

## MODELING THE RELATIONSHIP BETWEEN THE MISERY INDEX AND CONSUMER CONFIDENCE IN MEXICO USING AN ARDL APPROACH

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Fecha de recepción: 21 de abril de 2025. Fecha de aceptación: 13 de octubre de 2025.

<https://doi.org/10.22201/iiec.20078951e.2026.224.70405>

**Abstract.** Confidence is a key element of any economy, as it determines variables such as consumption and investment. In particular, consumer confidence has proven useful in analyzing and forecasting private consumption. Therefore, this study explores the relationship between the consumer confidence indicator and Okun's Misery Index in Mexico using an autoregressive distributed lag model, which also considers the real GDP and the bilateral real exchange rate of Mexico with the U.S. as control variables. The model uses quarterly observations for the period 2005Q1 to 2024Q2. The results demonstrate that GDP increases the consumer confidence indicator, whereas depreciation in the Mexican peso negatively affects it. However, Okun's misery index negatively affects the consumer confidence indicator only in the long term.

**Key words:** consumer confidence; Okun's Misery Index (MI); subjective indicators; ARDL.

## MODELIZACIÓN DE LA RELACIÓN ENTRE EL ÍNDICE DE MISERIA Y LA CONFIANZA DEL CONSUMIDOR EN MÉXICO UTILIZANDO UN ENFOQUE ARDL

**Resumen.** La confianza es un elemento clave de cualquier economía, ya que determina variables como el consumo y la inversión. En particular, la confianza de los consumidores ha demostrado ser útil para analizar y pronosticar el consumo privado. Por lo tanto, este estudio explora la relación entre el indicador de confianza de los consumidores y el índice de miseria de Okun en México utilizando un modelo autorregresivo de retraso distribuido, que también tiene en cuenta el producto interno bruto real y el índice del tipo de cambio real bilateral de México con Estados Unidos como variables de control. El modelo utiliza observaciones trimestrales para el periodo comprendido entre el primer trimestre de 2005 y el segundo trimestre de 2024. Los resultados demuestran que el PIB aumenta el índice de confianza del consumidor, mientras que la depreciación del peso mexicano afecta negativamente a dicho índice. Sin embargo, el índice de miseria de Okun sólo afecta negativamente al índice de confianza del consumidor a largo plazo.

**Palabras clave:** confianza del consumidor; índice de miseria de Okun; indicadores subjetivos; ARDL.

**Clasificación JEL:** C19; C22; E29; I31; I39.

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## 1. INTRODUCTION

Compiling information related to economic expectations is now recognized as highly important by both academics and policymakers. Given that economic decisions concerning the future involve uncertainty, expectations play a central role in household choices, such as buying durable goods, saving, wage negotiations, and investment (Armantier *et al.*, 2017). As such, the indices developed to measure consumer confidence are associated with both consumer perceptions of and trust in the economy (Leyva *et al.*, 2016).

Consumer confidence is useful for forecasting private consumption because the results usually present a low margin of error and also mirror the state of economic activity (Olowofeso and Doguwa, 2015). In this sense, crises negatively affect both consumer and business confidence, which can, in turn, affect financial markets, such as in the 2008 international financial crisis (Organisation for Economic Co-operation and Development [OECD], 2010).

Although consumer confidence has been associated with economic activity, it cannot significantly explain the gross domestic product (GDP) in certain countries such as Jamaica; however, it is a good predictor of remittances (Sergeant *et al.*, 2011). In countries such as Mexico (Percastre, 2018) and Trinidad and Tobago (Sergeant *et al.*, 2011), consumer confidence has a statistically significant effect on GDP. Evidently, the association between confidence indicators and output varies across countries and types of confidence measures (Santero and Westerlund, 1996).

Consumer confidence has been linked to variables such as personal income, sustainability, the stock market, education, and innovation freedom (El Alaoui *et al.*, 2020). In a sample of Dutch people, evidence suggested that public opinion on Facebook and Twitter (recently renamed X) can alter consumer confidence, suggesting that factors affecting consumer confidence also affect the sentiment of people active on such social networks (Daas and Puts, 2014). In Malaysia, a small but statistically significant association was found between social media sentiment and consumer confidence (Shayaa *et al.*, 2018).

In this study, we explore the consumer confidence indicator (CCI) in Mexico by analyzing how it is affected by Okun's Misery Index (MI). To achieve this objective, an autoregressive distributed lag (ARDL) model is estimated using data for the period 2005Q1 to 2024Q2, considering the bilateral real exchange rate index (XR) and real GDP as control variables. The main results show that, in both the long and short term, depreciation in the Mexican peso with respect to the U.S. dollar diminishes the CCI, whereas GDP exerts a posi-

tive effect. Meanwhile, Okun's MI negatively affects the CCI in the long term but does not exert any effect in the short term.

In the literature regarding Mexico, although the exchange rate and GDP are common variables for explaining consumer confidence, to the best of our knowledge, the only study to examine the relationship between Okun's MI and consumer confidence is that of Percastre (2018), who applied a short-run structural vector autoregressive model. In comparison, in this study, we calculate the long-term coefficients of Okun's MI related to the CCI in Mexico. It should be noted that in the international literature, Lovell and Tien (2000) have already explored such a relationship, and Bolhuis *et al.* (2024) point out that economists have commonly relied on inflation and unemployment to explain consumer confidence. Further, most studies employing the CCI consider nominal exchange rates and argue that consumers are usually unaware of the variations in real exchange rates (Vazquez *et al.*, 2010). In this sense, this study contributes to the existing literature by showing that XR exerts significant effects on the CCI. GDP is a variable traditionally used to explain changes in the CCI, as can be seen in the works of Borisov (2022), Percastre (2018), and Sergeant *et al.* (2011). The effect of MI on the CCI has been almost completely unexplored in the Mexican economy and in the international literature.

We are certain that this research will be of interest to both economists and policymakers, as it reveals the effects of the main macroeconomic variables on consumer confidence, which is crucial in determining economic activity, as well as private businesses that utilize consumer confidence indicators to adjust their supply to market conditions.

