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TRADABLE VS. NON-TRADABLE SECTOR PRODUCTIVITY: IMPACTS ON INFLATIONARY TRENDS

TESINA

QUE PARA OBTENER EL TÍTULO DE

LICENCIADO EN ECONOMÍA

PRESENTA

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Abstract

This research investigates inflation dynamics in Mexico from 2001 to 2021, focusing on the pass-through effect of the productivity differential between tradable and non-tradable goods. Using the Autoregressive Distributed Lag (ARDL) model, the study examines the long-run relationships between these inflation rates, accounting for external factors such as exchange rates and US inflation. The findings indicate a significant cointegration relationship, highlighting a robust long-term equilibrium between tradable and non-tradable productivity differentials. The results underscore the influence of external shocks on domestic inflationary processes, particularly in light of Mexico's persistent inflation rates, which consistently exceed target levels. This study contributes to the understanding of inflation dynamics, offering insights into the mechanisms driving sectoral inflation through differences in productivity.

List of abbreviations

Abbreviation	Meaning
ARDL	Auto-regressive Distributed Lag
FRED	Federal Reserve Economic Data
GDP	Gross Domestic Product
INEGI	Instituto Nacional de Estadística y Geografía
UK	United Kingdom
US	United States

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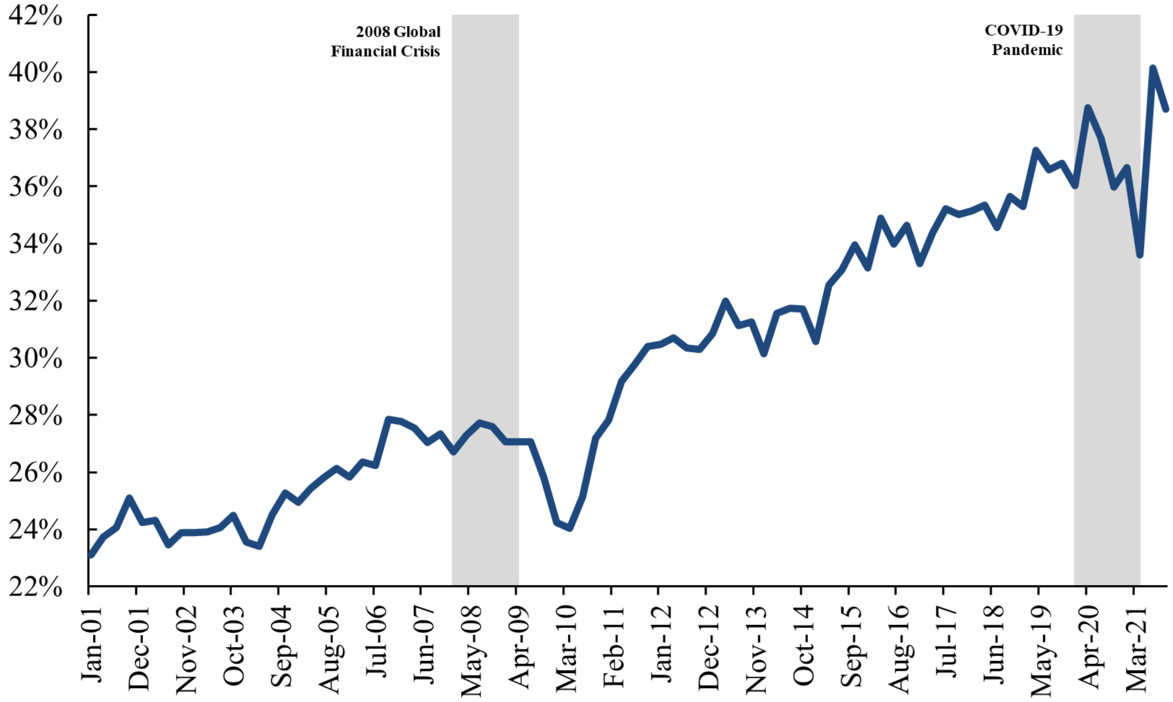
1. Introduction

Governments must maintain low inflation levels to ensure long-term economic growth and development. However, the global average headline inflation rate in 2022 was 8% (World Bank, 2024). Therefore, it has become increasingly important for policymakers and economists to understand the factors influencing Inflation. One such factor is the productivity of different sectors of the economy. In recent years, globalization has led to a significant increase in international trade. These increases in trade mean more demand for tradable goods, which makes this sector more efficient than the non-tradable sector.

Understanding how productivity differences can impact inflation to maintain economic stability and promote sustainable growth is crucial. The prices of tradables depend on international goods markets. As international demand and prices can be higher than domestic ones, firms can increase wages. When wages increase in the tradable sector, productivity also rises. Consequently, wages in the non-tradable sector need to grow as well. If this does not happen, workers may transition to the tradable sector. However, the productivity of the non-tradable sector remains lower than other industries, leading to the same output level but at higher costs. Ultimately, these higher costs, stemming from productivity differences, drive up the prices of non-tradable goods. This effect is more pronounced in countries with non-tradable sectors that rely heavily on labor.

Now, Mexico has a large exporting sector (see Figure 1.1) The Mexican economy is a particular case in which productivity differentials theory can be relevant. In addition to being an exporting country, in 1995, the Board of Banco de México introduced an objective of 3% annual inflation. The former objective, according to the Board, was established because of an international consensus that countries with economic stability needed to maintain low inflation levels (Banco de México, 1995). Nonetheless, the headline inflation rate has rarely reached the objective (see Figure 1.2). The former suggests that structural factors in the Mexican economy prevent reaching the established objective. We analyze the effects of the productivity differential between the non-tradable and tradable sectors on the relative prices of these sectors in Mexico. By exploring this complex relationship, we can gain valuable insights into the causes of inflationary pressures in the Mexican economy and devise more effective strategies to achieve and maintain price stability.

Figure 1.1: Mexico's Exports as a percentage of GDP from 2001 to 2021.

