Dynamic convergence of trade exchanges between China and Mexico, 1993-2019

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Abstract

This article examines the dynamic stability of the stochastic process, using the trade exchanges between Mexico and China during the period 1993-2019. The methodology consists of applying stationarity tests and estimating an autoregressive model in both annual and monthly figures. Despite persistent fluctuations registered in the series of the analysis, the variance presents a significant reduction across the study period, while the solutions to the resulting equations confirm that the trade flows between the two countries converge to a stability level of 17.5, measured using the ratio between Mexican imports and exports with China.

Keywords: trade flows; variance; unit root; convergence; dynamic stability.

1. INTRODUCTION

According to figures from the Ministry of Economy (Secretaría de Economía [SE], 2020), Mexico has sustained deficit balances in its trade exchanges with China for over 30 years, constantly and with an upward trend. Between 1993 and 2019 alone, the annual growth rate averaged 23.1%, rising from US$341.7 million to US$75,922 million; in other words, Mexico's trade deficit with China has multiplied by 222 times over the last 26 years.

All signs indicate that this figure could continue increasing over time in absolute terms. In light of this, the current article seeks to analyze the dynamic stability of this stochastic process, expressing Sino-Mexican trade exchanges in relative terms as a process of dynamic convergence. This approach has been adopted as this indicator's temporal trajectory would register a tendency towards a particular level, although the formal definition can be seen below. This article intends to use the findings obtained from this analysis to describe the trade relationship between these nations in both qualitative and quantitative terms and, above all, to contribute to designing effective and profitable trade policies for Mexico to adopt with its second trading partner, a predominant economy within the contemporary global environment.

The first step in the analysis was to identify statistical data related to trade exchanges between the two nations, in both absolute and relative terms, for the period 1993-2019. On the one hand, the deficit balance in absolute terms definitely shows an increasing trend for Mexico over time. On the other hand, the same figures, but in relative terms and expressed by the ratio between Mexican imports (M) and exports (X) with its second trading partner (M/X), are on an apparently decreasing path, possibly leading to equilibrium.

Theoretically, the time series models applied in this study forecast the dynamic pattern of temporal behavior or the extrapolation of a stochastic process (Harvey, 1993; Maddala, 2001; Guerrero, 2011; enders, 2015). The temporal trajectory of a variable, therefore, depends on the characteristics of its predictable components and their lags over time, which serve as the core of the dynamic analysis. In this article, the M/X ratio is represented by a differential equation as a function of its own lags, and the results obtained reveal a dynamic convergence behavior with a downward trend, in addition to the fact that the fluctuations found in this variable present a persistently downward trend.

These realities demonstrate that although bilateral trade between Mexico and China is characterized by an imbalance, since 1993 and up to the present day, trade balances have favored China. Likewise, this period also witnessed frequent ups and downs. This is because, on average, the total value of imports from China represents 13.5 times the value of reciprocal exports, both in annual figures. In extreme cases, as occurred in 1997, this gap widened to its maximum point of 27.2, while in 1993, the same figure was at least 8.6, with a variance of 15.2. The projections offered by the model proposed here predict that this variable would tend to converge to a level of 17.5 as the equilibrium point.

This article consists of five sections, including this introduction. The second section offers a brief review of the trade exchanges recorded between the two nations during the last 26 years and then goes on to present estimates of the corresponding variances in their different modalities and in different periods, ranging from 4 to 10 years. The estimates confirm that the fluctuations of the variable have registered an imminent downward trend, thus indicating a link between the data and the methodology used in this study, in the sense that the trade flows between the two economies have headed towards an increasingly stable path. The fourth section applies the augmented Dickey-Fuller (DFA) unit root test to determine that the M/X series shows a fluctuating decreasing trend without stationarity due, resulting from a random walk in the annual figures for 1993-2019. Meanwhile, the same series registered a convergent dynamic behavior when measured monthly, with the particularity that it does not present a unit root and, therefore, is stationary.

Finally, based on the results obtained in the unit root tests and the variance calculations in their different modalities, the relevant forecasts were made to project the future behavior of trade between the two economies. The final section then offers some conclusions.

2. THE DEBATE ON CHINA-MEXICO TRADE, 1993-2019

Sustained bilateral trade between the two economies began to attract attention from both governmental and academic circles during the 1990s, when Mexico imposed countervailing duties against a massive basket of products imported from China in response to their increased presence in the domestic market. Since implementing these measures, the Mexican authorities have not relaxed them.

New instruments for alleviating the the trade imbalance

The study period witnessed the implementation of certain policies in response to the "threat" of competition from Chinese goods, in view of China's imminent entry into the World Trade Organization (WTO) at the end of 2001. This applies not only to the Mexican domestic market, but also to the foreign market, especially with the United States, which accounts for over 80% of Mexico’s exports.

Among these new instruments is the agreement signed by the two governments, reserved in the protocol of accession of China to the WTO in December 2001, in which Mexico maintained compensatory quotas on a total of 953 tariff fractions for a period of six years. According to the Ministry of Economy (Secretaría de Economía [SE], 2007), this agreement obliged China to adopt internationally agreed WTO rules governing its import and export practices. The agreement also stipulated that Mexico had a six-year transition period to implement an industrial adjustment and competitiveness program via countervailing duties in 21 sectors, including bicycles, footwear and footwear parts, brass padlocks, prams, doorknobs and locks, malleable iron fittings, textiles, toys, pencils, and clothing.

