

NBER WORKING PAPER SERIES

**CAN CAPITAL CONTROLS ALTER THE
INFLATION-UNEMPLOYMENT TRADEOFF?**

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Working Paper No. 5239

**NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
August 1995**

This paper is part of NBER's research program in International Finance and Macroeconomics. Any opinions expressed are those of the authors and not those of the National Bureau of Economic Research.

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ABSTRACT

It is well-known that, in the Mundell-Fleming model, capital mobility creates a channel through which permanent (transitory) shocks to aggregate demand such as fiscal and trade shocks are completely (partially) neutralized by the response of the real exchange rate. An important policy implication of the model which went largely unnoticed is how the transmission of these shocks under different degrees of capital mobility may alter the inflation-unemployment tradeoff, i.e., the Phillips Curve. In the context of the stochastic Mundell-Fleming model, we show that capital controls reduce the output/employment variations at the expense of bigger variations in inflation rates. When the policy maker puts heavier weight on stable employment than on stable inflation, therefore, his/her objective can be attained more easily under capital controls.

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by

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August 15, 1995

It is well-known that, in the Mundell-Fleming model, capital mobility creates a channel through which permanent (transitory) shocks to aggregate demand such as fiscal and trade shocks are completely (partially) neutralized by the response of real exchange rate. An important policy implication of the model which went largely unnoticed is how the transmission of these shocks under different degrees of capital mobility may alter the inflation-unemployment tradeoff, i.e., the Phillips Curve. In the context of the stochastic Mundell-Fleming model, we try to fill this missing gap by comparing this tradeoff under perfect capital mobility and capital controls.

The organization of the paper is as follows. Section I lays out the model and provides the equilibrium solution under free capital mobility. Capital controls are introduced in Section II. Policy implications are discussed in Section III.

I. The Stochastic Mundell-Fleming Model Under Free Capital Mobility

The Mundell-Fleming model--the workhorse model of international macroeconomics (see Frenkel and Razin (1987))--has been cast in a stochastic rational-expectations framework in the early eighties (see, for example, Flood and Marion (1991)), and applied empirically, recently, by Clarida and Jordi (1994). Such a framework assumes a set of exogenous

stochastic processes (e.g., money supply) which drives the dynamics of the equilibrium system. Since economic agents are forward looking, each short term equilibrium is based on expectations about future shocks and the resulting future short term equilibria.

Let us begin with a description of the stochastic version of the Mundell-Fleming model. For simplicity, we express all variables in logarithmic forms (except for the interest rates) and assume all behavioral relations are linear in these log variables. This linear system (similar to the one in Clarida and Gali (1994)) can be viewed as an approximation to an original nonlinear system.

Aggregate demand in period t , y_t^d , specified as a function of an exogenous demand component, d_t , the real exchange rate, q_t , and the domestic real rate of interest, r_t , is given by

$$y_t^d = d_t + \eta q_t - \sigma r_t. \quad (1)$$

where η and σ are positive elasticities. As is usual, the real variables are derived from the following nominal variables: s_t , the spot exchange rate (the domestic value of foreign currency); p^* , the foreign price level; p_t , the domestic price level; and i_t , the domestic nominal rate of interest. More specifically, $q_t = s_t + p^* - p_t$ and $r_t = i_t - E_t(p_{t+1} - p_t)$. For simplicity, we assume the foreign price level, p^* , to be constant over time.

Aggregate demand is positively related to the exogenous demand shock, capturing external, fiscal expansion and other internal shocks. The real exchange rate affects positively aggregate demand by stimulating the traded sector (exportables and domestic production of importables). The real interest rate affects negatively aggregate demand by discouraging investment and consumption.

Money market equilibrium is specified as:

$$m_t^s - p_t = y_t - \lambda i_t, \quad (2)$$

where m_t^s is the money supply at time t , and $\lambda (> 0)$ the interest semi-elasticity of the demand for money. As usual, the domestic nominal rate of interest (i_t) has a negative effect on the demand for money, while domestic output (y_t) has a positive effect. To simplify matters, the output demand elasticity is assumed to be unity.

Price setting is based on a mix of auction markets and long term contract markets. The market clearing price in the auction market is p_t^e . The price in the long term contract market is set one period in advance according to expectations of the future market clearing price in that market, $E_{t-1}p_t^e$. Accordingly, the general price level in the domestic economy, p_t , is given by a weighted average of these two prices:

$$p_t = (1-\theta)E_{t-1}p_t^e + \theta p_t^e, \quad (3)$$

where $0 < \theta < 1$ is the share of the auction market in domestic output. The long term contract element is akin to Taylor (1981) and Fischer (1981). This introduces an element of price rigidity into the system.

