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Exchange rate and economic growth in Mexico

Tipo de cambio y crecimiento económico en México

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Abstract

Mexico's rate of inflation has remained low and stable, while the average growth rate of output (2.5%) has been stagnant over the period 2001-2018, despite the continuous expansion of exports. The persistent stagnation of the Mexican economy and other Latin American economies has prompted some authors to maintain that slow growth results from the Central Banks' practice of appreciating the exchange rate with the aim of anchoring inflation, hence the acceleration of economic growth depends on adopting a competitive exchange rate. In order to test this hypothesis, a regression model with breaks is used to estimate an equilibrium exchange rate; then, a NARDL model is estimated to determine exchange rate deviations (appreciations and depreciations) from the equilibrium value. It is empirically shown that a competitive and stable exchange rate per se was unable to accelerate output growth over the period 1993-2018.

JEL Code: C10, F43, N16
Keywords: exchange rate; economic growth; econometric models; Mexico

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Resumen

Durante 2001-2018 la tasa de inflación se mantuvo baja y estable en México y el crecimiento económico registró una tasa promedio anual de 2.5%, a pesar del constante aumento en las exportaciones. El notable estancamiento de la economía mexicana y de otras economías de América Latina, indujo a algunos autores a argumentar que el origen del lento crecimiento estriba en que los bancos centrales aprecian el tipo de cambio para anclar la inflación. Para acelerar el crecimiento económico proponen un tipo de cambio competitivo. Para comprobar esta hipótesis elaboramos un modelo de regresión con rupturas para calcular el tipo de cambio de equilibrio; a partir de esto estimamos un modelo NADRL para conocer las desviaciones (apreciaciones y depreciaciones) con respecto al tipo de cambio de equilibrio. Los resultados muestran que durante 1993-2018 un tipo de cambio estable y competitivo per se no acelera el crecimiento económico.

Código JEL: C10, F43, N16
Palabras clave: tipo de cambio estable y competitivo; crecimiento económico; modelación econométrica; México

Introduction

With the 1995 crisis in Mexico, a transition to price stabilization began, an objective achieved by establishing an inflation target. During the 2001-2018 period, the inflation rate remained stable at around 3%. At the same time, nevertheless, the slowdown in economic activity was reflected in the low growth of GDP (approximately 2.5% annual average), despite the boom in exports.

The slow growth phenomenon is observed in other Latin American countries. Some economists have proposed adopting a competitive exchange rate policy to break out of the stagnation trap and accelerate economic growth. Luiz Carlos Bresser-Pereira (2007, 2011), one of the authors of the New Developmentalism theory, argues that the slow growth results from the appreciation of the real exchange rate; this has affected competitiveness and led to lower returns on investment in the tradable goods sector. Other authors such as Dani Rodrik (2008), Jaime Ros (2006, 2009, 2013), Razmi et al. (2012), and Roberto Frenkel (2006) also support this hypothesis: exchange rate appreciation is the effect of an asymmetric monetary policy in the face of movements in that variable: the monetary authority (the central bank or the Treasury) is permissive when the exchange rate appreciates but intervenes and prevents currency slippage when it depreciates. This asymmetric policy depresses the economy. They state that the devaluation of the exchange rate increases the competitiveness of tradable goods, leading to an increase in exports and hence in the economic growth rate. Therefore, they claim that the real exchange rate should reach a stable and competitive level through monetary and exchange rate policy (Ros & Galindo, 2006, 2009).

There is a conflict between the export growth model and the inflation targeting model in Mexico, which is explained by the dual role of the exchange rate in the economy. The conflict is that the export

model needs a competitive exchange rate, and based on the Taylor rule, the price stability strategy needs a non-competitive exchange rate. If so, exchange rate appreciation is required to achieve the Bank of Mexico's inflation target, suggesting that inflation may not be purely monetary but has structural causes.

The main objective of this paper is to empirically test the null hypothesis that a competitive exchange rate can accelerate economic growth, as argued by the authors mentioned above.

The article is structured as follows: first, a theoretical discussion of the relation between the exchange rate and the price level, the interest rate, and the balance of payments. The following section presents a brief review of the empirical literature regarding the estimation of structural models, the implications underlying the choice of exchange rate regime, the structural aspects of the exchange rate, and the relation between the competitive exchange rate and economic growth. Later, an econometric analysis is developed in which the methodology for calculating the equilibrium exchange rate and its respective deviations is presented. The empirical analysis focuses on the relation between the exchange rate and economic growth in Mexico by applying an NADRL model to test the hypothesis that a competitive exchange rate accelerates economic growth versus the hypothesis that rejects this as a panacea for the structural stagnation of the Mexican economy. The results of the theoretical discussion and econometric analysis are summarized in the conclusion.

Review of the conceptual literature on exchange rates

The purchasing power parity (PPP) theory proposes a relation of equilibrium between currencies based on relative inflation; thus, a rise in the inflation rate induced by nominal means (increase in the money supply) requires an adjustment in the nominal exchange rate in the long term. If the inflationary process originates either on the demand or supply side, an adjustment in the nominal exchange rate causes, in the same proportion, a change in the real exchange rate that brings about a return to equilibrium. Based on this approach, it has been argued that a flexible regime is necessary to maintain a competitive exchange rate that contributes to economic growth (Friedman, 1953; Bresser-Pereira, 2011, Frenkel, 2006; Ros & Galindo, 2006; Rodrik, 2008).

Exchange rate and inflation

Starting from the absolute PPP defined in the previous section, it can be expressed in general terms as follows:

$$e = P^*/ P \tag{1}$$

Equation (1) shows that the real exchange rate is equivalent to the ratio of relative prices; that is, it corresponds to the domestic price level P relative to the foreign price level P*[1]. The equation indicates the degree of international competitiveness of a country's tradable goods since an increase in e expresses that domestic tradable goods are more competitive than foreign goods and also than non-tradable goods, and vice versa. The relative price ratio reflects the production costs for both goods and the degree of competitiveness that can be measured through unit labor costs.

