

An Empirical Test of the Mundell-Fleming Model: The Case of A Latin American Country

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Abstract: Applying an extended Mundell-Fleming model to Chile, this paper finds that fiscal expansion reduces output but causes real appreciation and that monetary expansion increases output and leads to real depreciation. Besides, a lower real interest rate or a higher real stock price helps raise output; and a higher real interest rate or a higher real stock price results in real appreciation. Hence, except for the negative impact of fiscal expansion on output, other predictions of the Mundell-Fleming model are applicable to Chile.

1. Introduction

Chile's authorities have engaged in fiscal policy, monetary policy and other macroeconomic measures to stimulate or stabilize its economy. During the global financial crisis, the Chilean government changed fiscal policy from a government surplus of 3.934% of GDP in 2008 to a government deficit of 4.241% of GDP in 2009. As the economy continued to improve, the deficit-to-GDP ratio declined to a low of 0.933% in 2018. Central government debt as a percent of GDP also rose from 4.92% in 2008 to a high of 5.82% in 2009, and then continued to rise to 23.799% in 2018. These statistics suggest that Chilean authorities have attempted to maintain fiscal discipline and meet the standards of the government deficit-to-GDP ratio and debt-to-GDP ratio of 3% and 60%, respectively, as suggested by the EU.

During the global financial crisis, the Central Bank of Chile lowered the lending rate from 13.2618% in 2008 to 7.2506% in 2009 and 4.178% in 2018. M3 money supply rose 18.1321% during 2007-2008 to provide more liquidity to the banking and financial systems.

The Central Bank of Chile has pursued a floating exchange rate system and allows market demand and supply to determine the peso exchange rate. However, the Central Bank of Chile may intervene in the exchange rate market in order to reduce unwarranted fluctuations of the peso exchange rate.

To the author's knowledge, few of previous studies have examined the effects of monetary policy and fiscal policy on output and the real exchange rate in Chile within the framework of an extended Mundell-Fleming model. This paper attempts to test if the predictions of the Mundell-Fleming model may apply to Chile. According to the Mundell-Fleming Model (Mundell, 1963, 2001; Fleming, 1962; Romer, 1996; Obstfeld, 2001; Mankiw, 2019), under a floating exchange rate system, fiscal expansion is ineffective in raising output and causes real appreciation whereas monetary expansion is effective in raising output and causes real depreciation. This paper differs from previous studies partly because the real exchange rate is included in the money demand function. Hence, the LM* curve may not be vertical, and fiscal expansion may affect output.

2. Literature Survey

Several recent studies have examined the effects of monetary policy, fiscal policy, and exchange rate movements on output and other related variables for Chile and other related countries.

Based on a sample consisting of 44 countries including Chile, Ilzetzki, Mendoza, and Végh (2010) revealed that the effect of fiscal expansion depended on exchange rate systems, fiscal position, trade openness, and the development stage. The fiscal multiplier was zero under a floating exchange rate and larger under a predetermined exchange rate. The fiscal multiplier was greater for closed economies and industrialized countries and negative for countries with huge debt.

Using a sample consisting of 61 countries including Chile, Karras (2011) showed that the long-run fiscal multiplier was estimated to be between 0.98 and 1.39 for countries with floating exchange rates, between 1.44 and 2.43 for countries with fixed exchange rates, and between 1.21 and 1.53 in the full sample. Hence, fiscal multipliers were less effective under floating exchange rates than under fixed exchange rates. Using a sample of 179 developing and developed countries including Chile during 1970-2011, Karras (2014) also showed that the domestic multiplier was much lower in the most open economies than in the least open economies, that the spillover effect was much smaller in the least open economies than in the most open economies. These findings indicate that there was a tradeoff of the spillover effect and the domestic multiplier in the most open and least open economies.