The remainder of this paper is organized as follows: Section 2 presents the literature review, which has been divided into two subsections, with the first presenting a review related to consumer confidence, and the second presenting a review on the relationship among the variables in this study. Section 3 is also divided into two subsections, with the first presenting the data sources and unit root tests, whereas the second presents a graphical exploration of the data. Section 4 presents the methodology and econometric results, and section 5 presents the conclusions.

## 2. LITERATURE REVIEW

### Consumer Confidence Indicator

The first measure of consumer confidence was developed at the University of Michigan in the 1940s by George Katona (Heath, 2012), who is considered the founding father of the so-called “old behavioral economics” (Hosseini, 2011). Katona and colleagues’ research “[...] led to the use of survey method in economics and its utilization in measuring the impact of consumer expectations on macroeconomic activity” (Hosseini, 2003, p. 391). In fact, Katona’s developments led to the creation of the first cci, known as the “Consumer Sentiment Index”, which was jointly developed by Thompson Reuters and the University of Michigan (Heath, 2012).

In Mexico, the first consumer confidence index was developed by the newspaper *Reforma*, based on a sample collected through a telephone survey that started in October 2000. This index considered eight questions relating to the following 12 months, making it a perspective index (Heath, 2012). The National Institute of Statistics and Geography (INEGI in Spanish) started reporting the “Consumer Confidence Index” in April 2001, which was developed following the OECD recommendations for international comparability. Although *Reforma*’s and INEGI’s indicators were complementary, *Reforma* stopped publishing its index once official data became available (Heath, 2012).

Formally, the CCI, currently reported by INEGI (2024a), is a diffusion indicator. Such indicators consider qualitative information, which is transformed into quantitative data (Heath, 2021), and are helpful for analyzing a nation’s economic status. The CCI can be classified as an indicator of perception and confidence (Leyva *et al.*, 2016).

To elaborate on the CCI, five aspects related to current and future expectations are considered: the current economic situation of household members compared to that one year ago, the economic situation of household members within 12 months, the current economic situation of the country compared to that 12 months ago, the economic situation of the country within 12 months, and the current possibility of purchasing goods such as furniture and home appliances (Banco de México [Banxico], 2024a). The CCI is obtained by averaging these five partial indicators (INEGI, 2024b). The index takes values between 0 and 100, with 0 indicating a totally pessimistic situation and 100 indicating the most optimistic case; 50 points is the threshold between the optimistic and pessimistic scenarios (Heath, 2021).

The objective of the CCI is to measure consumers' perceptions of their individual economic situation, as well as that of their country and their expectations concerning the economy in the future (INEGI, 2024b). The CCI thus serves as a “thermometer” of both economic sentiment and general perceptions related to economic activity (Heath, 2021).

Consumer confidence indices can serve as leading indicators of economic activity, making them valuable for designing economic policies (Abad Barrantes *et al.*, 2023). An awareness of consumer confidence facilitates the prediction of consumers' purchasing behavior, permitting producers to adapt their marketing campaigns and supplies to market conditions (Huth *et al.*, 1994). Therefore, pessimistic attitudes among consumers, even if not founded on economic factors, can lead to economic slowdown (Matsusaka and Sbordone, 1995).

As mentioned by Ramalho *et al.* (2011, p. 26), the “[...] interest in the trajectory of confidence and in the factors that determine the formation of subjective evaluations of the economy, as reflected by confidence indexes [...]”, has motivated different researchers to model the process through which confidence is created; these studies have considered numerous political and economic variables, as well as wars and violent historical events.

Finally, the literature highlights unemployment, wages, and consumption taxes as the most important determinants of consumer confidence (Garabiza *et al.*, 2022). Similarly, other determinants include place of residence, type of job, number of employed and unemployed household members, consciousness of economic indicators, and the use of social networking sites. It is necessary to note that the better a job is, the more favorable its impact on consumer confidence (Pavithra and Velmurugan, 2023).

### **Misery Index, economic growth, exchange rate and consumer confidence**

According to the Secretaría de Economía (2023), Mexico has signed 14 free trade agreements with 50 nations, in addition to different international agreements related to investment protection and economic complementation agreements. In an open economy, households are affected by both exchange rates and terms of trade (Malovaná *et al.*, 2021); additionally, the immediate effect of national currency depreciation is a reduction in purchasing power. This has contractionary effects on economic activity under circumstances such as trade balance deficits (Krugman and Taylor, 1978). Thus, nominal exchan-

ge rates play a central role in determining consumer confidence, at least in the short term (Vazquez *et al.*, 2010).

Empirical evidence suggests that nominal exchange rates are important determinants in acquiring home appliances, houses, cars, and other durable goods, as their fluctuations directly affect prices; however, most consumers are unaware of real exchange rates (Vazquez *et al.*, 2010). The exchange rate can modify consumption habits, as depreciation implies an increase in the price of imports, which are present in most consumption baskets (Krugman *et al.*, 2023). Notably, in Turkey, a unidirectional statistically significant relationship between the exchange rate and consumer confidence has been observed (Görmüş and Güneş, 2010).

An increase in the MI, the standard version of which is calculated as a simple addition of unemployment and inflation rates (Hortalà and Rey, 2011; Sánchez, 2020), stifles human development, as it negatively affects education, health, and income; conversely, foreign investment and trade openness boost human development (Singh, 2024). Unemployment plays a crucial role in determining subjective happiness, having stronger effects on lower income households. On the contrary, inflation has an insignificant or weak statistical effect on happiness in some cases (Arge, 2022). In fact, in estimations using European data, the so-called “misery ratio” establishes that, if the unemployment rate increases by one percentage point, well-being decreases by more than five times as much as if the inflation rate increased by the same proportion (Blanchflower *et al.*, 2014).

