La curva de Phillips en México (1980-2019): ¿una muerte anunciada?

The Phillips Curve in Mexico (1980-2019), a death foretold?

A curva de Phillips no México (1980-2019): uma morte anunciada?

Ericka Judith Arias Guzmán
Universidad Nacional Autónoma de México, Facultad de Estudios Superiores Acatlán, México
erickajudith@comunidad.unam.mx
https://orcid.org/0000-0002-1663-9509

Felipe Cruz Díaz
Universidad Nacional Autónoma de México, Facultad de Estudios Superiores Acatlán, México
fel_economista@comunidad.unam.mx
https://orcid.org/0000-0003-0600-6940

Karla Estefanía Barcellos
Investigadora independiente
karla.barcellos.eco@gmail.com
https://orcid.org/0000-0002-9861-7257

Resumen

La curva de Phillips ha sido utilizada para tomar decisiones importantes en la política monetaria. En el presente artículo, mediante un modelo estructural de vectores autorregresivos (SVAR por sus siglas en inglés), se estima la curva de Phillips para el caso de la economía mexicana durante el periodo 1980-2019. Pese a que algunos autores afirman que existe una relación inversa entre la tasa de desempleo y el nivel de los precios, dicha relación no es clara para la economía mexicana debido a que, desde finales de la década de los ochenta, la política monetaria ha estado dirigida a la estabilidad o control de precios sin que haya un resultado favorable en la generación de empleo.

Palabras clave: curva de Phillips, desempleo, inflación, modelo estructural de vectores autorregresivos, precios.

Abstract

The objective of this paper is to estimate the Phillips Curve for the case of the Mexican economy to the period 1980-2019 using a structural model of autoregressive vectors (SVAR). This Curve has been the subject of great debate as to the importance it has for monetary policy decision-making in the world economies. Some authors agree with the statement that there is an inverse relationship between the unemployment rate and the Price level. However, this relationship is not clear for the Mexican economy due to the fact that since the end of the eighties, monetary policy has been directed at controlling prices without a favorable result in the generation of employment.

Keywords: Phillips Curve, unemployment, inflation, SVAR model, prices.

Resumo

A curva de Phillips tem sido usada para tomar decisões importantes na política monetária. Neste artigo, usando um modelo de vetor estrutural autorregressivo (SVAR), a curva de Phillips é estimada para o caso da economia mexicana durante o período 1980-2019. Embora alguns autores afirmem que existe uma relação inversa entre a taxa de desemprego e o nível de preços, essa relação não é clara para a economia mexicana porque, desde o final dos anos 1980, a política monetária tem sido voltada para a estabilidade ou controle de preços sem um resultado favorável em. criação de emprego.

Introduction

W. Phillips (1958) showed that there was an inverse relationship between the growth of money wages (and prices) and the unemployment rate for the UK. For this reason, for the analysis of the relationship of these variables, the inverse of the unemployment rate was used as an indicator of excess labor demand in order to expose the possibility that inflation is considered as a variable in estimating the level of employment. unemployment and, therefore, of the product (Mántey, 1997).

The success of the Phillips curve is due to its analytical ability to adjust to different theories that have been developed about inflation. In some studies, it was estimated for other countries and similar results were obtained to those of the United Kingdom, and they were interpreted as indicators of the potential of monetary and fiscal policies to accelerate growth (Rodríguez, Ludlow and Peredo, 2004).

The estimates in these countries were used for decision-making regarding economic policy in order to establish stable inflation and unemployment targets that would allow the output level to be boosted.

In this sense, they assumed that the behavior of said curve would be vertical in the long term, which meant that at a natural rate of unemployment (NAIRU) inflation would remain constant because it would coincide with full employment of the productive factors (Dorta, Álvarez and Zavarce, 2001).

In order to make estimates in the different economies and to facilitate their approach, in the Phillips curve the wage equation was replaced by one of prices. In this way, the unemployment levels compatible with a certain inflation target could be derived from the slope of said curve. Currently, the debate centers on the assertion that, for each economy, there is a level of employment or unemployment that does not necessarily accelerate inflation.

The objective of this work, therefore, is to estimate the Phillips curve for the Mexican economy in the period 1980-2019 using an SVAR model. For this, this work is divided into three sections.

In the first, a brief presentation is made of the theoretical-historical development of the discussion on the Phillips curve, as well as the empirical results for some countries; In the second section, given that one of the variables of the Phillips curve is inflation, the relationship between the interest rate as an intermediate objective of monetary policy and the exchange rate is analyzed. This is to achieve price stability in Mexico that has been applied since the eighties. Finally, the third section presents the methodology and the SVAR econometric model that was used to estimate the Phillips curve in the case of Mexico during the period 1980-2019.

Theoretical-historical development of the discussion and empirical evidence on the Phillips curve

The publication of Phillips' work in 1958, entitled The relation between unemployment and the rate of change of money wages in the United Kingdom, sparked a great debate that continues. Phillips' analysis is based on the assumption that there is a shortage of labor in the labor market, which implies that in order to increase the level of output, the level of nominal wages must be increased, which in turn will increase the wage rate. ; on the contrary, when unemployment increases, the wage rate decreases slowly, which would determine an inverse relationship between unemployment and the rate of change in wages (Phillips, 1958).

Theoretical-historical development of the Phillips curve

Under the analytical framework presented in the previous section, Phillips carried out an empirical study for England in which he considered the relationship between the variables money wage and unemployment for a period of 96 years. This divided it into different stages delimited by the various historical-economic processes that took place during that time. The model that he estimated was a regression by the ordinary least squares method as follows:

$$Y + a = bX^c$$

that when applying a logarithmic transformation it was as follows:

$$\log(Y + a) = logb + clogX$$

As Y is the rate of change of wages; X is the percentage of unemployment, and a, b and c they are constant.

