



## ARE THE PREDICTIONS OF THE MUNDELL-FLEMING MODEL APPLICABLE TO MEXICO?

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### ABSTRACT

#### Article History

Received: 20 February 2020

Revised: 23 December 2020

Accepted: 12 January 2021

Published: 15 February 2021

#### Keywords

Fiscal expansion

Monetary expansion

Exchange rates

Mundell-Fleming model

Appreciation/depreciation

Money demand.

#### JEL Classification:

E52; E62; F41.

According to the Mundell-Fleming model (Romer, 2006) under a floating exchange rate system, fiscal expansion is ineffective in raising output and causes real appreciation whereas monetary expansion raises output and causes real depreciation. Applying an extended Mundell-Fleming model, this paper employs a simultaneous-equation model to test whether the predictions of the Mundell-Fleming model would apply to Mexico. The GARCH process is employed in empirical work. This study finds that fiscal expansion reduces output and causes real appreciation and that monetary expansion raises output and leads to real depreciation. In addition, a higher real interest rate reduces output and causes real appreciation, and a higher real stock price results in real appreciation. Therefore, except for the impact of fiscal expansion on output, the Mundell-Fleming model applies to Mexico.

**Contribution/Originality:** This paper relaxes the assumption of no relationship between real money demand and the real exchange rate in the Mundell-Fleming model, uses a simultaneous-equation model to estimate real GDP and the real effective exchange rate, and includes the real stock price as a proxy for financial wealth.

### 1. INTRODUCTION

Mexican authorities have continued to use fiscal expansion, monetary expansion and exchange rates to stimulate or stabilize its economy. During the 2008-2009 global financial crisis, Mexico engaged in fiscal expansion by raising general government debt as a percent of GDP from 37.205% in 2007 to 42.491% in 2008 and 43.5675% in 2009. Debt-financed government spending is expected to make up part of the losses in consumption and investment spending. The Bank of Mexico also lowered its policy rate from 8.25% in December 2008 to 4.5% in December 2009. The decrease in the policy rate is expected to cause other interest rates to decline. M2 money grew 11.60% in 2008 in order to provide more liquidity to the banking and financial systems. The value of the peso declined 21.42% versus the U.S. dollar during 2008-2009, making Mexican-made goods cheaper and helping Mexico's exports.

To the author's knowledge, few of previous studies have empirically estimated output and the real effective exchange rate simultaneously for Mexico within the framework of the Mundell-Fleming model. There is a research gap in the literature. Fan and Fan (2002) reviewed the literature but did not empirically test the Mundell-Fleming model. Mishkin and Savastano (2001); Best (2013) and Demid (2018) focused on monetary policy. Sanchez-Juarez,

García, and Barajas (2016); Tran (2018); Priftis and Zimic (2018); Carriere-Swallow, David, and Leigh (2018); Bhattacharyya and Mukherjee (2018) and Esquivel, Kehoe, and Nicolini (2019) examined fiscal policy. These previous studies did not consider the simultaneous determination of real GDP and the real exchange rate. Applying an extended IS-LM-AS model, this paper attempts to examine whether the predictions of the Mundell-Fleming model (Fleming, 1962; Mankiw, 2019; Mundell, 1963; Mundell, 2001; Obstfeld, 2001; Romer, 2006) would apply to Mexico and has some unique aspects. The real effective exchange rate is incorporated in the money demand function so that the LM\* curve may not be vertical and fiscal expansion may affect output. The real stock price is included in the IS and LM functions. A higher real stock price is expected to increase consumption and investment spending due to the wealth effect, the balance sheet channel and Tobin's q theory (Mishkin, 1995). A higher real stock price may reduce real money demand due to the substitution effect or increase real money demand due to the wealth effect (Friedman, 1988). The choice of Mexico as a case study is appropriate as it has adopted floating exchange rate regime since 2000.