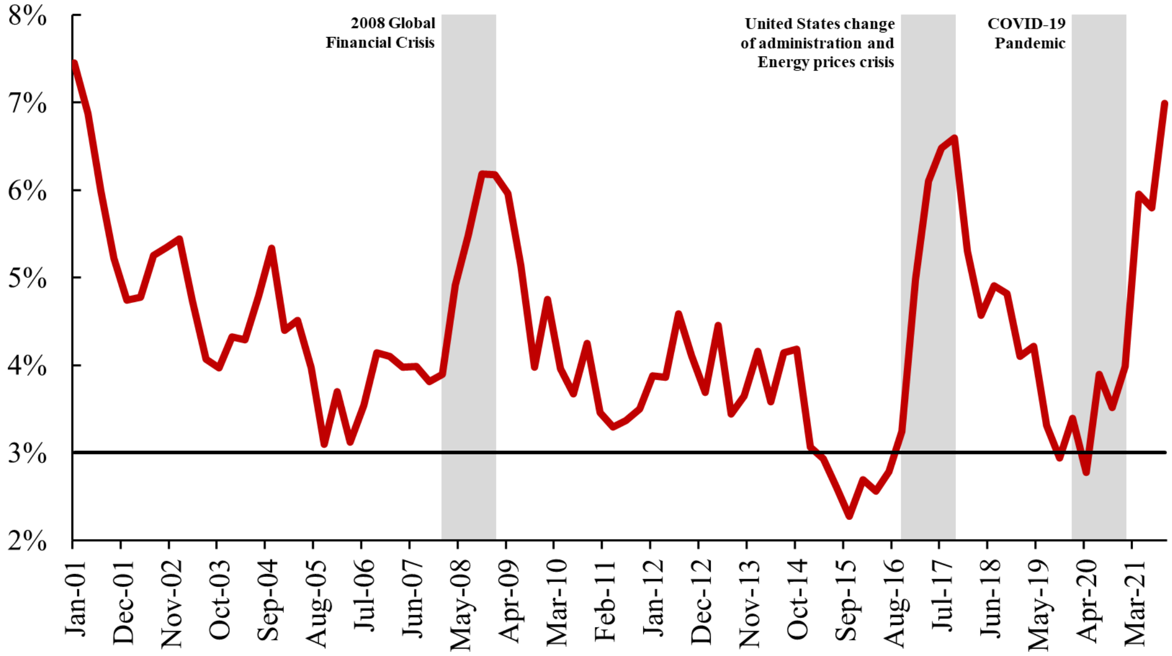


Source: Banco de México, 2024.

To analyze the variable of interest, we employ an ARDL model with a Hybrid Phillips Curve specification described later in the article. Four models are estimated: one for headline inflation, one for core inflation, one for goods inflation, and another for services inflation. The results show that the productivity differential affects inflation in Mexico through the tradable sector. These results highlight the need to consider structural factors that affect inflation to have effective inflation-targeting policies.

This thesis is presented as follows. In section 2, we present previous research on the subject. Section 3 presents the theoretical and econometric model, the data, and the econometric specification. In section 4, we show our results. Finally, in section 5, we mention some implications of the results.

Figure 1.2: Headline Inflation in Mexico from 2001 to 2021.



Source: Banco de México, 2024.

2. Literature Review

Froot and Rogoff (1985) analyze previous literature on purchasing power parity (PPP) determinants. First, they examine time series literature regarding tests for purchasing power parity. Second, they analyze historical data for England and France. Third, they look for possible long-term determinants of the exchange rate. This analysis's main objective is to better understand the determinants of PPP and offer some insights for future research. The review's main conclusion is a long-run convergence of the PPP. This article helped pave the way for the conversation on how supply and demand in the economy affect prices in a world with open economies.

Specifically, Rogoff (1992) examines intertemporal consumption smoothing to understand better how relative prices of nontraded goods affect the near-random walk behavior of exchange rates. The author uses the exchange rate of the yen and the dollar case to demonstrate the relationship empirically. The main results support that shocks to traded goods can only partially predict the exchange rate in an open capital market. Nonetheless, analyzing the different determinants of prices between the sectors, such as their productivity differential, remains important to fully understand inflation dynamics.

For example, De Gregorio et al. (1994) examine how sectoral productivity differentials affect inflation rates. In the paper, the authors analyze the supply side and consider the possibility that demand-side determinants affect the inflation rate. The analysis is focused on OECD countries. The results show that the non-tradable sector has primarily driven inflation upwards. Other results show that higher income causes higher relative prices in non-tradable markets. Finally, rapid growth in total factor productivity of the tradable sector compared to the non-tradable sector affects inflation.

De Gregorio and Wolf (1994) examine terms of trade and productivity differentials on tradable and non-tradable goods to comprehend their joint effects on the real exchange rate. The model they use is a three-goods small open economy. The authors run two regressions. First, the exchange rate is the dependent variable, and second, the relative non-tradable prices are the dependent variable. Both models support the Balassa-Samuelson hypothesis, but the magnitude weakens in the second regression. Generally, both the differential and terms of trade are significant in determining exchange rates.

Benigno and Thoenissen (2003) present an innovative analysis of the relationship between changes in supply behavior and their impact on the equilibrium exchange rates. Their study of UK exchange rate appreciation from 1996 to 2003 is not just a reiteration of existing theories but a fresh perspective that incorporates elements such as imperfect competitive goods and labor markets, non-traded goods taste bias, and international price discrimination. The analysis uncovers that positive supply changes lead to a real exchange rate depreciation.

Choudhri and Khan (2005) study the Balassa-Samuelson effect, a critical factor in the long-term movements of the exchange rate, particularly in developing countries. Their investigation explores two relations that cause the Balassa-Samuelson effect, using the relation of the real exchange rate to relative prices of non-trade goods in domestic and foreign countries, including terms of trade. Based on panel data for 16 countries and DOLS, their findings reaffirm the relevance of the Balassa and Samuelson effect in developing countries, although with a smaller magnitude than predicted, underscoring the importance of their research in a global economic context.