The relative PPP, which considers the nominal exchange rate E equal to relative prices multiplied by a constant relation, can be expressed as follows

$$E = \varsigma\, P^*/P \tag{2}$$

Where ς is a constant parameter. For the calculation of relative PPP, price indices are commonly used; nevertheless, it is important to say that in Equation (2), there is no definite causality, so causality can be bidirectional so that the price ratio and E are endogenous variables. Therefore, the following definition of the real exchange rate e is used to test the PPP hypothesis:

$$e = E\, P^*/P \tag{3}$$

The real exchange rate is invariant over time t. From Equation (3), then a depreciation (appreciation) of the nominal or real exchange rate causes a shift in the allocation of resources in favor of (against) domestic tradable goods. The real exchange rate expressed in the equation is an indicator of a country's international competitiveness; nonetheless, it does not account for changes in the allocation of resources between both sectors (tradable and non-tradable) nor the effects of changes in the external sector and the balance of payments, as well as taxes on foreign trade.

The validity of the PPP hypothesis in the short and long run has been questioned mainly due to external forces affecting the price index. The PPP hypothesis is supported by the following conditions: (i) tradable or export goods satisfy the law of one price; (ii) non-tradable or locally produced goods have the same production function, and factor prices are internationally equivalent; and (iii) goods included in the price index are weighted in the same way across trading countries (Isard, 1995). Given these conditions, the validity of PPP in the short and long term is difficult to sustain because the characteristics and

[1]The ratio of prices of tradable goods to prices of non-tradable goods is commonly used in the case of developing countries, while P/P* is a criterion used by the International Monetary Fund. In this case, the first criterion is applied, which implies that a depreciation (appreciation) of the nominal and real exchange rate is reflected in an increase (decrease) of the respective indices.

structures of production, factor endowments, and the composition of price indices are not uniform across countries.

Insufficient evidence has favored the fulfillment of conditions ii) and iii) in the long term. Some authors claim that PPP deviations originated from monetary shocks rather than structural differences between countries (Balassa, 1964). Changes in the price index can also be explained by the productivity gap (Samuelson, 1964) and the presence of different income elasticities of import and export demand affecting the real exchange rate (Houthakker & Magee, 1969). Nevertheless, in the case of the latter evidence, when it occurs in countries with higher export income elasticity, redefining the real exchange rate equation is necessary to reduce its adverse effect (Krugman, 1990). Thus, if the restrictive conditions mentioned above are satisfied, the PPP hypothesis can be valid in the long run for the particular case of exportable goods.

Regarding the behavior of the real exchange rate, empirical evidence does not validate the PPP hypothesis in the short term since the relation between the nominal exchange rate and the price level is not stable. Nonetheless, even with these short and medium-term deviations, some theories, such as those of Samuelson and Balassa mentioned above, cannot be invalidated. The Balassa-Samuelson effect on the price level arising from structural factors to analyze long-run behavior and the validity of the PPP hypothesis was subject to analysis in the 1980s. These analyses affirm that the hypothesis holds only for tradable goods and in the medium term.

Evidence shows that the variability of the real exchange rate responds to the nominal exchange rate regime (i.e., considering a wide band between the fixed and flexible regimes), a fact that should be considered in the choice of the exchange rate regime. In the case of a fixed exchange rate regime, international reserves are of great importance in the face of real shocks, so when selecting a fixed exchange rate regime, optional measures are applied to restrict foreign trade, such as capital controls or taxes, to absorb or minimize the real shock. Regarding a flexible exchange rate, the pressure is exerted to a greater extent on the nominal exchange rate. A greater variability of the real exchange rate is currently observed due to international capital's free mobility (Isard, 1995).

Given the evidence of a high association between the nominal and real exchange rates, it is difficult to assert that nominal variables do not affect real variables, as is argued in the neoclassical approach. On the other hand, it is argued that nominal exchange rate fluctuations result from real shocks and not monetary policy or nominal shocks. The presence of "sticky or rigid" prices increases the importance of using the exchange rate as a policy instrument since a nominal currency depreciation can generate greater international competitiveness if the real exchange rate depreciates (Isard, 1995). Although the PPP hypothesis has theoretical limits and problems in its calculation, in a practical sense it is used as a starting point for analyzing the real exchange rate.

Exchange rate and interest rate

With the adoption of the Taylor rule as a monetary policy framework, using the interest rate as an instrument to influence inflation and the exchange rate became explicit. In the face of an appreciation (depreciation) of the exchange rate, the monetary authority can counteract it by decreasing (increasing) the interest rate. The relation between the exchange rate and interest rates can be observed by buying and selling foreign currency to carry out transactions in the international trade of goods and services or an international investment portfolio. The acquisition of foreign currency can be made immediately in the spot market (S) or by contract in the futures or forward market (F). The forward exchange rate theory explains that the distinction between S and F exchange rates lies in the differential between local and foreign interest rates.

J.M. Keynes (1923) systematized the theory of future exchange rate behavior[2] through what is now known as the interest rate parity hypothesis. When analyzing the choice between acquiring foreign currency in one financial center and another, Keynes observed that holding these funds depended on several factors, but the differential between local and foreign interest rates was the most significant. The interest rate parity hypothesis comprises the covered interest parity condition (CIP) and the uncovered interest parity condition (UIP). To explain such conditions, let it be supposed that there are only two currencies, X and Y, that the interest rate at present is r_t, and the future interest rate (t + 1) from abroad is r*. If an investor exchanges an amount of currency X for currency Y in the spot market, he will accumulate S (1 + rt) of currency Y at time t + 1. In case of a future exchange rate arrangement at present t, the investor holds an amount of currency X until the term of the future contract t + 1, in which he will obtain F (1 + r*) amount of currency Y.

Then the CIP hypothesis can be represented as follows:

$$Ft - St/St \approx ft - st \approx r - r^* \tag{4}$$

Where f and s are the logarithms of the forward and spot exchange rates, respectively. The equation is an approximate relation of the CIP where the differential of the spot and forward interest rates are equivalent to the difference of the logarithms of the forward minus the spot exchange rate. This difference implies that the premiums obtained from exchanging a currency S or a futures contract F are approximately equivalent since the investor pays in advance the risk or premium that will be received in period t + 1.

[2]In 1923 J.M. Keynes described his complete theory in A Tract on Monetary Reform, the result of several supplements published in The Manchester Guardian Commercial in 1922.