In this study, it was concluded that the rate of change of unemployment determines the rate of monetary changes, but it is pointed out that this conclusion is relative, since it should be deepened in the analysis of the relationship between unemployment, the rate of wages, prices, and productivity (Phillips, 1958).

On the other hand, as mentioned in Rodríguez et al. (2004), Lipsey (1960) argued that the changes in prices corresponded to the behavior of wages, in such a way that the curve was reformulated in terms of the inverse relationship between the price change rate and the unemployment rate. For their part, Samuelson and Solow (1960) carried out a similar study for the United States economy considering the period 1900-1960, where they start from the contributions of Lipsey (1960) and arrive again at the inverse relationship between inflation and unemployment. previously detected in the empirical tests of Phillips in 1958. It was from this confirmation that the relationship between inflation and unemployment rates was called the Phillips curve.

For their part, Friedman (1967) and Phelps (1968) contributed to the discussion of the Phillips curve by returning to the classic argument where equilibrium in the labor market depends on the real wage, and not on the nominal wage. In this way, an excess demand in the labor market is resolved by increasing the real wage, and not the nominal wage. Starting from the concept of the natural rate applied by Wicksell to the interest rate, these economists postulated the presence of a natural rate of unemployment to affirm that a reduction in unemployment through expansionary policies would cause higher rates of inflation.

This new conception of the traditional Phillips curve prevailed until the 1970s when the analysis of expectations as another determinant of prices was incorporated into the debate. This curve was called the expectations-augmented Phillips curve.

Later, the development of rational expectations in the works of Muth (1961), Lucas (1973), Sargent (1973) and Sargent and Wallace (1975) contributed to reinforcing the Friedman-Phelps approach by stating that the rational behavior of Economic agents allowed them to anticipate the inflationary effect of the expansionary policy, in such a way that the incorporation of these expectations into their wage negotiations ensured that the real wage remained in equilibrium. This statement implied that the Phillips curve was vertical, with which the discussion minimized the impact of fiscal policy to stimulate the growth of

output and employment (this arguing that any increase in government spending would generate an inflationary effect without any effect). at the long-term product level).

On the other hand, with the contribution of James Tobin (1972) a price equation and a wage equation were elaborated, and he focused on the analysis of the effects of the wage-price relationship on the dynamics of aggregate supply. In this regard, he concludes that a change in labor productivity as a consequence of movements in unemployment is a component that supports the idea of a constant markup useful to explain acyclic movements in wages.

At present, the discussion around the Phillips curve has regained importance because some economists consider that it is an important instrument in the design and decision-making of economic policy.

In the case of the New Keynesian school, its analysis focuses on the character of the non-linearity of said curve. In this regard, in the works of Calvo (1983), Schaling (1999), Mankiw (2001) and Colombo and Weinrich (2003) it is argued that price rigidity prevents the classical equilibrium of the labor market from being fulfilled.

In the research carried out by Okun (1962) an important analytical element is introduced in the Phillips curve, since it analyzes the relationship between unemployment and the product from the concept of the output gap instead of the gap in the output gap. unemployment (Okun's law). The first represents the difference between the observed and potential product levels. The potential product is measured by the level of product consistent at a certain inflation rate that is a function of the productive capital in existence; the second represents the observed deviations of the unemployment rate with respect to the natural rate. This rate is the one that is maintained when prices and wages are incorporated, and is also known as NAIRU.

For several decades, the Phillips curve has been used by decision-makers of economic policy and particularly of monetary policy, since through its estimation the inflationary target is set. In this sense, it is stated that the inflation rate will be stable as long as the observed product is equal to the product; otherwise, if the observed output level is above potential output, the monetary authority will intervene to reduce inflationary pressures. On the other hand, if the observed product level is below the potential product, product growth can be stimulated without compromising the price level.

From a Keynesian perspective, the level of inflation is determined by the level of the output gap, since it is assumed that an increase in inflation is the result of a reduction in it, despite the fact that the level of output does not grow above output. potential. Indeed, it is estimated that the increase in prices may be more pronounced in the growing phase of the economic cycle than in the deceleration observed when the output gap is negative. This idea is based on the Keynesian position that the curve is almost vertical when it is close to the level of potential output (Laguna, 2007).

On the other hand, Fisher argues that nominal interest rates are indicators of inflation expectations and, therefore, a useful tool for what he calls the correct application of monetary policy. In this sense, if it is considered that the Central Bank aims to stabilize the inflation rate in the medium and long terms, it is essential that the monetary authority knows the inflation expectations of the agents, and if the Fisher effect is fulfilled, the Nominal interest rates will become the ideal instrument for the correct application of monetary policy.

Empirical evidence for the existence of the Phillips curve

López and Misas (1999) estimated the linear Phillips curve in Colombia, where they presented empirical evidence on the nature of the trade-off between output and inflation in that country, and showed the possibilities that exist to improve the estimation of a linear Phillips curve.

Other works such as Muñoz, Rojas, Sáenz and Tenorio (2003) estimated the expectations-augmented Phillips curve for Costa Rica using the error correction method, applying a technique suggested by Engle and Granger (1987). The study concludes that 90% of the behavior of inflation was the result of the behavior of the nominal devaluation rate, the external inflation rate, the output gap and lagged inflation.

For his part, Morales (2004) estimated a VAR model to investigate the effect of monetary factors on inflation in the euro area on the supply side. From the results they reached three conclusions: 1) a significant persistence of inflation in the euro area; 2) domestic costs are a fundamental determinant of inflation, on the supply side of the euro area economies, and 3) inflation in the short term had a cyclical behavior. The estimated coefficient for the error correction mechanism is very small. This implies that prices adjust

very slowly in the face of variations, so that equilibrium is gradually reestablished. (Laguna, 2007).