Jacobs and Williams (2014) studied the inflation of non-tradable goods in Australia. Their primary goal was to identify the drivers of non-tradable goods inflation compared to tradables inflation. They employed two main approaches. The first approach involved macroeconomic analysis using markup and Phillips curve models. The second approach involved examining the components of the non-tradable sector to uncover the underlying factors influencing their prices. Their findings at a macroeconomic level revealed the prices of non-tradable goods can be affected by the business cycle; a slack labor market lowers prices, while a tight labor market raises them. Furthermore, their analysis showed that different goods in the non-tradable sector are influenced by various factors. Housing services are primarily impacted by changes in capital, while market and administered services are predominantly influenced by fluctuations in the labor market.

Farhi and Gabaix (2016) developed a model of exchange rates to examine whether rare and extreme disasters have an essential effect on determining the risk prime in asset markets. The model integrates many exchange rate problems, such as forward premiums and excess volatility. It helps understand the relationship between high-risk events and changes in asset value. Adding to the conversation on exchange rates, this article sheds light on the relationship between the international financial markets and changes in domestic goods prices, primarily tradable goods.

Bordo et al. (2017) examine the Balassa-Samuelson effect in 4 monetary regimes using historical data from 14 countries. They compare the conventional model with two modern approaches that specify the terms of trade. The first is based on specialization in production, and the second is on monopolistic competition. They analyze the data using Panel Dynamic Ordinary Least Squares and Group Mean procedures. Finally, the authors conclude that the conventional Balassa-Samuelson model can't explain the variation between regimes, and considering terms of trade can explain the variation in the regimes analyzed. The results highlight the complicated connections between the analyzed sectors and the exchange rate. Including other variables can always improve the understanding of complex economic relationships. As such, studying the case of Mexico's productivity is of high relevance for policy making.

López-Marmolejo et al. (2023) analyze the factors causing real exchange rate depreciation. They argue that decreasing oil production in Mexico has been a significant cause of such depreciation. To evaluate this, they use a Balassa-Samuelson model and estimate the effect between Mexico and the United States using quarterly governmental data from each country. They calculate the productivity data of each sector using the Solow residual due to the scarcity of productivity data. The authors then use local projections to analyze the effects of oil production on the real exchange rate. They find an inverse Balassa-Samuelson effect in the case of Mexico, concluding that the decreasing oil production is causing depreciation.

The research mentioned finds many results but generally supports the Balassa-Samuelson effect with specific considerations, such as terms of trade. Previous research considered different countries, but it did not consider Mexico. Our research contributes to the subject by analyzing the case of Mexican inflation using a model proposed by Obstfeld and Rogoff (1996), which focused on inflation rather than the exchange rate.

3. Methodology

3.1. Relationship between sector factor productivity and the relative price of non-tradable and tradable goods

We analyze the effect of productivity differentials on the relative prices of tradable and non-tradable goods in the Mexican economy. As mentioned, we use the model proposed by Obstfeld and Rogoff (1996). They described an open economy in which all goods can be divided into tradable and non-tradable sectors. In such an economy, there are two production functions with constant returns of scale, in which the output depends on the capital and labor employed

$$\begin{aligned} Y_T &= A_T F(K_T, L_T), \\ Y_N &= A_N F(K_N, L_N) \end{aligned} \tag{3.1}$$

where *Y* is the output, *K* is capital, *L* is labor, and *A* represents the productivity of each sector. Finally, the sub-indexes represent the sectors, *T* for tradable and *N* for non-tradable.

Also, wages are considered the same within sectors to simplify the analysis. This condition can be interpreted as labor can move freely between industries. We assume that labor supply is given by labor in the tradable sector plus labor in the non-tradable sector. Capital doesn't have a constraint, such as labor. However, only tradables can be transformed into capital. We also assume perfect international capital mobility, which makes the world interest rate the rate of return for domestic capital. The last assumption in the model can be seen in the non-tradable sector measured in tradable goods. Let us define the capital-labor ratio of the tradable production as $k_T = K_T/L_T$ and of non-tradable production as $k_N = K_N/L_N$ and the output of a worker of each sector as $y_T = A_T f(k_T) \equiv A_T F(k_T, 1)$ and $y_N = A_T f(k_N) \equiv A_N F(k_N, 1)$ respectively. Using the properties of constant return-to-scale production functions, we can write the first-order conditions for capital and labor as

$$A_T f'(k_T) = r \tag{3.2}$$

and

$$A_T[f(k_T) - f'(k_T)k_T] = \omega \tag{3.3}$$

in the tradable sector and

$$pA_T f'(k_N) = r \tag{3.4}$$

and

$$pA_T[f(k_N) - f'(k_N)k_N] = \omega \tag{3.5}$$

in the non-tradable sector, where *p* is the relative price of non-tradable in terms of tradable goods. Also, *r* can be considered the world interest rate in terms of tradables.

Now, the zero-profit conditions for each sector imply:

$$\begin{aligned} A_T(k_T) &= rk_T + \omega, \\ pA_N = pA_N f(k_N) &= rk_N + \omega. \end{aligned} \tag{3.6}$$

Taking natural logs to the zero-profit condition of the tradable sector and differentiating, we get

$$\frac{dA_T}{A_T} + \frac{rk_T}{A_T f(k_T)k_T}\frac{dk_T}{k_t} = \frac{rk_T}{A_T f(k_T)}\frac{dk_T}{k_T} + \frac{\omega}{A_T f(k_T)}\frac{d\omega}{\omega} \tag{3.7}$$

To simplify, we define $\mu_{LT} \equiv \omega L_T / Y_T$ and $\mu_{LN} \equiv \omega L_N / pY_N$. Also, let any variable with a "hat" denote the logarithmic derivative of the variable. In this way, the former expression is reduced to

$$\hat{A} = \mu_{LT}\hat{\omega} \tag{3.8}$$

Doing a similar process to the zero-profit condition of the non-tradable sector yields

$$\hat{p} + \hat{A_N} = \mu_{LN}\hat{\omega} \tag{3.9}$$

Finally, substituting ω from Equation 3.8 in Equation 3.9 gives

$$\hat{p} = \frac{\mu_{LN}}{\mu_{LT}}\hat{A_T} - \hat{A_N} \tag{3.10}$$

Equation 3.10 represents the relationship between the productivity change of tradable and non-tradable sectors. If $\frac{\mu_{LN}}{\mu_{LT}} \geq 1$, it means that the non-tradable sector is more labor intensive than the tradable, suggesting that wage changes affect more the former sector given the productivity differential.

