

Testing the Empirical Validity of the Mundell-Fleming Model

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Abstract: *Considering the constant outflow of capital and the constant trade deficit in the Nigerian economy, the Mundell-Fleming model provides policy prescriptions for such unfavourable situation. However, the empirical validity of this model is tested in this work to find out if the model can be applied to the Nigerian economy. The study was carried out using data obtained from the Central Bank of Nigeria (CBN) 1970 to 2012. The technique of Vector Autoregressive Model and the Granger causality test were used to test the empirical validity of this model in Nigeria. The result of the impulse – response function using VAR shows that the prediction of the Mundell-Fleming theory holds and its policy prescriptions can be effective in the Nigerian economy. However, the results of the Granger –causality test showed that net exports granger-causes FDI without a feedback, and no causality in other variables.*

Keywords: Mundell- Fleming model, interest rate, exchange rate, FDI, net exports

1. Introduction

The Mundell-Fleming model was first put together in the 1960s by two prominent economists; Robert Mundell, at Columbia university and Marcus Fleming at the international monetary fund, (IMF). Their work was done on the macro economy to incorporate, the role of capital flows (Boughton, 2003, Floden 2010). On the policy aspect of the Mundell-Fleming model, in a fixed exchange rate system, monetary policy typically focuses on maintaining the exchange rate, so that it cannot target domestic demand. A fiscal expansion, by comparison, will raise interest rate, encourage capital inflows, and tend to appreciate the exchange rate.

In a flexible exchange rate, a monetary expansion that lowers domestic interest rates will encourage capital outflows that depreciate the exchange rate and further stimulate income as the lower exchange rate raises net exports. A fiscal expansion, by contrast, will raise interest rates, promoting capital inflows that appreciate the exchange rate and reduce net exports, offsetting the rise in national income from fiscal expansion. Thus fiscal policy will have much less impact on national income under flexible exchange rates.

Nigeria practices a managed float exchange rate system and tends more to the flexible exchange rate system. However, Nigeria has an independent monetary authority that formulates monetary policy. The monetary policy instrument of interest rate has also been used by the central bank of Nigeria to achieve certain objectives. Interest rate in Nigeria is determined by the monetary policy rate. The monetary policy rate is fixed by the monetary policy committee of Nigeria. The monetary policy rate in Nigeria is at 13% while the interest rate as at 2012 was 16.17%. However, despite the use of these monetary tools, Nigeria continues to experience external deficits. And from theory, external deficits both in the current and capital account have negative effects on the economy.

The Mundell – Fleming model offers a set of policy solutions to the problem of external deficit. The crux of the matter remains to determine whether the data of the Nigeria’s economy conform to the predictions of the Mundell – Fleming model. Can the policy prescriptions offered by the model be applied effectively to the Nigerian economy to achieve the expected results?

This phenomenon poses a problem for the Nigerian economy. Capital outflow causes a threat to a country’s economy. For instance, a decrease in FDI means that investment funds are flowing out of the country. This has an effect on the level of employment. As foreigners withdraw investment funds from the economy, some of the foreign companies begin to fold up and as such workers are laid off and unemployment will increase.

On the other hand, as net exports decrease, it means the proportions of exports to imports have reduced. As exports decreases, the effect on the economy is that the national income decreases. The decrease in national income occurs as a result of a shrinking of the export sector which reduces external demand for Nigeria’s output. However, the Mundell – Fleming model is a widely accepted model in external economy macroeconomics and the model offers a set of policy solutions to the problem of external deficit. The issue is to find out if the data of Nigeria conforms to the predictions of the Mundell – Fleming model. Can the policy prescriptions offered by the model be applied effectively to the Nigerian economy to achieve the expected results?

Since the problem in the external sector of the Economy has been stated, the following research questions are asked

- Does a monetary policy shock (changes in interest rate) affect the flow of FDI, the exchange rate and the net exports?
- Does the causal relationship that runs from interest rate to FDI to exchange rate and to net exports exist in the

Nigerian economy as theorized by the Mundell-Fleming model?

The objectives of the study

The specific objectives of this study are as follows:

- To determine if monetary policy shocks (change in interest rate) has any effect on FDI, exchange rate and Net exports.
- To determine if a causal relationship runs from interest rate to FDI, to exchange rate and to Net exports.