Studying exchange rate pass-through (ERPT) for Chile, Alvarez, Jaramillo, and Selaive (2012) found that there was a complete non-decreasing ERPT in the long run, that the wholesale price level appeared to be less sensitive to exchange rate movements, and that there was a weak evidence of asymmetric ERPT from depreciation vs. appreciation for the import index. Hence, several previous findings that ERPT was incomplete and declined during the 1990s were not confirmed.

da Silva and Vieira (2017) examined monetary and fiscal policy for 113 advanced and developing countries including Chile during 2001-2008 and 2009-2012. Monetary policy appeared to be countercyclical in advanced countries before the global financial crisis. Fiscal policy seemed to be procyclical before the crisis. Smoothing of interest rates appeared to be an important instrument in monetary policy. Central banks in advanced countries ceased to react to the output gap after the global financial crisis. No significant relation between government spending and the output gap was found.

Afonso, Huart, Jalles, and Stanek (2018) studied the subject of the twin deficit using a sample of 193 countries including Chile during 1980-2016. The twin deficit relationship was confirmed if the fiscal rules were absent. The estimated coefficient for the effect of the budget balance on the current account balance was between 0.68 and 0.79. If fiscal rules were adopted, the coefficient would be 0.1.

Using a sample of eight Latin American countries including Chile, Alberola, Kataryniuk, Melguizo, and Orozco (2018) indicated that fiscal policy was countercyclical during the financial crisis but changed to be procyclical recently, that financing conditions were the main driver of procyclical fiscal policy, and that fiscal rules reduced procyclicality and tend to neutralize it.

3. The Model

Suppose that aggregate expenditures are a function of real income, government tax revenues, government spending, the real interest rate, the real stock price, and the real exchange rate and that real money demand is determined by the nominal interest rate, real GDP, the real stock price, and the real exchange rate. Extending Romer (1996), Mankiw (2019) and other studies, we can express the IS and LM functions as:

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

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

where

Y = real GDP in Chile,

T = government tax revenue,

G = government spending,

R = the nominal interest rate,

π^e = the expected inflation rate,

S = the real stock price,

ε = the real exchange rate (An increase means real depreciation.),

M = the money supply, and

P = the price level.

Solving for the two endogenous variables, Y and ε , we can find equilibrium real GDP and real exchange rate as:

$$\bar{Y} = \bar{Y}(G - T, M/P, R - \pi^e, S), \quad (3)$$

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

Assume that $\bar{x}_\varepsilon > 0$ and that $x_G > x_T$. The determinant of the Jacobian matrix for the two endogenous variables is given by:

$$|J| = [-\bar{x}_\varepsilon(1 - x_Y) - x_\varepsilon \bar{x}_Y] < 0. \quad (5)$$

The impacts of fiscal expansion on equilibrium Y and ε can be shown as:

$$\partial \bar{Y} / \partial G - \partial \bar{Y} / \partial T = -(x_G - x_T) \bar{x}_\varepsilon / |J| > 0, \quad (6)$$

$$\partial \bar{\varepsilon} / \partial G - \partial \bar{\varepsilon} / \partial T = (x_G - x_T) \bar{x}_Y / |J| < 0. \quad (7)$$

Equations (6) and (7) suggest that more government deficit tends to raise output and lead to real appreciation. The prediction in equation (6) is different from the Mundell-Fleming model because of the inclusion of the real exchange rate in the money demand function. In the conventional Mundell-Fleming model, because the real exchange rate is not included, $\bar{x}_\varepsilon = 0$, and the partial derivative of equilibrium real GDP with respect to the government deficit is zero, suggesting that fiscal expansion does not affect real GDP.

The partial derivatives of equilibrium Y and ε with respect to the money supply can be expressed as:

$$\partial \bar{Y} / \partial M = -P^{-1} x_\varepsilon / |J| > 0, \quad (8)$$

$$\partial \bar{\varepsilon} / \partial M = -P^{-1} (1 - x_Y) / |J| > 0. \quad (9)$$

Equations (8) and (9) indicate that more money supply tends to raise output and cause real depreciation. When the money supply increases, the LM^* curve shifts to the right, equilibrium real GDP rises, and equilibrium real exchange rate declines.