On the other hand, the UIP condition states that if a certain amount of currency X is held and later in the future it is exchanged for another currency Y, there is no certainty that when currency X is exchanged for currency Y in period t + 1, a profit will be obtained. In this way, the investor is uncertain about the premium obtained until the future time of exchange rate conversion, that is, between the current interval t and the future interval t + 1. It is important to note that the UIP hypothesis assumes that the market forces mechanism ensures that the investor obtains the premium at t + 1[3].

UIP can be expressed as:

$$EtSt + 1\ (1 + rt^*) = St\ (1 + rt) \tag{5}$$

EtSt + 1 is the current expected value t of the spot exchange rate at time t + 1; then the spread of the expected value of the spot exchange rate and interest rates can be represented as:

$$EtSt + 1 - St \approx rt - rt^* \tag{6}$$

Equation (6) states that the spread between the expected and current value of the spot exchange rate is approximately equal to the spread between local and foreign interest rates. When Equation (6) is satisfied, the expected spot exchange rate EtSt + 1 can be predicted based on the local and foreign interest rate differential. The validity of both conditions (CIP and UIP) has implications for intervention in the foreign exchange markets.

Based on the assumptions mentioned above of the UIP, if it proves to be valid, then the authority's intervention is not effective, and even if not, policy instruments (such as the interest rate) could be applied to achieve exchange rate objectives[4]. On the other hand, with the validity of the CIP, sterilized intervention to correct possible exchange rate deviations is accepted. Considering that the characteristics in the financial markets present similar behaviors regarding capital control, credit risk, and taxes and given the assumption that the availability of financial instruments can only be differentiated in the currency in which they are denominated, as well as in interest rates, then the validity of the CIP is more robust. Thus, it seems that the validity of the CIP can be questioned only when financial shocks occur.

Two main sources have been used to test the validity of CIP: its calculation in practice and based on data analysis. Empirical studies analyzing interest rate data in several countries have found deviations that political risk, transaction costs, or capital controls could not explain. Therefore, it is suggested that sample data be selected with caution. Testing the validity of UIP with the assumption that the interest rate

[3]The UIP condition is based on the theory of efficient markets assuming that agents have complete information for decision making. This condition is found in international asset pricing models.
[4]Sterilized intervention in the foreign exchange market is conducted through the purchase and sale of foreign currency to influence the behavior of the exchange rate.

differential can forecast the future spot exchange rate (see Equation 6) presents the difficulty of finding data for the EtSt + 1 variable. Therefore, the quality of the UIP forecast results is called into question.

Some regression analyses focus on testing the validity of CIP. Nevertheless, a biased prediction has been obtained, and the coefficient of the interest rate differential is negative. Therefore, considering the above evidence, it cannot be affirmed that the interest rate differential (rt - rt*) can predict exchange rate variations. This situation calls into question the influence of monetary policy instruments on the behavior of the exchange rate and their influence on nominal and real variables.

Exchange rate and balance of payments

Since the 17th century, the role of the exchange rate in the deviations between the balance of payments and domestic conditions in the economy has been recognized in political circles in Italy and Great Britain (Einzig, 1970). In the tradition of A. Marshall, the exchange rate is considered the price that can adjust the deviations arising in supply and demand to return to equilibrium. This type of model is known as the elasticities approach and is based on the following assumptions: an imported good M is consumed locally (demand curve), and a good X is exported (supply curve); the prices of both goods are considered in terms of the local currency (PM and PX respectively); only the nominal exchange rate (ratio of local currency unit to foreign currency unit) E is considered in the analysis; the markets for local goods and exported goods are in equilibrium; finally, the law of one price is satisfied. The model explains that equilibrium in the trade balance can be achieved through changes in the elasticities of demand and supply. If the above assumptions are fulfilled, the model predicts that a devaluation of the nominal exchange rate E will improve the trade balance only if the sum of both import elasticities is greater than one. Assuming that the supply of exports is infinitely elastic, the above inequality is known as the Marshall-Lerner condition[5]. The elasticities approach analyzes the effect of changes in the nominal exchange rate on the balance of payments considering partial equilibrium.

The elasticities approach has the following limitations: only the nominal exchange rate is adjusted. Thus, not including relative prices in the analysis omits real output and productive capacity. It does not specify the asset used to carry out the transactions of the goods. Finally, it does not consider the changes in the trade balance to be equivalent to the national income account (the result of the differential between local output and spending); these changes are not included in the model.

[5]The Marshall-Lerner condition is a particular case that emerges from the broader condition originally outlined by Bickerdike (1920) and presented by Robinson (1947) and Metzler (1949).

In the 1950s, the elasticities approach was integrated into the Keynesian view of national income. The result was a merger of the elasticities-absorption approach, which holds that adjustment in the exchange rate induces a change in the current account balance, which, in turn, has effects on employment and domestic production (Robinson, 1947; Harberger, 1950; Meade, 1951; Alexander, 1952). According to this model, a devaluation in the local currency causes a decrease in the price of locally produced goods, which not only modifies the composition of demand but also raises the level of production, which favors the trade balance.

After the collapse of the Bretton Woods system in the 1970s, interest in the elasticities-absorption approach and exchange rate management based on this approach reemerged. An example is the so-called J-curve, where the effect of a devaluation temporarily degrades the trade balance since, in the short term, the price of imports can increase faster than the price of exports. Thus, a negative effect on the trade balance is initially experienced, but later a positive effect occurs, causing a surplus in the trade balance. One argument against the elasticity-absorption approach is that it provides a static analysis. Nevertheless, it has been a premise of the stabilization policies applied in Latin America after the 1982 external debt crisis.

The balance of payments models mentioned above focus on the relation of the exchange rate effect on the current account. Nonetheless, the movement of capital flows is omitted. The 1960s saw the emergence of the Mundell-Fleming model, which includes private capital flows and the current account in the analysis[6]. Similar to the IS-LM model (Hicks, 1937), it introduces the goods market and the money market, with the difference that it analyzes an open economy assuming that the net international capital flow depends on the local interest rate. The model considers prices and the foreign interest rate as exogenous; the monetary policy instruments are the interest rate, money supply control, and the exchange rate. On the other hand, fiscal policy aims to increase income to maintain a balanced budget.

The Mundell-Fleming model explains the balance of payments equilibrium in terms of equality between monetary income and the interest rate (see Figure 1); it considers two cases of a balance of payments equilibrium: the trade balance depends on local income and the overall balance of payments shows the relation between the capital account balance and the local interest rate. In Figure 1, the balance of payments BP and the money market D are represented positively, while the goods market B shows a downward-sloping curve. As can be seen, the Mundell-Fleming model shows the internal balance through the D and B curves; the external balance corresponds to the BP balance of payments.