3.2. Productivity of tradable and non-tradable sectors

Calculating the relative prices using equation 3.10 requires the total factor productivity of each sector. In this context, the Solow residual plays a crucial role. Therefore, for our analysis, we use the following equation to estimate the productivity of each sector:

$$A_{t,i} = \frac{Y_{t,i}}{K_{t,i}^{\alpha} L_{t,i}^{1-\alpha}} \tag{3.11}$$

where α is an elasticity parameter, the subscript i = T, N represents the tradable and non-tradable sectors, and t denotes time.

3.3. Data

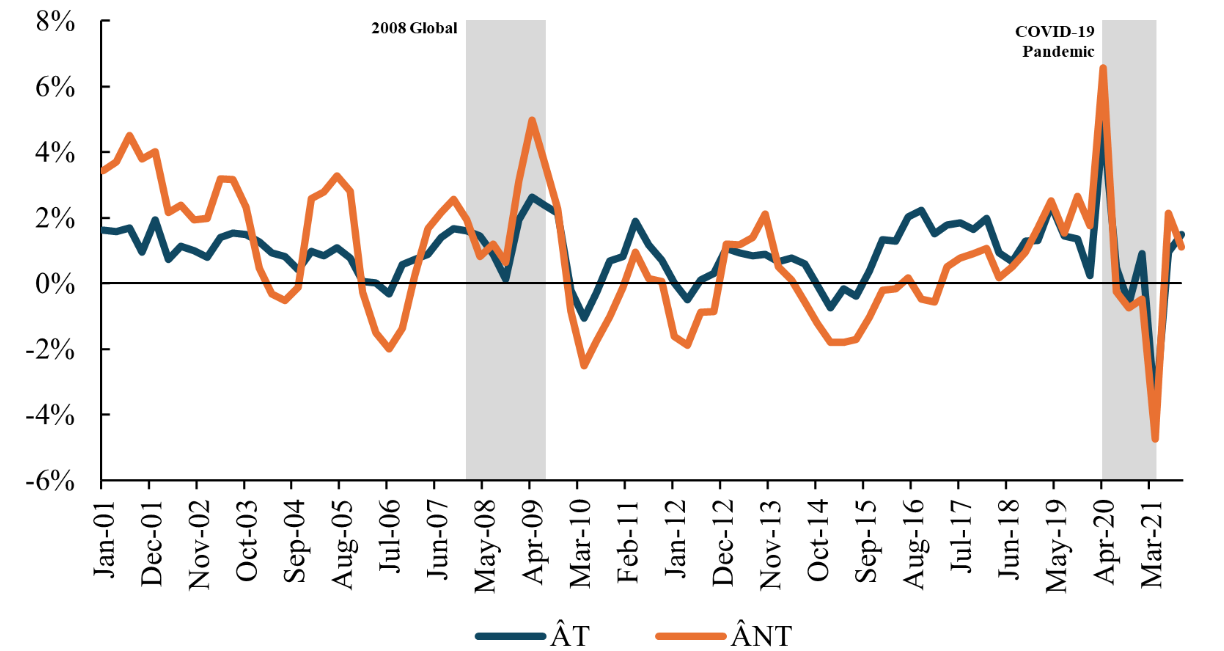
We obtained the data from different sources. The data for the GDP gap comes from the Bank of Mexico's calculations in the October-December 2021 Quarterly Report. The inflation expectations are the average of the Bank of Mexico's survey. We obtained the exchange rate from the Economic Information System (Sistema de Información Económica in Spanish) of Banco de México. The US inflation data is from the FRED of the Federal Reserve Bank of St. Louis. Finally, the productivity differential is our indicator, and we used data from INEGI for capital, labor, and national GDP; for wages, we used data from IMSS. We also use the database of López-Marmolejo et al. (2023), where they calculated the Solow residual for the tradable and non-tradable sectors in Mexico.

As seen in Figure 3.1 $\hat{A_N}$ and $\hat{A_T}$ have similar movements across time. Nonetheless, $\hat{A_N}$ has more volatility than $\hat{A_T}$. Also, it is more affected by economic crises such as the 2008 financial crisis. Now $\hat{A_T}$ seems more stable, but it is still affected by economic factors.

Figure 3.2 shows μ_{LN} and μ_{LT}, which represent the labor share of the income generated within each sector. The graph shows that μ_{LN} is more prominent and growing faster than μ_{LT}. This means that the non-tradable sector is more dependent on labor than the tradable sector. Therefore, changes in wages should have a significant effect on the sector's prices.