According to this agreement, the anti-dumping measures that Mexico applied "to Chinese products during the six years following China’s accession will not be subject to the provisions of the WTO agreement nor to the provisions on anti-dumping measures" (Federal Official Gazette [Diario Oficial de la Federación, DOF] 2007, p. 11). In other words, these measures, which apply to more than 1,300 Chinese products, may not be challenged with a WTO dispute settlement panel for a period of six years following China’s accession to the WTO.

On June 1, 2008, the two authorities again agreed to maintain the countervailing duties for 204 of the 953 tariff items that Mexico had until December 11, 2011 to remove, as a transitional measure (Secretaría de Economía [SE], 2008).

Unlike several Latin American countries, to date Mexico has failed to recognize the Chinese economy as a market economy. Furthermore, however, Mexico has also refused to adopt a transitional position of using prices similar to those charged in China, and instead uses the prices or costs of similar products in third countries to determine whether China is dumping its exports. Similarly, this transitional approach would also be used to determine whether Chinese exporters receive official subsidies or subsidies. Reference import prices for products from China are determined based on these comparisons.

Assessment of Mexico’s trade imbalance with China Mexico's trade imbalance with China

Within the debate on this issue, there is both agreement and disagreement regarding the characteristics of trade between the two economies. Some authors argue that, in Mexico’s trade with the US and China, there is weak intra-industry integration between Mexico and China and greater integration between Mexico and the US, although this is decreasing (Cárdenas and Dussel, 2011; López and Rodil, 2019). In addition empirical estimates concluded that Mexico’s exports to the US decreased rapidly as a result of direct competition with China (Jenkins and Dussel, 2009; Gallagher and Porzecanski, 2010; Gallagher and Dussel, 2013).

First, there is a wide consensus that Chinese products, ranging from inputs, intermediate goods, and capital goods, have multiple and eminent competitive advantages compared to their Mexican counterparts, both in Mexico's domestic and export markets. In fact, figures from the Ministry of Economy indicate that since 1993, Mexico-China trade shows deficit balances, with this trend increasing for Mexico, rising from US$341.7 million in 1993 to US$75,922 million in 2019 (Secretaría de Economía [SE], 2020).

A review of the behavior of products from both countries in the US market leads to the same conclusion. Since 1994, despite the benefits of being part of the North American Free Trade Agreement (NAFTA), Mexican products’ share of the US market has significantly decreased in response to the growing presence of similar Chinese products. According to figures from the United States Census Bureau (2015), in 1993 (before NAFTA came into effect), Chinese products’ share of the US market was 5.43%, compared to 6.87% for Mexican products; in other words, there was a difference of 1.44% in favor of the Mexican economy.

It is important to mention that this advantage continued to grow until 2000, when it reached its highest level of 2.95% and Mexico’s and China’s respective market shares were 11.16% and 8.21%. However, things changed considerably after China became a member of the WTO, as the competitive advantages between Chinese products and similar products from Mexico were reversed. Given the almost stagnant growth, and even negative growth in some years, of Mexican exports to the US market, China displaced Mexico as the second-largest supplier of the world's largest country.[1]

Between 1993-2019, bilateral trade between the two countries was restructured, shifting from mainly general consumer products to intermediate consumption and capital goods. In other words, Mexico’s overwhelming deficit in its trade balance with China is increasingly due to increased imports of items required for processing and integration into domestic chains, and which are subsequently destined for both domestic and foreign markets. This restructuring of domestic bilateral trade between the two economies produced diverse and sometimes controversial opinions, from various perspectives, regarding the trade imbalances between China and Mexico. A brief summary of these positions now follows.

From a theoretical point of view, this restructuring of bilateral trade between China and Mexico over the last three decades could have two consequences. On the one hand, it could lead to imports from the US being substituted for Chinese imports. On the other hand, export-oriented companies operating in Mexico could increase their efficiency and productivity, given that Chinese imports are cheaper than their equivalents from other sources, mainly from the US. Given that Chinese exports to Mexico represent lower cost and better-quality inputs for Mexican companies, Mexican companies should be able to export at a more competitive price and, consequently, gain a larger share of the North American market. However, according to Dussel and Gallagher (2014), in a total of 53 market sectors, the US is losing market share to China in sectors where Mexico is also losing its share of the North American market to China, for example, footwear, toys, textile products, clothing items and electrical and electronics (Oropeza, 2006). On average, Mexico had captured 14% of the U.S. import market in these sectors in 2000, but its share dropped to 9% in 2009.

In the same vein, other scholars have studied the Mexican export model, which requires an increasing share of Chinese goods, and concluded that it “is detrimental to competitiveness, productivity, and the domestic market" (De la Cruz and Veintimilla, 2014, p. 498). Furthermore, the failure to increase competitiveness has led to a drop in wages and an increase in Mexico’s deficit with China. Thus, maintaining the policy of establishing foreign trade as the Mexican economy’s growth engine is insufficient, and consequently development of the Mexican economy’s strategic sectors and regions must be prioritized (De la Cruz and Veintimilla, 2014).