Rico (1999) analyzed the Fisher effect and the real interest parity for the Spanish economy from 1982 to 1998 using the time series methodology, particularly the Johansen procedure to differentiate the short- and long-term effects. The work concludes that the Fisher effect is fulfilled in the long term adjusted for taxes, and not for real interest parity. During the period considered, interest rates anticipated the future behavior of the inflation rate and were used to set long-term inflation targets. Despite this effect, it was not fulfilled for the short and medium term, and the interest rate influenced consumption and investment decisions.

In the work of Rodríguez et al. (2004) estimates were made for Mexico with monthly data from 1987 to 2003 and the expanded Phillips curve with adaptive expectations as follows:

$$\pi_t = \beta_1 \pi_{t-1} - \beta_2 (u_t - u^*) + v$$

as, π_t is current inflation, π_{t-1} past inflation, v the error term and u^* as a constant.

The results obtained in this study presented statistical difficulties because inflation behaved stationary, and unemployment was non-stationary; A step function was considered to obtain a correct and statistically robust estimate.

On the other hand, the numerical estimates of the unemployment rate show that it is higher in periods where inflation is high; however, the observed unemployment was lower than the NAIRU rates. This is a consequence of the containment of wages that the Mexican authority has promoted since the eighties due to the objective of inflationary targets that has depressed aggregate demand.

Subsequently, these same authors, in 2006, proposed an equation and measurement of the unemployment level using the Phillips curve as a conceptual framework for Latin American countries (Argentina, Brazil, Colombia, Chile and Mexico) based on the assumption of price stability in the framework of economic and financial liberalization.

They estimated a panel data model for these countries and concluded that there is evidence to configure the Phillips curve; However, they recognized that the model is robust because the inverse relationship between inflation and unemployment is not obtained with other specifications.

On the contrary, in the work of Loría, Valdez and Tirado (2019) the NAIRU is estimated through the generalized model of moments with the methodology of Ball and Mankinw (2002). With this they showed that the relationship between unemployment and inflation has strengthened in recent years.

Monetary policy in Mexico. The interest rate as an intermediate objective of monetary policy and the exchange rate as a transmission mechanism of monetary policy

Starting in 1982, the band strategy was implemented in Mexico with the purpose of maintaining an undervalued nominal exchange rate to boost exports and promote import substitution that would cause the current account deficit of the balance of payments to remain stable with the increase in the level of exports. However, the design of monetary policy was subordinated to the inflationary effect of the devaluation because the higher the margin of undervaluation, the greater the pressure on prices. Indeed, it was expected that, with a surplus in the trade balance and high real interest rates, the main components of aggregate demand (consumption and investment) would decrease, thereby reducing price pressures. In this sense, while the undervalued exchange rate made it possible to face external pressures, the policy of high interest rates fed the pressures on prices. Faced with this situation, the devaluation of the peso was imminent at the end of 1987 with the consequent increase in the price level.

Starting in 1988, the exchange rate was adopted as a nominal anchor that sought to influence inflation expectations, for which the exchange band mechanism was implemented to allow the nominal exchange rate to be kept stable, as shown in figure 1 The stability of the exchange rate was achieved through sterilization operations, while the variations in liquidity were offset through net domestic credit. (Cruz, 2006).

Figura 1. Tipo de cambio nominal e inflación, 1980-2019 (promedios mensuales)
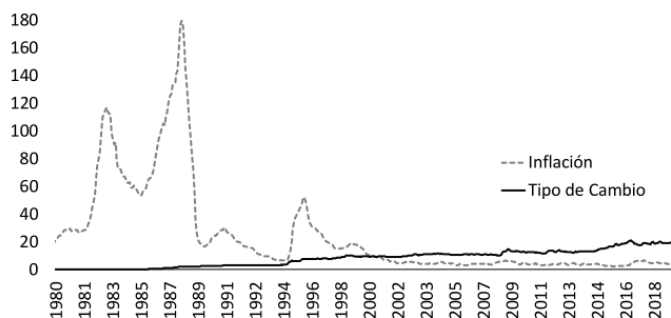
Fuente: Elaboración propia con datos del Inegi y del Banco de México

Figure 2 shows how since the decade of the nineties the internal debt is significant. Particularly in 2001, a period of growth began as a monetary policy measure to contain inflation. Indeed, debt is used as a compensatory mechanism to maintain the level of international reserves with an increasing trend in order to stabilize inflation and achieve the monetary policy objective.

Figura 2. Deuda interna y cetes, 1990-2019 (cierres anuales y variaciones)
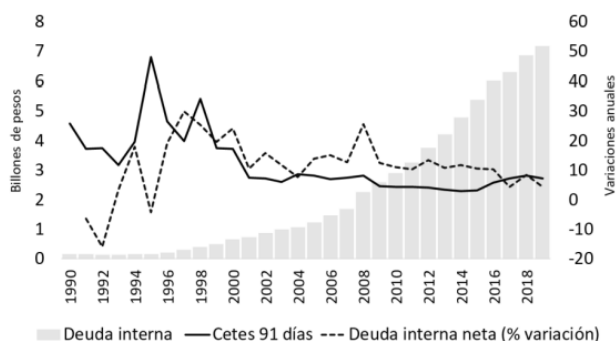
Fuente: Elaboración propia con datos del INEGI y de la Secretaría de Hacienda y Crédito Público

In recent years, due to the behavior of inflation and the need to equate domestic interest rates with international ones, Banco de México has been forced to use restrictive monetary measures to achieve the objective of price stability. The trend shown by the exchange rate and the inflation rate, as well as the behavior of international interest rates, have influenced the management and design of monetary policy. Although the short-term interest rate influences the first saving and investment decisions, it is true that in the case of Mexico the exchange rate is the main transmission mechanism of monetary policy (Levy, 2001).

