A Re-examination of the Mundell-Fleming Flexible Exchange-Rate Model

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**ABSTRACT**

For over thirty years, the Mundell-Fleming model has served not only as a template for research in international macroeconomics, but also as an important pedagogical tool. The underlying pedagogical value of the model is that it can be combined with other models to explain how different exogenous factors impact the balance of payments and the exchange rate. The purpose of this paper, in turn, is to elucidate the pedagogical value of the Mundell-Fleming model by presenting a traditional market model consisting of their model and a Keynesian-Hicksian IS/LM and aggregate supply and demand curve model that can be used to evaluate the impacts macroeconomic policies and events have on exchange rates.

**Introduction**

Since the re-emergence of the flexible exchange-rate system in the early 1970s, a debate has developed over what determines exchange-rate movements. The major exchange-rate models are the asset market approach, the monetarist model, the open-economy dynamic general equilibrium models, and the Mundell-Fleming model. In the 1970s and 1980s, the asset market and the monetary models were the new models, providing alternatives to the balance of payment model of Mundell and Fleming. The asset market approach views the exchange rate as being determined by essentially the same forces that determine the prices of other assets traded in the asset market (Dornbush 1976a,b, Frenkel 1976a,b, and Poole 1967). This approach, in turn, extends investment theories such as the efficient market theory to explain the stochastic movements of exchange rates. Proponents of this approach share the view that exchange rates are an asset price. As such, they argue that exchange rate models based on balance of payment flows fail to include the exchange rate’s role in equating the demand and supply of assets – assets that are of an order of magnitude greater than the balance of payments (Mussa 1976). In treating the exchange rate as an asset price, the asset market approach maintains that the currency market, like the financial market, tends to exhibit delayed overreactions to exogenous shocks. These delayed overreactions, or "overshootings", follow from liquidity effects on interest rates, uncovered interest rate parity, and long-run purchasing power parity (Dornbush 1976).

The models of exchange-rate determination based on the monetary approach to the balance of payments, on the other hand, assume that exchange rates are determined by the long-run average of money stock differentials and the arbitrage-free purchasing power parity condition (Bilson 1978, Huang 1981, and Magee 1976). In explaining the determinants of exchange rates, the monetarist model maintains that inflationary expectations based on money supply differentials dominate all other factors. In contrast to the asset-market approach, monetarists posit that efficient currency market conditions exist such that exogenous shocks that alter inflation expectations and relative prices lead to a relatively quick change in

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the level of exchange rates. Empirical studies, though, have questioned the role of relative prices in determining exchange rates. In a 1986 study, Mussa found that price levels had little impact in explaining the variability of real and nominal exchange rates. In a more recent study, Engel (1999) found large price disparities between arbitrated tradable goods.\(^5\)

The open-economy macroeconomics models are the most recent approach to explaining international macroeconomics and exchange-rate determination. Models and research related to this approach are a product of the accumulation of empirical evidence showing the existence of sticky (or preset) prices and barriers between trading countries. The open-economy macroeconomics models synthesize Keynesian normal rigidity conditions and imperfect competition to explain these empirical regularities (Obstfeld 1998, Obstfeld and Rogoff 1995, and Betts and Devereux 1996).\(^6\)

Finally, the classic Mundell-Fleming model explains the equilibrium exchange rate in terms of a traditional macroeconomic model and the foreign currency supply and demand market model. Their model and related works represent an extension of the seminal work of James Meade (1951). Meade’s treatise on the balance of payments combined Keynesian economic conditions with monetary factors to explain the balance of payments, the economic impacts of devaluations, and the factors governing the flexible exchange rate system. As Frenkel and Razin (1987) point out, Mundell’s model extended Mead’s work by providing the explanation of how international capital flows and monetary changes worked to restore internal and external equilibriums. Related works by Mundell and Fleming subsequently addressed how fixed and flexible exchange-rate systems adjusted to exogenous shocks, the importance of fiscal policy for restoring a full-employment internal equilibrium under a fixed exchange-rate system, and the monetary approach to the balance of payments equilibrium. Their body of work, in turn, provided the foundation for the later integration of Tobin’s (1969) portfolio balance approach with monetary flows in explaining floating exchange rates, the extension by Black (1973) of the rational expectation’s argument to exchange rates, and Dornbush’s (1976) exchange rate overshooting model.\(^7\)

Some recent papers have applauded the enduring contributions of Mundell and Fleming. In his overview of international macroeconomics, Maurice Obstfeld states: “By merging Keynesian pricing assumptions and international market segmentation within a simple yet illuminating model, Mundell and Fleming provided the basic template for much of the subsequent research in both theory and policy.” Obstfeld further notes that “a testament to the lasting influence of their work is that much of the current discussion can be framed to what Fleming and especially Mundell accomplished in their work of the 1960s and 1970s….No wonder this body of work has been honored through the award to Mundell of the 1999 Nobel Prize in Economic Sciences.” (Obstfeld 2001, p. 2)

In addition to being a basic template for subsequent research (to use Obstfeld words), the Mundell-Fleming model has also become a valuable pedagogical model for explaining international macroeconomics. The familiar Mundell-Fleming IS/LM/BP model is presented in a number of International Economics texts (Appleyard, Field, and Cobb 2005 and Pugel 2004). The underlying pedagogical value of their model is that it can be combined with other models to explain how different exogenous factors impact the balance of payments and the exchange rate. The purpose of this paper, in turn, is to elucidate the pedagogical value of the Mundell-Fleming model by presenting a traditional market model consisting of their model and a Keynesian-Hicksian IS/LM and aggregate supply and demand curve model that can be used to evaluate the impacts macroeconomic policies and events have on the exchange rate. To this end, in the next section a comparative static model is presented in which an economy’s internal equilibrium is explained by an IS/LM and aggregate supply and demand curve model, and its external equilibrium is explained by the Mundell-Fleming foreign currency market model. In section 3, this comparative static model is used to explain the impacts that exogenous changes have on the exchange rate. The model presented here is similar to the IS/LM/BP model. However, the BP curve is excluded, while the curves

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\(^5\) Several empirical studies have also examined the relationship between exogenous changes and exchange rate behavior (Huang 1981 and Giaccotto, Johnson, and Zuber 1993). These studies have shown that there is considerably more exchange rate variability than would exist in an efficient currency market that adjusted quickly.