Lovell and Tien (2000) analyze the relationship between the MI and consumer sentiment and find that an increase in the MI has a negative impact on consumer sentiment. To consider the harmful effects of deflation in an economy, they use a MI in which the values of the inflation rate are transformed by applying the absolute value. In the U.S., low consumer sentiment that could not be explained by variations in unemployment and inflation was associated with borrowing costs and consumer credit supply (Bolhuis *et al.*, 2024).

For its part, GDP indicates the level of economic activity, as it mirrors the evolution of the value of all goods and services generated by an economy using a constant set of prices (Mankiw, 2000). Moreover, GDP plays an important role in compensating for the negative effect of inflation and unemployment (Hortalà and Rey, 2011). In this sense, “The reason we care about growth is that we care about the standard of living. Looking across time, we want to know by how much the standard of living has increased. Looking across countries, we want to know how much higher the standard of living is in one country relative to another” (Blanchard and Johnson, 2013, p. 208). In the case of

Mexico, the empirical evidence suggests that GDP exerts a positive contemporaneous effect on the CCI (Kim, 2016); meanwhile, in the case of the Eurozone, GDP causes, in the Granger sense, consumer confidence (Borisov, 2022).

### 3. DATA AND GRAPHICAL EXPLORATION

#### Sources and unit root tests

This research's study period ran from 2005Q1 to 2024Q2 ( $N = 78$ ), and the following variables were collected from the INEGI (2024a): the consumer confidence indicator (CCI), real GDP ( $Y$ ) with base year 2018, unemployment rate, and national price consumer index (INPC) (2018 = 100). The bilateral real exchange rate index of Mexico with respect to the U.S. ( $XR$ ) was retrieved from Banxico (2024b).

The series, with the exception of GDP, have monthly periodicity and were averaged into quarterly data to obtain consistent information, as “An autoregressive distributed lag (ARDL) model is an ordinary least square (OLS) based model [...]” (Shrestha and Bhatta, 2018, p. 79); more precisely, “ARDLs are standard least squares regressions that include lags of both the dependent variable and explanatory variables as regressors [...]” (Eviews 12 User's Guide, 2020, p. 321), and “A typical time series regression model involves data sampled at the same frequency” (Ghysels *et al.*, 2004, p. 1). All four quarterly series were seasonally adjusted using the Census-X12 filter. To calculate Okun's MI, the inflation rate was obtained as the growth rate of the INPC, and unemployment and inflation were summed.

An analysis of the integration order of the series was conducted by applying the following classical unit root tests: the Augmented Dickey-Fuller (ADF), Phillips-Perron (PP), and Kwiatkowski-Phillips-Schmidt-Shin (KPSS). Note that the ADF and PP tests use the null hypothesis of a unit root, whereas the KPSS test considers a null hypothesis of stationarity. In practice, the relevance of performing tests with contrasting null hypotheses lies in the different conclusions drawn from such approaches (Maddala, 1992).

The results in table 1 establish that, according to the ADF and PP tests, all series, with the exception of GDP, can be considered  $I(1)$ . GDP, according to specification A of both the ADF and PP tests, is an  $I(0)$  series, whereas the rest of the specifications indicate that it is an  $I(1)$  variable. In all four cases, KPSS exhibited varying results, and all the tests discussed in this section confirm that all four series are stationary when the first differences is considered.

Table 1. Standard unit root test, 2005Q1 - 2024Q2

Series	ADF			PP			KPSS			
	A	B	C	A	B	C	A	B	C	
$\ln CCI$	-2.4378	-2.2314	0.1555	-2.5724	-2.3911	0.1555	0.1803**	0.2489	0.1555	0.2489
$\ln XR$	-1.5785	-1.5382	0.1860	-1.7793	-1.5382	0.1715	0.1176	0.8400***	0.1715	0.8400***
$\ln MI$	-2.7630	-2.3248	-0.5154	-3.0300	-2.8024*	-0.2999	0.1519**	0.2512	-0.2999	0.2512
$\ln Y$	-4.0499**	-1.2940	1.4292	-3.9731**	-1.3778	2.0497	0.1080	1.1309***	2.0497	1.1309***
$\hat{c}\hat{c}t$	-8.9960***	-8.9858***	-9.0365***	-8.9960***	-8.9858***	-9.0365***	0.0267	0.1048	-9.0365***	0.1048
$\hat{x}t$	-7.6713***	-7.6675***	-7.7114***	-7.6354***	-7.6474***	-7.6928***	0.0845	0.1179	-7.6928***	0.1179
$\hat{m}t$	-12.600***	-12.564***	-12.638***	-12.756***	-12.608***	-12.679***	0.0578	0.2545	-12.679***	0.2545
$\hat{y}$	-11.612***	-11.691***	-11.521***	-13.018***	-13.125***	-12.099***	0.0655	0.0704	-12.099***	0.0704

Notes: A) Trend and intercept; B) intercept; C) none. \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . Symbolization:  $\hat{c}\hat{c}t_t = \Delta \ln CCI$ ;  $\hat{m}t_t = \Delta \ln MI$ ;  $\hat{x}t_t = \Delta \ln XR$ ;  $\hat{y}_t = \Delta \ln Y$ . Source: own elaboration.

Given the results of the unit root tests, the ARDL methodology was selected for this study, and, in order to prevent the long-term analysis from providing misleading results, we conducted an augmented ARDL bounds test. Finally, the econometric analysis is performed using EViews® 12 University Version.