## 2. LITERATURE SURVEY

Several recent studies have examined the Mundell-Fleming model, monetary policy, and fiscal policy for Mexico and related countries. In reviewing the Mundell-Fleming model, Fan and Fan (2002) indicated that only Mankiw (2000) specified that IS\* and LM\* are functions of real GDP and the exchange rate and that LM\* is independent of the exchange rate whereas other authors specified that IS and LM are functions of real GDP and the interest rate. Under a floating exchange rate system, monetary expansion is effective whereas fiscal expansion is not. Under a fixed exchange rate regime, fiscal expansion is effective whereas monetary expansion is not. Mankiw predicted that under a fixed exchange rate system, trade restriction raises the trade balance. They indicated that Mankiw's prediction is true only if the marginal propensity to save is greater than the marginal propensity to invest. Mishkin and Savastano (2001) evaluated three monetary policy strategies for Latin American countries, namely, a hard peg, monetary targeting and inflation targeting. Their answer was that it depended on the institutional environment in a country. A hard peg or even dollarization was strongly recommended if a country cannot constrain the discretion of monetary policy. If a country can constrain monetary policy discretion, inflation targeting would be a better strategy. A sound banking system and fiscal discipline are vital to the success of inflation targeting. Lack of fiscal discipline was associated with Brazil and Columbia whereas a weak banking system was associated with Mexico and Peru.

Best (2013) explored Mexico's monetary policy after 1994. He estimated a Taylor rule to measure the reaction of monetary policy to exchange rate movements and indicated that after the 1994 crisis, the interest rate consistently reacted to the short-term exchange rate. Thus, the Bank of Mexico has maintained a credible free floating exchange rate regime and pursued inflation targeting.

Assessing the interaction of fiscal and monetary policies for 42 countries during 1991-2016, Demid (2018) reported that if a central bank is independent and adopts inflation targeting, fiscal and monetary policies showed more degree of coordination and were more counter-cyclical. Estimating the debt threshold for 14 emerging countries including Mexico during 1999-2016, Meza (2018) reviewed Mexico's macroeconomic policies during 1960-2016. He attributed declining inflation rates to primary surpluses, cooperation among workers, businesses and the government, the Constitutional change authorizing the independence of the Bank of Mexico, and the adoption of inflation targeting in 2003. The debt ratio was on the decline during 1980s to 2009, after which the debt ratio rose continually. Examining the relationship between public spending and output for Mexico during 1925-2014, Sanchez-Juarez et al. (2016) tested whether public spending causes growth (the Keynesian hypothesis) or growth causes public spending (the Wagner hypothesis). They found that the Keynesian hypothesis is valid whereas the Wagner hypothesis is not confirmed. Hence, public spending is a major factor to growth. Tran (2018) found that the threshold of government debt for non-Latin American countries was in the range of 40%-55% of GDP and that

the turning point for government debt was around 35% of GDP for Latin American countries. Hence, fiscal sustainability was more demanding for the latter group, and Latin American countries also encountered higher default risk because risk premium of their sovereign debt reacted to the level of debt strongly.

Investigating the fiscal multiplier for 59 countries including Mexico, Priftis and Zimic (2018) revealed that the magnitude of the fiscal multiplier depended on the types of buyers of the government debt. Fiscal multipliers were smaller when local residents purchased government debt due to crowding-out of domestic private spending. More international capital mobility reduced the difference.

Studying the impacts of fiscal consolidation for 14 Latin American and Caribbean countries, Carriere-Swallow et al. (2018) showed that fiscal consolidation was contractionary with a multiplier value of 0.9. Similar results were also found for the effect of fiscal consolidation on the current account balance, suggesting the evidence of the twin-deficit hypothesis. Bhattacharyya and Mukherjee (2018) evaluated effectiveness of fiscal policy for 20 emerging market economies during 2000-2016. If the full sample was used, fiscal expansion was ineffective. If financial factors causing the crisis was controlled and if the sample was divided into the pre-crisis and the post-crisis periods, fiscal expansion had a positive significant impact on the post-crisis period. Economic downturns would be much worse if fiscal expansion was not engaged. Esquivel et al. (2019) reviewed the lessons from macroeconomic policies in 10 Latin American countries including Mexico and found that macroeconomic instability was mostly caused by lack of fiscal discipline in the form of denomination of the debt in U.S. dollar, short maturity of government debt, large transfers of government money to the private sector without congressional approval. Rising or falling commodity prices may not lead to economic growth or contraction. In conclusion, fiscal stabilization led to growth.