In addition to highlighting the negative outcomes of the growing trade between Mexico and China, other scholars have also suggested that this imbalance is unsustainable in the long term. From this perspective, there is a need to explore alternative models designed to serve three objectives: to raise regional competitiveness, improve regional integration, and boost growth; increase Mexican exports (through incentive policies); and to attract investments in the national productive plant (Villareal, 2014). This Ley (2012) to claim that "it is vital to comprehensively rethink Sino-Mexican economic relations" (p. 61). Similarly, there is a need to enact official Sino-Mexican statements proposing a strategic relationship between the two countries, to which the adjective "integral" was added in 2013, that is, relations discursively defined as a comprehensive strategic partnership (Anguiano, 2016).

However, in contrast to the considerations described above, the Mexican Ministry of Foreign Affairs, via its embassy in China, has expressed favorable opinions on trade exchanges between the two economies: "a growing complementarity that helps us to be more competitive in the international market, China is currently our second trading partner, with exchanges close to US$75 billion in 2016; the second source of our imports; and the third destination of our exports" (Mexican Embassy in China [Embajada de México en China], 2015). For its part, Mexico remains China's first trading partner in Latin America.

In light of this, Limas (2019) argued that the majority of Mexico’s imports from China contribute to Mexico’s productive and exporting structure, in particular to the US. Without the preceding imports from China, many Mexican industries would simply not be able to function or would be much less competitive.

Additionally, it is worth noting that although the trade deficit with China has increased practically every year since 1993, Mexico's foreign trade has remained very close to equilibrium since the 1995 crisis. The deficit in the trade balance with China has been more than offset by the surplus with the US (Ruíz, 2004; Zhang, 2013; Ortiz, 2011; Zottele and Santiago, 2015). In fact, the majority of imports into Mexico can be attributed to large transnationals intending to return to international markets, which could still alleviate the possible negative effects of exchange rate adjustments (Liu, 2012). Most importantly here, the deficit with China has never been a factor of macroeconomic imbalance in Mexico to date, although the trade balance still demands more comprehensive research (Limas, 2019).

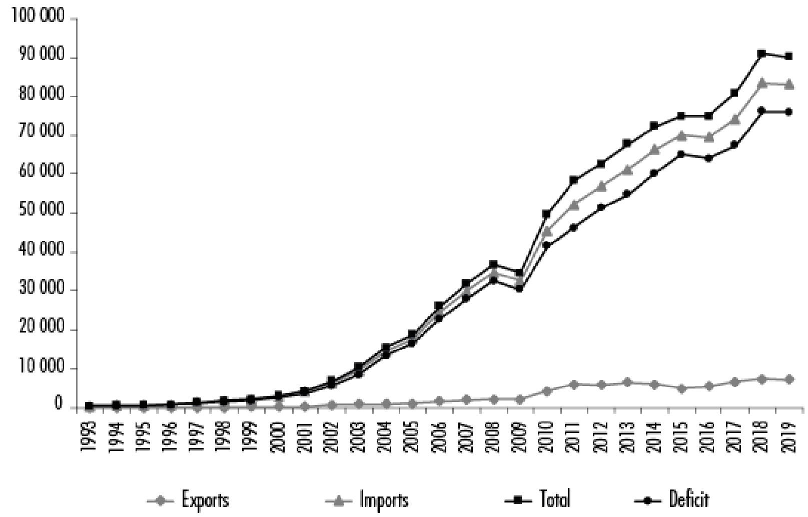
3. CHARACTERISTICS OF CHINA-MEXICO TRADE, 1993-2019

Two interesting characteristics stand out in China-Mexico trade exchanges between 1993 and 2019, which are mainly due to China's high import share in products belonging to chapters 27, 84, 85, and 87 of the Harmonized Commodity Description and Coding System.[2] The first of these is the growing deficit balance for Mexico, which has slowed since 2008 due to the already known causes of the global economic crisis. The second is the stabilization of the gap between imports and exports despite persistent fluctuations.

Mexico's growing deficit balance in its trade balance with China

Figure 1 presents an overview of the trade exchanges between China and Mexico during 1993-2019. When visualizing the behaviors of imports, exports and deficit balances registered by Mexico with its second trading partner, there is a clear, accelerated growth rate that covers practically most of the study period until at least 2010, with the same indicator subsequently slowing down within one digit as of the present.

Figure 1. Bilateral trade between China and Mexico, 1993-2019 in millions of US$



Source: Compiled by the authors using figures from the Ministry of Economy (Secretaría de Economía [SE]) (2020).

As can be seen, from 1993 to 2010, the annual growth rate of Mexico's trade deficit with China averaged 32.6%, while for the period 2010-2019, this figure was 6.7%. This particularity can also be seen by comparing the number of years required to duplicate the volume of the different indicators related to trade exchanges between the two countries. Specifically, before 2008, Mexico's total volume, imports, exports, and the trade deficit with China doubled in a period of three to four years. Since then, however, the doubling period has been extended to approximately eight years.

Figure 1 also shows another characteristic of the sustained trade exchanges between China and Mexico over the last 26 years. Before 2000, the indicators were low, despite the accelerated growth in their volumes, while the gap between imports and exports was small, less than US$2 billion per year. However, from 2010 onwards the growth rate of trade exchanges was reduced to single digits, and Mexico's trade deficit with China has exceeded US$50 billion per year since 2012. From 2010 to 2019, the deficit balance widened by a total of US$34.5 billion in absolute terms, and a net increase on average of US$3.8 billion per year.