2. Literature Review

- The major theories that back up this work are the IS-LM theory, the Mundell-Fleming theory and the Marshall – Lerner theory. The IS-LM theory shows the impact of monetary and fiscal policy in an economy. The model identifies money supply as the tool for monetary policy and identifies government expenditure and taxes as the tool for fiscal policy. According to Chiba and Kaiwen (2007), the IS-LM model inherits the Keynesian beliefs with regard to efficiency of governmental policies in the economy.
- The Mundell-Fleming model on the other hand is the open economy version of the IS-LM model. The model shows that the international flow of goods and services and the international flow of capital can affect the country in profound ways Floden(2010).It analyzes the effectiveness of monetary and fiscal policy under different exchange rate systems; fixed and flexible exchange rate. In the Mundell – Fleming model, it is expected that, under a flexible exchange rate regime , a decrease in the interest rate causes capital outflow and the outflow of capital causes a decrease in exchange rate and a decrease in exchange rate causes net exports to increase.
- Certain empirical works have been carried out by various researchers to test certain predictions of the Mundell-Fleming model. In the foreign empirical literature, certain studies validate aspects of the Mundell-Fleming theory in most economies while others do not. In the United States, Paudel (2011), conducted a research on the international transmission of the U.S real and nominal shocks. The study was carried out using a Vector Auto regressive (VAR) model. The results showed that supply shocks in the U.S led to an increase in relative U.S real GDP and relative U.S prices. This supports a postulation of the Mundell- Fleming model which states that under a flexible exchange rate system, increase in foreign interest rate leads to expansion of domestic output. Huh (1999) did a similar study to find out how well the Australian data fits the Mundell-Fleming model since the collapse of the Breton woods system. The result of the study, using a VAR model shows that most of the data matches the predictions of the Mundell- Fleming model. Hirsch (2009) also conducted a study of the behavior of the Indonesian rupiah /U.S dollars exchange rate and its policy implications. The study discovered that a higher domestic interest rate will cause real depreciation of the IDR/U.S dollars exchange rate whereas a higher stock price will lead to real appreciation and this is consistent with the postulation of the Mundell –Fleming model. However the study by Siklos (1988), in Canada did not empirically validate the Mundell Fleming model. The study was carried out using a VAR model and the results showed that there is no empirical link between output deficits and interest rates. Further foreign empirical findings show that devaluation as a policy instrument in the Mundell- Fleming model increases net exports. This is a postulation supported by the Marshall-Lerner theory. Flen et al (2004), studied the Marshall- Lerner condition in China and found out that depreciation leads to an improvement in a net capital flow. Further on the effect of exchange rate on the flow of net exports. Udomkerdmonkol et al (2006), investigated the impact of exchange rates on the U.S FDI inflows to a sample of sixteen emerging market countries using panel data for period 1990-2002. The results show that there is a negative relationship between the expectation of local currency depreciation and FDI inflows. In other words, cheaper local currency (devaluation) attracts FDI while volatile exchange rates discourage FDI. Ullah et al (2012) studied the relationship among FDI, exchange rate and exchange rate volatility. In this study, time series data have been used for foreign direct investment, exchange rate, exchange rate volatility, trade openness and inflation, from 1981 to 2010 for Pakistan. The results squeezed from the study demonstrate that FDI is positively associated with Rupee depreciation and exchange rate volatility deters FDI. Pandey(2013) did a work on trade elasticities and the Marshall -Lerner condition for China. Using a multivariate co integration approach, the research found that a rise in real exchange rate boosts India’s exports as expected in theory, meaning that the Marshall- Lerner condition holds in India. Chingarade et al (2012) tried to find the relationship and impact of interest rates on FDI flows. They also sought to find out other determinants that significantly affect FDI inflows in Zimbabwe in the period February 2009-june 2011. The research hypothesis tested that high interest rates have a positive impact on FDI inflows. The technique of ordinary least squares (OLS) was used. This paper found that interest rate had no significant impact on FDI and hence cannot be used in making policies.
- On the domestic literature reviewed, Olasunkunmi and Babatunde(2013) conducted a research on empirical analysis of fiscal policy shocks and current account dynamics in Nigeria over the period 1980:1-2010:4. The work was done using a VAR model and the results show that an expansionary fiscal policy shocks has a positive effect on output, exchange rate and negative impacts on current account balance and interest rate and this is in line with the postulations of the Mundell-Fleming model. Babatunde w. and Akinwade a.(2010) examines the consistency, persistency and severity of volatility in exchange rate of the Nigeria currency vis-a-vis United States dollar using monthly time series data from 1986-2008. The ARCH and GARCH methodology was employed. The results indicate the presence of overshooting volatility shocks. Ibrahim (2013) investigated the effects of real exchange rate misalignment on capital inflow in Nigeria between the year 1960 and 2011. The paper computes real effective exchange rate using IT trade partners of Nigeria. The two stage error correction method developed by Engel and Granger (1989)

was used. The paper observed that misalignment has a depreciating effect on the flow of FDI to the country.