[6]The papers by Fleming (1962) and Mundell (1960, 1961a, 1961c, 1962 and 1963) were written independently.

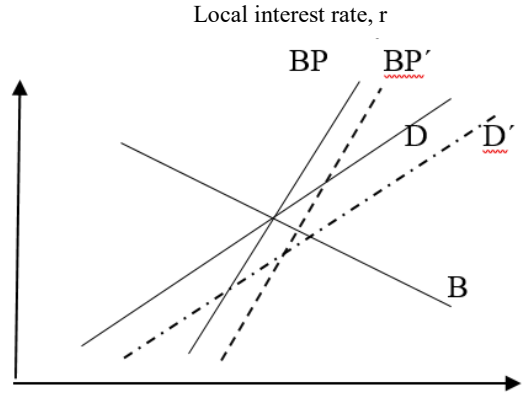

Figure 1. Mundell-Fleming model
Source: created by the author

Figure 1 shows that with a devaluation of the local currency, the balance of payments and the LM curve shift to the right (BP' and D,' respectively), improving the trade balance. Figure 1 does not explicitly show the exchange rate; its effect is exerted through the relative price of goods (local and foreign) in the BP and D curves. At any level of income, a stabilization monetary policy can be applied. In this case, the decrease in the local interest rate favors the equilibrium of the BP and the goods market. Nevertheless, if a fixed exchange rate regime prevails, monetary policy alone cannot achieve equilibrium and full employment; fiscal policy is required[7]. As Mundell (1963) envisioned, the challenge is to adopt rules for using policy instruments that simultaneously ensure internal and external balances.

In the Mundell-Fleming model, the application of economic policies (monetary or fiscal) depends on the origin of the misalignment (internal or external balance) and its effectiveness. The latter —the effectiveness of monetary or fiscal policy— results from the initial conditions (fixed or flexible exchange rate regime) and the degree of capital mobility). Based on this, monetary or fiscal policy is oriented toward a single objective to correct the internal or external imbalance; the intervention must be made with the instrument that exerts a direct and effective influence, as stated in the principle of the effective market (Mundell, 1960). The effectiveness of monetary and fiscal policy depends on the exchange rate regime and the degree of capital account openness in the economy.

[7]On the need to apply stabilization policies, Mundell states that the principle of classical international trade theory posits the existence of a mechanism that ensures equilibrium in the balance of payments, which in reality is not observed. Thus, the application of a monetary policy is necessary to achieve full employment by diverting it from its original function as long as an instrument that can be applied to equilibrate the balance of payments is not developed (Mundell, 1961a).

Mundell (1963) proposes two scenarios: case i) there is perfect capital mobility and a fixed exchange rate regime, the application of monetary policy through an increase in the money supply causes a rise in the volume of foreign exchange reserves, but no effect on income and employment. To achieve a positive effect on income, an expansionary fiscal policy is required, which, on the other hand, negatively affects the trade balance. In case ii), there is perfect capital mobility and a flexible exchange rate. An increase in government spending generates a change in the trade balance in the same direction but none in income and employment. Conversely, the expansion of the money supply may leave the interest rate unchanged but causes a depreciation in the exchange rate favoring the trade balance and, consequently, income and employment increase (Isard, 1995, pp. 102).

Nevertheless, capital flows are not continuous, as assumed by the Mundell-Fleming model. Recognition of this fact led to an analysis of the relation between the exchange rate and the balance of payments considering changes in the capital account stock. From there, two approaches emerged: the monetary and portfolio balance approaches. The essential difference between the two approaches is that financial assets (excluding money) are perfect or imperfect substitutes for foreign assets.

In the monetary view and the portfolio balance, the exchange rate is analyzed in the so-called asset balance models[8], which proceed from an equilibrium perspective in the stock of assets and assume that only the country's residents have these assets. Portfolio balance models are based on analyzing the demand and supply of the portfolio stock, including the holding of private assets and government bonds that can finance the fiscal deficit through their issuance. This analysis leads to the conclusion that the stock of assets in the economy (dependent on the policy applied) is the variable that determines the exchange rate and the interest rate, which are adjusted to keep the market in equilibrium. Nonetheless, the system is not solved since including r and r* does not determine the current and expected exchange rate.

Analysis of the empirical literature

Empirical estimations of structural models

During the 1970s and 1980s, several efforts were made to explain the behavior of the exchange rate. One of these approaches uses structural models in a reduced form based on three main models: the fixed-price monetary model, the flexible-price monetary model, and the portfolio balance model. These models have

[8]The development of these models arose in the 1970s, after the collapse of the Bretton Woods system; their development is also related to the advance of econometric analysis.

different economic policy implications. A second approach is the application of structural models of simultaneous equations or macro-econometric models.

When estimating the expected exchange rate from the predictions of reduced form equations, Meese and Rogoff (1983a; 1983b) find several limitations: bias due to possible omitted variables, simultaneity problem, and misspecification. The problem persists even after correcting for the simultaneity problem and including explanatory variables in real terms. Where applicable, portfolio balance models have focused on testing whether the risk premium varies over time and whether sterilized interventions affect the exchange rate (Meese and Rogoff, 1983a). It can be concluded based on the evidence that the hypothesis of no bias is rejected, and the exchange rate presents non-predictable behaviors. Due to problems such as that of simultaneity that arise when estimating a reduced-form equation, the application of multivariate models has also been explored as an alternative. Of the latter models, it can be stated that they accurately estimate the parameters; nonetheless, they present problems of misspecification that originate in one equation and can affect the rest of the equations. It can be concluded that although the reduced form and multivariate models have some limitations, these models are used in practice to calculate the exchange rate and obtain satisfactory results.

Selection of the exchange rate regime: fixed versus flexible

The relation between the exchange rate and economic variables (interest rates, balance of payments, price level, economic growth, employment, etcetera.) is driven by the authorities' economic policy objectives. The choice of exchange rate regime can be either a rigid or flexible layout or somewhere between the two extreme regimes[9].