Since 2010, the considerable increase in trade flows between the two economies, in imports and consequently in the deficit balance, can be explained by the additional impetus created by China's accession to the WTO and by the new arrangements made by both authorities on bilateral trade, as mentioned above. Of course, there are other elements whose impact should not be underestimated and which are directly related to the reconfiguration of global value chains as a result of the 2007 financial crisis, on the one hand, and, on the other, the reinforcement of sectoral promotion measures implemented by the Ministry of Economy to recover and strengthen exports.

Statistics show that Mexico was one of the few countries that immediately recovered its pre-financial crisis export level to the US in 2010, after suffering significant drops in 2009, a dynamism that was maintained until 2019. In fact, sales of Mexican products to the US market are increasing, rising from 238.7 in 2010 to 371.0 in 2019 in billions of US$, with a net increase of US$132.3 billion. In other words, there is probably a causal relationship between the restructuring of imports from China and a greater proportion in generalized consumption to those of inputs, intermediates, and capital, as well as the dynamism of Mexican exports to the US in the same period.

In other words, the slower rate of growth in bilateral trade after 2010 is valid when measured in relative terms; however, in absolute terms the picture is different, as the gap between exports and imports is widening in favor of China due to its high market share, policy of openness, and the structure of global value chains. Therefore, analysis must factor in both relative and absolute figures to gain a fuller picture.

Ratio between imports and exports: a decreasing trend in spite of persistent fluctuations

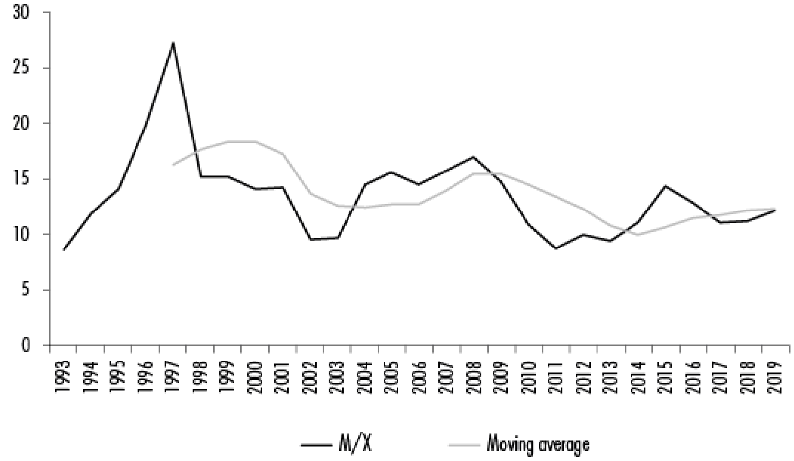
When analyzing the dynamic trend of trade flows between the two economies and, most importantly, ascertaining whether there is stability and dynamic convergence, it is crucial to mention the accentuated imbalance in absolute terms over the last 10 years. In light of this, the most appropriate approach here is to adopt a relative term formalized via the ratio between Chinese imports and exports in the Mexican economy.

Thus, if Mexican imports from China are expressed as *M* and Mexican exports to China as *X*, the ratio *Px* can be defined as follows:

$$Px = M/X \tag{1}$$

Based on the Ministry of Economy statistics presented in Figure 1, the behavior of the series derived from equation (1) is shown in Figure 2.

Figure 2. Mexico's imports/exports ratio with China, 1993-2019



Source: Compiled by the authors based on figures from the Ministry of Economy (Secretaría de Economía [SE]) (2020).

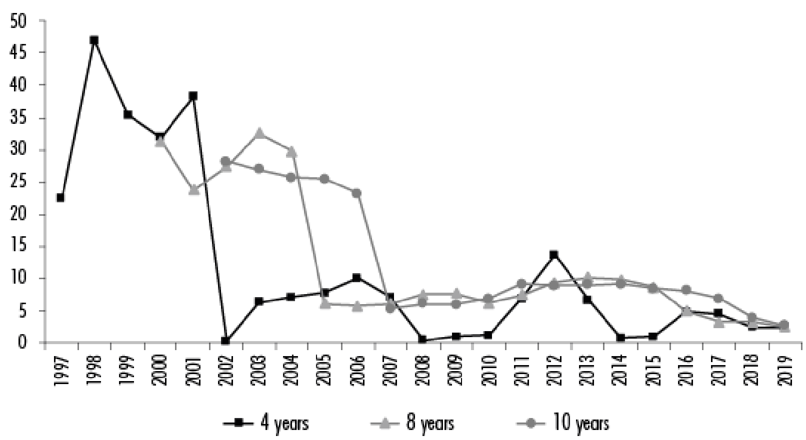
It can be seen that the *Px* series shows a decreasing trend with persistent fluctuations of decreasing magnitude over time during the study period; likewise, the same indicator smoothes out the fluctuations in the five-year moving average.

Figure 2 also shows that the *Px* variable reached its highest levels of 27.2, 19.8, and 17.0 in 1997, 1996, and 2008, respectively; the lowest values were recorded in 1993 and 2011, at 8.6 and 8.8 in each case, with an average of 13.4 for the entire period. In other words, for every dollar of Mexican exports to China, the respective imports would tend to reach US$13.4. However, the same indicator was approximately 11 over the last 10 years, a figure below the average for the entire study period.