3. The Model

The model for the study is Vector Autoregressive which is specified as

$$\Delta NX_t = \alpha_0 + \sum_{i=1}^n \alpha_{1i} \Delta NX_{t-i} + \sum_{i=0}^n \alpha_{2i} \Delta IR_{t-i} + \sum_{i=0}^n \alpha_{3i} \Delta FDI_{t-i} + \sum_{i=0}^n \alpha_{4i} \Delta EXR_{t-i} + \mu_{1i}$$

----- 1

$$\Delta IR_t = \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta IR_t + \sum_{i=0}^n \beta_{2i} \Delta NX_{t-i} + \sum_{i=0}^n \beta_{3i} \Delta FDI_{t-i} + \sum_{i=0}^n \beta_{4i} \Delta EXR_{t-i} + \mu_{2i}$$

----- 2

$$\Delta FDI_t = \gamma_0 + \sum_{i=1}^n \gamma_{1i} \Delta FDI_{t-i} + \sum_{i=0}^n \gamma_{2i} \Delta NX_{t-i} + \sum_{i=0}^n \gamma_{3i} \Delta IR_{t-i} + \sum_{i=0}^n \gamma_{4i} \Delta EXR_{t-i} + \mu_{3i}$$

----- 3

$$\Delta EXR_t = \delta_0 + \sum_{i=1}^n \delta_{1i} \Delta EXR_{t-i} + \sum_{i=0}^n \delta_{2i} \Delta NX_{t-i} + \sum_{i=0}^n \delta_{3i} \Delta IR_{t-i} + \sum_{i=0}^n \delta_{4i} \Delta FDI_{t-i} + \mu_{4i}$$

----- 4

Where, IR is the nominal interest rate

- FDI is foreign direct investment
- EXR is the nominal exchange rate and
- NX is the net exports
- IR is the interest rate
- FDI is the foreign direct investment and
- Δ is the difference operator.

CAUSALITY TEST

• In order to determine the causation of shocks among interest rate, foreign direct investment, exchange rate and net exports, Granger Causality test was applied. This is specified as:

$$Y_t = \alpha + \sum_{i=1}^n \beta_i Y_{t-i} + \sum_{i=1}^n \gamma_i X_{t-i} + \mu$$

$$X_t = \alpha + \sum_{i=1}^n \beta_i X_{t-i} + \sum_{i=1}^n \varphi_i Y_{t-i} + \mu$$

• Where Y_t and X_t are defined as Y and X observed over time periods; n represents the number of lags, α, β, γ and φ are parameters to be estimated and μ represents the serially uncorrelated error terms.

- The test is based on the following hypothesis
- $H_0: \gamma_1 = \varphi_1 = 0$ For all i's
- $H_0: \gamma_1 \neq 0$ and $\varphi_1 \neq 0$ For all i's

- The hypothesis is tested using a chi-square statistics. If the value of γ is statistically significant but those of φ are not then x causes y. if the values of both coefficients are statistically significant, then there exist a bidirectional causality between X and Y and if both coefficients are not statistically significant, then we have a case of independence or no causal relationship between X and Y.

4. Results

- The impulse-response graph is used to trace the impact of the shocks in interest rate on the other variables in the model namely, interest rate, FDI and exchange rate.

• Dir and Dfdi

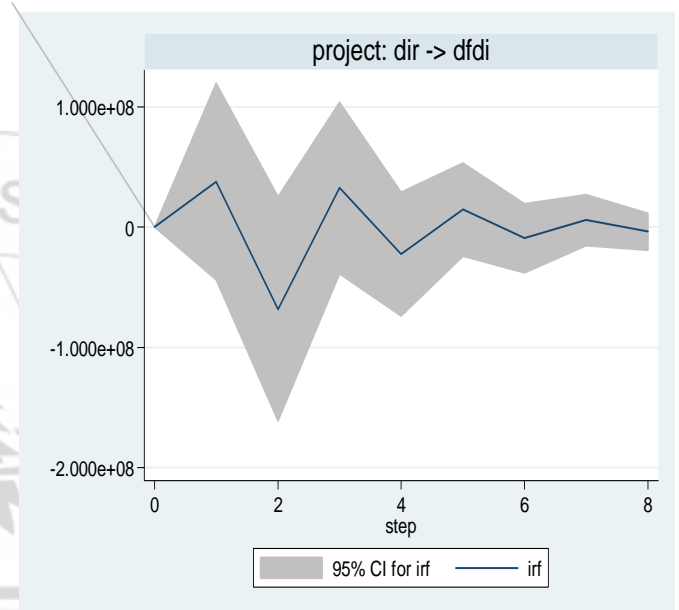


Figure 4.2: Impulse response function of interest rate and FDI

Source: Researcher's estimation, using STATA 12

- There are a total of 8 periods. This is shown by the x-axis of the IRF graph.
- The graph shows that from period zero to period one, shocks in interest rate leads to an approximate increase in foreign direct investment. From period 1 to period 2, shocks in interest rate, leads to an approximate decrease in FDI. From period 2 to period 3, shocks in interest rate, leads to an approximate increase in FDI. From period 3 to period 4 shocks in interest rate, leads to an approximate decrease in FDI but at a steeper rate. From period 4 to 5, shocks in interest rate, leads to an increase in FDI but the increase is at a steeper rate. From period 5 to 6 however, shocks in interest rate leads to a decrease in FDI but at a steeper rate. From period 6 to 7, shocks in interest rate leads to an increase in FDI but at a steeper rate, while from period 7 to 8, shocks in interest rate leads to a decrease in FDI but also at a steeper rate.