Due to free capital mobility, interest parity prevails. Assuming risk neutrality, uncovered interest parity should hold. That is,

$$i_t = i^* + E_t(s_{t+1} - s_t), \quad (4)$$

where i^* is the world rate of interest, assumed for simplicity to be constant over time. Through costless arbitrage, the return on investing one unit of domestic currency in domestic security, i_t , is made equal to the expected value of the domestic currency return on investing

the same amount in foreign security, which yields a foreign currency return, i^* , plus an expected depreciation of domestic currency, $E_t(s_{t+1} - s_t)$.

The equilibrium system consists of the four equations (1)–(4) at each point in time. Observe that domestic output is demand-determined, as in all models with price rigidity.

The shock (or forcing stochastic) processes that drive the dynamics of the equilibrium system are:

$$y_t^s = g_y + y_{t-1}^s + \epsilon_{yt}, \quad (5a)$$

$$d_t = g_d + d_{t-1} + \epsilon_{dt}, \quad (5b)$$

$$m_t^s = g_m + m_{t-1}^s + \epsilon_{mt}, \quad (5c)$$

where g_y and g_m are the deterministic growth rates of output and money, and ϵ_{yt} , ϵ_{dt} , ϵ_{mt} are independently and identically distributed (i.i.d.) *supply*, *demand*, and *money* shocks, respectively, with zero means and constant variances.¹ Accordingly, our specification assumes that the system is bombarded by permanent shocks in a random walk fashion.²

I.1 Flex-Price Equilibrium

Since our stochastic framework is both forward and backward looking, a systematic procedure is required to obtain a solution. We thus apply a two-stage procedure for solving the equilibrium system (1)–(5). In the first stage, we solve for a flexible price equilibrium

¹To guarantee the existence of a long run (steady state) equilibrium for our system, the deterministic growth rates of output on both the supply and demand sides (g_y) are assumed to be identical.

²Transitory shocks are considered in Clarida and Gali(1994).

that corresponds to this system. In the second stage, we use the flex-price equilibrium to arrive at a full-fledged solution for the mixed fix-flex-price system.

Using superscript 'e' to denote flex-price equilibrium values, we can express the first stage solution in the following form.

$$y_t^e = y_t^s. \quad (6)$$

$$q_t^e = \frac{1}{\eta}(y_t^s - d_t + \sigma i^*). \quad (7)$$

$$p_t^e = m_t^s - y_t^s + \lambda(i^* + g_m - g_y). \quad (8)$$

$$\pi_t^e (\equiv E_t P_{t+1}^e - p_t^e) = g_m - g_y. \quad (9)$$

$$r_t^e = i^*. \quad (10)$$

$$i_t^e = i^* + g_m - g_y. \quad (11)$$

$$s_t^e = m_t^s + \left(\frac{1}{\eta} - 1\right)y_t^s - \frac{1}{\eta}d_t + \left(\frac{\sigma}{\eta} + \lambda\right)i^* - p^* + \lambda(g_m - g_y). \quad (12)$$

The flex-price equilibrium is economically intuitive. When prices are flexible and the supply of output is exogenous, output must be supply-determined, hence (6). With constant money demand elasticities, the expected rate of inflation (which turns out also to be the actual inflation rate) must be equal to the difference between money growth and output growth, hence (9). Since world prices are constant in the foreign country (hence, zero world inflation), the world real and nominal rates of interest must be equal to i^* . Under the assumption of free

capital mobility, the domestic real rate of interest must be equal to i^* as well, hence (10). From (9) and the Fisher equation linking the nominal rate of interest to the real rate and the expected rate of inflation, we can obtain the corresponding domestic nominal interest rate as (11). Using the domestic real interest rate expression in (10), the real exchange rate that equates output demand to the exogenous supply of output can be solved from the aggregate demand equation (1) to yield (7). Given the domestic nominal rate of interest (11) and output (6), the domestic price level which is consistent with money market equilibrium (2) can be expressed as in (8). Finally, we can derive the nominal exchange rate from (7) and (8) together with the definition of real exchange rate in terms the nominal exchange rate and domestic and foreign price levels, hence (12). The familiar effects of fiscal and monetary policies under capital mobility can easily be verified by considering changes in d_t and m_t^s .³

I.2 Full-fledged Equilibrium

Following our two-stage solution procedure, we can now use the flex-price equilibrium values obtained in the first stage to solve for the full-fledged equilibrium in this second stage.