### **Graphical exploration**

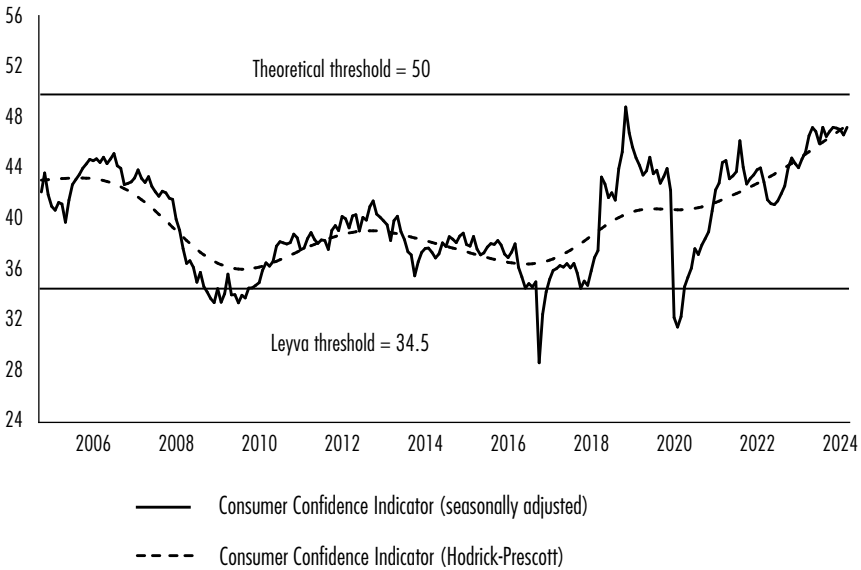
This section presents a graphical bivariate analysis using control charts consisting of scatterplots with confidence ellipses and linear and nearest-neighbor fits. The analysis studies the individual effects of the variables selected to explain the CCI. Confidence ellipses are important in detecting atypical data (Johnson and Wichern, 2007), which, following Everitt and Dunn's (2001) example, consists of observations lying outside the frontier of the ellipse. Meanwhile, the nearest-neighbor analysis is relatively easy to apply and highly effective at detecting data patterns (Bhatia and Vandana, 2010).

To elaborate on figure 1, monthly time series data were overlaid to illustrate the evolution of the CCI. This figure displays the trend component of the CCI, which was calculated by applying Hodrick and Prescott's (1997) method to the seasonally adjusted CCI. The smoothing parameter  $\lambda$  was set to a value of 14 400, as recommended for series with a monthly frequency (EViews 12 User's Guide, 2020).

Figure 1 shows that the CCI consistently remained below the theoretical threshold of 50 points, indicating that Mexican consumers have been consistently pessimistic, even during periods of economic dynamism (Heath, 2021; Leyva *et al.*, 2016). Leyva *et al.* (2016) calculated an empirical threshold of 34.5 points and concluded that, when the CCI is above this value, the probability of private consumption showing a positive growth rate in the same month with respect to the previous year is 94%. According to Heath (2021), this empirical threshold is called the "Leyva threshold". The figure also reveals that the CCI was below the Leyva threshold during the 2008 international financial crisis, the Covid-19 pandemic, and in January 2017.

The 2008 international financial crisis caused a reduction in remittances due to the economic slowdown in the U.S., particularly in the construction and manufacturing sectors, where most Mexican migrants work. In addition, in 2009, the unemployment rates in Mexico and North America increased (Díaz-Bautista, 2009). In January 2017, the XR grew by 3.05% compared to the previous month and the unemployment rate reached 3.60 points, which represented a difference of 0.22 points in regard to the preceding month, according to the data provided by the INEGI (2024a).

Figure 1. Monthly Consumer Confidence Indicator, 2005M01-2024M06



Source: own elaboration.

The Covid-19 outbreak led to the closure of thousands of businesses, causing an increase in the unemployment rate in Mexico, which led to a reduction in consumers' purchasing power. At the time, Mexico also faced falling oil prices and rising exchange rates (Chiatchoua *et al.*, 2020). Further, many workers experienced wage cuts or unpaid temporary layoffs (Sánchez-Castañeda, 2020).

Figure 2 presents scatterplots concerning the relationship between the CCI and the independent variables in the ARDL, namely: *XR*, Okun's MI, and real GDP; it illustrates both short and long-term effects using series in levels and first differences. Note that all the figures describe contemporaneous effects, as no lagged series are used.

Figure 2a shows two evident outliers: the first in 2017Q1 and the second in 2020Q2. The data present a very low correlation; however, on the right side of the figure, a negative relationship can be observed between the variables, as the linear fit has a negative slope. Figure 2b shows three outliers: 2008Q4, 2018Q3, and 2020Q2. The figure reveals that *XR* diminishes the CCI in the short term.

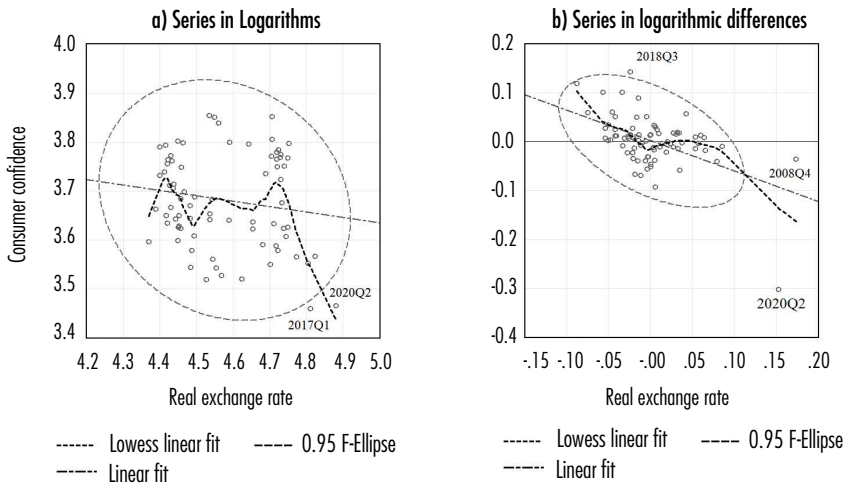
Figure 2c reveals a clear negative linear relationship between Okun's MI and the CCI, as well as an evident outlier in 2020Q2. Meanwhile, the nearest neighbor analysis presented in figure 2d shows no relationship between these variables, with an almost horizontal line, and the linear regression fit shows similar results but indicates a weak negative relationship. There were three outliers according to the confidence ellipses: 2018Q3, 2020Q2, and 2020Q3.

Figure 2e shows that there have been episodes in which GDP has been low and the CCI has been high. However, the nearest neighbor analysis suggests a positive relationship between these variables, which appears to become stronger in the right part of the figure. The linear fit also showed a positive association between these variables.