This indicator's previous behavior can also be verified by calculating the moving averages (MA) to eliminate the temporal effects caused by various events. In this case, the MA is applied for every five years (see figure 2), the results of which also show a decreasing trend.

Likewise, the variances of the *Px* series are calculated in their different modes within a period of 4, 8, and 10 years, respectively, the results of which are shown in Figure 3.

Figure 3. Moving average and variances of different *Px* modalities



Source: Compiled by the authors based on figures from the Ministry of Economy (Secretaría de Economía [SE]) (2020).

The variances in their different modes point in the same direction: a decreasing trend which, for the final year, the figures are 2.41, 2.42, and 2.61, respectively for lags of 4, 8, and 10 years. Thus, it is clear that the *Px* series not only shows a decreasing trend, but also persistently reduced fluctuations.

4. ANALYSIS OF THE EQUILIBRIUM CONVERGENCE AND DYNAMIC STABILITY OF *PX*

The qualitative analysis above indicates that bilateral trade between China and Mexico shows a converging trend, especially when using the ratio between Mexican imports and exports with China, i.e., *Px* in equation (1). To confirm the possible convergence to equilibrium and the dynamic stability of the series, a unit root test is required.

Convergence to equilibrium or dynamic stability of a series

For the sake of simplicity, the dynamic stability analysis starts with a drift-free random walk model viewed as a first-order difference equation:

$$Y_t = a_0 Y_{t-1} \qquad (2)$$

This can be solved through the process of iterative delays:

$$Y_t = a_0^t Y_0 \qquad (3)$$

Generalized as follows:

$$Y_t = Ab^t \qquad (4)$$

In the solution to equation (2), the random walk model, part *A* serves as a constant that only generates scale effect without modifying the basic configuration of the behavior of b^t. Thus, the discrete time trajectory presented in equation (4) depends mainly on the value of *b*. If the function Y_t tends to zero when *t* increases infinitely, the equilibrium is dynamically stable and Y_t converges to equilibrium; otherwise, the Y_t series would diverge if *t* increases infinitely.

Table 1 summarizes the behavior of the dynamic trajectory of Y_t according to b values.

$b > 0$	Not oscillatory
$b < 0$	Oscillatory
$\lvert b \rvert \geq 1$	Divergent
$\lvert b \rvert < 1$	Convergent

Source: Compiled by the authors

For a model represented by a non-homogeneous first-order difference equation, which could be a random walk model with drift, the expression corresponds to equation (5):

$$Y_t + aY_{t-1} = c \qquad (5)$$

Where *a* and *c* are constants.

The general solution is composed by the sum of a particular solution Y_p and a complementary solution Y_c, which form a general solution to the complete inhomogeneous equation as shown in equation (5).Thus, the complementary solution will be in terms of equation (2):

$$Y_t + aY_{t-1} = 0 \qquad (6)$$

Its characteristic function is:

$$(b + a) = 0$$

$$b = -a$$

The complementary solution is:

$$Y = A(-a)^t \qquad (7)$$

There are two ways to find the particular solution that depends on the value that *a* takes. When $a \neq -1$, the first type of particular solution of equation (6) is:

$$k = \frac{c}{1+a} \qquad (8)$$

As Chiang and Wainwright (2006) point out, if $a = -1$ the particular solution remains undefined, and based on the analysis in the previous section, it represents a case of unit root and it is thus vital to find another particular solution for the non-homogeneous equation (equation 5). In this case:

$$Y_p = ct \tag{9}$$

From the above, if $a \neq -1$, the general solution is:

$$Y_t = A(-a)^t + \frac{c}{1+a} \tag{10}$$

When $a = -1$, the general solution is:

$$Y = A(-a)^t + ct = A + ct \tag{10´}$$

Using the initial condition: if t = 0 then Y_t = Y, for the case where $a \neq -1$

$$A = Y_0 - \frac{c}{1+a} \tag{11}$$

Therefore, equation (10) is replaced by:

$$Y_t = \left[Y_0 - \frac{c}{1+a}\right](-a)^t + \frac{c}{1+a} \tag{12}$$

If $a = -1$, then the general solution is:

$$Y_t = Y_0 + ct \tag{13}$$

Where Y_0 is the initial value of the series.

Given the two general solutions represented by equations (12) and (13), it can be observed that when $a = -1$, the trajectory of Y_t according to equation (13) would not converge to any equilibrium because it diverges as the value of t increases infinitely. On the other hand, when $a = 1$, Y_t adopts the value of $A + y_p$ according to equation (12), it will be unable to reach Y_p unless $A = 0$. Consequently, the trajectory is considered divergent, because $A \neq 0$ and, therefore, there will be a constant deviation concerning the moving equilibrium that is the particular solution $\frac{c}{1+a}$, but under no circumstances would it converge to that equilibrium point.

Therefore, in stipulating the condition of convergence of the time path Y_t to the equilibrium Y_p, we must rule out the case of $b = \pm 1$, which in other words translates into the presence of a unit root. Consequently, the equilibrium condition is confirmed: that a trajectory is convergent if and only if $|b| < 1$.

In summary, the general solution of equation (5) would converge to its particular. Y_p represents the intertemporal equilibrium level of Y_t, and Y_c is the deviations of the dynamic path from that equilibrium.