This explains the reason why, since the late 1980s, Banco de México has used interest rates as an intermediate monetary policy instrument and the exchange rate as a price stabilizing mechanism.

In this regard, several studies carried out for the case of Mexico have shown the close relationship that exists between the devaluation rate and the inflation rate (Mántey, 2005; Ros, 1979), that is, the transmission mechanism of monetary policy is based on the exchange rate.

Figure 3 shows the close relationship that exists between the undervaluation or overvaluation rate and the inflation rate, and how both show the same trend, suggesting a cointegration in the long term.

Figura 3. Índice de sub/sobrevaluación del tipo de cambio e inflación anual, 1980-2019
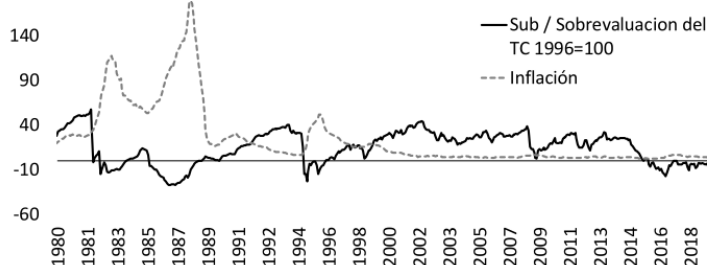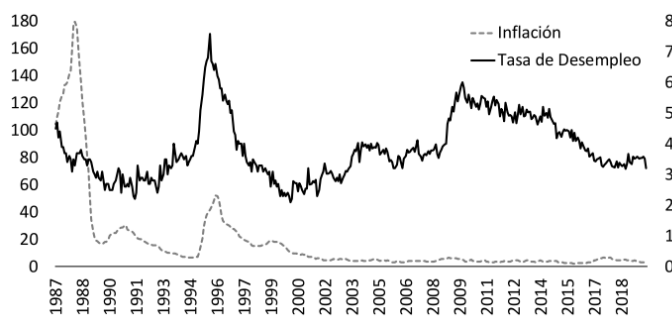

Fuente: Elaboración propia con datos del INEGI, del Banco de México y del Federal Reserve Bank of St. Louis, EE. UU.

Overvaluation or undervaluation is the difference in percentage points between the nominal exchange rate and the theoretical exchange rate. In this exercise, the base year is 1996. The negative sign shows an undervaluation of the peso against the dollar and, on the contrary, the positive sign reveals an overvaluation.

For its part, during the period from 1980 to 2019, the Phillips curve in Mexico has shown a positive slope (figure 4). This means that as inflation increases, unemployment is higher. The highest and longest-lasting inflation rates in Mexico occurred in the 1980s: in 1982 due to the debt crisis; in 1987 due to the problems caused by the fall in the Stock Market, as well as the pressures at the international level; in 1995 due to the financial crisis; and in 2009 due to the real estate crisis originating in the United States. Figure 4 shows the behavior of these variables, highlighting that they present the same trend, that is, that there is a positive relationship between the unemployment rate and inflation.

Figura 4. Inflación y desempleo en México 1987-2019

Fuente: Elaboración propia con datos del INEGI y la OCDE

During the last twenty years, although it is not clear, a relationship can also be observed between the variables, so it could be deduced that the relationship occurs in short periods, but not in the long term or in a sustained manner (see the graphs correlation, figure 5).

Figura 5. Curva de Phillips en México, periodos 1980-2019 y 2008-2019
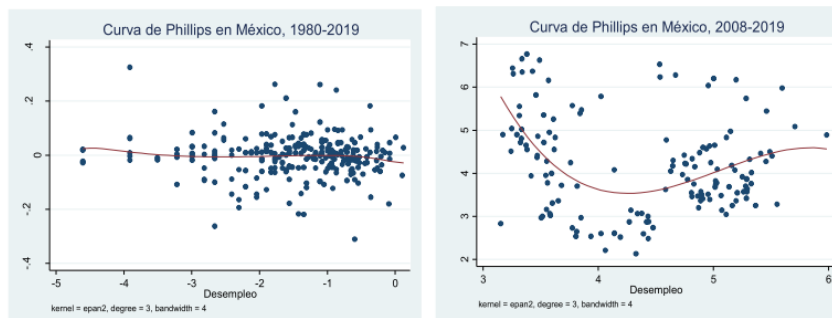
Fuente: Elaboración propia con información del modelo

Figure 6 shows the relationship between the real minimum wage, that is, the deflated minimum wage, and unemployment. It should be noted that the inverse relationship between wages and unemployment that Phillips originally argued for the case of Mexico is observed in the period from 1980 to 1995; however, in the following years there is a clear unleashing between these variables.

Figura 6. Desempleo y salario real, 1980-2019

Fuente: Elaboración propia con datos del INEGI y la Secretaría de Hacienda y Crédito Público

The validity of the Phillips curve in Mexico: estimation using an SVAR model

The SVAR methodology is estimated when the variables analyzed are not integrated with each other and the data series are stationary (Schenck, 2016). These aim to define dynamic responses in the economic variables that are analyzed, making use of the information contained in the time series and economic theory (Ramos, 2000).

Traditional VAR models are used on self-explanatory variables, that is, on endogenous variables. In some cases with deterministic regressors, but they do not integrate economic theory into the modeling (Amisano and Giannini, 1997). The advantages of the SVAR models are that, in addition to establishing the dynamic responses, they allow explicit modeling that identifies the interdependence between the variables (Forni and Gambetti, 2014), highlighting the analysis of the variance decomposition and the impulse response functions. .