Figure 2f reveals a clear positive association between the variables; however, most of the data are concentrated at the center of the confidence ellipse, showing a mostly vertical pattern. In fact, the atypical observations of 2020Q2 and 2020Q3 outline this positive relationship. The figure reveals two additional outliers for 2017Q2 and 2018Q3.

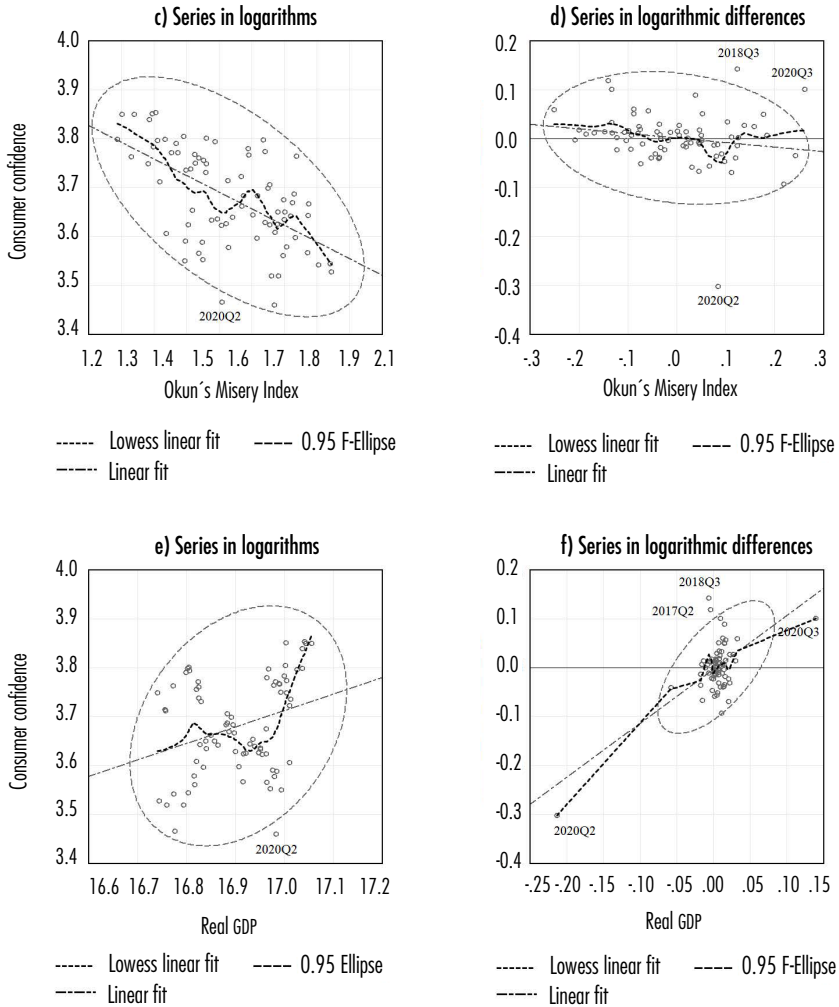
Finally, the results in figure 2 correspond to the expected signs and are congruent with the literature reviewed previously, as increases in the exchange rate and Okun's MI negatively affect the CCI, whereas GDP positively affects consumer confidence.

Figure 2. Scatterplot with confidence ellipses and linear and nearest neighbor fits



Continue

Figure 2. Scatterplot with confidence ellipses and linear and nearest neighbor fits (*continuation*)



Source: own elaboration.

#### 4. METHOD AND ECONOMETRIC RESULTS

##### Empirical design

As mentioned, the main objective of this study is to analyze the effects of Okun's MI on the CCI in Mexico, using the  $XR$  and  $GDP$  as control variables. Therefore, the objective of this section is to present the methods employed to empirically model the following function:

$$CCI = f(MI, XR, Y) \quad (1)$$

In general terms, "ARDL models are linear time series models in which both the dependent and independent variables are related not only contemporaneously, but across historical (lagged) values as well" (EViews 12 User's Guide, 2020, p. 321). The ARDL methodology allows for detecting long-run relationships "irrespective of whether the underlying variables are  $I(0)$ ,  $I(1)$ , or a combination of both" (Nkoro and Uko, 2016, p. 76).

Although ARDL models are robust when time series data with different integration orders are used to estimate them, the traditional approach to testing for the existence of long-run relationships in these types of models establishes the following prerequisites "the exogeneity of the independent variables, the dependent variable must be  $I(1)$ , and the absence of degenerate cases" (Sam *et al.*, 2019, p. 130). However, the CCI, our chosen dependent variable, does not fulfill the prerequisite of being an  $I(1)$  series (see table 1). To overcome this eventuality, we apply the relatively new augmented ARDL (AARDL) bounds test because, with this test, we can overlook the assumption of an  $I(1)$  dependent variable to test for the existence of an equilibrium relationship (Sam *et al.*, 2019).

Additionally, ARDL models are robust when there is a single cointegrating vector, particularly when the series span short time periods. Accordingly, the existence of multiple equilibrium relationships must be rejected when using these types of models. It is worth mentioning that the existence of a unique long-term relationship prevents cointegration techniques such as the Johansen-Juselius test from being applied, as they are more appropriate in the presence of multiple cointegration relationships (Nkoro and Uko, 2016). In addition, traditional cointegration tests do not allow for mixed integration orders (Sam *et al.*, 2019).

The general form of an ARDL ( $p, q_1, q_2, \dots, q_k$ ) is shown in Equation (2):

$$y_t = \alpha_0 + \alpha_1 t + \sum_{i=1}^p \varphi_i y_{t-i} + \sum_{j=1}^k \sum_{l_j=0}^{q_j} \beta_{j,l_j} x_{j,t-l_j} + \varepsilon_t \quad (2)$$

Where  $y_t$  is the dependent variable;  $\{x_1, x_2, \dots, x_k\}$  is a set of independent variables;  $\alpha_0$  is a constant;  $t$  is a linear trend; and  $\varepsilon_t$  is the error term (EViews 12 User's Guide, 2020).