### 3. THE MODEL

Suppose that aggregate expenditures are a function of real income, government tax revenue, government spending, the real interest rate, the real stock price and the real effective exchange rate, that real money demand is determined by the nominal interest rate, real output, the real stock price and the real effective exchange rate, and that in the aggregate supply function, the price is affected by the expected price, the output gap and the real effective exchange rate. Extending Romer (2006) and Mankiw (2019) we can express the IS, LM and aggregate supply functions as:

$$Y = f(Y, T, G, R - \pi^e, S, \varepsilon) \quad (1)$$

$$M/P = g(R, Y, S, \varepsilon) \quad (2)$$

$$P = h(P^e, Y - Y^*, \varepsilon) \quad (3)$$

where

Y = real GDP in Mexico.

T = government tax revenue.

G = government spending.

R = the nominal interest rate.

$\pi^e$  = the expected inflation rate.

S = the real stock price.

$\varepsilon$  = the real effective exchange rate (An increase means real appreciation.).

M = nominal money supply.

P = the price level.

$P^e$  = the expected price level.

$Y^*$  = potential real GDP.

Suppose that potential real GDP is a constant in the short run. Solving for the three endogenous variables, we find equilibrium  $Y$ ,  $\varepsilon$  and  $P$  as:

$$\bar{Y} = \bar{Y}(G - T, M, R - \pi^e, S, P^e) \quad (4)$$

$$\bar{\varepsilon} = \bar{\varepsilon}(G - T, M, R - \pi^e, S, P^e) \quad (5)$$

$$\bar{P} = \bar{P}(G - T, M, R - \pi^e, S, P^e) \quad (6)$$

Assume that  $g_\varepsilon < 0$ ,  $f_\varepsilon < 0$ , and  $h_\varepsilon < 0$ . The determinant of the Jacobian matrix for the three endogenous variables is given by:

$$|J| = [-g_\varepsilon(1 - f_Y) - MP^{-2}f_\varepsilon h_Y - MP^{-2}h_\varepsilon(1 - f_Y) - f_\varepsilon g_Y] > 0. \quad (7)$$

The respective impacts of fiscal expansion on equilibrium real GDP and real effective exchange rate can be shown as:

$$\partial \bar{Y} / \partial G - \partial \bar{Y} / \partial T = [-(f_G - f_T)g_\varepsilon - (f_G - f_T)MP^{-2}h_\varepsilon] / |J| > 0, \quad (8)$$

$$\partial \bar{\varepsilon} / \partial G - \partial \bar{\varepsilon} / \partial T = [(f_G - f_T)g_Y + (f_G - f_T)MP^{-2}h_Y] / |J| > 0. \quad (9)$$

Equation 8 suggests that fiscal expansion has a positive effect on equilibrium real GDP under some assumptions. Equation 9 indicates that fiscal expansion causes real appreciation under certain assumptions as predicted by the Mundell-Fleming model. The prediction in Equation 8 is different from the conventional Mundell-Fleming model mainly because this paper does not assume a LM\* curve whereas the conventional Mundell-Fleming model assumes a vertical LM\* curve, causing a rightward shift in the IS\* curve ineffective in increasing real GDP.

The partial derivatives of equilibrium real GDP and real effective exchange rate with respect to the money supply can be written as:

$$\partial \bar{Y} / \partial M = -P^{-1}f_\varepsilon / |J| > 0. \quad (10)$$

$$\partial \bar{\varepsilon} / \partial M = -P^{-1}(1 - f_Y) / |J| < 0. \quad (11)$$

Equations 10 and 11 suggest that monetary expansion raises equilibrium real GDP and causes real depreciation. The predictions in Equations 10 and 11 are the same as the Mundell-Fleming model.

#### 4. EMPIRICAL RESULTS

The data were collected from IMF's International Financial Statistics and World Economic Outlook, the Bank of Mexico, and the Federal Reserve Bank of St. Luis. Real GDP is measured in million pesos. Fiscal policy is represented by the fiscal deficit as a percent of GDP. M2 money measured in thousand pesos is selected to represent monetary policy. The real interest rate is represented by the government bond yield minus the expected inflation rate, which is represented by the lagged inflation rate. The stock price index is divided by the consumer price index

to derive the real stock price index. The lagged consumer price index is chosen to represent the expected price level. Due to lack of quarterly data for fiscal deficit as a percent of GDP, the sample consists of annual data ranging from 2000 to 2018. The data for the government bond yield before 2000 are unavailable.