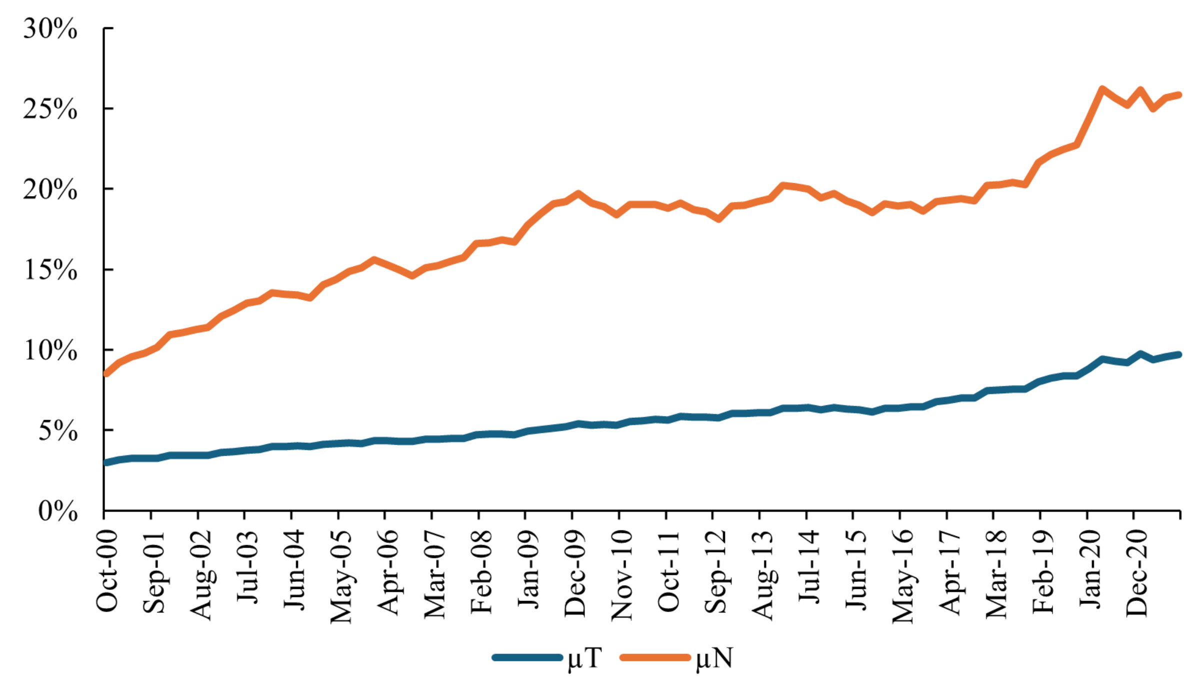
Finally, Figure 3.3 shows the changes in the relative price of non-tradables. Now, $\hat{p}$ is mostly above zero. This implies that the productivity differential pressures the prices of the nontradable upwards.

Figure 3.1: Productivity of tradable and non-tradable sectors.



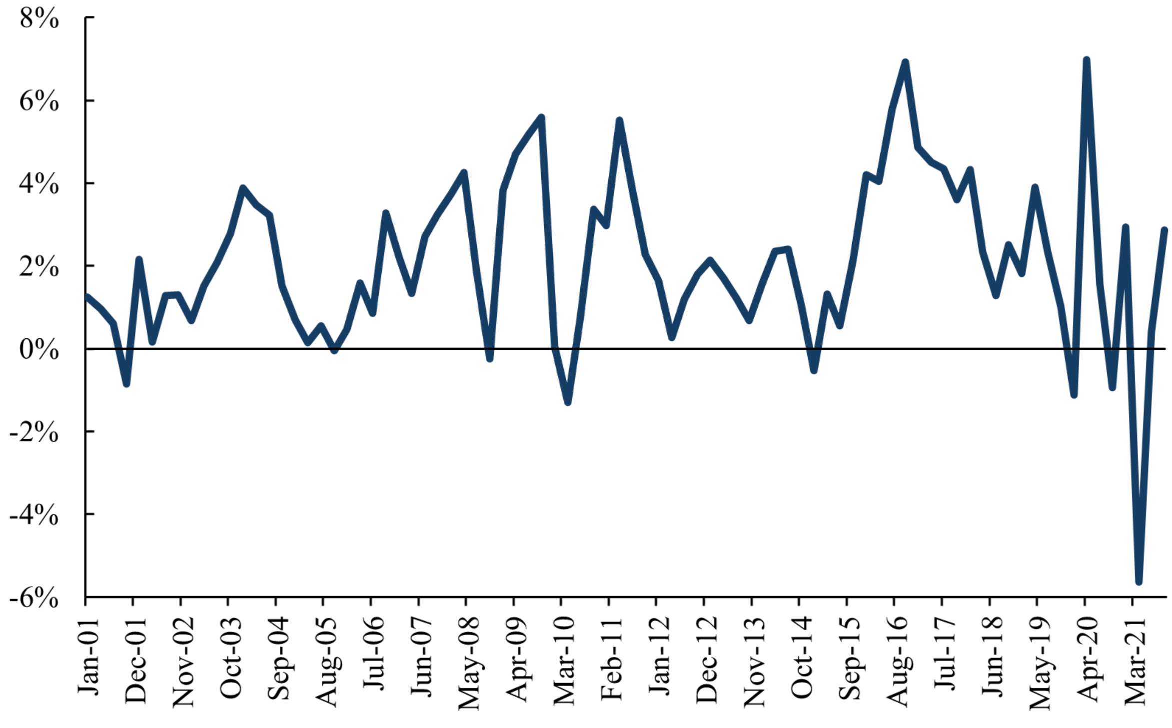
Source: own elaboration with data from Lopéz-Marmolejo et al., 2023.

Figure 3.2: Income share of labor of the tradable and non-tradable sectors.



Source: own elaboration with data from López-Marmolejo et al., 2023 and INEGI, 2024.

Figure 3.3: Relative price of non-tradables to tradable goods.



Source: own elaboration with data from López-Marmolejo et al., 2023 and INEGI, 2024.

3.4. Econometric Model

In the initial stage of the econometric analysis, a static linear regression model is employed to examine headline, core, goods, and services inflation. The aim is to assess the impact of productivity differentials on inflation levels in Mexico.

Given that past values and other lagged variables often influence inflation, a standard linear regression model may not be sufficient for accurate modeling. Specifically, the residuals are autocorrelated. Therefore, the primary analysis utilizes the Autoregressive Distributed Lag Model (ARDL). This model is advantageous in the context of Inflation and productivity differentials in Mexico as it includes past values of both dependent and explanatory variables. This improves the modeling process and accurately represents the relationship between Inflation and productivity differentials.

$$y_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i y_{t-i} + \sum_{j=0}^{q} \beta_j X_{t-j} + \epsilon_t \tag{3.12}$$

Also, including the first differences in the variables helps minimize auto-correlation in the residuals. In the end, the model is as follows.

$$\Delta y_t = \phi_0 + \sum_{i=1}^{p-1} \phi_i \Delta y_{t-i} + \sum_{j=0}^{q-1} \gamma_j \Delta x_{t-j} + \lambda(y_{t-1} - \theta_0 - \theta_1 x_{t-1}) + \epsilon_t \tag{3.13}$$

This analysis aims to determine the long-run relationship between Inflation and the productivity differential across sectors. Dynamic Models enable the study of long-term relationships between dependent and explanatory variables. This is simply because we assume that it is in equilibrium.

$$y_t = y_{t+1} = ... = y \tag{3.14}$$

$$x_t = x_{t+1} = ... = x \tag{3.15}$$

For all variables.