To calculate the ARDL model, the “unrestricted constant and no trend” specification is utilized. Equation (3) represents the general form of the conditional error correction (CEC) regression of an ARDL estimated using this specification. A detailed explanation of the CEC regression is provided in the EViews 12 User's Guide (2020).

$$\begin{aligned} \Delta y_t = & a_0 + b_0 y_{t-1} + \sum_{j=1}^k b_j x_{j,t-1} + \sum_{i=1}^{p-1} c_{0,i} \Delta y_{t-i} \\ & + \sum_{j=1}^k \sum_{l_j=1}^{q_j-1} c_{j,l_j} \Delta x_{j,t-l_j} + \sum_{j=1}^k d_j \Delta x_{j,t} + \varepsilon_t \end{aligned} \quad (3)$$

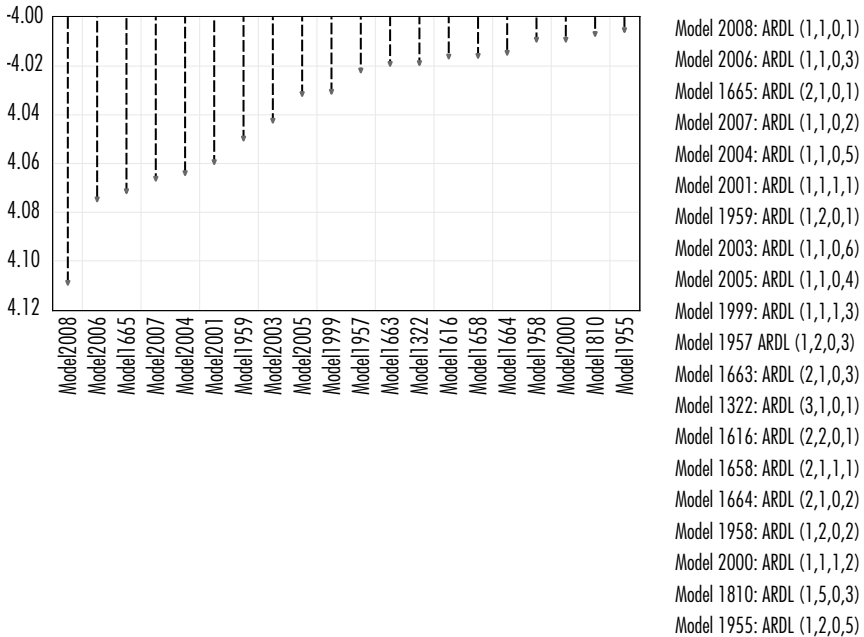
The model considers a fixed variable  $D_t$ , the main purpose of which is to correct for the main breaks in the dependent variable.  $D_t$  is defined in equation (4).

$$D_t = \begin{cases} 1 & \text{if } t = 2018Q3; 2019Q1; 2021Q2; 2021Q4 \\ -1 & \text{if } t = 2008Q2; 2016Q3; 2017Q1; 2018Q1. \\ 0 & \text{Otherwise} \end{cases} \quad (4)$$

The Schwarz information criterion is used to introduce an adequate number of lags into the model; it finds that, among 2 058 models, the best specification is an ARDL(1,1,0,1). The results are summarized in figure 3.

As ARDL models are usually computed using the OLS method (Srinivasan *et al.*, 2012), once the model is computed, the traditional correct specification tests for an OLS model are applied, namely, normality, autocorrelation, heteroskedasticity, global significance, goodness of fit, and stability.

Figure 3. Schwarz information criteria (top 20 models)



Source: own elaboration.

To test the parameter stability assumption, which is essential in time-series analyses, the cumulative sum test (CUSUM) and the cumulative sum of squares test (CUSUMSQ) were applied (Jan *et al.*, 2021; Meo *et al.*, 2018; Ravinthirakumaran *et al.*, 2015). The objective of the former is to identify possible “[...] systematic changes in the regression coefficients”, while the latter is applied to detect possible “[...] sudden changes from the constancy of the regression coefficients” (Ravinthirakumaran *et al.*, 2015, p. 253).

### Econometric results and discussion

An ARDL model is estimated based on the values shown in table 1. The “unrestricted constant and no trend” specification is used to estimate the model; once it is estimated, standard correct specification tests are conducted (see table 2).

The tests listed in table 2 indicate that the model satisfies the main assumptions of these types of models. The stability of the parameters is verified by applying CUSUM and CUSUM of squares tests (see figure 4). The results indicate that the ARDL model is stable (Jan *et al.*, 2021; Meo *et al.*, 2018).

**Table 2. ARDL correct specification tests**

<i>Test</i>		<i>Value</i>	<i>p-Value</i>
Jarque-Bera Normality Test	$\chi^2$	0.9413	0.6245
Breusch-Godfrey Serial Correlation LM Test (12)	$\chi^2$	13.4153	0.3396
White Heteroskedasticity Test (no cross terms)	$\chi^2$	7.6070	0.3685
White Heteroskedasticity Test (cross terms)	$\chi^2$	23.7346	0.7419
ARCH LM Test (12)	$\chi^2$	15.5306	0.2137
Ramsey RESET Test	<i>F</i>	0.0053	0.9417
F-Statistic	<i>F</i>	149.2263	0.0000***
R <sup>2</sup>	-	0.9380	-
Adjusted R <sup>2</sup>	-	0.9317	-

Note: \*\*\*  $p < 0.01$ .

Source: own elaboration.