Figure 1 indicates that fiscal deficit as a percent of GDP improved from 2000 to 2003, deteriorated from 2004 to 2014, and then has improved since 2015. The global financial crisis increased fiscal deficit significantly from -1.3% in 2008 to -3.7% in 2009. Figure 2 shows that M2 money rose a great deal from 1,817.2 million pesos in 2000 to 8,839.2 million pesos in 2018.

The exponential GARCH method (Nelson & Cao, 1992) is employed in empirical work to estimate regression parameters. The advantage of the exponential GARCH method is that it has less restrictions on the parameters in the conditional variation equation. The positive variance is satisfied because the equation is on log variance. On the other hand, the GARCH model places the restriction of positive values on the parameters.

Table 1 presents empirical results. To avoid a high degree of multicollinearity, real GDP, M2 money, the real stock price and the expected price level are transformed to a log scale. Fiscal deficit as a percent of GDP and the real interest rate are in the level form due to negative values after or before log transformation. The GARCH process is employed in empirical work to correct for potential autoregressive conditional heteroscedasticity. In the estimated regression for real GDP, the value of R-squared is estimated to be 97.31%. Except for the coefficient of the real stock price, other coefficients are significant at the 1% or 5% level. Real GDP is negatively affected by fiscal deficit as a percent of GDP, the real interest rate and the expected price level and positively associated with M2 money.

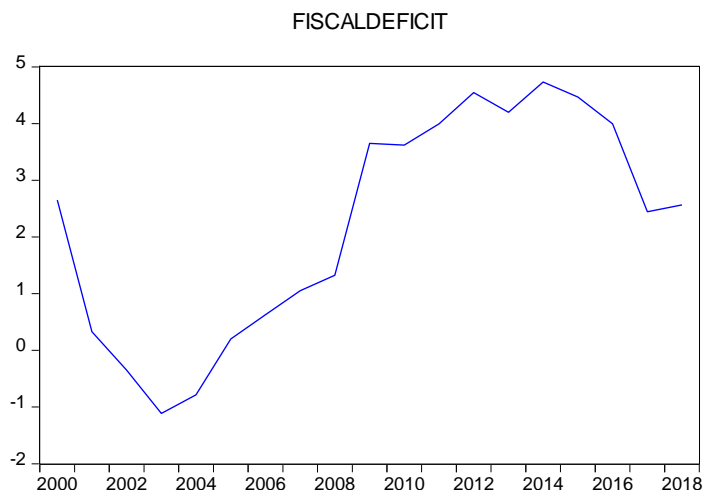


Figure-1. Fiscal deficit in Mexico over time.

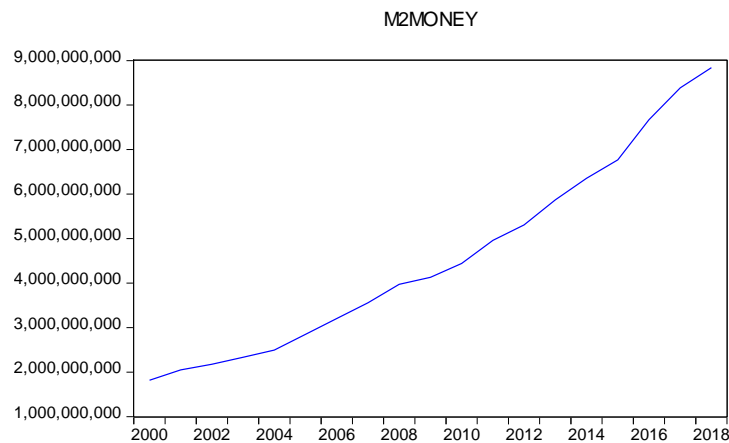


Figure-2. M2 Money over Time.

Table-1. Estimated regressions for real GDP and the real effective exchange rate.