This means that in the long run, there are no changes in the variables.

$$\Delta y_t = y - y = 0 \tag{3.16}$$

$$\Delta x_t = x - x = 0 \tag{3.17}$$

In this way, the error correction part of equation 3.13 shows the long-run static equilibrium. We are particularly interested in the long-run multipliers of productivity differentials.

3.4.1. Econometric Specification

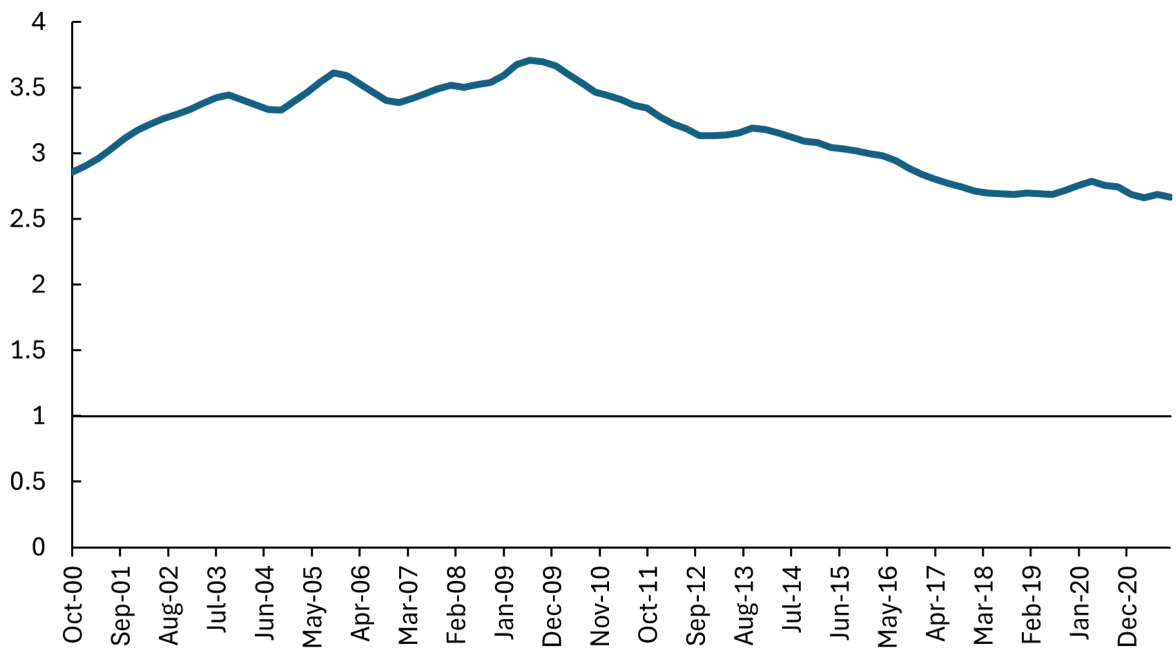
Our model's specification follows the framework used in Box 4 of the Bank of Mexico's Quarterly Report for October-December 2017. The report estimates a Hybrid Phillips Curve specification using various macroeconomic indicators, such as the output gap, inflation expectations, real exchange rate, and other control variables (Banco de México, 2018). We use the GDP gap, inflation expectations, Mexican peso, United States dollar exchange rate, and US inflation as they did. We also added the productivity differential factor as an explanatory variable. We estimate four models. First is the headline inflation, second is the core Inflation, third is the goods inflation, and fourth is the services inflation.

4. Results

4.1. Regression Results

First, we compute the corresponding $\hat{p}$. As mentioned, a larger ratio between the income share of labor in non-tradable and tradable sectors ($\frac{\mu_{LN}}{\mu_{LT}}$) generates pressure on the relative prices of the less productive sector. After these calculations, the ratio for the period is above one, which, according to the theory, we can conclude that productivity differentials between the sectors in Mexico push the relative prices of the non-tradable upward. These results are presented in figure 4.1.

Figure 4.1: Labor share ratio between sectors ($\frac{\mu_{LN}}{\mu_{LT}}$).



Source: own elaboration with data from López-Marmolejo et al., 2023 and INEGI, 2024.

We estimate linear static regressions to see the effect of these relative price pressures on inflation in Mexico. For that, we run a regression for the headline, another for the core, and then two more for goods and services inflation. The independent variable for all specifications is $\hat{p}$.

Table 4.1: Regression Results

	Dependent variable:			
	Headline	Core	Goods	Services
	(1)	(2)	(3)	(4)
$\hat{p}$	0.016	0.028	0.373^{***}	-0.304^{***}
	(0.077)	(0.071)	(0.092)	(0.112)
Constant	4.274^{***}	3.745^{***}	3.109^{***}	4.427^{***}
	(0.205)	(0.190)	(0.245)	(0.297)
Observations	74	74	74	74
R^2	0.001	0.002	0.185	0.093
Adjusted R^2	−0.013	−0.012	0.174	0.081
Residual Std. Error (df = 72)	0.940	0.870	1.122	1.360
F Statistic (df = 1; 72)	0.042	0.148	16.379^{***}	7.402^{***}
Note:				*p<0.1; **p<0.05; ***p<0.01

Source: own elaboration with data from Banco de México, 2024
and López-Marmolejo et al., 2023.

In Table 4.1, we report the resulting coefficients and standard errors for each independent variable. The independent variable "$\hat{p}$" appears to have statistically significant effects on two dependent variables: Goods and Services. Specifically, an increase in "$\hat{p}$" is associated with a statistically significant increase in the Goods component of the CPI but a decrease in the Services components. Overall, these regression results provide valuable insights into the potential impact of the independent variable "$\hat{p}$" on different components of the Consumer Price Index, shedding light on the dynamics of Inflation within various sectors of the economy.