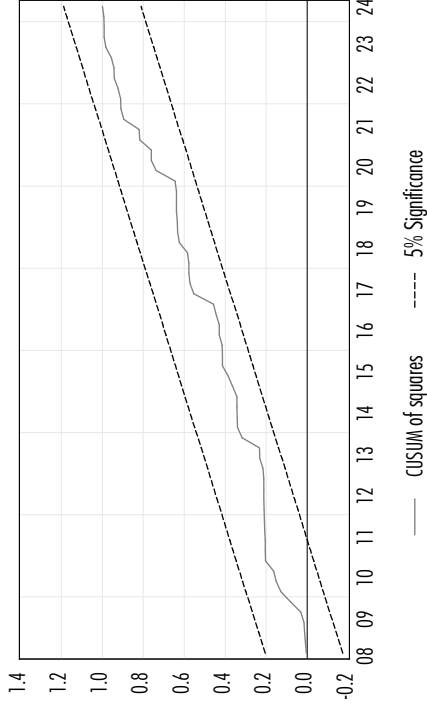
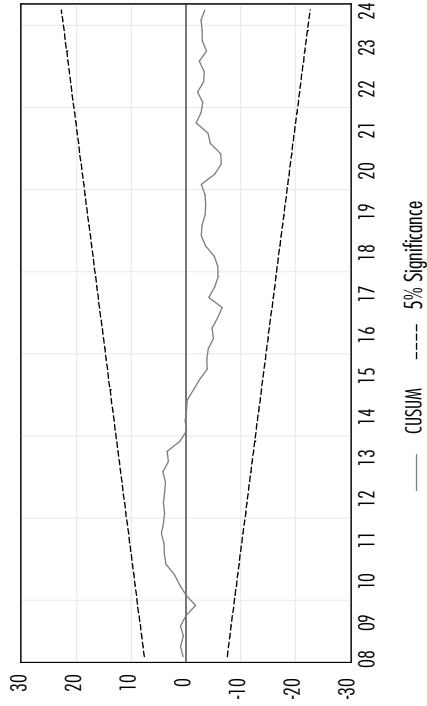
As a final misspecification test, the accuracy of the ARDL in simulating the dependent variable is tested using a static forecast (see figure 5).

Figure 5 shows that the model reasonably simulates the main breaks in the CCI series, including those related to the Covid-19 outbreak and international financial crisis. After confirming that the ARDL model is correctly specified, the CEC regression is estimated according to the specifications in figure 3 (see table 3).

In the selected model,  $\ln MI$  did not have lags (see figure 3); therefore, this variable is not considered in the short-run CEC regression path (see table 3). This implies that, in this model, the MI has not short-term effect on CCI, which is consistent with figure 2d.

To test for an equilibrium relationship, the augmented ARDL bounds test is conducted given that, as mentioned previously, the unit root tests provided mixed results for the dependent variable  $\ln CCI$  (see table 1).

Figure 4. CUSUM and CUSUM of squares



Source: own elaboration.

Figure 5. Consumer Confidence Indicator, 2005Q2 - 2024Q2



Source: own elaboration.

Table 3. Conditional error correction regression

Variable	Coefficient	t-Statistic
Constant	-0.566767	-0.7102
$\ln CCI_{t-1}$	-0.249312	-5.9615***
$\ln XR_{t-1}$ <sup>a</sup>	-0.076823	-2.3755**
$\ln MI_t$	-0.094620	-4.0343***
$\ln Y_{t-1}$	0.117605	2.2073**
$\dot{x}r_t$	-0.322655	-4.1055***
$\dot{y}_t$	0.875526	7.9924***
$D_t$	0.087013	9.2848***

Note: <sup>a</sup> Variable interpreted as  $Z = Z(-1) + D(Z)$ ; \*\* and \*\*\* represent  $p < 0.05$  and  $p < 0.01$ , respectively.

Source: own elaboration.

The results of all three tests, presented in table 4, refute the null hypothesis of no relationship in levels; thus, one can assume the existence of a long-term relationship among the variables (Sam *et al.*, 2019).

**Table 4. Augmented ARDL bounds test**

<i>Actual sample</i>	<i>Overall F-Bounds test</i>		<i>Exogenous F-Bounds test</i>		<i>t-Bounds test</i>	
<i>n = 77</i>	9.811531		8.950277		-5.961545	
<i>Critical values</i>						
<i>Sample</i>	<i>Overall F-Bounds test</i>		<i>Exogenous F-Bounds test</i>		<i>t-Bounds test</i>	
	<i>I(0)</i>	<i>I(1)</i>	<i>I(0)</i>	<i>I(1)</i>	<i>I(0)</i>	<i>I(1)</i>
<i>n = 80</i>	4.568	5.96	4.09	6.71	-3.43	-4.37
<i>n = 75</i>	4.725	6.08	4.13	6.79		

Note: all three tests at the 1% significance level. The critical values were collected from Narayan (2005), Sam *et al.* (2019), and Pesaran *et al.* (2001).

Source: own elaboration.

However, as previously noted, for an ARDL to be robust when using small samples, it is mandatory to prove the existence of a unique long-term relationship among the variables selected to estimate it. To fulfill this requirement, given the integration order of the series (see table 1), we apply the AARDL bounds test to three alternative models that can be estimated using the variables in this study (see table 5).

Table 5 shows that, when used as dependent variables, the real exchange rate and the GDP reject all three tests in the AARDL bounds test at the 5% significance level. Meanwhile, when estimating the ARDL with the MI as the dependent variable, the Exogenous F-bounds test is the only one rejected at the 5% significance level. According to Sam *et al.* (2019), this case indicates the presence of the “degenerate lagged independent variable(s) case”, and suggests that there is no long-term relationship among the variables. These results imply that only the model using ln CCI as a dependent variable provides a long-term relationship (see table 4).