To carry out this type of exercise, the SVAR methodology is used, with which the original structural parameters are recovered through combinations of structural disturbances that, in our case, were presented through monetary and exchange policy shocks that allow defining the restrictions of short and long term in our models.

Database

In a first approximation, this study analyzes the monthly series of the inflation and unemployment rates for Mexico in order to observe the relationship between them in the long term for the period from 1980 to 2019.

In a second model, the variables exchange rate and interest rate are added in order to identify the differences in the dynamics established in the first model. For the second model, the period is limited to the years 2008 to 2019 to have homogeneous data published by the National Institute of Geography and Statistics in the National Occupation and Employment Survey (ENOE), as well as to take into account the period in which the Bank of Mexico has implemented the target interest rate as part of the monetary policy in the country.

For the econometric estimates, information on macroeconomic variables published by the National Institute of Geography and Statistics (INEGI), the Bank of Mexico and the Organization for Economic Cooperation and Development was used. The variables were obtained in rates and were transformed to the natural logarithm and, in some cases, to first differences. The data of the series are monthly and comply with the basic and fundamental stationarity principle for its econometric modeling (see figure 7).

Figura 7. Análisis de las series en tasas y pesos. En logaritmos naturales y primeras
diferencias
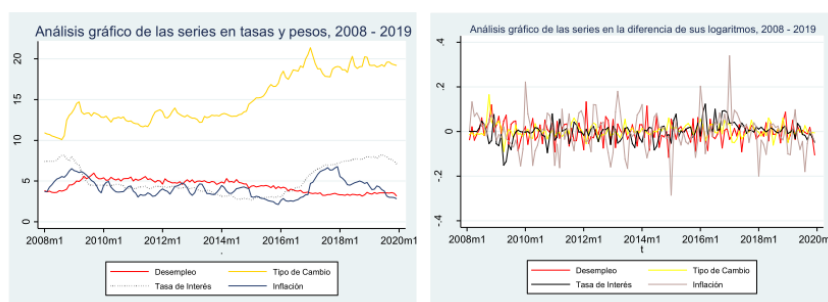
Fuente: Elaboración propia con información del modelo

The variables used in the model are listed in table 1:

Tabla 1. Características de las variables

Variable	Características
Inflación	Se empleó la tasa de inflación anual como variable para representar el nivel de precios prevaleciente en México.
Desempleo	Representa la tasa de desempleo en México presentada por la OCDE.
Desempleo-ENOE	Representa la tasa de desempleo en México medida por la ENOE.
Tipo de cambio	Representa el índice de tipo de cambio promedio de México.
Tasas de interés	Es la tasa de interés nominal de los Cetes a 28 días.
Postcrisis	Variable dummy que representa cambios estructurales derivados de la crisis económica mundial.
Trump	Variable dummy que representa los cambios derivados de las elecciones presidenciales en Estados Unidos.
Objetivo	Variable dummy que representa los movimientos en la tasa de interés objetivo por parte del Banco de México.

Fuente: Elaboración propia

Model 1. Phillips curve for Mexico 1980-2019. Long-term constraints in an autoregressive vector structural model

For the first model, the long-term restrictions are established for a structural model of autoregressive vectors for the variables inflation and unemployment, which present two shocks (of our variables on the other and on themselves). It is contemplated that the response of the variables to shocks in the long term must be zero, since the variables are stationary. In addition, the restriction is established that, in the long term, unemployment has no effect on inflation; therefore, according to Schenk (2016), the response impulses will be zero. In this way, the "inflshock" shock is defined as one that leads to a change in the level of inflation and the "desemshock" shock is defined as one that does not change the level of inflation in the long term, which occurs as follows:

$$A(L)\begin{bmatrix} \Delta inf_t \\ desem_t \end{bmatrix} = \begin{bmatrix} e_{t^{inflashock}} \\ e_{t^{desemshock}} \end{bmatrix} \dots\dots\dots\dots\dots\dots\dots\dots\dots (1)$$

where L is the delay operator and A (L) is the polynomial delay. Then:

$$\begin{bmatrix} \Delta inf_t \\ desem_t \end{bmatrix} = C(L)\begin{bmatrix} e_{t^{inflashock}} \\ e_{t^{desemshock}} \end{bmatrix} \dots\dots\dots\dots\dots\dots\dots\dots (2)$$

where C (L) is a two-by-two matrix that captures the long-term responses.

The following is the interpretation of the graphs that show the impulse and response functions for the unemployment and inflation variables for the case of Mexico, in terms of

the growth rate of our variables specified in the SVAR model. In the first row, it is observed that in the face of an unemployment shock, inflation increases in the first months, but falls significantly during the following periods, and then returns to its stationary value and increases a little. In the bottom row it is observed that in the face of an inflation shock, unemployment initially rises, returns to its initial value in the first period, maintains the same behavior in the second period and increases during the next three to stay slightly above its stationary value.

In the case of the functions observed in their accumulated impulses, in the first part we observe that inflation increases with the impact in the first periods and falls and then returns to its stationary value, a behavior that is repeated in the second case. Based on the above, although a momentary reaction could be observed, no elements were found to ensure the existence of the Phillips curve in the long term for Mexico in the analyzed period (see graphs of impulse and response functions, and impulse function and cumulative response, figure 8).