Now, $\hat{p}$ is not statistically significant for the Headline and Core inflation. The specifications for these regressions still need to be completed for the Goods and Services specification. For this reason, we estimate the ARDL model described in the previous section.

4.2. ARDL estimation

4.2.1. Headline Inflation

The ARDL long-run results in Table 4.2 show that Mexican inflation is influenced by several variables, but only a few are statistically significant. The output gap has a positive but not statistically significant coefficient. inflation expectations also have a positive, not statistically

Table 4.2: Headline Inflation long-run coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Output Gap	0.135	0.104	1.299	0.197
Inflation Expectations	0.915	0.906	1.009	0.316
Exchange Rate	0.054	0.048	1.105	0.272
US Inflation	0.548*	0.314	1.743	0.085
Productivity Differential	0.296*	0.133	2.226	0.029
Constant	−1.531	2.801	−0.546	0.586
Note:		*p<0.1; **p<0.05; ***p<0.01		

Source: own elaboration with data from Banco de México, 2024; FRED, 2024 and López-Marmolejo et al., 2023.

significant coefficient of 0.915. The exchange rate has a minor, not statistically significant, positive effect. U.S. inflation has a statistically significant positive coefficient of 0.548, impacting Mexican inflation. The productivity differential shows a positive, statistically significant effect of 0.296. These results suggest that U.S. inflation and productivity differentials are essential for explaining long-term Mexican inflation.

4.2.2. Core Inflation

Table 4.3: Core Inflation long-run coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Output Gap	0.186***	0.059	3.155	0.002
Inflation Expectations	0.787	0.674	1.167	0.247
Exchange Rate	0.054**	0.026	2.032	0.045
US Inflation	0.593**	0.225	2.627	0.010
Productivity Differential	0.181**	0.083	2.179	0.032
Constant	−1.369	2.074	−0.660	0.511
Note:		*p<0.1; **p<0.05; ***p<0.01		

Source: own elaboration with data from Banco de México, 2024; FRED, 2024 and López-Marmolejo et al., 2023.

In Table 4.3, the output gap has a positive coefficient of 0.186 and is statistically significant, indicating a significant positive effect on core inflation. inflation expectations have a positive coefficient but are not statistically significant, suggesting no apparent impact. The exchange rate has a positive coefficient of 0.0546 and is statistically significant, indicating a positive effect on Mexican core inflation. US inflation has a positive and significant coefficient of 0.593, showing a significant positive relationship with inflation in Mexico. The productivity differential across sectors has a positive and significant coefficient of 0.181, indicating a positive effect on core inflation. Until now, the hypothesis has been correct: productivity differential is pressuring inflation upward. To understand better how the productivity differential affects inflation, we estimate two more models, one for goods inflation and another for services inflation.

4.2.3. Goods Inflation

Table 4.4: Goods Inflation long-run coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Output Gap	-0.315^{**}	0.135	-2.323	0.023
Inflation Expectations	-4.566^{*}	2.369	-1.927	0.058
Exchange Rate	0.210^{*}	0.123	1.707	0.092
US Inflation	2.281^{*}	1.166	1.955	0.054
Productivity Differential	1.597^{**}	0.654	2.441	0.017
Constant	12.569^{**}	6.176	2.034	0.045
Note:		*p<0.1; **p<0.05; ***p<0.01		

Source: own elaboration with data from Banco de México, 2024;
FRED, 2024 and López-Marmolejo et al., 2023.

The ARDL long-run results for goods inflation (see Table 4.4) show that the output gap has a negative and statistically significant coefficient of -0.315. Inflation expectations also have a negative statistically significant effect. The Exchange rate has a positive statistically significant coefficient. U.S. inflation shows a positive statistically significant relationship with Mexican goods inflation. The productivity differential is positive and statistically significant at 1.597, indicating productivity improvements increase goods inflation. Which contradicts the theoretical hypothesis.

Table 4.5: Services Inflation long-run coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Output Gap	0.614***	0.141	4.333	0.000
Inflation Expectations	2.698***	0.486	5.543	0.000
Exchange Rate	0.027	0.038	0.701	0.485
US Inflation	0.269	0.226	1.189	0.238
Productivity Differential	−0.568***	0.163	−3.474	0.000
Constant	−6.896***	1.778	−3.876	0.000
Note:		*p<0.1; **p<0.05; ***p<0.01		

Source: own elaboration with data from Banco de México, 2024;
FRED, 2024 and López-Marmolejo et al., 2023.

4.2.4. Services Inflation

Table 4.5 shows the coefficients for services inflation. The output gap has a statistically significant positive coefficient of 0.614. Inflation expectations also show a statistically significant positive effect of 2.698. The exchange rate is positive but not statistically significant. U.S. inflation has a positive but, again, not statistically significant coefficient. The productivity differential has a statistically significant negative impact of -0.568, indicating that a higher productivity differential reduces service inflation. These results suggest that the output gap and inflation expectations are significant drivers of services inflation, while productivity improvements reduce it. Again, this result contradicts the theoretical hypothesis.

The results from the previous estimation highlight the significant roles of domestic factors on inflation, such as productivity differential and the output gap. Nevertheless, as more sectors are aggregated to the inflation indicator, as is the case with core and headline inflation, the effect of productivity differentials is lower. The former can happen because headline inflation considers many factors that don't affect goods and services directly. As mentioned before, the prices of tradables are more affected by international market conditions, and the results support that. The exchange rate and US inflation are not statistically significant in the services inflation model. On the contrary, goods inflation is affected by both domestic and foreign conditions.

4.3. ARDL with dummies

Now, we estimate other ARDL models with the same variables but add dummy variables to reduce the effect of outliers in the data. For the headline, core, and goods inflation, we consider two dummies. First, we add one variable equal to 1 in the first quarter of 2009 (2009q101) to account for the 2008 Global Financial Crisis effect. Second, we consider a variable equal to 1 in the final quarter of 2017 (2017q4) to control for the effects of the beginning of Donald Trump's presidential term. For the model of the services inflation, we only consider the first dummy variable since the outlier effects of 2017 are unimportant in this specification. In the following sections, we present the results.

