico, some authors who have applied Okun's law in Mexico were:

Lopez, 2023 described Okun's law where he states that there was a growth in the unemployment rate in the period 2005-2022, going from 3.5% in May 2019 to 4.2% in May 2020; noting the reduction unemployment will be affected by the territory, economic complexity and natural factors.

Urbina, (2020) conducted an observation of Okun's law applied to Mexico for the period from 2005 to 2020, where he estimated the original Okun's formulations through three structural time series models with the Hodrick-Prescott filter, in order to find that variations in production have effects on the unemployment rate of the Mexican economy.

The Institute of Economics conducted an observation of the relationship between Latin American labour markets and Okun's law, where Mexico was ranked number 2 for presenting a low coefficient, this result may vary as it depends on the cyclical variations that the country has and the human development it has (Arena, 2020).

An application of the Phillips curve was 2021 by Andrade (2021) where he shows that through an econometric model it is not possible to relate changes in the levels of production, unemployment and economic growth. Finally, the paper emphasises that unemployment and inflation relationships that might consider factors other than linear and cause autocorrelation problems.

In the period 2002-2018 Valdez (2020) observed that it is possible to estimate a decrease in the inflation rate with this methodology, this is due to the fact that a stabilising policy that generates permanent effects on the unemployment rate was not observed; the regression parameters do not present structural change and the existence of non-linearities is rejected, so it can be concluded that the response of the acceleration of inflation to the unemployment gap has been constant for the whole period and can have equilibrium.

Rodriguez (2012) observed that a country can have simultaneously high inflation and high unemployment, in the case of Mexico the Phillips curve can be correctly specified its constituent elements: the real wage, the real exchange rate and output, determining that there is enough time for the long-run relationships to manifest themselves without affecting the inflation rate.

Methodology

Okun's law is an empirical observation proposed in 1962 in the United States by the economist Arthur Okun, where a correlation is made between changes in the unemployment rate and the growth of an economy (Blackley, 1991); detecting these two factors, it is defined that the growth of the active population and the growth of labour productivity will be used to find the balance of unemployment and economic growth (Blanchard, 2012), described by the following formula:

$$u_t - u_{t-1} = -B(g_{Yt} - g_y)$$

Where:

- u_t = Unemployment rate for a given time.
- u_{t-1} = Unemployment rate earlier than the given time.

- b = Sensitivity of economic growth to reduction in unemployment rate.
- g_{Yt} = Growth rate (GDP) at a given time.
- g_Y = Growth rate (GDP) earlier than the given time.

The model indicates the sensitivity that exists in unemployment, since a decrease in the growth of production causes an increase in unemployment and vice versa (Amighini, 2012).

The Phillips curve is an operation that was created by William Phillips 1958 with the purpose of finding a relationship between inflation and unemployment, inflation depends on the target to reduce it and the deviation of unemployment with respect to the natural rate, this equation has to relate the unemployment rate with the predicted inflation at the end of the year (Larraín, 2012), is described by the following formula:

$$\pi_t - \pi_{t-1} = -a(u_t - u_n)$$

Variants of the Phillips Curve:

- π_t = Inflation rate for a given time
- π_{t-1} = Inflation rate earlier than the given time
- a = Inflation sensitivity of unemployment rate growth.
- u_t = Unemployment rate for a given time
- u_{t-1} = Unemployment rate earlier than the time determined

Source: (Blanchard, 2012)

When unemployment is lower than the natural rate inflation increases; when it is higher inflation decreases, this parameter indicates how unemployment affects the variation of annual inflation and how it could be avoided, if there is an increase in unemployment implies a decrease in inflation (Mankiw, Macro Economics, 2014); some of the authors who have conducted empirical research are:

Milton Friedman named in 1976 that the Phillips curve is corresponding to the expected inflation rate and will determine the level of unemployment as the natural rate, Friedman concludes that if unemployment tries to be below the natural rate would have to accelerate again the inflationary process and move to a higher level of inflation. If you want to reduce the rate of unemployment you have to subject the economy to an inflationary process of increasing rate, in order to keep the inflation rate constant and decreasing" (Ravier, 2010).