Figura 8. Funciones de impulso y respuesta y función de impulso y respuesta acumulada para las variables de *desempleo* e *inflación* para el caso de México
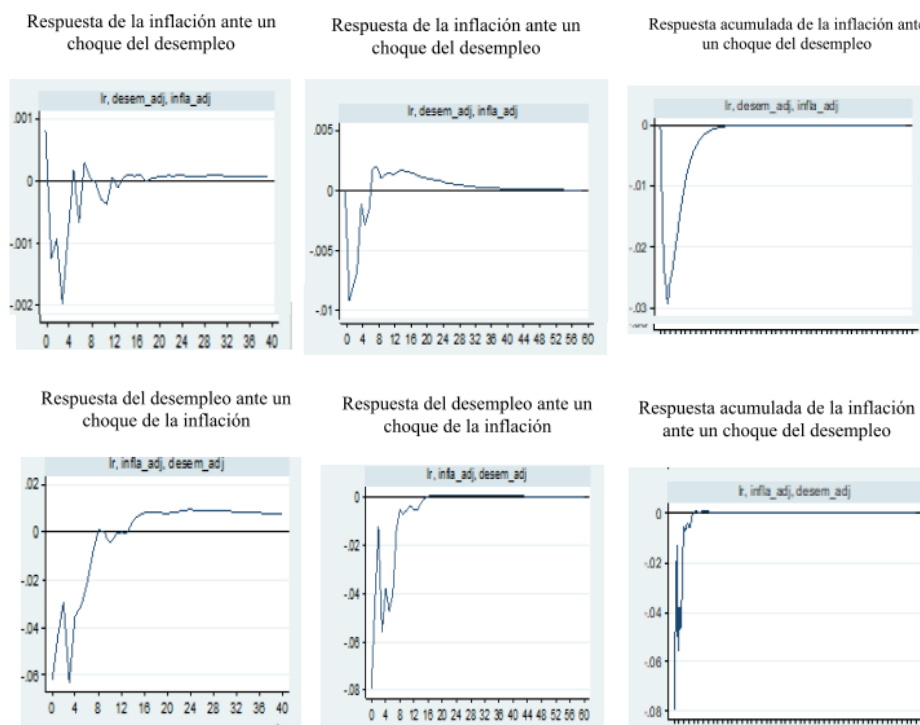
Fuente: Elaboración propia con los datos del modelo planteado

Model 2. Phillips curve, interest rate and exchange rate for Mexico 2008-2019. Structural model of autoregressive vectors

In this second model, the degree of interdependence between the interest rate and the exchange rate is analyzed for the case of Mexico, using the period from 2008 to 2019, the period in which Banco de México has implemented the target interest rate. as part of the monetary policy in the country. Next, the results of the estimation of the SVAR model with four equations and twelve lags are presented, and two structural cuts are considered. One for the period from July 2008 to April 2009 and another for the period from January 2017 to August 2018. In addition, the model integrates a dummy variable to indicate the movements in the target interest rate; This variable takes the value 1 in the case of the months in which this variable has been modified as part of Banco de México's monetary policy.

For the econometric estimates, information from macroeconomic variables published by INEGI and Banco de México was used. The variables were obtained in rates and were transformed to the natural logarithm and, in some cases, to first differences. The data of the series are monthly and all the series comply with the stationarity principle and the model complies with the joint tests.

The model complies with the assumptions of normality, heteroscedasticity and autocorrelation and is a stable model. Regarding normality, the model does not integrate the Jarque-Bera test because the "dfk" tool was used in estimating the SVAR, which is an econometric option that adjusts the degrees of freedom for small samples, giving by assuming the principle holds. This technique is used in cases like ours in which little data was available to make the corresponding estimates (StataCorp, 2013). Through the Portmanteau test, it was possible to show that contemporary innovations squared behave like white noise. Furthermore, according to the Lagrange multiplier statistical test, there is no autocorrelation between the residuals of the presented simultaneous equations model. Finally, all the values were found within the unit circle, so the model meets the stability conditions (see tables 2, 3 and 4).

Tabla 2. Pruebas Dickey-Fuller-aumentada para variables adicionales

Variable	$Z(t)$	1 % valor crítico	5 % valor crítico	10 % valor crítico	Significancia
Desempleo	11.104	4.026	3.445	3.145	*
Inflación	7.729	4.026	3.445	3.145	*
Tipo de cambio	8.262	4.026	3.445	3.145	*
Tasa de interés	7.066	4.026	3.445	3.145	*
*Significativos al 1 %, 5 % y 10 %					

Fuente: Estimación elaborada con datos del Inegi y del Banco de México

Tabla 3. Prueba del multiplicador de Lagrange

Número de retardo	chi^2	$Prob > chi^2$
1	22.5412	0.12656
2	21.5494	0.15835
3	15.9867	0.45389
4	18.9011	0.27383
5	10.9793	0.81076
6	17.539	0.35157
7	18.8415	0.27697
8	13.1109	0.66463
9	17.4758	0.35547
10	14.0365	0.596
11	15.4511	0.49188
12	9.3061	0.90027

Fuente: Elaboración propia con base en los resultados del modelo

Tabla 4. Prueba estadístico Portmanteau

	Estadístico Portmanteau	$Prob > chi^2$
Desempleo	0.1114	0.7385
Inflación	0.2354	0.6275
Tipo de cambio	0.0117	0.9137
Tasa de interés	0.4791	0.4888

Fuente: Elaboración propia con base en el modelo

Results

Next, the interpretation of the graphs showing the impulse and response functions is presented (see impulse-response graphs, figure 9) for the variables unemployment, inflation, exchange rate and interest rate for the case of Mexico, this in terms of the growth rate of the variables specified in the SVAR model. The values of the coefficients represent the percentage change in the variables corresponding to an impulse.