• **Dir and Dexr**

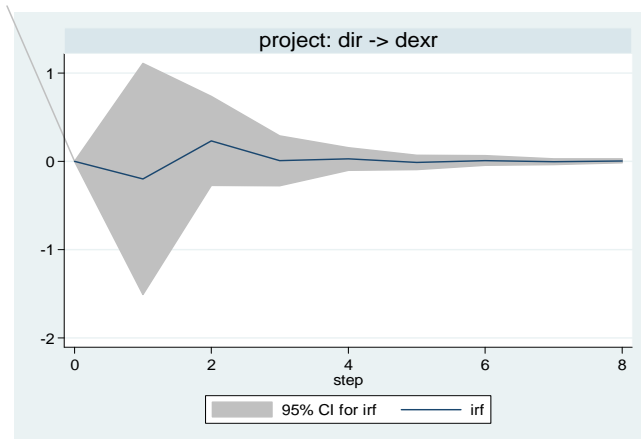


Figure 4.3: impulse response function of interest rate and exchange rate

Source: Researcher's estimation, using STATA 12

- From period 0 to 1, shocks in interest rate cause an approximate decrease in exchange rate while from period 1 to 2, shocks in interest rate cause an approximate increase in exchange rate. On the other hand, from period 2 to 3, shocks in interest rate, cause an approximate decrease in exchange rate but at a steeper rate, from period 3 to 8 shocks in interest rate, causes small approximate fluctuations in exchange rate.

• **Dir and Dnex**

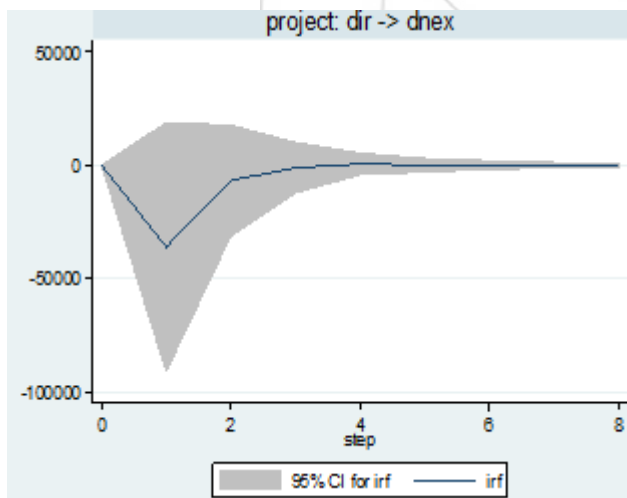


Figure 4.4: impulse response function of interest rate and exchange rate

Source: Researcher's estimation, using STATA 12

- From period 0 to period 1, shocks in interest rate causes an approximate decrease in net exports while from period 1 to 2, shocks in interest rate causes an approximate increase in net exports. From period 2 to 3 shocks in interest rate causes an increase in exchange rate but at a steeper rate. From period 3, the fluctuations evened out.

5. Granger Causality Test

- The first differences of the variables are used to conduct the granger causality test and the results show that the difference of net exports granger causes the difference of FDI. This conclusion is based on the fact that the probability value is less than 0.05 (i.e. 0.0003).
- The probability values of the other hypothesis are not statistically significant, so the Null hypothesis is not rejected

6. Conclusion

- 1) The work was done to test the empirical validity of the Mundell-Fleming model. The variables used for conducting this empirical analysis are interest rate, exchange rate, foreign direct investment and net exports. The vector autoregressive methodology was employed for this purpose. The granger causality test was also employed to test the causality of the variables
- 2) The result of the impulse-response function was also used to trace the response of the variables to a changes or shocks in interest rate. The result of the granger causality test also shows that FDI is the only variable that Granger-causes net exports.
- 3) In summary, the results showed that though the impulse-response function shows that shocks in interest rate affects the other variables, it does not necessarily mean that causality exists between them as proposed by the Mundell-Fleming model. This means that though the impact exist, the postulation that changes in interest rate, causes changes in capital flow which further causes changes in exchange rate and finally leads to changes in net export, does not necessarily hold true. In other words, though impact exists, causality does not necessarily exist. This also means that interest rate can effectively be used as a monetary policy tool for affecting the external sector, in other to achieve desired result. The conclusion of this work supports the findings of Huh (1999) and Paudel(2011)

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