In the case of a rigid exchange rate regime, the government assigns a given exchange rate parity, which it keeps constant through the purchase or sale of foreign currency. The central bank makes official interventions in the foreign exchange market. Thus buying (selling) foreign currency increases (decreases) reserves. Since appreciation and depreciation are zero, then the interest rate parity condition is valid ($r = r^*$).

In a flexible exchange rate regime, no government or central bank intervention exists in the foreign exchange market. Therefore, the exchange rate is determined by the supply and demand of the national currency compared to other currencies. As can be seen, in this case the UIP is considered valid since arbitrage determines the variations in the exchange rate.

[9]The International Monetary Fund offers an official classification of the exchange rate: fixed, flexible, and an intermediate regime between the two with limited flexibility.

The behavior of the exchange rate also responds to the international monetary system established by convention in most countries. Its objective is to monitor and manage the exchange rate between different currencies. The Bretton Woods system (1946-1971) was characterized mainly as a period that leaned toward a fixed exchange rate regime, stable inflation, and high economic growth rates. Since Bretton Woods, the flexible exchange rate regime has spread rapidly, especially since the 1990s, due to financial development and the increasing mobility of capital flows. It follows that one of the functions of the exchange rate is to maintain internal and external equilibrium in the economy. Thus, the choice of regime has important economic policy implications. In the case of a fixed exchange rate regime, monetary policy focuses on maintaining stability through interventions in the foreign exchange market. In contrast, under a flexible exchange rate regime, monetary policy is autonomous and can be oriented to other domestic objectives.

The advantages and disadvantages of adopting a fixed or flexible regime (or somewhere in between) have been discussed since the 1960s[10]. The monetarist approach (Friedman, 1953; Frenkel, 1981) argues against the fixed exchange rate (due to the high cost of keeping it stable) and in favor of the flexible exchange rate since it can be adjusted to improve competitiveness in the face of rigid international prices and wages and to stabilize private capital speculation[11].

In Mundell's (1961b) analysis, the optimal selection of an exchange rate regime must consider the following aspects: structural characteristics[12], the constantly changing external and macroeconomic environment, and capital flows. Nurkse (1944) questioned whether the free adjustment of the exchange rate contributes to trade balance equilibrium and maintains stability in the face of capital movements. He considers a regime where the exchange rate is volatile. Krugman (1989), in turn, states that the flexible exchange rate can be adverse to productive investment when appreciated; and that depreciation can be negative for creating productive capacity and capital gains.

On the other hand, the adoption of a fixed exchange rate regime during the Bretton Woods system was characterized by stable economic growth. During the 1990s, which were characterized by increased trade and financial openness, empirical studies conducted by the International Monetary Fund for the period 1980-2006 conclude, in general terms, that developing countries should adopt intermediate

[10]Originally the debate centered on whether international capital flows could be stabilized by a flexible exchange rate regime.
[11]The argument that the exchange rate can be adjusted to avoid inflationary and deflationary periods is supported by the validity of PPP where the real exchange rate equals the inflation differential (P - P*).
[12]Structural characteristics include size and trade openness, diversification of productive activities and labor force skills, geographic mobility of productive factors, fiscal redistribution mechanism, policy preferences, price flexibility and wage rate, exposure to local and external shocks, and financial development.

regimes, i.e., between the peg[13] and floating exchange rates. The choice of the exchange rate is important because it can affect the macroeconomic environment (growth, inflation) and the international monetary system. Evidence has shown that the authority loses the capacity and freedom to implement macroeconomic policies after adopting a rigid exchange rate. On the contrary, in a regime of complete flexibility, the relative price level adjusts, but it can also lead to exchange rate deviations and short-term shocks. Thus, a stable exchange rate depends on productivity, fiscal and monetary discipline, control of capital flows, and international political cooperation (Isard, 1995).

Structural exchange rate conditions

The different theories explain that the exchange rate is determined by various factors: relative inflation in the case of the PPP hypothesis; demand in the case of the elasticity-absorption model; the portfolio approach emphasizes the foreign exchange and financial assets market; and the monetarist approach explains it based on the relative money supply.

The structuralist theory explains the exchange rate based on the structural conditions of the economy; the exchange rate is a structural, rather than monetary, phenomenon. Production costs, productivity, and structural balance of payments constraints drive its dynamics. From this point of view, exchange rate instability is a consequence, not a cause, of the balance of payments problems and structural and external restrictions that limit economic growth. In the case of economies such as Mexico's, these structural conditions are summarized in Engel's Law and Thirlwall's Law, indicating that current account imbalances are due to the adverse differential between the income elasticities of demand for exports and imports. This fact determines a structural and endemic deficit in the balance of payments that must be financed with a surplus in the balance of capital.

Capital flows have the effect of appreciating the currency of deficit economies. Thus, the trend toward exchange rate appreciation results from the economy's structural problems. Therefore, this appreciation is not the cause of economic stagnation but rather the effect of the dynamics of an economy whose growth confronts the skewness between the income elasticities mentioned above (Engel's Law) and, therefore, is constrained by the balance of payments equilibrium (Thirlwall's Law) (see Perrotini & Vázquez, 2017 and 2018; Perrotini, Vázquez, & Angoa, 2019).

[13]The term *peg* exchange rate refers to a currency being paired with another currency in search of stability. To achieve this, the authorities must maintain large reserves of the currency to which the local currency is linked in order to control variations in supply and demand in the foreign exchange market.

The competitive real exchange rate and economic growth

Various authors propose a competitive exchange rate policy to stimulate growth, especially in developing countries. Indeed, in an economy that follows an export-oriented model, this policy can generate a trade effect (increase in exports and detriment to imports), a pecuniary effect (increase in foreign exchange, household, and corporate income) and a development effect (companies with increasing returns benefit from access to technology). The effects are achieved through three mechanisms: wage declines, the macroeconomic channel, and the development channel (Dvoskin & Feldman, 2015).[14]

Empirical evidence shows that exchange rate devaluation positively affects growth, increasing exports and strengthening the economy's tradable or industrial goods sector. Several studies, such as the one by Rodrik (2008), analyze the period 1950-2004 with panel data from 188 countries and draw up a depreciation —or overvaluation—index based on the price index adjusted by the Samuelson-Balassa effect. It shows that exchange rate policy can function as a "second best" in the face of economic distortion costs.[15] Ros and Galindo (2006) show the existence of a positive relation between the exchange rate and growth in the case of Mexico when evaluating the role of monetary and exchange rate policy in achieving the inflation target. They find a positive association between the real exchange rate and investment, thus concluding that a devaluation of the real exchange rate generates economic growth in the long run.