4. Empirical Results

The data were collected from the *International Financial Statistics* and the Central Bank of Chile. Real GDP is measured in million peso. Government borrowing as a percent of GDP is chosen to represent fiscal policy. The real exchange rate is equal to the nominal exchange rate (units of the Chilean peso per U.S. dollar)

times relative prices in the U.S. and Chile. An increase means real depreciation. Real money supply is represented by M3 money adjusted for the consumer price index. M1 money is relatively narrow as it does not include saving accounts, small time deposits, money market accounts, and money market deposit accounts. The lending rate minus the expected inflation rate is selected to represent the real interest rate. Other types of interest rates are not readily available. The stock price is represented by an index with a value of 100 in year 2010. The consumer price index is used to derive the real stock price. The expected inflation rate is estimated as the average of lagged inflation rates in the past three years. Real GDP, real M3, and the real stock index are transformed to a log scale. The government borrowing-to-GDP ratio, the real lending rate and the expected inflation rate are not transformed to a log scale due to negative values before or after the transformation. The sample consists of annual data ranging from 1990 to 2018.

Figure 1 shows that real GDP and the government borrowing-to-GDP ratio seemed not to exhibit a clear relationship during 1990-2018. Figure 2 indicates that real GDP and real M3 had a strong positive relationship during the sample period of 1990-2018.

The EGARCH process is employed in empirical work to correct for autoregressive conditional heteroscedasticity. The estimated coefficients in the conditional variance equation are significant at the 1% level, suggesting that the EGARCH process is appropriate.

In the estimated regression for real GDP in Table 1, the four exogenous variables can explain approximately 99.09% of the variation in real GDP. All the estimated coefficients are significant at the 1% level. Real GDP has a positive relationship real M3 money and the real stock price and a negative relationship with the government borrowing-to-GDP ratio and the real interest rate. A possible reason for the negative effect of fiscal expansion on real GDP is that the negative crowding-out effect on private spending outweighs the positive effect of fiscal expansion on aggregate demand.

The positive significant coefficient of the real stock price indicates that the substitution effect dominates the wealth effect (Friedman, 1988). The substitution effect shows that a higher real stock price tends to reduce real money demand whereas the wealth effect indicates that a higher real stock price tends increase real money demand. If the substitution effect dominates the wealth effect, the LM^{*} curve will shift to the right.

Specifically, a 1% increase in real M3 money would raise real GDP by 0.5883%. If the real stock price rises 1%, real GDP would increase by 0.0058%. A higher real stock price raises real GDP mainly due to increases in consumption and investment expenditures through the wealth effect, the balance sheet channel and Tobin's q theory (Mishkin, 1995).

Figure 1: Scatter Diagram between Real GDP (RGDP) and the Government Borrowing-to-GDP Ratio (BY)

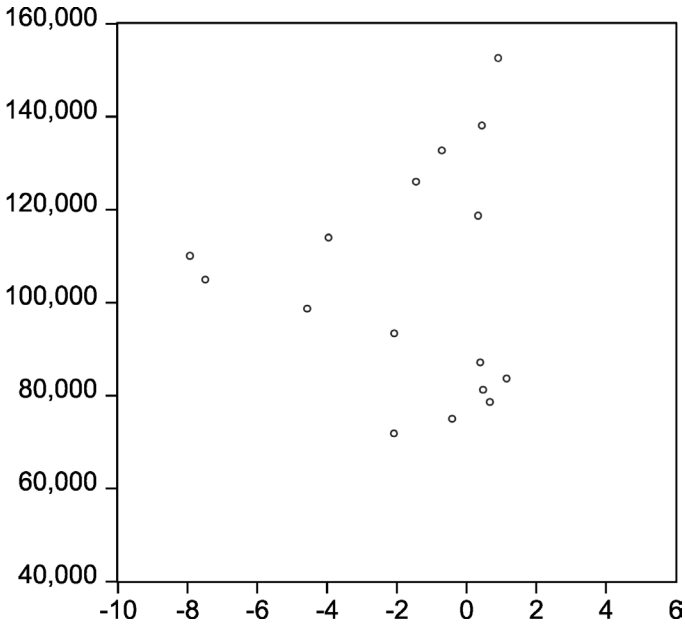
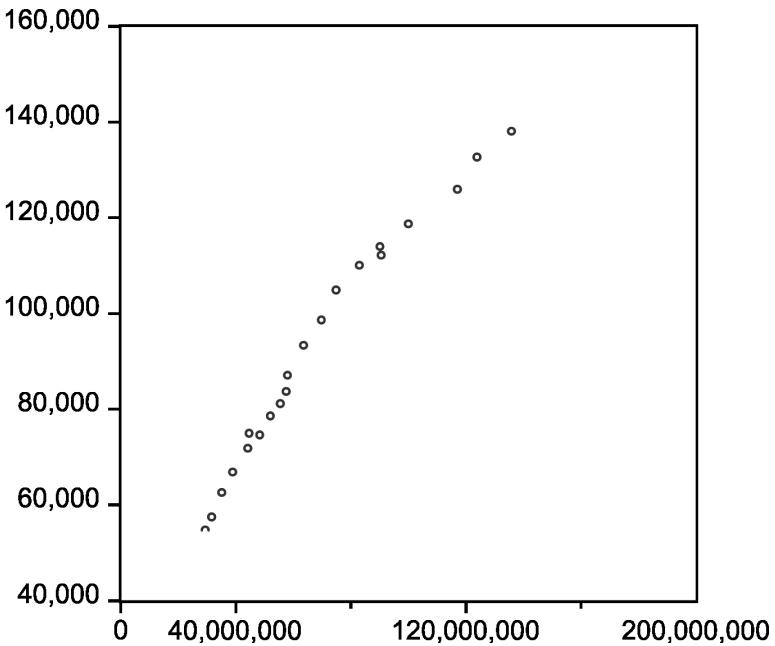