**Table 5. Complementary AARDL bounds tests**

<i>Dependent Variable</i>	<i>Actual sample</i>	<i>Overall F-Bounds test</i>		<i>Exogenous F-Bounds test</i>		<i>t-Bounds test</i>	
ln MI	<i>n</i> = 75	4.577765		4.577246		-3.887418	
ln XR	<i>n</i> = 77	3.535634		4.238532		-2.849782	
ln Y	<i>n</i> = 76	2.537387		2.679214		-1.257393	
<i>Critical values</i>							
	<i>Sample</i>	<i>Overall F-Bounds test</i>		<i>Exogenous F-Bounds test</i>		<i>t-Bounds test</i>	
		<i>I(0)</i>	<i>I(1)</i>	<i>I(0)</i>	<i>I(1)</i>	<i>I(0)</i>	<i>I(1)</i>
	<i>n</i> = 80	3.363	4.515	2.73	4.77	-2.86	-3.78
	<i>n</i> = 75	3.408	4.55	2.74	4.79		

Note: all three tests used the 5% significance level. The critical values were retrieved from Narayan (2005), Sam *et al.* (2019), and Pesaran *et al.* (2001). All three tests were performed using the “unrestricted constant and no trend” specification for consistency with the main model.

Source: own elaboration.

The results in table 6 show that the CCI is inelastic to variations in all three dependent variables. If the XR increases by 1%, the CCI decreases by 0.30%; if the MI increases by 1%, the CCI decreases by 0.37%; and if GDP rises by 1%, the CCI increases by 0.47%.

Table 7, on the other hand, contains the results of the error correction regression, whose term  $EC_{t-1}$  represents the error correction term with one lag; the estimated parameter associated with this term is expected to have a negative sign for the model to be convergent (Nkoro and Uko, 2016). The short-run results show that GDP has a stronger positive effect on the CCI in the short term than in the long term. In contrast, depreciation negatively affects the CCI more strongly in the short term than in the long term, whereas Okun’s MI does not affect the CCI in the short term. However, using a structural vector autoregressive model, Percastre (2018) found a short-term relationship between the MI and the consumer confidence index in Mexico.

Table 6 also shows that  $EC_{t-1}$  is negative; therefore, the model converges. More precisely,  $EC_{t-1}$  shows that 24.93% of the disequilibrium in the model is corrected within one quarter.

**Table 6. ARDL long-run coefficients**

<i>Variable</i>	<i>Coefficient</i>	<i>t-Statistic</i>
$\ln XR_t$	-0.3081	-2.6016**
$\ln Y_t$	0.4717	2.2868**
$\ln MI_t$	-0.3795	-4.5757***

Note: \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$ .

Source: own elaboration.

**Table 7. Error correction model**

<i>Variable</i>	<i>Coefficient</i>	<i>t-Statistic</i>
<i>Constant</i>	-0.5667	-6.4212***
$\dot{x}r_t$	-0.3226	-4.2954***
$\dot{y}_t$	0.8755	8.4070***
$D_t$	0.0870	9.5568***
$EC_{t-1}$	-0.2493	-6.3994***

Note: \*\*\*  $p < 0.01$ .

Source: own elaboration.

The ARDL model shows that depreciation in the Mexican peso has negative effects in both the long and short term. An increase in the exchange rate leads to a decrease in the purchasing power of domestic consumers as it increases the prices of imported goods (Krugman *et al.*, 2023); meanwhile, Okun's MI negatively affected the CCI only in the long term. Increases in Okun's MI, by definition, are boosted by increases in unemployment and inflation, which are economic indicators reflecting citizens' loss of purchasing power (Grabia, 2011). This is consistent with previous analyses, such as that of Lovell and Tien (2000). Finally, the ARDL model also exhibits results consistent with those of Kim (2016) and Percastre (2018) in the sense that GDP stimulates consumer confidence.

## 5. DISCUSSION AND CONCLUSIONS

In this study, Mexico's CCI is analyzed for the period 2005Q1-2024Q2 using a traditional ARDL model with the *XR*, the *MI*, and *GDP* as explanatory variables. Similarly, a bivariate analysis consisting of scatterplots with linear and nearest neighbor fits was applied.

The model successfully passed the stability and diagnostic tests. The augmented ARDL bounds test confirms the existence of an equilibrium relationship, and the error correction exhibits a relatively fast convergence to equilibrium (see table 7). The model results, in addition to being reliable, are adequate for drawing policy recommendations (Jan *et al.*, 2021).

The long-run model results show that both the *XR* and Okun's *MI* negatively affect the CCI; meanwhile, *GDP* stimulates consumer confidence. In the short run, Okun's *MI* does not affect the CCI, whereas *GDP* has a stronger positive effect on the CCI in the short term than in the long term, while the *XR* has a slightly stronger negative effect on the CCI in the short term. These results are consistent with those in the existing literature.

Changes in exchange rates determine international trade: "The real exchange rate is one of the key relative prices in an economy, defining the rate of exchange between domestic goods and their foreign counterparts" (Bayoumi, 1996, p. 29). In general, an increase in the exchange rate is reflected in purchasing power reductions, as it diminishes real income in the country where depreciation takes place by augmenting the price of imports (Krugman and Taylor, 1978).

Increases in Okun's *MI* are related to income reductions because unemployment prevents people from receiving salaries, whereas inflation reduces citizens' consumption capacity (Grabia, 2011; Riascos, 2009). Accordingly, Grabia (2011) considers Okun's *MI* to represent a certain type of poverty index, while Riascos (2009) mentions that the *MI*, from the perspective of poverty indices, should be included as a monetary measure of poverty. An important observation is that Okun's *MI* is statistically the most important variable for explaining the CCI in the long run, as it has the largest t-statistics (see table 6). *GDP* is considered to alleviate the economic malaise caused by both unemployment and inflation (Hortalà and Rey, 2011). Economic growth is important because of its effect on the standard of living (Blanchard and Johnson, 2013).

The variables selected to carry out this study are related to purchasing power; two of them—namely, Okun's *MI* and the exchange rate—have a negative effect on Mexico's CCI. This is particularly important because Mexico's

CCI remained below the theoretical optimistic threshold throughout the study period. Mexican consumers seem to be more enthusiastic about the future than the present (Heath, 2021).

### ACKNOWLEDGMENTS

This work was supported by UNAM Postdoctoral Program.

### DATA AVAILABILITY

The data that support the findings of this study are openly available at Mendeley Data (<https://doi.org/10.17632/gy38kz3rp7.1>).

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