Discussion of the empirical literature

The behavior of the real exchange rate over time is unstable because it depends on several factors, such as productivity, government spending, terms of trade, non-tariff measures, the balance of foreign assets, and capital flows that influence the price level and the nominal exchange rate. Likewise, after the collapse of the Bretton Woods international monetary and financial system, the discussion has focused on the importance of the nominal exchange rate as a strategic instrument to maintain stability or alleviate instability. Thus, the choice of regime and its implications for developing economies is a subject of an ongoing debate that requires the definition and calculation of an equilibrium exchange rate as a comparative basis for evaluating the cost-benefit of the exchange rate policy adopted by the monetary authorities.

[14]The mechanisms mentioned presuppose the existence of a high wage elasticity faced with changes in labor demand, the complete absorption of export demand (Marshall-Lerner condition), investment demand without realization problems, and uniform returns to capital in the face of capital flow openness.
[15]Due to the difficulty in measuring market failures, Rodrik (2008, p. 397) states that it is practically impossible to provide direct evidence that some types of goods present this kind of distortion.

It was also identified that there is a paradoxical consensus among some neoclassical (PPP theory and monetarist approach) and heterodox authors about the virtues of the exchange rate to accelerate growth. A rise in the inflation rate (an increase in the money supply) requires an adjustment of the nominal exchange rate in the long term, which causes an equivalent adjustment in the real exchange rate, thus returning to equilibrium. Therefore, a flexible exchange rate regime that maintains a competitive exchange rate which puts greater pressure on the nominal exchange rate is imperative.[16]

The calculation of the real equilibrium exchange rate (REER) serves as a reference to determine whether a currency is overvalued or undervalued.[17] Williamson (1985) proposes calculating the REER using the fundamental equilibrium exchange rate (FEER). Estimating the REER consistent with macroeconomic performance is important in the Washington Consensus economic policy outline because it influences growth. Based on this approach, the appropriate exchange rate for macroeconomic stability and competitiveness that encourages exports and maintains external equilibrium is considered. Thus, any deviation from the 'appropriate' REER can harm economic growth (Williamson, 1985).

The FEER is estimated using structural econometric models based on 'fundamental' economic variables. John Williamson (1985, 1994) states that the FEER calculation is adequate to calculate the equilibrium exchange rate that acts as a benchmark. The FEER is the real effective exchange rate in equilibrium consistent with the macroeconomic balance. This concept implies an economy at full employment and low inflation (internal balance) with a sustainable current account or line with capital flows (external balance). The term 'fundamentals' considers only medium- and long-term effects of variables to exclude short-term effects (Clark & MacDonald, 1998). Since the FEER varies over time, the equilibrium real exchange rate is intended to achieve potential output growth and a sustainable current account, and its trajectory can be known based on changes in the real effective exchange rate (Williamson, 1994).

The FEER is calculated by estimating equilibrium patterns of the real exchange rate based on the specification (or assumption) of the behavior of the 'fundamentals' and the real exchange rate equations (Elbadawi, 1994). Thus, the FEER offers an approach to the real effective exchange rate from fundamentals that the equality between the current and capital accounts can represent. The complexity of its calculation lies in the number of parameters that need to be included in the estimation model.

[16]Because of the association between the nominal and real exchange rate, it cannot be affirmed that nominal variables have no effect on real variables, as monetarism claims.
[17]The REER refers to the equilibrium between the internal and external balances in an economy (Nurkse, 1945), which varies, according to the PPP hypothesis, due to real and nominal factors in the short run and only real factors in the long run (Edwards, 1991).

Econometric analysis

A structural econometric model is proposed to estimate the REER as a proximation to the FEER. From the REER, it is possible to determine the real exchange rate deviations (appreciations and depreciations) and their effect on economic growth in Mexico. Thus, the econometric analysis focuses on testing the validity of the competitive and stable exchange rate.

The null hypothesis assumes that devaluing the exchange rate positively affects economic growth, and the alternative hypothesis assumes that it has a negative effect. The methodology applied is as follows: first, a unit root test (Augmented Dickey-Fuller and Phillips-Perron test) was performed on the variables in levels and in difference to determine their order of integration. Second, the Engel-Granger (1987) cointegration test was applied. If there is a long-term relation, then the REER is estimated. A least squares regression with selected breaks was performed using the Bai-Perron test (2003) to estimate it. Third, the short-term and random effects were eliminated from the estimated data using the Hodrick-Prescott. Finally, a NADRL model was applied to test the validity of the aforementioned null hypothesis.

The NADRL model has the advantage of estimating at the same time the skewness and the cointegration of non-stationary variables in the long run, expressed as follows:

$$\Delta Y_t = \gamma + \beta_y Y_{t-1} + \beta_X X_{t-1} + \sum_{i=1}^{p-1} \delta_i \Delta Y_{t-1} + \sum_{i=0}^{q-1} (\omega_i^+ \Delta X_{t-1}^+ + \omega_i^- \Delta X_{t-1}^-) + \varepsilon_t \quad (7)$$

γ is a constant, Yt and Xt the dependent and independent variables, respectively, δi corresponds to the lags of the dependent variable in period i, p and q denote the number of distributed lags of the dependent and exogenous variables, respectively, Δ is the operator denoting variations in growth, ωi are the positive and negative coefficients of the independent variable and, finally, εt is the error term at time t. Through the inclusion of positive and negative independent variables, a dynamic error correction model is derived with which the short (ω_i^+ and ω_i^-) and long-run skewness (β's), respectively, and their effect on the dependent variable can be estimated.

The analysis is performed for a sample of 104 observations with quarterly data corresponding to 1993Q1-2018Q4 in the case of Mexico. The fundamental economic variables (FEER) included in the analysis are money supply for its short-term effect; terms of trade; international reserves; and the ratio of prices of tradable to non-tradable goods[18] for its long-term influence. The terms of trade are obtained from

[18]The prices of tradable goods are calculated by considering primary activities, mining, and manufacturing; the price index of non-tradable goods includes construction activities, electric power, water, gas, and tertiary services. Data obtained from INEGI (National Institute of Statistics, Geography, and Informatics).

the ratio of the price index of exports to that of imports; international reserves are denominated in dollars and indicate when the demand for local currency increases or decreases; the price ratio is an indicator of competitiveness; and the money supply indicates the adjustments resulting from monetary policy.