\(^6\) For a good survey article on the new open economy macroeconomics, see Lane (1990). For an electronic link to many papers in this area go to [http://www.princeton.edu/bindoyle/open.html](http://www.princeton.edu/bindoyle/open.html).

\(^7\) For a good analysis and interpretation of the Mundell-Fleming model, see Frenkel and Razin (1987).
defining net import and net capital flow functions (from which the Mundell-Fleming BP curve is generated) are included. This is done to highlight the equilibrium adjustment process that takes place in each market.

The Mundell-Fleming Exchange-Rate Model

Assumptions

A model of an open economy that combines the traditional Keynesian-Hicksian macroeconomic model with the Mundell-Fleming market model for foreign currency can be defined in terms of an economy’s internal and external equilibrium conditions. In the Keynesian-Hicksian model, the internal equilibrium occurs at an aggregate real output level, y, interest rate, r, and price level, P, in which supply and demand are equal in both the goods and capital markets. Graphically, this equilibrium occurs at the intersection of the IS and LM curves and the aggregate supply and demand curves, SS and DD (see Exhibit 1). The Mundell-Fleming external equilibrium occurs at an exchange rate, $E_0^*$, where the balance of payments is zero or equivalently where the supply and demand for foreign currency are equal.

To keep the combined models relatively simple, assume the following: (1) no expenditure-switching variables such as tariffs, exchange controls, and the like, (2) direct investment has no impact on the balance of payments, and (3) investors treat short-term and long-term investments as the same. Also, to avoid the complications associated with reciprocal impacts, assume that foreign prices, interest rates, and real income are constant. Note that by assuming foreign parameters are constant, it is not necessary to assume that such endogenous international variables as exports, imports, and capital flows are a function of the differentials in parameters. The development of a more detailed model, of course, would require such specifications.

Mundell-Fleming Model

In terms of the Mundell-Fleming model, a country's exchange rate is explained in terms of a balance of payments function and the internal equilibrium conditions determining real income, interest rates, and prices. Equation (1) defines a balance of payments function incorporating the above assumptions in which the external balance, B, is expressed in terms of the money values of exports, imports, and net capital flows:

$$ B = X - M + F = X(P, E_0) - M(y, P, E_0) + F'(r) $$

The money value of exports, X, is assumed to depend on the domestic price level and the spot exchange rate expressed in terms of the amount of domestic currency needed to buy one unit of foreign currency.\(^8\) As indicated in Equation (1), the partial of exports with respect to the price level can be either positive or negative; its sign depends on the price elasticity of real export spending. The partial of exports with respect to the exchange rate, though, is assumed to be positive. The money value of imports, M, is assumed to be a function of real income, y, the price level, and the exchange rate. Both the partial of imports with respect to real income and the partial with respect to prices are assumed to be positive; the sign of the latter partial reflects a substitution effect. The partial of imports with respect to the exchange rate is shown to be either positive or negative; its sign depends on the elasticity of real imports with respect to the exchange rate.\(^9\)

\(^8\) The money value of exports is the product of real aggregate exports, x, and the domestic price level (index) for exports, P, X = P x; the money value of imports is equal to the product of aggregate real imports, m, and the domestic price (index) of foreign goods, P f; capital inflows are equal to the money value of foreign purchases of domestic assets in domestic units, F; and capital outflows, F o, are equal to the money value of domestic purchases of foreign assets in foreign currency units, F o', times the exchange rate, F o' = (F o')(E_0).

\(^9\) Note that in the new open-economy macroeconomics models distinctions are made between producers who preset prices either domestically or in foreign currency. The distinction is used to explain how a zero exchange-rate pass through contributes to price rigidity in exchange rate movements. See Betts and Devereux (1996). The Mundell-Fleming model would imply a pass-through from exchange rates to import prices.
Graphically, the import and export functions give rise to the MX curve shown in the southeast quadrant of Exhibit 1. This curve shows the relationship between M-X and y for given price and exchange rate levels. The slope of the MX curve is the marginal propensity to import, \( \partial M/\partial y \), and the position of the curve is determined by P and E_0. Depending on the price elasticity of real exports, a price change in the economy will shift the MX curve either up or down by \( \partial(M \times X)/\partial P \). If the elasticity is greater than one in absolute value, then a price increase will lead to a decrease in the money value of exports. This decrease, combined with a decrease in the money value of imports resulting from a substitution effect, will increase M-X, leading to a downward shift in the MX curve. Similarly, depending on the exchange-rate elasticity of real imports, a change in the exchange rate will shift the MX curve either up or down by \( \partial(M \times X)/\partial E_0 \). If the elasticity is greater than one in absolute value, then an increase in the exchange rate will decrease the money value of imports (valued in terms of domestic currency). The increase in the exchange rate will also lower the foreign currency price of exports, increasing export demand and the money value of exports (valued in domestic currency). The combined effect of the exchange-rate increase will therefore be a decrease in M-X, leading to an upward shift in the MX curve.