Variable	Log(Real GDP)	Log(REER)
Constant	8.7068 (0.0000)	6.0257 (0.0000)
Fiscal deficit/GDP ratio	-0.0131 (0.0007)	0.0115 (0.0100)
Log(M2)	0.3661 (0.0000)	-0.0454 (0.0000)
Real interest rate	-0.0091 (0.0319)	0.0124 (0.0063)
Log(Real stock price)	-0.0131 (0.3343)	0.0118 (0.0000)
Expected price	-0.0020 (0.0004)	-0.0053 (0.0000)
R-squared	0.9731	0.7765
Adjusted R-squared	0.9627	0.6905
Sample period	2000-2018	2000-2018
Methodology	EGRACH	EGARCH

Notes: The number in the parenthesis is the probability. REER is the real effective exchange rate. An increase in REER means real appreciation.

Specifically, when fiscal deficit as a percent of GDP rises by 1 percentage point, the log of real GDP would decline by 0.0131. A 1% increase in M2 money would increase real GDP by 0.3661%. If the real interest rate rises 1 percentage point, the log of real GDP would decline by 0.0091. The negative significant coefficient of fiscal deficit as a percent of GDP suggests that the positive impact of government spending may be less than the negative impact of government taxes and that the negative crowding-out effect may be greater than the positive impact of deficit spending. The positive effect of monetary expansion indicates that when M2 money supply rises, LM\* shifts to the right, real GDP increases, and the real effective exchange rate declines. The negative significant coefficient of the real interest rate implies that a higher real interest rate reduces consumption and investment spending, cause IS\* to shift to the left, and reduces real GDP. The negative insignificant coefficient of the real stock price suggests that the negative substitution effect on real money demand may cancel out the positive wealth effect on real money demand (Friedman, 1988).

In the estimated regression for the real effective exchange rate, more fiscal deficit as a percent of GDP, a higher real interest rate and a higher real stock price tend to cause real appreciation of the peso whereas more M2 money and a higher expected price level tend to cause real depreciation of the peso. Approximately 77.65% of the change in the real effective exchange rate can be explained by the five exogenous variables. All the estimated parameters are significant at the 1% level. When fiscal deficit as a percent of GDP rises 1 percentage point, the log of the real effective exchange rate would rise by 0.0115. A 1% increase in M2 money would cause the real effective exchange rate to decline by 0.0454%. If the real interest rate rises 1 percentage point, the log of the real effective exchange rate would increase by 0.0124. The positive significant coefficient of fiscal expansion indicates that more deficit spending shifts IS\* to the right and causes real appreciation. The negative significant coefficient of monetary expansion suggests that more M2 money supply shifts LM\* to the right and causes real depreciation of the Mexican peso. The positive significant coefficient of the real interest rate suggests that the Bank of Mexico would be able to stabilize a declining peso by raising the policy rate in real terms.

## 5. SUMMARY AND CONCLUSION

This paper has empirically tested whether the Mundell-Fleming model may apply to Mexico. An extended Mundell-Fleming model including IS, LM and aggregate supply is specified and analyzed. Except for the impact of fiscal expansion on real GDP, other results are consistent with the Mundell-Fleming model. The negative effect of fiscal expansion on real GDP may be attributable to a larger crowding-out effect, which completely cancels out the positive effect of deficit spending.

There may be several policy implications. Although Mexico's fiscal deficit declined to less than 3% of GDP in 2017 and 2018, its general government debt rose from 37.205% of GDP in 2007 to 56.807% of GDP in 2016 and then declined to 53.517% of GDP in 2018. Due to the negative impact of fiscal expansion on output, fiscal discipline may need to be exercised. In comparison, monetary expansion seems to be a better policy choice than fiscal expansion because the former raises real GDP and causes real depreciation, which would stimulate exports. A higher real interest rate reduces real GDP and causes real appreciation of the peso. Hence, the timing of using the real interest rate to defend the peso may need to be cautious due to the tradeoff. It is appropriate for the government to maintain a healthy stock market as a higher real stock value would increase consumption, investment and international capital inflows due to the wealth effect, the balance sheet channel and Tobin's q theory (Mishkin, 1995).

**Funding:** This study received no specific financial support.

**Competing Interests:** The author declares that there are no conflicts of interests regarding the publication of this paper.

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