Then, the econometric model for calculating the REER is specified as follows:

$$\text{REER} = C + \alpha 1 RES + \alpha 2 MON + \alpha 3 TNT + \alpha 4 TOT + \varepsilon$$

Where RES is the international reserves denominated in foreign currency, MON is the money supply, TNT is the ratio of tradable to non-tradable goods' prices, TOT is the trade terms, and ε represents the error term. The variables that affect the REER in the short and long term are included. As can be seen, the model includes variables representing the current account (trade balance and terms of trade) and the capital account (foreign currency reserves and money supply).

The Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests are applied by analyzing the integration of the variables in levels and first difference. It is verified that the variables are stationary in the first difference, and the optimal number of lags is selected using the Akaike criterion (see Table A1 in the appendix). It is also found that the variables present a long-run relation with the Engel-Granger test, and the stability of the parameters is tested with the Hansen test (1992), which accepts the null hypothesis: the series are cointegrated (see Table A2 in the appendix).

The series in the analysis period presents several structural changes that are checked with the Bai and Perron (2003) sequential test, which determines the breaks to be incorporated in the sample (see Table 1). With the F statistic and a significance level of 5%, the number of optimal breaks is determined as four. Thus, the REER is estimated through a least squares regression with intercept, including 4 breaks (1995Q4, 1999Q2, 2009Q3, 2015Q1), splitting the whole series into five parts.

Table 1
Bai-Perron multiple break test

Test of break	F-statistic	Scale F-statistic	Value Critical**
0 vs. 1 *	36.54	182.69	18.68
1 vs. 2 *	22.66	113.31	20.57
2 vs. 3 *	20.58	102.89	21.60
3 vs. 4 *	27.61	138.07	22.55
4 vs. 5	3.74	18.70	23.00

Note: Significance level at 5%
Source: created by the author

The results of the regression with breaks to estimate the REER are presented in Table 2.

Table 2
Model with break regression

Dependent variable: REER			
Variable	Coefficient	t-Statistical	Prob.
MON	-1.58E-08	-0.69	0.49
RES	4.09E-05	0.18	0.86
C	-308.25	-27.12	8.85E-42
1999Q2 - 2009Q2 -- 41 obs			
TOT	333.60	80.47	1.44E-77
TNT	1.02	183.64	1.03E-105
MON	7.50E-10	0.35	0.73
RES	1.59E-05	0.56	0.58
C	-342.18	-62.84	3.25E-69
2009Q3 - 2014Q4 -- 22 obs			
TOT	455.64	33.93	7.43E-49
TNT	0.99	100.48	4.08E-85
MON	-4.90E-09	-1.53	0.13
RES	6.53E-05	1.60	0.11
C	-450.56	-28.70	1.54E-43
2015Q1 - 2018Q4 -- 16 obs			
TOT	689.75	30.71	1.12E-45
TNT	0.95	107.11	2.72E-87
MON	-1.75E-10	-0.13	0.89
RES	8.89E-06	0.18	0.86
C	-659.62	-24.79	5.11E-39
R Square	0.99	SRC	47.35
R-squared adjusted	0.99	F-statistic	148175.48
Deviation error	0.77	Prob(F-Statistical)	6.56E-174

Note: Significance level 5%; breaks are determined with the Bai-Perron test, and SRC is the sum of squared residuals.
Source: created by the author

When comparing the REER with economic growth in the analysis period, a strong deviation is observed in which the exchange rate is below the estimated REER (depreciation) without boosting growth as of 2014 (see Figure 2).

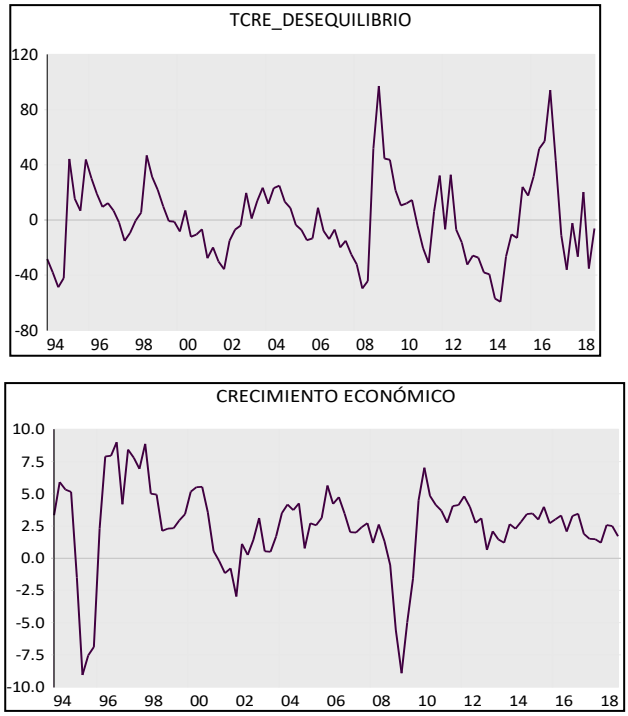

Figure 2. Estimated REER and economic growth (GY)
Source: created by the author

Table 3 shows the selected ADRL model where the dependent variable is output growth (GY) and the independent variable is the REER estimated above.

The selected model (5, 3, 0) through the Hanna-Quinn (HG) information criterion includes five lags of the dependent variable corresponding to the growth rate (GY), three lags REER POS(-3) and one lag REER NEG(-1).

Serial autocorrelation Breusch-Godfrey LM tests for four lags were applied without rejecting the null hypothesis of serial correlation. The Breusch-Pagan-Godfrey test rejects the presence of heteroscedasticity (see Table A3 in the appendix).

The model results show the effects of an appreciation and depreciation of the REER on economic growth. According to the new developmental approach and the null hypothesis, a devaluation could improve competitiveness and increase exports, positively affecting growth. On the contrary, an exchange rate appreciation would generate a negative effect. All positive and negative coefficients were found to be significant, except for the REER (POS). The first lag harms growth and disappears quickly in the second and third quarters. This fact may imply that the effect is short-term or, at most, medium-term.