The final function in Equation (1) is net capital flows, F\( ^n \). For simplicity, net capital flows, capital inflows, F\( ^i \), minus capital outflows, F\( ^o \), are assumed to depend only on the domestic interest rate, r. The derivative of net capital flows with respect to the interest rate is assumed to be positive. That is, a rise in the domestic rate is assumed to increase the purchases of existing financial assets by foreigners (F\( ^i \)), and through a substitution effect, decrease the purchases of foreign assets by residents (F\( ^o \)). Graphically, the net capital flows function gives rise to the FF curve shown in the northwest quadrant of Exhibit 1. The curve shows the positive relationship between F\( ^i \) and r, where the slope of FF is \( \partial F^n/\partial r \).

The external equilibrium occurs at y, P, r and E_0 levels in which the balance of payments is zero. This condition is shown in the southwest quadrant where the external equilibrium condition of F\( ^n \) = M – X (B = 0) is specified by the 45° line. Graphically, the external equilibrium condition requires the coordinate M-X and F\( ^n \) to be on the 45° line; if F\( ^n \) > M - X, the coordinate is above the line and there is a surplus; if F\( ^n \) < M - X, the coordinate is below the line and there is a deficit. The external equilibrium condition of B = 0 is also equivalent to the supply and demand for foreign currency, FC, being equal in the foreign currency market. In terms of this model, the supply of FC is determined by exports and capital inflows, which, in turn, are functions of the exchange rate, prices, and interest rates; the demand for FC is determined by imports and capital outflows, which, in turn, depend on the exchange rate, real income, prices, and interest rates:

\[
S_{FC} = X(P, E_0) + F^i(r) \tag{2}
\]
\[
D_{FC} = M(P, y, E_0) + F^o(r)
\]

These functions give rise to the supply and demand curves for foreign currency, S\( ^f \) and D\( ^f \), also shown in Exhibit 1.

The economy’s internal equilibrium, as noted, occurs at the intersections of the IS and LM curves and the aggregate SS and DD curves as shown in Exhibit 1. In the context of an IS/LM and SS/DD model, the equilibrium levels of real income, y*, prices, P*, and the interest rate, r*, depend on the assumed exogenous variables, A (e.g., monetary and fiscal policy changes and exogenous changes in production costs) and the balance of payments and the factors that affect it. That is, for an open economy, both the IS and DD curves shift if there is a change in real exports, x\( ^f \), or imports, m\( ^f \), resulting from a change in the exchange rate, and the LM and DD curves shift when there is an international deficit or surplus that causes the money supply, M\( _r \), to change. Formally:

\[
\begin{align*}
y^* &= f(A, x^f - m^f, M_r^f) \\
P^* &= f(A, x^f - m^f, M_r^f) \\
r^* &= f(A, x^f - m^f, M_r^f)
\end{align*}
\]
where:

\[ x^f - m^f = f(E_0) \]
\[ M^f_r = f(B) \]

A > 0 ⇒ Expansionary Exogenous Force
A < 0 ⇒ Contractory Exogenous Force

Note that in the Mundell-Fleming model, the IS/LM and SS/DD shifts that result from changes in the exchange rate and changes in the money supply due to the external imbalance occur during the equilibrium adjustment process to a deficit or surplus. It should also be noted that in a Keynesian-Hicksian model for an open economy, the slope of the IS curve includes the marginal propensity to import and the slope of the aggregate demand curve reflects the inverse relation between net real exports and prices.

Given the balance of payments function and the internal equilibrium conditions, total equilibrium occurs at the \( y^*, P^*, r^* \), and \( E_0^* \) levels in which the economy is simultaneously in internal and external equilibrium. This is shown in Exhibit 1 where \( y_0^*, P_0^*, r_0^* \), and \( E_0^* \) levels are defined by the intersections of the IS and LM curves and SS and DD curves, and where \( M-X \) and \( F^0 \) levels are equal; that is, the \((M-X)_0 \) and \( F^0 \) coordinate is on the 45° line. The total equilibrium condition is also shown in the accompanying foreign currency supply and demand figure where the \( S'S^I \) and \( D'D^I \) curves intersect at \( E_0^* \) and the positions of the \( S'S^I \) and \( D'D^I \) curves are defined by \( y_0^*, P_0^*, \) and \( r_0^* \) levels that satisfy the internal equilibrium condition.

The Equilibrium-Adjustment Process

Under a flexible-exchange rate system, a balance of payments deficit or surplus initially affects the exchange rate and the money supply. In the foreign currency market, a deficit reflects an excess demand for FC. This excess demand has a tendency to increase the exchange rate and decrease the country’s money supply as its banks and financial institutions go into the currency market to buy FC with their local currency holdings. On the other hand, if a country has a surplus, then it will be reflected by an excess supply of FC. This excess has a tendency to lower the exchange rate and increase the FC holdings of the country’s banks and financial institutions. If banks and financial institutions subsequently convert their FC holdings to local currency, then the money supply will increase.