Figure 2: Scatter Diagram between Real GDP (RGDP) and Real M3 (RM3)



In the estimated regression for the real exchange rate, approximately 78.26% of the change in the dependent variable can be explained by the four right-hand side variables. All the coefficients are significant at the 1% level. The real exchange rate is negatively affected by the government borrowing-to-GDP ratio, the real interest rate and the real stock price and positively influenced by real M3 money. These results indicate that fiscal expansion results in real appreciation whereas monetary expansion leads to real depreciation. A higher real interest rate tends to attract international capital inflows, increase the demand for the peso, and shift LM^* to the right. On the other hand, a higher real interest rate tends to hurt private spending and shifts IS^* leftward. The net impact is real appreciation of the peso. A higher real stock value tends to increase consumption and investment spending, shift IS^* to the right, and cause real appreciation (Mishkin, 1995).

Table 1
Estimated Regressions for Real GDP and the Real Exchange Rate

	<i>Log(real GDP)</i>	<i>Log(Real exchange rate)</i>
Constant	0.8116 (226.3053)	1.0978 (86.2779)
Government borrowing as a percent of GDP	-0.0079 (-18.3816)	-0.0140 (-17.3214)
Log(real M3)	0.5883 (99680.22)	0.4103 (768.8160)
Real interest rate	-0.0020 (-4.7217)	-0.0188 (-308397.1)
Log(real stock price)	0.0058 (6.1038)	-0.5378 (-76.7384)
R-squared	0.9909	0.7826
Adjusted R-squared	0.9894	0.7463
Akaike information criterion	-3.9797	-2.7324
Schwarz criterion	-3.6496	-2.3552
Sample period	1990-2018	1990-2018
Number of observations	29	29

Notes: Figures in the parentheses are z-statistics.

5. Summary and Conclusions

This paper has examined whether the Mundell-Fleming model may apply to Chile's economy. For Chile, fiscal expansion reduces output but causes real appreciation whereas monetary expansion raises output and leads to real depreciation. Except for the negative effect of fiscal expansion on output, other findings are consistent with the predictions of the Mundell-Fleming model. In addition, a lower real

interest rate or a higher real stock price raises output; and a higher real interest rate or a higher real stock price results in real appreciation.

There are several policy implications. Fiscal discipline may need to be exercised as deficit-financed spending has a negative impact on output. Monetary expansion would be a better strategy than fiscal expansion as the former leads to more output and real depreciation whereas the latter results in real appreciation and decrease in output. Real appreciation hurts exports. A higher real interest rate hurts output and causes real appreciation. Hence, if the macroeconomic goal is to stimulate exports and output, a lower real interest rate would be a better strategy because it tends to lead to real depreciation. A healthy stock market is important as a higher real stock value would lead to more output and real appreciation. Real appreciation tends to increase international capital inflows but hurt exports.

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