Figura 9. Funciones impulso respuesta
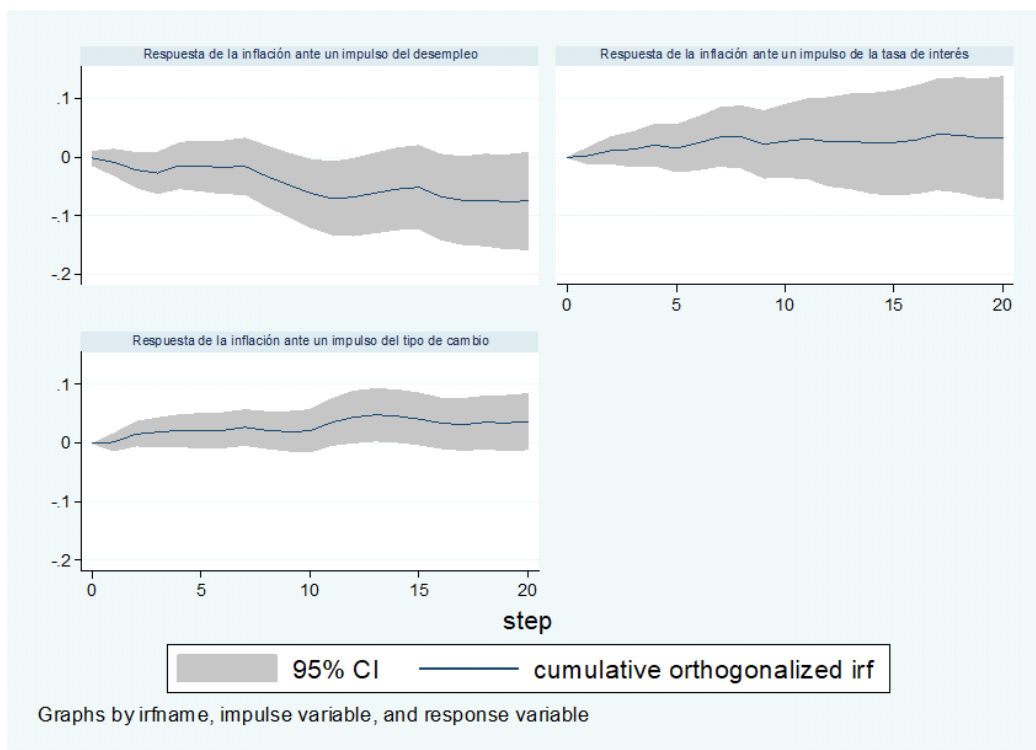
Fuente: Elaboración propia con los datos del modelo planteado

According to the observed responses, inflation responds slightly to the shocks of the variables analyzed. Faced with a boost from unemployment, inflation falls marginally during the first periods and then returns to its average. Regarding the responses, considering the momentum of the interest rate and the exchange rate, it is observed that inflation increases and maintains growth for several periods before returning to its average. Contrary to expectations, the model shows that an interest rate shock increases inflation slightly, although in the long term it is once again close to its average.

In this document, two SVAR models were presented to analyze the Phillips curve in Mexico. In the first, a two-equation model was analyzed, focused on analyzing the long-term restrictions in a structural model of autoregressive vectors in which it is observed that

the curve does not appear in the long term. In the second, an SVAR model of four equations was made in which, in addition to the variables of unemployment in inflation, the variables of interest rate and exchange rate were used. The results of the second model showed a weak Phillips curve with a greater response of inflation to shocks caused by the exchange rate and the interest rate than unemployment.

Conclusions

The Phillips curve measures the ratio of fundamental variables of an economy. For this reason, the debate regarding this has been controversial since its inception. The original proposal of this curve and its theoretical evolution has developed the analysis of inflation and unemployment as determining variables for making economic policy decisions.

With the estimation of the SVAR model with the variables inflation and unemployment, it was shown that the Phillips curve for Mexico occurs only in the short term. When the model was estimated, including the variables interest rate and exchange rate, it was found that these are the ones that explain the movements in inflation.

In Mexico, the central bank has applied a restrictive monetary policy in order to keep the price level stable, particularly the interest rate and the exchange rate.

The close relationship that exists between the overvaluation of the exchange rate and the low level of inflation shows that this strategy is the one that has become the main mechanism for controlling prices, particularly inflation.

For all this, and unlike some studies, it was shown that the Phillips curve does not hold for the case of Mexico in the long term, in the study period 1980-2019.

Future lines of research

Despite the fact that there are no models that prove the existence of the Phillips curve, the Mexican central bank continues to take this tool into account in its management of monetary policy, in which its main objective is inflation control. However, in the last year, due to the economic crisis generated by COVID-19, central banks have adopted expansionary policies, with increases in fiscal stimuli, relaxed interest rates and allowing a higher inflation rate.

This leads us to consider that the Bank of Mexico should set aside that a higher employment rate will increase price levels, which would give rise to the central bank

having a double mandate, not only with special attention to inflation, but also in the search for full employment. The foregoing gives rise to the following lines of research:

- Determinants of inflation in Mexico in a context of inflation control, 1994-2021.

- Keynesians, Post-Keynesians and New Keynesians in Mexico, an analysis of methodologies and results, 2000-2020.

- Inflation expectations in Mexico: analysis of the words in the announcements and minutes of monetary policy, 1994-2021.

  - Adaptation of monetary policies during the covid-19 crisis, international experiences of Mexico, the United States and Canada, 2019-2021.

References

Amisano, G. and Giannini, C. (1997). *Topics in Structural VAR Econometrics* (2nd ed.). Heidelberg: Springer.

BALL, L. and MANKIW, G. M. (2002). The NAIRU in theory and practice. The Journal of Economic Perspectives, 16(4), Autumn, 115-136.

Calvo, G. (1983). Staggered prices in a utility-maximizing framework. *Journal of Monetary Economics, 12*(3), 983-998.

Colombo, L. and Weinrich, G. (2003). The Phillips Curve as a long run phenomenon in a macroeconomic modelo with complex dynamics. *Journal of Economic Dynamics & Control*, *28*(1), 1-26.

Cruz, F. (2006). *La política monetaria y el tipo de cambio: el mecanismo de estabilidad monetaria en México (1988-2005)* (tesis de maestría). México: FES-Acatlán.