In a Mundell-Fleming world, the equilibrium adjustments to a deficit or surplus are assumed to start with the balance of payments changing in response to the change in the exchange rate and the changes in \( y, P, \) and \( r \) resulting from the change in the money supply. In addition, the balance of payments is also affected by the secondary effect that changes in the exchange rate have on \( y, P \) and \( r \). This secondary effect, though, has the opposite effect on \( y \) and \( P \) that the monetary effect has. For example, in the case of a deficit, the resulting monetary contraction lowers \( y \) and \( P \), while the resulting higher exchange rate stimulates the economy by increasing real exports and decreasing real imports, leading, in turn, to a larger \( y \) and \( P \). The combined monetary and secondary internal effect on \( y \) and \( P \) may therefore be negligible. The two effects do work, though, in same direction on interest rates: The monetary contraction resulting from a deficit pushes rates up, and the increase in transaction demand resulting from the increase in net real export demand also pushes rates up. If the monetary and secondary internal effects on \( y \) and \( P \) offset each other, then the equilibrium adjustment process will occur through changes in just the exchange rate and the interest rate.

The equilibrium adjustment process for a deficit country using the Mundell-Fleming model is shown in Exhibit 2. As shown, the economy is initially at \( y_0, P_0, r_0 \) and \( E_0 \) where it has an internal equilibrium, but a balance of payments deficit: the \((M-X)_0 \) coordinate is below the 45° line. In the FC market, this deficit is reflected by an excess demand for FC of \( D_{FC} - S_{FC} \). The excess, in turn, leads to an increase in the exchange rate. As the exchange rate rises, the money value of exports starts to increase (movement along \( S'S^I \)) and the money value of imports begins to decrease if the exchange rate elasticity of real imports is greater than one in absolute value (movement along \( D'D^I \)). The combination of the increase in exports and

\[ \text{(11) Note that in subsequent discussions of equilibrium, the superscript } * \text{ that indicates equilibrium levels for } y, P, \text{ and } r \text{ is deleted.} \]
decrease in imports serves to improve the balance of payments; this is reflected by the upward shift in the MX curve.

In addition to the exchange rate impact on the balance of payments, the deficit also decreases the money supply. In terms of the IS/LM and DD/SS model, this monetary effect leads to leftward shifts in the LM and aggregate demand curves, causing y and P to decrease and r to increase. As previously noted, the increase in the exchange rate also increases real exports and decreases real imports, stimulating the economy. In terms of the model, the increase in real exports and the decrease in real imports causes the IS and aggregate demand curves to shift to the right, causing y, P, and r to increase. If we assume that the internal effect on y and P (rightward shifts in IS and DD) and the monetary effect on y and P (leftward shifts in LM and DD) offset each other, then their combined effect would lead to just an increase in the interest rate (this is the case shown in Exhibit 2). If this is the case, then in the FC market, the higher interest rates will lead to greater capital inflows and lower capital outflows. The increase in capital inflows leads to an increase in the supply of FC (S’S’ shifts right), and the decrease in capital outflows, in turn, leads to a decrease in the demand for FC (D’D’ shifts left). Combined, the capital inflow increase and capital outflow decrease augment net capital flows, improving the balance of payments. This improvement in the balance of payments is reflected by a movement up the FF curve.

The equilibrium adjustment process will continue until the balance of payments is zero or equivalently where the demand and supply for FC are equal. As shown in Exhibit 2, this equilibrium occurs at y₀, P₀, r₁, and E₀₁. At those levels, the coordinate (M-X)₁ and Fⁿ₁ is on the 45° line, implying B = 0, and equivalently the supply and demand for FC are equal in the FC market.

**Comparative Equilibrium Analysis**

As a comparative-static model, the Mundell-Fleming model is useful in explaining how changes in exogenous variables affect the balance of payments and the exchange rate. In terms of the model, the impact of a change in an exogenous variable on the exchange rate can be explained in terms of four effects:

1. The internal impact the exogenous change has on y, P, and r (IS/LM and SS/DD shifts).
2. The balance of payments impact that the resulting changes in y, P, and r have on M, X, and F^n.
3. The foreign currency impact that the resulting changes in the balance of payments items have on the supply and demand for FC.
4. The equilibrium adjustment impact in which the resulting excess supply or demand for FC leads to new equilibrium levels for r and E₀.

Mathematically, the impact of changes in exogenous variables have on the exchange rate can be quantified in terms of the derivatives dE₀/dA and dE₀/dB. The derivatives are obtained by: (1) taking the derivative of Equation (1) with respect to a change in an exogenous variable, (2) substituting into that equation the partial derivatives for y*, P*, and r* from Equation (3), (3) setting dB/dA = 0 to satisfy the equilibrium condition that the supply and demand for foreign currency are equal or (B = 0), and (4) solving the resulting equation for ∂E₀/∂B. If it is assumed that the internal effect on y and P (rightward shift in IS and DD) and the monetary effect on y and P (leftward shifts in LM and DD) offset each other then the resulting equation for ∂E₀/∂B is:

\[
\frac{\partial E_0}{\partial B} = \frac{1}{\partial (X-M) \partial B} \left[ \frac{\partial (X-M) \partial P}{\partial A} \frac{\partial M}{\partial A} \frac{\partial y}{\partial A} \frac{\partial F^n}{\partial r} \right] + \frac{1}{\partial (X-M) \partial B} \left[ \frac{\partial F^n}{\partial r} \left( \frac{\partial y}{\partial A} - \frac{\partial (x^f - m^f)}{\partial A} \frac{\partial E_0}{\partial B} \right) + \frac{\partial F^n}{\partial r} \frac{\partial r}{\partial M^f} \frac{\partial B}{\partial A} \right] \]

(4)
This equation shows mathematically that the impact of a change in an exogenous variable on the exchange rate depends on:

1. The internal impact of the exogenous change on the internal economy: \( \partial P/\partial A \), \( \partial y/\partial A \), and \( \partial r/\partial A \) (shifts in IS and LM and SS and DD curves).