Unit root test

Testing for the existence of the unit root of a time series often requires applying the Augmented Dickey-Fuller test (1979), which is crucial when determining the stationarity of the series or the absence of unit root (Granger and Newbold, 1974).

Here, the following equation represents a stochastic process without drift:

$$Y_t = \rho Y_{t-1} + u_t \tag{14}$$

Where $u_t \backsim IIDN(0, \sigma^2)$. If $\rho = 1$, then we are dealing with a random walk model without drift and there is the presence of a unit root; or, in other words, a non-stationary series. If $|\rho| < 1$, Y_t is considered a stationary and convergent series.

However, the usual t-test for testing the hypothesis that $\rho = 1$ could result in a very marked bias that would skew the result (Gujarati and Porter, 2010). Therefore, we proceed to make adjustments to equation (14) by subtracting Y_{t-1} simultaneously on both sides to obtain equation (15):

$$Y_t - Y_{t-1} = \rho Y_{t-1} - Y_{t-1} + u_t$$

$$\Delta Y_t = (\rho - 1)Y_{t-1} + u_t$$

$$\Delta Y_t = \delta Y_{t-1} + u_t \tag{15}$$

Where $\delta = (\rho - 1)$ and Δ is the first difference operator.

Therefore, the estimation is applied to equation (15) rather than equation (14) to test the null hypothesis of $\delta = 0$ against the alternative of $\delta < 0$.

- $H_0: \delta = 0$ (implying a non-stationary stochastic process or presence of a unit root).

- $H_1: \delta < 0$ (implying a stationary stochastic process) possibly around a deterministic trend.

In practice, the above tests are performed in their various forms when estimating the regression equation.

- Y_t is a random walk (without intercept): $\Delta Y_t = \delta Y_{t-1} + u_t$

- Y_t is a random walk with drift (with intercept): $\Delta Y_t = \beta_1 + \delta Y_{t-1} + u_t$

- Y_t is a random walk with drift around a deterministic trend, $\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + u_t$ where *t* is the time or trend variable.

Consequently, if the null hypothesis $\delta = 0$ is not rejected, then $\rho = 1$; i.e., the presence of the unit root is proved, and the series Y_t is non-stationary.

Before analyzing the findings obtained it is first necessary to decide which of the three models is the most appropriate. The most obvious approach is to discard those in which the value of δ is positive. Given that $\delta = (\rho - 1)$, a positive δ would imply that $\rho > 1$, which, although a theoretical possibility (divergence), its exclusion is based on the fact that the time series *Yt* would be explosive.[3]

It is important to highlight two points about the result of the unit root hypothesis test. First, for the cases of a random walk (without intercept) and a random walk with drift (with intercept), the stationarity of the Y_t series coincides with the convergence to equilibrium or the existence of dynamic stability of the series. However, for the third case involving a deterministic trend, the Y_t series does not necessarily converge to an equilibrium level.[4]

Application of the unit root test for bilateral trade between China and Mexico

This section analyzes both annualized and monthly figures for sustained trade between China and Mexico, both with the purpose of testing for stationarity and possible dynamic convergence through the use of unit root tests.

Estimation for annualized figures

The correlogram corresponding to the annualized figures (below) reveals that the lags are statistically significant, given that the probability value is lower than 0.05; consequently, the series is non-stationary (see Figure 4).

Figure 4. Correlogram of the *Px* series

Autocorrelation	Partial correlation		AC	PAC	Q-Stat	Prob
		1	0.525	0.525	8.0296	0.005
		2	0.114	-0.223	8.4273	0.015
		3	-0.107	-0.092	8.7874	0.032
		4	-0.208	-0.110	10.222	0.037
		5	-0.253	-0.125	12.438	0.029
		6	-0.275	-0.147	15.185	0.019
		7	-0.008	0.257	15.187	0.034

Source: Compiled by the authors using E-views econometric software.

Applying unit root tests for annualized *Px* yields the following results were obtained for each of its three regression modes, using the Augmented Dickey-Fuller approach. For the three cases, the null hypothesis is not rejected, given that probability values of 0.4694, 0.0798, and 0.0803 were obtained, respectively, indicating that the series is non-stationary or has stochastic tenure (the estimates are shown in tables A1, A2, and A3 in the Appendix).

Despite the results obtained in the different regressive modes, the first two regressions present convergent results for the *Px* series, while the last one with an explosive (divergent) trend without dynamic stability is the model chosen to determine its stability according to the Akaike, Schwartz, and Hannan-Quinn criteria.

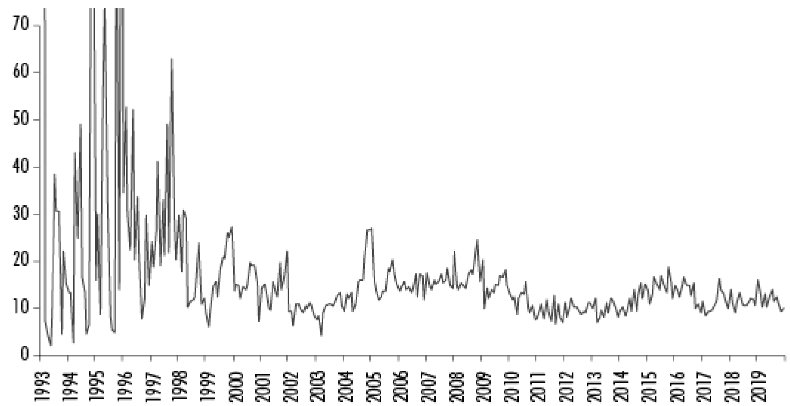
Estimate for monthly figures

For monthly figures, the results of the unit root test confirm that the *Px* series is stationary and convergent.