The correlation method is a statistical measure that expresses the point of comparison of variables or relationship, this method is used to describe simple relationships without making statements about cause and effect; the result of the analysis is a coefficient that can take values between -1 and +1, the sign indicates the type of correlation between variables (Larraín, Macroeconomics in the global economy, 2023), it is described by the following formula:

$$r = \frac{\sum xy}{\sqrt{(\sum x^2)}\sqrt{(\sum y^2)}}$$

Variants of the correlation method:

- \sum Variants of the correlation method $xy =$ Covariance between X and Y
- $\sum x =$ Deviation from X
- $\sum y =$ Deviation from Y
- Formula clearance:
- $Y_t = a_t + \beta x + \varepsilon_t$

Variants of the correlation method:

- Y_t = Dependent variable of the study
- B = Coefficient measuring the trend of the dependent variable
- x = Variable explains the result
- ε_t = Random error term

Source: (Blanchard, 2012)

A positive sign indicates that there is a positive relationship, i.e., if one variable increases, the other increases. A negative sign indicates that there is a negative relationship, one increases and the second decreases. If two variables are independent, the correlation coefficient is zero. The strength of the relationship increases as the correlation coefficient approaches -1 or $+1$ (Giavazzi, 2012), some of the authors who have performed correlations are:

To perform the estimates of the coefficient of Okun's law and the Phillips curve the data to be used were collected; unemployment rate issued by (INEGI, 2019)(INEGI, 2022), economic growth (GDP) which was issued by (INEGI, 2022) of Mexico and inflation rate (Bank of Mexico, 2022), covering the 32 states of the Mexican republic of the year 2021.

Results

In making a comparison of the period 2019-2022 on the application of Okun's law in Mexico, it was found that the unemployment rate has a direct effect on the development of the country, Rodriguez (2007) determined that the variables are stationary and affect the economy according to the season of the year, based on this three seasons were determined, in the first one unemployment is considered as a dependent variable, and the explanatory variable is the product; the second uses the state variable determined by the Kalman Filter and the third is the gap between the potential product.

From January 2019 to March 2021 the country had no economic growth resulting in an increase in unemployment; Loría (2012) observed different dynamic effects of great relevance, such as the negative effect of the duration of the growth rate as a product to the variation of unemployment, as well as the inverse effect, then, the following figure of unemployment and GDP variations is presented.

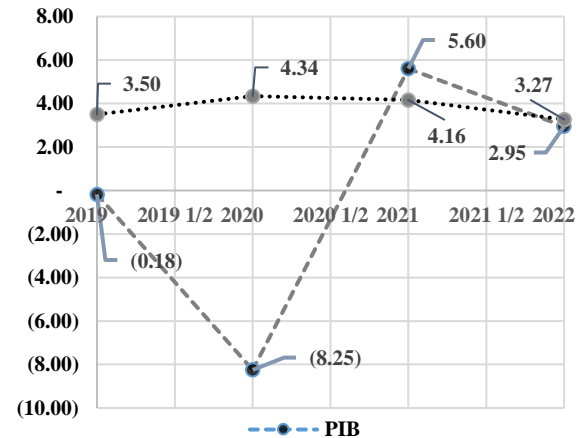


Figure 1 Unemployment rate and GDP variation in Mexico

Source: Own elaboration based on INEGI data

Figure 1 shows the variation of GDP and unemployment from 2019 to 2022, in 2019 there was a variation between unemployment and GDP, because unemployment increased by 3.50% and GDP -0.18%; the increase in unemployment was mainly due to informal workers who were laid off for unknown reasons and the change of government that year, this increase in unemployment affected GDP and for this reason there was a decrease. In 2020 unemployment increased by 0.84% more than the previous year and GDP decreased by -8.25%; this increase in unemployment increased from the month of July, where the cause was the beginning of the quarantine by COVID-19, generating an impact on GDP. In 2021, unemployment decreased by 0.18% and GDP closed with an increase of 11% more than the previous year; unemployment was affected by the pandemic and population losses and GDP increased due to the end of the pandemic.

Closing the period in 2022 with an unemployment rate of 3.27% and a GDP of 2.95%, there was a reduction in unemployment due to the reactivation of the economy and the end of the quarantine, generating an increase in GDP. Okun stated that a country with a higher employment rate will have higher economic growth.

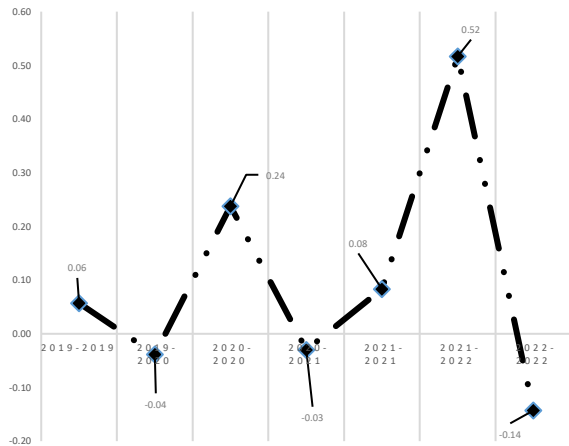


Figure 2 Sensitivity of GDP on the unemployment rate
Source: Own elaboration based on INEGI data

Figure 2 shows the sensitivity of economic growth to the half-yearly unemployment rate for the period 2019-2022, resulting in the first half of 2019 with a sensitivity of 0.06% resulting in an increase in unemployment; in the second half of the year the sensitivity was -0.04% resulting in an increase in employment. In the following year the result of the first half of 2020 was 0.24% increasing unemployment and generating a reduction in economic growth, the second half had an increase in employment of -0.03% of the same year.