2. The balance of payments impact where the balance of payments items change in response to the changes in \( y \), \( P \), and \( r \): \( \partial(X-M)/\partial P \), \( \partial M/\partial y \), and \( \partial F/\partial r \) (shifts in MX and the movements along MX and FF).

3. The foreign currency impact where the supply and demand for FC change in response to the changes \( M \), \( X \), and \( F \) resulting from the changes in \( y \), \( P \), and \( r \) (shifts in \( S^fS^f \) and \( D^fD^f \)).

4. The equilibrium adjustment of net exports to the change in the exchange rate: \( 1/[(\partial(X-M)/\partial E_0)(\partial E_0/\partial B)] \) (the slopes of \( S^fS^f \) and \( D^fD^f \)) and the adjustment of capital flows to the change in the interest rate: second term on the right-hand side of Equation (4) (shifts of \( S^fS^f \) and \( D^fD^f \)).

The impact exogenous changes have on the balance of payments and the exchange rate can differ depending on whether the change affects aggregate supply or aggregate demand. The traditional exogenous forces on the demand-side of the economy are fiscal policy and autonomous changes in exports and imports, both of which affect aggregate spending (IS), and monetary policy, which affects aggregate wealth (LM). On the supply side, the standard exogenous factors are those related to the costs of production, such as exogenous changes in labor and energy prices, and capital and technological changes that impact productivity.

**Exogenous Changes in Aggregate Demand**

An exogenous demand-side change will cause \( P \) and \( y \) to change in the same direction provided the supply curve is positively sloped. As such, the resulting changes in \( P \) and \( y \) will work in the same direction on the balance of payments and the exchange rate. If the exogenous change also leads to a directional change in the interest rate that is opposite to the changes in \( P \) and \( y \), then the rate change will reinforce the price and income effects on the balance of payments and the exchange rate.

To illustrate the impact of a demand-side exogenous change on the balance of payments and the exchange rate consider the case of a contractionary monetary policy (see Exhibit 3). In terms of the traditional IS/LM analysis, the initial effect of the policy would be a contraction in aggregate demand, reflected by the leftward shifts of the LM curve to \( LM_1 \) and the demand curve to \( D_1D_1 \). As shown in Exhibit 3, the resulting decrease in aggregate demand, in turn, would lead to a decrease in prices, causing the LM curve to shift back to \( LM_0 \), the IS curve to shift to the right to \( IS_1 \), and the MX curve to shift upward to \( MX_0(P_1,E_0) \), given \( \partial(X-M)/\partial P < 0 \). Thus, the internal impact of the contractionary monetary policy would be a decrease in income from \( y_0 \) to \( y_1 \), a decrease in prices from \( P_0 \) to \( P_1 \), and an increase in interest rates from \( r_0 \) to \( r_1 \). (It should be noted that the IS curve shifts to the right because of the higher level of real export spending and the lower level of real import expenditures resulting from the price decrease.)

In terms of the external impact of the monetary contraction, the interest rate increase would augment inpayments by increasing net capital flows from \( F^f_0 \) to \( F^f_1 \), the price reduction would increase exports and reduce imports, as reflected by the upward shift in the MX curve (given that the elasticity condition holds); and the income reduction would decrease imports, as reflected by the movement along the MX curve. Thus, the impact of the contractionary policy on \( y \), \( P \), and \( r \) is one of creating an external surplus as reflected by the coordinate \( F^f_1 \), \( M-X \), and \( E \) being above the 45° line. In the foreign currency market, the balance of payments surplus would be reflected by an excess supply of FC at \( E_0 \) (where the elasticity conditions ensuring \( \partial(X-M)/\partial E_0 > 0 \) are assumed to exist). That is, the increase in X and \( F \) and the decrease in M and \( F \), respectively, would lead to rightward and leftward shifts in the supply and demand curves for foreign currency. Finally, the excess supply of FC would lead to an equilibrium adjustment. If we assume that the internal effect on \( y \) and \( P \) (leftward shift in IS to \( IS_1 \) and DD) and the monetary effect on \( y \) and \( P \) (rightward shifts in LM to \( LM_1 \) and DD) offset each other, then the equilibrium adjustment to the surplus would occur through a decrease in the exchange rate (movement along \( S^fS^f \) and \( D^fD^f \) and downward shift in the MX from \( MX_1(P_1,E_0) \) to \( MX_2(P_1,E_0) \)), and a decrease in the interest rate (downward shifts in \( S^fS^f \) and \( D^fD^f \) and
movement down the FF curve). As shown in Exhibit 3, the new equilibrium occurs at lower levels of real income and prices, \( y_1 \) and \( P_1 \), a higher interest rate, \( r_2 \), and a lower exchange rate, \( E_{01} \).

In general for monetary policy, there is a direct relationship between \( E_0 \) and the policy (\( dE_0/dA > 0 \)) given the following sufficient conditions:

1. There exists a positive relationship between the direction of monetary policy and the price and real income levels and a negative relationship for interest rates (positively sloped LM and SS curves and negatively sloped IS and DD curves).

2. The partials \( \partial F^n/\partial r \) and \( \partial M/\partial y \) are positive and \( \partial(X-M)/\partial P \) is negative, or, if not, then the condition of \( (\partial F^n/\partial r) + (\partial M/\partial y) > \partial(X-M)/\partial P \) must hold.