We consider the monthly fluctuation of trade exchanges between China and Mexico, for 1993-2019, estimated using the quotient between imports made by Mexico from China and Mexican exports to China.

When analyzing Figure 5 for stability and stationarity, the results are clearer than in the case of the annual figures (see Figure 2). In light of this, the probability values of 0.000 in the three modes of the regression reject the null hypothesis that the series has a unit root (as shown in Tables A4, A5, and A6 in the Appendix).

Figure 5. Ratio of Mexico's imports to exports with China



Source: Compiled by the authors based on figures from the Ministry of Economy (Secretaría de Economía [SE]) (2020)

Additionally, as the critical value of the statistic is lower than the observed, the null hypothesis is rejected at the different confidence levels of 99%, 95%, and 90%, respectively. Therefore, the *Px* series with monthly figures from 1993 to 2019 is a stationary stochastic process. On the other hand, the coefficients derived from the regressions represent negative values, which confirm the non-existence of a unit root of the same variable, and thus, it is also a dynamically stable series.

Forecasts based on unit root tests

The following differential equation is based on the results from the unit root test listed in Appendix Table A5:

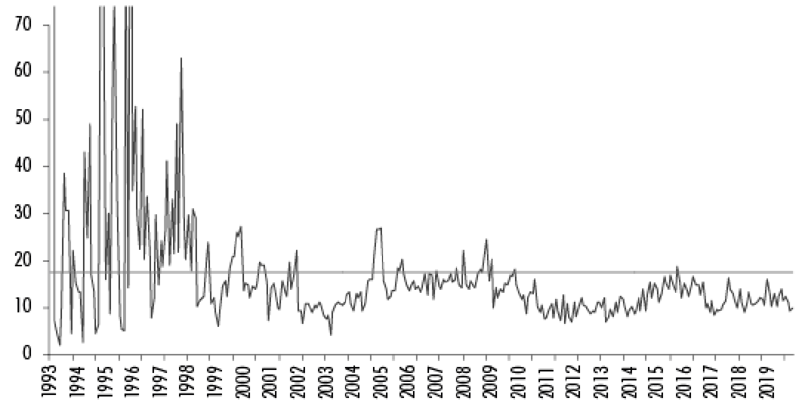
$$Y_t - 0.388238\delta Y_{t-1} = 10.69714 \quad (16)$$

The general solution to equation (16) consists of the sum of the complementary part and the particular part.

$$Y_t = A(0.388238)^t + 17.485787 \quad (17)$$

In light of this, this equation’s solution translates into the ratio between Mexico's imports and exports with China converging to 17.485787 when projected into the future; that is, for every dollar of Mexican exports to China, reciprocal imports would tend toward their equilibrium level of US$17.5 (see Figure 6).

Figure 6. Convergence of Mexico's import/export ratio with China



Source: Compiled by the authors based on figures from the Ministry of Economy (Secretaría de Economía [SE], (2020).

Here, it is vital to point out that the convergence at the indicated point of US$17.5 refers specifically to the fact that, despite the fluctuations in imports and exports between Mexico and China, the proportion is the same; in other words, these two variables have a corresponding behavioral trajectory moving in the same direction and proportion, with the result that the quotient between them will tend to 17.5. However, this should not be confused with the balance of trade balance in absolute terms, which represents the difference between the two variables with an explosive trend.

It is also worth mentioning that during the first two months of 2020, the indicator analyzed in this study began to register values of 14.3 and 12.6, respectively, despite the reductions and even stabilities observed during the last 10 years. Therefore, it is very likely that 2020 represents the beginning of a structural change based on recorded events, such as the trade frictions between China and the US and the SARS-Cov-2 pandemic, which need to be analyzed in greater detail in the future.

5. CONCLUSIONS

From a quantitative point of view, it can be concluded that despite the persistent fluctuations registered in trade exchanges between Chile and Mexico, their variance has reduced over the last 26 years. Furthermore, unit root tests confirm that trade between the two countries in relative terms tends to converge to a stability level of approximately 17.5, from its peak of 27.2 in 1997, regardless of the increasing absolute balance.

According to the annual figures, the series' stability appears to be ambiguous, given that the series is not a stationary series as the null hypothesis of the unit root test cannot be rejected. Therefore, we proceeded using monthly figures, which confirmed stationarity and dynamic convergence towards the equilibrium level.

The results obtained show that, despite fluctuations, Sino-Mexican trade exchanges converge at 17.5; that is, for every dollar that Mexico exports to China, US$17.5 is imported, which ratifies China's behavior regarding its opening reforms and their implications for Mexico's position in foreign trade.

For the purposes of this research, and based on the results obtained for the study period, it can be confirmed that the increase in the demand for Chinese products highlights the steady and upward increase in the trade balance in the Mexico-China relationship in favor of Mexico across the study period, with China thus consolidating its position as Mexico's second-largest trading partner.