The first semester of 2021 obtained a sensitivity of 0.08%, the second semester obtained a sensitivity of 0.52% where there was an increase in unemployment. In 2022, the first half of the year had a sensitivity of -0.14% and the second half closed with a 0.78% increase in the unemployment rate. This analysis shows the sensitivity of GDP to the growth or decrease in the unemployment rate.

In the years 2019 to 2022 the inflation and unemployment rates had unstable behaviours, this because the period had high inflation rates that were generated by the different variations, which indicate the relationship between production and inflation. Analysing all the data, it was observed that there is a positive relationship with the unemployment gap and inflation, in the year 2022 inflation had a higher register than in previous years, obtaining a drop in October of the same year, where a significant reduction in inflation was obtained after the increase in interest and an increase in unemployment (Lopez E. J., 2020).

Inflation in 2022 increased by 2.16% annually, the previous year's rate was 5.73%, as a consequence of these results was reflected in the decrease of the unemployment rate; closing with an average unemployment rate of 3.27% annually in 2022. In the same year there was an increase in wages in Mexico which affected the Mexican economy resulting in an increase in the prices of the basic food basket, the increase in wages aims to increase the purchasing power of Mexicans (INEGI, Indicadores de ocupación y empleo, 2022).

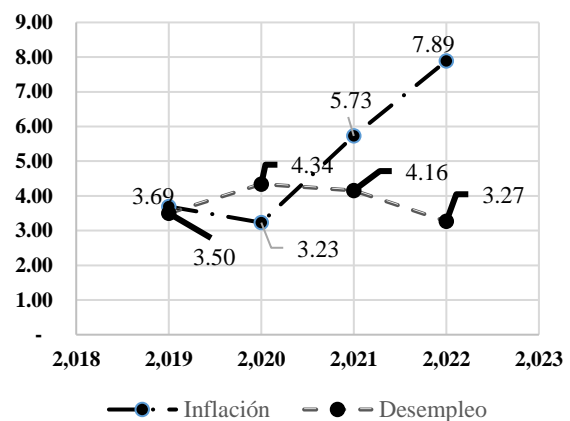


Figure 3 Unemployment rate and change in inflation Mexico
Source: Own elaboration based on data from INEGI and Banco de México

Figure 3 shows the percentage variation of the difference between unemployment and inflation, expressing the difference between unemployment and inflation in the period 2019-2022; in the first year, inflation grew by 3.69% and unemployment increased by 3.50%, the increase generated in that year was caused by the change of government and the decrease in informal employment; in 2020, inflation grew by 3.23% and unemployment decreased to 4.34%, the decrease in inflation was caused by the increase in unemployment.

In 2021 inflation increased by 5.73% and unemployment decreased to 4.16%, the decrease in unemployment was generated by the reactivation of the economy and caused an increase in inflation; in the last year of the period inflation increased by 7.89% and unemployment decreased by 3.27%, the decrease in unemployment caused an increase in inflation in Mexico. Philips stated that in order to have a reduction in inflation a country had to have an increase in the unemployment rate, resulting in a reduction in purchasing power.

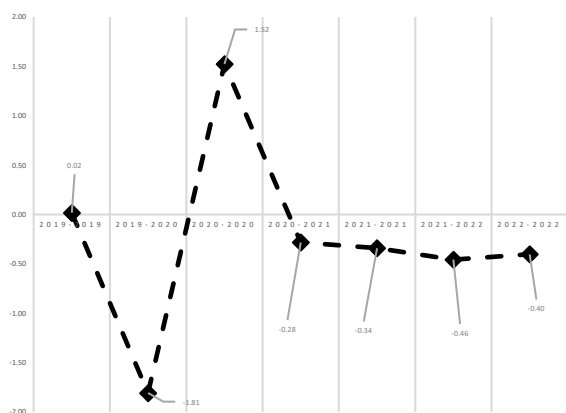


Figure 4 Sensitivity of inflation to the growth of the unemployment rate
Source: Own elaboration based on data from INEGI and Banco de México

Figure 4 shows the sensitivity of inflation to the half-yearly unemployment rate for the period 2019-2022, the first half of 2019 obtained a sensitivity of 0.02% resulting in a reduction of unemployment and a decrease in inflation; in the second half the sensitivity was -1.81% resulting in an increase in employment. In the following year, the first semester of 2020 obtained a sensitivity of 1.52% due to a reduction in inflation; in the second semester the sensitivity was -0.28% for the same year.