3. The elasticity conditions are such that \( \partial(X-M)/\partial E_0 > 0 \).

Exhibit 4 summarizes the impact of this contractionary monetary policy case on the internal economy, balance of payments, FC market, and the exchange rate along with the directional impacts of three other exogenous demand changes: expansionary monetary policy, expansionary fiscal policy, and an exogenous increase in export demand. Note that if the exogenous demand-side change also leads to a directional change in the interest rate that is the same as the change in \( P \) and \( y \) (such as a change in fiscal policy or an exogenous change in export demand that shifts the IS), then the interest rate change will have the opposite effect on the balance of payments and exchange-rate as the income and price effects do. However, in most cases one would expect that the combined price and income effects would dominate the interest rate effect. If this is the case, then exogenous changes that increase (decrease) aggregate demand would have deficit (surplus) tendencies, leading to increases (decreases) in the exchange rate.

### Exogenous Changes in Aggregate Supply

In contrast to exogenous demand changes, exogenous changes on the supply side normally have opposite effects on \( y \) and \( P \). As a result, the combined price and income effects on the balance of payments resulting from an exogenous change in aggregate supply are ambiguous. For example, given a negatively sloped demand curve, an increase in aggregate production costs due to an increase in the price of energy or a decline in labor productivity (a contractionary exogenous change) causes \( P \) to increase and \( y \) to decrease (leftward shift in SS). In terms of the model, the price increase will cause the money value of imports to increase and the money value of exports to decrease (assuming the price elasticity of real exports is greater than one in absolute value), leading to a deterioration in the external balance, while the real income decrease will lower imports, causing an improvement in the balance. Note, however, that the price change will also cause interest rates to change in the same direction as prices. Thus, the increase in prices resulting from an exogenous increase in production costs will push the interest rate up. The interest rate increase, in turn, will augment net capital flows, which will serve to improve the external balance. In general, an exogenous increase (decrease) in production costs will lead to improvement (deterioration) in the external balance and a decrease (increase) in the exchange rate if the combined income and interest rate effect dominates the price effect:

\[
\begin{align*}
\text{If } & \frac{\partial M}{\partial y} \frac{dy}{dA} + \frac{\partial F^n}{\partial r} \frac{dr}{dA} > \frac{\partial(X-M)}{\partial P} \frac{dP}{dA} \implies \text{Surplus Tendency and } E_0 \downarrow \\
\text{If } & \frac{\partial M}{\partial y} \frac{dy}{dA} + \frac{\partial F^n}{\partial r} \frac{dr}{dA} < \frac{\partial(X-M)}{\partial P} \frac{dP}{dA} \implies \text{Deficit Tendency and } E_0 \uparrow
\end{align*}
\]

Exhibit 5 summarizes the impact of four exogenous supply changes on the internal economy, the balance of payments, the FC market, and the exchange rate using the Mundell-Fleming model.

In summary, the Mundell-Fleming model combined with a Keynesian-Hicksian model explains changes in the level of exchange rates in terms of three impacts: (1) the impact supply and demand exogenous forces have on aggregate output, prices, and interest rates, (2) the impact changes in those variables have on

\(^{12}\) Mathematically, the condition can be stated as \( \frac{\partial(X-M)}{\partial P} \frac{dP}{dA} + \frac{\partial M}{\partial y} \frac{dy}{dA} > \frac{\partial F^n}{\partial r} \frac{dr}{dA} \implies \frac{dB}{dA} > 0 \) and \( \frac{dE_0}{dA} > 0 \)
the balance of payments and the supply and demand for foreign currency, and (3) the equilibrium adjustment to the resulting trade and foreign currency imbalance.

**Conclusion**

This paper re-examined the classical Mundell-Fleming exchange-rate determination model, showing that when it is combined with a Keynesian-Hicksian model, it can be used to explain the impact of macroeconomic policies and events on exchange rates. Unlike the dynamic open-economy macroeconomics models, this classical model is limited in scope by being a comparative static model. Nevertheless, as pointed out in the introduction, the model does provide a template for examining other international macroeconomic questions.

In conclusion, the debate as to what explains the behavior of exchange rates and whether foreign currency changes can be predicted and if so what factors determine such changes is an old and complex one. As Winston Churchill (1949) said: “There is no sphere of human thought in which it is easier to show superficial cleverness and the appearance of superior wisdom than in discussing questions of currency and exchange.” Winston Churchill sentiments notwithstanding, perhaps the important contribution of the Mundell model is that while it is only a comparative static analysis with simplifying assumptions, it does provide clarity in explaining what factors determine exchange rates.
References


Exhibit 1: Mundell-Fleming and Keynesian-Hicksian Model
Exhibit 2
Equilibrium Adjustment to a Deficit
Exhibit 3
Contractionary Monetary Policy
### Exhibit 4: The Impact of Exogenous Changes in Aggregate Demand