In the case of depreciation, only the first REER lag (NEG) is included, which is significant and positive; nevertheless, the impact on growth is very small and short-term in the first quarter. That is, a 1% depreciation causes an increase of only 0.0176 in economic growth.

Table 3
NADRL Model: REER-Growth

Dependent Variable: Economic Growth GY			
Selected Model: NARDL(5, 3, 0)			
Variable	Coefficient	t-Statistical	Prob.*
GY(-1)	0.76	8.11	0.00
GY(-2)	0.19	1.70	0.09
GY(-3)	-0.26	-2.38	0.02
GY(-4)	-0.37	-3.29	0.00
GY(-5)	0.39	4.71	0.00
REER_UNBALANCED_POS	-0.01	-1.15	0.25
REER_UNBALANCED_POS(-1)	-0.03	-1.88	0.06
REER_UNBALANCED_POS(-2)	0.04	2.65	0.01
REER_UNBALANCED_POS(-3)	0.02	1.93	0.06
REER_UNBALANCED_NEG	0.02	2.29	0.02
C	0.83	1.80	0.08
R-squared	0.80	SRC	207.89
Adjusted R-squared	0.78	F-Stat.	34.02
Deviation error	1.57	Prob.	0

Note: Model selection with the Hannan-Quinn (HQ) criterion
Source: created by the author

Conclusions

As a result of the theoretical review, aspects on which there is consensus between the neoclassical theory (PPP hypothesis and monetarism) and the authors who promote a competitive exchange rate policy were identified. From this approach, it is necessary to maintain a flexible exchange rate regime and price stability; since the UIP condition is not met, it is observed that the exchange rate appreciates, and the interest rate does not control it. Finally, its analysis focuses on the effect of depreciation on the current account without considering those that affect the capital account.

This study's objective was to prove the validity of the null hypothesis: a competitive exchange rate could accelerate growth during the 1993-2018 period characterized by stagnation in the Mexican economy. When comparing the estimated REER with economic growth, the econometric analysis shows a strong deviation in which the exchange rate is below (depreciation) the estimated REER without boosting growth from 2014. The estimation results (see Table 3) show that the coefficient REER_unbalanced (NEG) is meaningful, but the growth momentum is very low (0.017). Moreover, the REER_unbalanced (POS) coefficients included in the model only for the first lag are meaningful and exert

a negative but very small effect on growth that dissipates quickly. Periods of appreciation of the Mexican peso are a consequence of the problems of the structure and imbalance in the balance of payments in the economy. As a result, the capital flows needed to finance the current account deficit have an appreciating effect on the currency. In conclusion, the null hypothesis is rejected; therefore, a competitive exchange rate is not the silver bullet for Mexico's productive stagnation.

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Annex

Table A1
Integration Testing

	Unit root test (Phillips-Perron)					
Model	In level	REER	TOT	TNT	MON	RES
A	t-Statistical	-0.56	-3.06	-0.61	9.86	-0.05
	Probability	0.87**	0.03**	0.86	1.00	0.95
B	t-Statistical	-2.32	-2.95	-2.36	2.54	-2.17
	Probability	0.42	0.15	0.40	1.00	0.50
C	t-Statistical	2.35	0.56	1.85	15.93	2.15
	Probability	1.00	0.84	0.98	1.00	0.99
Model	First difference	d (REER)	d(TOT)	d(TNT)	d(MON)	d(RES)
A	t-Statistical	-10.83	-15.47	-10.72	-8.62	-6.62
	Probability	0***	0***	0***	0***	0***
B	t-Statistical	-10.77	-14.45	-10.66	-10.23	-6.61
	Probability	0***	0***	0***	0***	0***
C	t-Statistical	-10.19	-15.48	-10.27	-5.91	-6.11
	Probability	0***	0***	0***	0***	0***
	Augmented Dickey-Fuller unit root test					
Model	In level	REER	TOT	TNT	MON	RES
A	t-Statistical	-0.69	-2.15	-0.77	2.36	-0.16
	Probability	0.84	0.23	0.82	1.00	0.94
B	t-Statistical	-2.35	-1.69	-2.36	1.40	-2.40
	Probability	0.40	0.75	0.40	1.00	0.38
C	t-Statistical	2.02	0.61	1.48	2.36	1.69
	Probability	0.99	0.85	0.97	1.00	0.98
Model	First difference	d (REER)	d(TOT)	d(TNT)	d(MON)	d(RES)
A	t-Statistical	-10.75	-8.77	-10.59	-0.20	-6.62
	Probability	0***	0***	0***	0.93	0***
B	t-Statistical	-10.70	-8.97	-10.54	-1.94	-6.61
	Probability	0***	0***	0***	0.62	0***
C	t-Statistical	-10.19	-8.75	-10.27	1.16	-6.11
	Probability	0***	0***	0***	0.94	0***

Note: Significance level at *0.1, **0.05, ***0.01; statistics in bold indicate non-significant A, B, and C correspond to models with constant, with constant and trend, and without constant and trend, respectively.
Source: created by the author

Table A2
Engel-Granger cointegration test

H0: Non-cointegrated series		
	Value	Probability
Engle-Granger tau-statistic	-4.70	0.04
Engle-Granger z-statistic	-33.92	0.05

Note: MacKinnon (1996) p-values

Hansen test for stability in parameters

H0: Cointegrated series

Lc statistic	Stochastic Trends (m)	Deterministic Trends (k)	Excluded Trends (p2)	Prob.*
0.44	4	0	0	> 0.2

Note: the probability corresponds to 10% of significance
Source: created by the author

Table A3
Serial correlation and heteroscedasticity tests

Breusch-Godfrey Serial Correlation LM Test:	Statistic F	Prob. Chi-Square
Null Hypothesis: No serial correlation		
over 1 lag	0.39	0.50
over 2 lags	0.45	0.59
over 3 lags	0.54	0.60
over 4 lags	0.41	0.75
Breusch-Pagan Heterocedasticity Test	F-statistic	Prob. Chi-Square(10)
Null Hypothesis: Homoscedasticity	1.35	0.21
Heteroscedasticity Test: ARCH	F-statistic	Prob. Chi-Square(1)
	0.00	0.94

Note: Significance level at 5%
Source: created by the author