In light of this, it is crucial to identify the potential of Sino-Mexican relations and their possible impact on trade with the US, to allow for the implementation of a new institutional framework capable of rethinking international trade in terms of trade policy and sectoral incentives to increase the country's competitiveness, restructure global value chains and stimulate key manufacturing and technological production sectors in which China has gained ground.

Understood in this way, the Mexican economy and the national exporting force must not only strengthen and improve the overall level of competitiveness, but also efficiently develop local linkages and sectoral integration of the manufacturing industry. Achieving this would allow increased incorporation of national content and, consequently, increased added value in exports by taking advantage of the new development frameworks derived from the new trade agreement in the North American region.

Appendix

Table A1. Augmented Dickey-Fuller test for the random walk model with annualized figures

Augmented Dickey-Fuller test. Dependent Variable D(Px)				
		Coefficient	*t-statistic*	*p-value*
	Px (-1)	-0.0290	-0.5480	0.5887
Null hypothesis: Px has a unit root.				
			t-statistic	*p-value*
			-0.5480	0.4694
DFA Test		1%	-2.6607	
Critical values		5%	-1.9550	
		10%	-1.6090	

Source: Compiled by the authors (results obtained with the econometric software E-views).

Table A2. Augmented Dickey-Fuller test for the random walk model with intercept with annualized figures

Augmented Dickey-Fuller test. Dependent Variable D(Px)				
		Coefficient	*t-statistic*	*p-value*
	Px (-1)	-0.4684	-2.7511	0.0114
	C	6.4809	2.6860	0.0132
Null hypothesis: Px has a unit root				
			t-statistic	*p-value*
			-2.7511	0.0798
DFA Test		1%	-3.7240	
Critical values		5%	-2.9862	
		10%	-2.6326	

Source: Compiled by the authors (results obtained with the econometric software E-views).

Table A3. Augmented Dickey-Fuller test for the random walk model with intercept and trend with annualized figures

Augmented Dickey-Fuller test. Dependent Variable D(Px)			
	Coefficient	*t-statistic*	*p-value*
Px(-1)	-0.5746	-3.3572	0.0028
C	10.2100	3.3714	0.0028
Tendencia	-0.1747	-1.8814	0.0732
Null hypothesis: Px has a unit root			
		t-statistic	*p-value*
		-3.3572	0.0803
DFA Test	1%	-4.3743	
Critical values	5%	-3.6032	
	10%	-3.2380	

Source: Compiled by the authors (results obtained with the econometric software E-views).

Table A4. Augmented Dickey-Fuller test for the random walk model with monthly figures

Augmented Dickey-Fuller test. Dependent Variable D(Px)			
	Coefficient	*t-statistic*	*p-value*
Px(-1)	-0.4639	-10.9959	0.0000
Null hypothesis: Px has a unit root			
		t-statistic	*p-value*
		-10.9959	0.0000
DFA Test	1%	-2.5724	
Critical values	5%	-1.9418	
	10%	-1.6160	

Source: Compiled by the authors (results obtained with the econometric software E-views).

Table A5. Augmented Dickey-Fuller test for the random walk model with intercept with monthly figures

Augmented Dickey-Fuller test. Dependent Variable D(Px)				
		Coefficient	*t-statistic*	*p-value*
	Px(-1)	-0.6117	-13.2227	0.0000
	C	10.6971	6.2686	0.0000
Null hypothesis: Px has a unit root				
			t-statistic	*p-value*
			-13.2227	0.0000
DFA Test		1%	-3.4512	
Critical values		5%	-2.8706	
		10%	-2.5716	

Source: Compiled by the authors (results obtained with the econometric software E-views).

Table A6. Augmented Dickey-Fuller test for the random walk model with intercept and trend with monthly figures

Augmented Dickey-Fuller test. Dependent Variable D(Px)				
		Coefficient	*t-statistic*	*p-value*
	Px(-1)	-0.6520	-13.6949	0.0000
	C	19.3301	5.7965	0.0000
	Trend	-0.0504	-2.9997	0.0029
Null hypothesis: Px has a unit root				
			t-statistic	*p-value*
			-13.6949	0.0000
DFA Test		1%	-3.9878	
Critical values		5%	-3.4243	
		10%	-3.1352	

Source: Compiled by the authors (results obtained with the econometric software E-views).

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[1] Several events in the early 2000s, such as the US signing free trade agreements (in particular with Central American and Caribbean countries), combined with China's entry in the WTO, resulted in Mexican exports to the US becoming less competitive. (Espinosa and Serra, 2005).

[2] According to this system, Chapter 84 covers nuclear reactors, boilers, machinery, mechanical appliances, apparatus, and parts thereof. Chapter 85 covers electrical machinery, apparatus, equipment, and parts thereof; sound recorders and reproducers; television image and sound recorders and reproducers, and parts and accessories thereof. Chapter 87 covers motor vehicles, tractors, cycles and other land vehicles; parts and accessories thereof.

[3] In this test, it is important to rule out the possibility that $\delta > 0$ because in this case $\rho > 1$, and if so, the underlying time series would be explosive or divergent. Therefore, the unit root test is constrained at ≤ 1.

[4] It is important to mention that for a model represented by equation (15), the non-stationarity of Y_t, derived from the unit root test, would not necessarily imply divergence of the Y_t series. However, this article analyses neither the mathematical or practical verification, given that the article's objective is to study the consistencies between stationarity and dynamic convergence.