<table>
<thead>
<tr>
<th>Policy</th>
<th>Internal Impact</th>
<th>External Impact</th>
<th>FC Impact</th>
<th>Equilibrium Adjustment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contractionary Monetary Policy</td>
<td>$y \downarrow, P \downarrow, r \uparrow$ Leftward shift of LM and DD</td>
<td>$y \downarrow \Rightarrow M \downarrow \Rightarrow Surplus$ $P \downarrow \Rightarrow M \downarrow \Rightarrow D_{EC} \downarrow$ $r \uparrow \Rightarrow F^\uparrow \Rightarrow D_{EC} \downarrow$</td>
<td>$y \downarrow \Rightarrow M \downarrow \Rightarrow D_{EC} \downarrow$ $P \downarrow \Rightarrow M \downarrow \Rightarrow D_{EC} \downarrow$ $r \uparrow \Rightarrow F^\uparrow \Rightarrow D_{EC} \downarrow$</td>
<td>(1) Excess supply for FC $\Rightarrow E = 0$ (2) $E_0 \Rightarrow X$ $E_0 \Rightarrow M$ (3) Inward Exchange Rate Adjustments: $E_0 \downarrow \Rightarrow real exports \Rightarrow y \downarrow, P_k, r \downarrow$ $E_0 \uparrow \Rightarrow real imports \Rightarrow y \downarrow, P_k, r \downarrow$ Leftward shift in IS curve (4) Monetary Adjustment: Excess Supply of FC $\Rightarrow M_i$, if FC converted $\Rightarrow M_i \Rightarrow y \uparrow, P_k, r \downarrow$ Rightward shift in LM curve $\Rightarrow$ Net effect of internal and monetary $\Delta y = 0, \Delta P = 0, r \downarrow$ $r \downarrow \Rightarrow F^\uparrow$ $r \downarrow \Rightarrow F^\uparrow$</td>
</tr>
<tr>
<td>Expansionary Monetary Policy</td>
<td>$y \uparrow, P \uparrow, r \downarrow$ Rightward shift of LM and DD</td>
<td>$y \uparrow \Rightarrow M \uparrow \Rightarrow Deficit$ $P \uparrow \Rightarrow M \uparrow \Rightarrow D_{EC} \uparrow$ $r \downarrow \Rightarrow F^\downarrow \Rightarrow Deficit$</td>
<td>$y \uparrow \Rightarrow M \uparrow \Rightarrow D_{EC} \uparrow$ $P \uparrow \Rightarrow M \uparrow \Rightarrow D_{EC} \uparrow$ $r \downarrow \Rightarrow F^\downarrow \Rightarrow D_{EC} \uparrow$</td>
<td>(1) Excess demand for FC $\Rightarrow E = 0$ (2) $E_0 \Rightarrow X$ $E_0 \Rightarrow M$ (3) Internal Exchange Rate Adjustments: $E_0 \downarrow \Rightarrow real exports \Rightarrow y \uparrow, P_k, r \uparrow$ $E_0 \uparrow \Rightarrow real imports \Rightarrow y \uparrow, P_k, r \uparrow$ Rightward shift in IS curve (4) Monetary Adjustment: Excess demand for FC $\Rightarrow M_i \downarrow$ $M_i \downarrow \Rightarrow y \downarrow, P_k, r \uparrow$ Leftward shift in LM curve $\Rightarrow$ Net effect of internal and monetary $\Delta y = 0, \Delta P = 0, r \uparrow$ $r \uparrow \Rightarrow F^\uparrow$ $r \uparrow \Rightarrow F^\uparrow$</td>
</tr>
<tr>
<td>Expansionary Fiscal Policy</td>
<td>$y \uparrow, P \uparrow, r \uparrow$ Rightward shift of IS and DD</td>
<td>$y \uparrow \Rightarrow M \uparrow \Rightarrow Deficit$ $P \uparrow \Rightarrow M \uparrow \Rightarrow D_{EC} \uparrow$ $r \downarrow \Rightarrow F^\downarrow \Rightarrow Surplus$</td>
<td>$y \uparrow \Rightarrow M \uparrow \Rightarrow D_{EC} \uparrow$ $P \uparrow \Rightarrow M \uparrow \Rightarrow D_{EC} \uparrow$ $r \uparrow \Rightarrow F^\uparrow \Rightarrow D_{EC} \uparrow$</td>
<td>(1) Excess demand for FC $\Rightarrow E = 0$ (2) $E_0 \Rightarrow X$ $E_0 \Rightarrow M$ (3) Internal Exchange Rate Adjustments: $E_0 \downarrow \Rightarrow real exports \Rightarrow y \uparrow, P_k, r \uparrow$ $E_0 \uparrow \Rightarrow real imports \Rightarrow y \uparrow, P_k, r \uparrow$ Rightward shift in IS curve (4) Monetary Adjustment: Excess demand for FC $\Rightarrow M_i \downarrow$ $M_i \downarrow \Rightarrow y \downarrow, P_k, r \uparrow$ Leftward shift in LM curve $\Rightarrow$ Net effect of internal and monetary $\Delta y = 0, \Delta P = 0, r \uparrow$ $r \uparrow \Rightarrow F^\uparrow$ $r \uparrow \Rightarrow F^\uparrow$</td>
</tr>
</tbody>
</table>

**Notes:** $^*$ Assumes $\% \Delta real exports/\% \Delta P > 1$; $^{**}$ assumes $\% \Delta real exports/\% \Delta E_0 = 1$; $^{***}$ assumes the monetary and internal exchange rate adjustments impacts on P and y offset each other; $^{****}$ assumes the price and income effects on the external balance dominate the interest rate effect; $^{*****}$ assumes the price effect on the external balance dominates the interest rate effect.
Exhibit 5: The Impact of Exogenous Changes in Aggregate Supply