4.3.1. Headline Inflation Model with dummies

Table 4.6: ARDL with dummies: Headline Inflation long-run coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Output Gap	0.151	0.114	1.320	0.1911
Inflation Expectations	1.116	0.921	1.211	0.229
Exchange Rate	0.058	0.053	1.102	0.274
US Inflation	0.596*	0.327	1.821	0.072
Productivity Differential	0.343**	0.136	2.513	0.014
Constant	−2.513	2.880	−0.872	0.385
Note:		*p<0.1; **p<0.05; ***p<0.01		

Source: own elaboration with data from Banco de México, 2024;
FRED, 2024 and López-Marmolejo et al., 2023.

Table 4.6 for the headline shows the long-run coefficients obtained from the ARDL model with the dummy variables for the headline inflation. The coefficient for the output gap is 0.151, but the effect is not statistically significant at conventional levels. Inflation expectations have a coefficient of 1.116, which is also not statistically significant. The exchange rate's coefficient is again not statistically significant. However, US inflation has a coefficient of 0.596, which is statistically significant at the 10% level. The productivity differential has a coefficient of 0.343, statistically significant at the 5% level, indicating a positive long-run relationship with headline inflation. Thus controlling with dummies yields a bigger and more significant effect of the productivity differential.

4.3.2. Core Inflation Model with dummies

The results for the core inflation model shown in Table 4.7 indicate that the output gap has a coefficient of 0.185, statistically significant at the 1% level, indicating a positive long-run

Table 4.7: ARDL with dummies: Core Inflation long-run coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Output Gap	0.185^{***}	0.065	2.849	0.005
Inflation Expectations	0.842	0.676	1.244	0.217
Exchange Rate	0.054^{*}	0.028	1.933	0.057
US Inflation	0.602^{**}	0.240	2.499	0.014
Productivity Differential	0.190^{**}	0.089	2.123	0.037
Constant	-1.619	2.068	-0.782	0.436
Note:		*p<0.1; **p<0.05; ***p<0.01		

Source: own elaboration with data from Banco de México, 2024;
FRED, 2024 and López-Marmolejo et al., 2023.

effect on core inflation. Inflation expectations have a positive coefficient but are not statistically significant. The exchange rate has a coefficient of 0.054, which is statistically significant at the 10% level. US inflation is positively related to core inflation with a coefficient of 0.602 and is statistically significant at the 5% level. The productivity differential coefficient is 0.190, which is also significant at a 5% level.

4.3.3. Goods Inflation Model with dummies

Table 4.8: ARDL with dummies: Goods Inflation long-run coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Output Gap	-0.273^{***}	0.098	-2.780	0.007
Inflation Expectations	-4.257^{**}	1.853	-2.296	0.024
Exchange Rate	0.167^{**}	0.083	2.006	0.048
US Inflation	1.853^{**}	0.836	2.216	0.029
Productivity Differential	1.543^{***}	0.539	2.858	0.005
Constant	12.414^{**}	4.988	2.488	0.015
Note:		*p<0.1; **p<0.05; ***p<0.01		

Source: own elaboration with data from Banco de México, 2024;
FRED, 2024 and López-Marmolejo et al., 2023.

Regarding goods inflation, Table 4.8 indicates that the output gap has a negative coefficient of -0.273, statistically significant at the 1% level, indicating a negative long-run relationship with goods inflation. Inflation expectations have a negative coefficient of -4.257, significant at the 5% level. The exchange rate has a positive coefficient of 0.167, statistically significant at the 5% level. US inflation is positively associated with goods inflation, with a coefficient of 1.853, significant at 5%. The productivity differential has a positive coefficient of 1.543, statistically significant at the 1% level.

4.3.4. Services Inflation Model with dummies

Table 4.9: ARDL with dummies: Services Inflation long-run coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Output Gap	0.587***	0.133	4.392	0.000
Inflation Expectations	2.939***	0.476	6.173	0.000
Exchange Rate	0.041	0.036	1.141	0.257
US Inflation	0.354	0.219	1.619	0.109
Productivity Differential	−0.568***	0.162082	−3.505	0.000
Constant	−8.004***	1.809727	−4.423	0.000
Note:		*p<0.1; **p<0.05; ***p<0.01		

Source: own elaboration with data from Banco de México, 2024;
FRED, 2024 and López-Marmolejo et al., 2023.

For the results services inflation model in Table 4.9, we find that the output gap has a positive coefficient of 0.587, which is highly significant at the 1% level, indicating a strong positive long-run relationship with service inflation. Inflation expectations have a very high positive coefficient of 2.939, also highly significant at the 1% level. The exchange rate's coefficient is not statistically significant. US inflation has a positive coefficient but, again, is not statistically significant. The productivity differential has a negative coefficient of -0.568, statistically significant at the 1% level.

Using dummies to control for the values of the outliers helped refine the estimation of the models. The results show improvements in the statistical significance of the variables, except for core inflation. Also, the dummy variables helped highlight the effect of productivity differential in all models.

5. Implications and Conclusion

Inflation is a central topic of discussion among policymakers. Understanding what affects it is crucial for developing effective monetary policies. This paper argues that productivity differential across tradable and non-tradable sectors affects inflation. Using a model proposed by Obstfeld and Rogoff, we estimated four ARDL models to observe the effect of the differential on headline, core, goods, and services inflation. The variables considered for the estimation were the output gap, inflation expectations, the exchange rate, and productivity differentials. The estimation shows that inflation in the US has a positive effect on headline and core inflation. The productivity differential increases headline, core, and goods inflation. Service inflation has a negative relation to productivity differentials. In the case of Mexico, the relationship between productivity differential and inflation in goods and services contradicts the theory. The former suggests that other factors of the economy affect this relationship. Policymakers must consider these relationships to target inflation and achieve economic stability effectively.

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