In the first half of 2021 the sensitivity was -0.34% due to a reduction in unemployment, the second half of 2021 the sensitivity was -0.46%. In 2022 the first semester obtained a sensitivity of -0.40% which generated an increase in inflation and a decrease in unemployment caused by the end of the pandemic and reactivation of the economy, finally, the second semester closed with -0.40% sensitivity caused by the increase in employment.

A correlation was made between Okun's law and the Phillips curve to establish the relationship between these two methods:

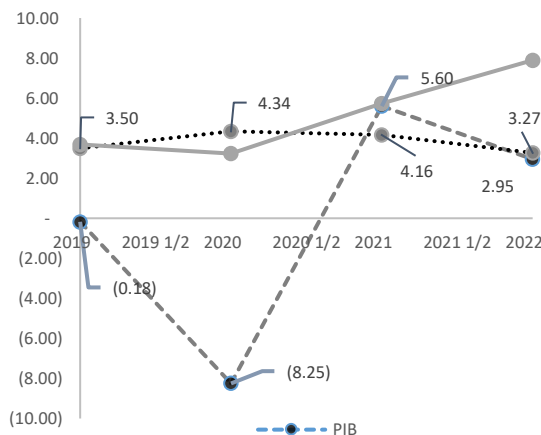


Figure 5 Unemployment rate, GDP and inflation in Mexico
Source: Own elaboration based on data from INEGI and Banco de México

Figure 5 shows the direct relationship between GDP and inflation and unemployment, this is due to the effect it generates, unemployment affects GDP because the decrease in employment will affect economic growth in the country and if there is an increase in unemployment there will be an increase in economic growth; but the opposite happens with inflation, this is due to the amount of money that is handled within the economy and its outflows, this indicates that if there is higher unemployment, inflation will be lower and vice versa.

Annexes

Data of the variables GDP, unemployment and inflation for the period 2019-2022:

Data			
Period	PIB	Unemployment	Inflation
2019	0.18	3.50	3.69
2020	8.25	4.34	3.23
2021	5.60	4.16	5.73
2022	2.95	3.27	7.89

Source: Own elaboration based on data from (INEGI, 2019), (INEGI, 2022) and (Bank of Mexico, 2022)

Semi-annual Okun's law data for the period 2019-2022:

Sensitivity of GDP to unemployment	
Period	Sensitivity
2019-2019	0.06
2019-2020	-0.04
2020-2020	0.24
2020-2021	-0.03
2021-2021	0.08
2021-2022	0.52
2022-2022	-0.14

Source: Own elaboration based on data from (INEGI, 2019), (INEGI, 2022) and (INEGI, 2022).

Half-yearly Phillips curve data for the period 2019-2022:

Unemployment sensitivity to inflation	
Period	Sensitivity
2019-2019	0.02
2019-2020	-1.81
2020-2020	1.52
2020-2021	-0.28
2021-2021	-0.34
2021-2022	-0.46
2022-2022	-0.40

Source: Own elaboration based on data from (INEGI, 2019), (INEGI, 2022) and (Banco de México, 2022)

Conclusions

Given the results, it is concluded that unemployment has direct effects on inflation and economic growth, since these variables will depend on the level of unemployment. Okun's law is fulfilled in the short term in the economy of Mexico in the period 2019-2022, where the year 2021 stands out with greater effects on unemployment, due to the increase that took place in that year and that generated low economic growth. In the Phillips curve is fulfilled for Mexico where the year 2020 stands out, where better results were obtained in inflation with a decrease of 0.27%, which is a reduction of prices in the Mexican economy.

With the analysis completed, it was observed that the model most related to Mexico is the Philips curve, which shows the relationship between unemployment and inflation. The correlation between the 3 variables resulted in a dependence of unemployment that affects economic growth and inflation, contrary to economic growth and inflation, which have an inverse relationship, since it is not possible to have high growth and low inflation.

This result shows the Mundell Fleming model that addresses the imperfect trinity that develops unemployment, economic growth and inflation, resulting in the fact that unemployment cannot be used as an economic stabiliser.

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