<table>
<thead>
<tr>
<th>Policy</th>
<th>Internal Impact</th>
<th>External impact</th>
<th>FC Impact</th>
<th>Equilibrium Adjustment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Exogenous Increase in Aggregate Supply</strong></td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>Example: Lower energy prices or increase in productivity due to technology</td>
<td></td>
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<tr>
<td>y↑, P↓, r↑</td>
<td>Rightward shift of SS; Rightward shift of LM.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>y↑ ⇒ M↑ ⇒ Deficit</td>
<td>P↑ ⇒ M↑ ⇒ D↑</td>
<td>D↑⇒ M↑ ⇒ D↑</td>
<td>(1) Excess demand for FC ⇒ E↑</td>
<td></td>
</tr>
<tr>
<td>P↑ ⇒ X↑ ⇒ Surplus</td>
<td>P↑ ⇒ M↑ ⇒ D↑</td>
<td>D↑⇒ M↑ ⇒ D↑</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P↑ ⇒ M↑ ⇒ Surplus</td>
<td>r↑ − P↑ ⇒ D↑</td>
<td>D↑⇒ M↑ ⇒ D↑</td>
<td>(2) E↑ ⇒ X↑</td>
<td></td>
</tr>
<tr>
<td>r↑ ⇒ P↑ ⇒ Deficit</td>
<td>r↑ − P↑ ⇒ D↑</td>
<td>D↑⇒ M↑ ⇒ D↑</td>
<td>(3) Internal Exchange Rate</td>
<td></td>
</tr>
<tr>
<td>Movement down MX; Uphward shift in MX; Movement down FF.</td>
<td>D↑⇒ M↑ ⇒ D↑</td>
<td>D↑⇒ M↑ ⇒ D↑</td>
<td>Adjustments: E↑ ⇒ real exports↑ ⇒ y↑, P↑, r↑</td>
<td></td>
</tr>
<tr>
<td>If income and interest rate effects dominate price effect, then deficit.</td>
<td>D↑⇒ M↑ ⇒ D↑</td>
<td>D↑⇒ M↑ ⇒ D↑</td>
<td>Rightward shift in IS curve</td>
<td></td>
</tr>
<tr>
<td>If ∂M dy − ∂P dr &gt; 0</td>
<td>∂M dy − ∂P dr &gt; 0</td>
<td>∂M dy − ∂P dr &gt; 0</td>
<td>(4) Monetary Adjustment: Excess demand for FC ⇒ M↑</td>
<td></td>
</tr>
<tr>
<td>∂M dy − ∂P dr &gt; 0</td>
<td>∂M dy − ∂P dr &gt; 0</td>
<td>∂M dy − ∂P dr &gt; 0</td>
<td>M↑ ⇒ y↑, P↑, r↑</td>
<td></td>
</tr>
<tr>
<td>then deficit.</td>
<td>then at current E↑, an excess demand for FC</td>
<td>then at current E↑, an excess demand for FC</td>
<td>Leftward shift in LM curve</td>
<td></td>
</tr>
<tr>
<td><strong>Exogenous Decrease in Aggregate Supply</strong></td>
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<td></td>
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<tr>
<td>Example: Higher energy prices or decrease in productivity.</td>
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<tr>
<td>y↓, P↑, r↑</td>
<td>Leftward shift of SS; Leftward shift of LM.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>y↓ ⇒ M↓ ⇒ Surplus</td>
<td>P↓ ⇒ M↑ ⇒ D↓</td>
<td>D↓⇒ M↑ ⇒ D↓</td>
<td>(1) Excess supply for FC ⇒ E↓</td>
<td></td>
</tr>
<tr>
<td>P↑ ⇒ X↑ ⇒ Surplus</td>
<td>P↓ ⇒ M↑ ⇒ D↓</td>
<td>D↓⇒ M↑ ⇒ D↓</td>
<td></td>
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<tr>
<td>P↑ ⇒ M↓ ⇒ Deficit</td>
<td>r↓ ⇒ P↑ ⇒ D↑</td>
<td>D↓⇒ M↑ ⇒ D↓</td>
<td>(2) E↓ ⇒ X↓</td>
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<tr>
<td>r↑ ⇒ P↑ ⇒ Deficit</td>
<td>r↓ ⇒ P↑ ⇒ D↑</td>
<td>D↓⇒ M↑ ⇒ D↓</td>
<td>(3) Internal Exchange Rate</td>
<td></td>
</tr>
<tr>
<td>Movement up MX; Downward shift in MX; Movement up FF.</td>
<td>D↓⇒ M↑ ⇒ D↓</td>
<td>D↓⇒ M↑ ⇒ D↓</td>
<td>Adjustments: E↓ ⇒ real exports↓ ⇒ y↓, P↑, r↑</td>
<td></td>
</tr>
<tr>
<td>If income and interest rate effects dominate price effect, then surplus.</td>
<td>D↓⇒ M↑ ⇒ D↓</td>
<td>D↓⇒ M↑ ⇒ D↓</td>
<td>Leftward shift in IS curve</td>
<td></td>
</tr>
<tr>
<td>If ∂M dy − ∂P dr &gt; 0</td>
<td>∂M dy − ∂P dr &gt; 0</td>
<td>∂M dy − ∂P dr &gt; 0</td>
<td>(4) Monetary Adjustment: Excess Supply of FC ⇒ M↑; if FC</td>
<td></td>
</tr>
<tr>
<td>∂M dy − ∂P dr &gt; 0</td>
<td>∂M dy − ∂P dr &gt; 0</td>
<td>∂M dy − ∂P dr &gt; 0</td>
<td>converted ⇒ M↑ ⇒ y↑, P↑, r↓</td>
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<tr>
<td>then surplus.</td>
<td>then at current E↓, an excess supply for FC</td>
<td>then at current E↓, an excess supply for FC</td>
<td>Rightward shift in LM curve</td>
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<tr>
<td>Notes: ** Assumes</td>
<td>Assumes</td>
<td>Assumes</td>
<td>Assumes</td>
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<tr>
<td>[Δ%Δ real exports%ΔP] &gt; 1; ** assumes</td>
<td>Δ%Δ real exports%ΔE↑ &gt; 1; *** assumes</td>
<td>the monetary and internal exchange rate adjustments impacts on P and y offset each other; **** assumes</td>
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