Dickey, D. A. and Fuller, W. A. (1981). Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root. *Econometrica*, (49).

Dorta, M., Álvarez, F. y Zavarce, H. (2001). *Curva de Phillips de mediano plazo*. Venezuela: Banco Central de Venezuela. Oficina de Consultoría Económica.

Engle, R. and Granger, W. (1987) Cointegration and Error Correction: Representation, Estimation and Testing. Econometrica, 55:251–276.

Forni, M. and Gambetti, L. (2014). Sufficient information in structural VARs. *Journal of Monetary Economics, 66*(C), 124-136.

Friedman, M. (1967); "The Role of Monetary Policy"; American Economic Review, marzo, pp. 1- 17.

Laguna, Ch. (2007). Dinámica inflacionaria y brecha en la producción. La curva de Phillips en México. *Análisis Económico*, *22*(50), 121-147.

Levy, N. (2001). *Cambios institucionales del sector financiero y su efecto sobre el fondeo de la inversión en México, 1960-1994*. México: Facultad de Economía UNAM.

Lipsey, R. G. (1960). The relation between unemployment and the rate of change of Money wage rates in the United Kingdom, 1862-1957: A further analysis. *Economica*, *27*, 283-299.

López, E. y Misas, M. (1999). *Un examen empírico de la curva de Phillips en Colombia*. Colombia: Banco de la República de Colombia.

Loria, E., Valdez, J. y Tirado, R. (2019). Estimación de la NAIRU para México, 2002Q1-2018Q2. *Investigación Económica, 78*(308).

Lucas, R. (1973). Econometric testing of the natural rate hypothesis. In Eckstein, O. (ed.), *The econometrics of price determination conference*. Board of Governors of the Federal Reserve System y Social Research Council, Washington D.C.

Lucas, R. (1973). Some international evidence on output-inflation trades off. *American Economic Review*, (63), 326-334.

Mankiw, N. (2001). The inexorable and mysterious trade-off between inflation and unempleoyment. *Economic Journal* (111), 45-61.

Mántey, G. (1997). *Lecciones de economía monetaria*. México: Ed. UACP y P-UNAM-Acatlán.

Mántey, G. (2005). La política monetaria en México y la tasa de interés real. *Investigación Económica*, (211).

Morales, A. (2004). *La inflación en la zona del euro: un análisis desde el lado de la oferta*. España: Sector Exterior Español.

Muñoz, E., Rojas, Sáenz y Tenorio, E. (2003). *La curva de Phillips en Costa Rica*. Banco Central de Costa Rica. Departamento de Investigaciones Económicas. Documento de Investigación.

Muth, J. F. (1961). Rational Expectations and the Theory of Price Movements. *Econometrica*, *29*(3), 315-335.

Okun, A. (1962). Potential GNP & Its Measurement and Significance. *American Statistical Association, Proceedings of the Business and Economics Statistics Section,* 98-104.

Phelps, E. (1968). Money-Wage dynamic and labor-market equilibrium. *Journal of Political Economy*, *76*(S4).

Phillips, A. W. (1958). The relation between unemployment and the rate of change of money wages in the United Kingdom, 1861-1957, *Economica, 25*(100), 283-299.

Ramos, R. (2000). *Objetivos e instrumentos de política económica: una aplicación a México.* México: Fondo de Cultura Económica.

Rico, P. (1999). *El efecto Fisher y la paridad de interés real. Evidencia para la economía española*. España: Instituto Valenciano de Investigaciones Económicas A.C. Universidad de Valencia.

Rodríguez, P., Ludlow, J. y Peredo. F. (2004). La curva de Phillips y la NAIRU en México. *Economía, Teoría y Práctica,* (20), pp. 83-102.

Ros, J (1979). Inflación: la experiencia de la década de los setenta. *Economía Mexicana*, (1).

Samuelson, P. and Solow, R. (1960). Analytical aspects of Anti-inflation Policy. *American Review*.

Sargent, T. J. (1973). Rational expectations, the real rule of interest, and the "natural" rate of unemployment. *Brookings papers on Economic Activity*, *2*, 429-472.

Sargent, T. J. and Wallace, N. (1975). Rational expectations the optimal money instrument and the optimal money supply rule. *Journal of Political Economy*, *83*(2), 241-254

Schaling, E. (1999). The nonlinear Phillips Curve and inflation forecast targeting. *Journal of Money, Credit and Banking*, *36*(3), 361-386.

Schenck, D. (2016). *Structural vector autoregression models in Stata*. Retrieved from https://blog.stata.com/2016/09/20/structural-vector-autoregression-models/

StataCorp. 2013. Stata 13 Base Reference Manual. College Station, TX: Stata Press. Retrieved from https://www.stata.com/manuals/tsvar.pdf

Tobin, J. (1972). The Wage-Price Mechanism Overview of the Conference. In Eckstein, O. (ed.), *The econometrics of price determination conference.* Washington D. C.: Federal Reserve System.

Rol de contribución	Autor(es)
Conceptualización	Ericka J. Arias Guzmán
Metodología	Ericka J. Arias Guzmán, Felipe Cruz Díaz y Karla Barcellos (igual)
Software	No aplica
Validación	No aplica
Análisis formal	Karla Barcellos
Investigación	Ericka J. Arias Guzmán, Felipe Cruz Díaz y Barcellos (igual)
Recursos	No aplica
Curación de datos	Karla Barcellos
Escritura- preparación del borrador original	Ericka J. Arias Guzmán
Visualización	Ericka J. Arias Guzmán, Felipe Cruz Díaz y Barcellos (igual)
Supervisión	Ericka J. Arias Guzmán
Administración de proyectos	Ericka J. Arias Guzmán
Adquisición de fondos	Karla Barcellos