The equilibrium, derived in Appendix A, is as follows.

³Consider an expansionary fiscal policy indicated by a positive $\Delta(d_t)$, where $\Delta(\cdot)$ is a difference operator. From (7) and (12), one can verify that the real and nominal exchange rates will appreciate, without any effects on output, prices, and interest rates. This is simply a restatement of the familiar result that, under a flexible exchange rate system with perfect capital mobility, fiscal policies are neutral. Consider next an expansionary monetary policy indicated by a positive $\Delta(m_t^s)$. From (8), the domestic price level will go up. From (12), the domestic nominal exchange rate will depreciate. Output, interest rates, and the domestic real exchange rate will not be affected. This is obviously consistent with the classical dichotomy between real and nominal magnitudes associated with monetary policy under flexible prices.

$$y_t = y_t^e + \left(\frac{\sigma + \eta}{\lambda + \sigma + \eta} \right) (1 + \lambda)(1 - \theta)(e_{mt} - e_{yt}). \quad (13)$$

$$q_t = q_t^e + \left(\frac{1}{\lambda + \sigma + \eta} \right) (1 + \lambda)(1 - \theta)(e_{mt} - e_{yt}). \quad (14)$$

$$p_t = p_t^e - (1 - \theta)(e_{mt} - e_{yt}). \quad (15)$$

$$\pi_t = \pi_t^e + (1 - \theta)(e_{mt} - e_{yt}). \quad (16)$$

$$r_t = r_t^e - \left(\frac{1}{\lambda + \sigma + \eta} \right) (1 + \lambda)(1 - \theta)(e_{mt} - e_{yt}). \quad (17)$$

$$i_t = i_t^e + \left(\frac{\sigma + \eta - 1}{\lambda + \sigma + \eta} \right) (1 - \theta)(e_{mt} - e_{yt}). \quad (18)$$

$$s_t = s_t^e - \left(\frac{\sigma + \eta - 1}{\lambda + \sigma + \eta} \right) (1 - \theta)(e_{mt} - e_{yt}). \quad (19)$$

In comparison with the flex-price equilibrium spelled out in the previous subsection, the full-fledged equilibrium contains an element of price rigidity. This is reflected in equation (15), which shows that a positive excess money shock generates a price increase which falls short of the market clearing price. With pre-set prices, the classical dichotomy no longer holds. Accordingly, in equation (13), one can observe that output responds to the innovation in the money supply in excess of the innovation in domestic output supply. The real exchange rate is positively affected, and the domestic real rate of interest negatively affected, by the difference in innovations. The magnitudes of these effects depend on the degree of price

flexibility, indicated by θ . Indeed, in the extreme case of complete price flexibility ($\theta = 1$), these real effects of monetary policy vanish completely--in line with the classical dichotomy.

Given free capital mobility and an exogenously determined world rate of interest, permanent demand shocks (such as fiscal or trade shocks) are fully offset by the response of the real exchange rate (see equation (7)), with no effect on output, interest rate, and prices. Accordingly, they do not affect deviations of the full-fledged equilibrium values of y_t , q_t , p_t , π_t , r_t , i_t , and s_t from their market-clearing values (see equations (13)-(19)). Other familiar features of the Mundell-Fleming model such as the real exchange rate-real interest rate relation⁴ and exchange rate overshooting⁵ can easily be verified by the interested reader.

I.3 The Phillips Curve

Denote excess output capacity, $y_t^e - y_t$, (which is directly related to the rate of unemployment) by u_t . Then we can obtain an expectations-augmented Phillips curve relation between the rate of inflation (π_t) and excess capacity (u_t) as follows:

⁴Substituting equation (17) into equation (14) yields a contemporaneous negative relation between the real exchange rate and the domestic real interest rate as follows:

$$q_t = q_t^e - (r_t - r_t^e).$$

This unambiguous prediction has been subject to a large body of empirical studies (see Campbell and Clarida (1987), Meese and Rogoff (1988), and Edison and Pauls (1993)), with mixed results.

⁵Applying the expectation operator as of period t to the system of equations (13)–(19) in periods $t+1$ and on reveals that the expected long run equilibrium values are equal to the flex-price solution. Equation (19) then shows that an excess money innovation will lead to exchange rate overshooting *a la* Dornbusch (1976) if the sum of demand elasticities ($\sigma + \eta$) falls short of unity.

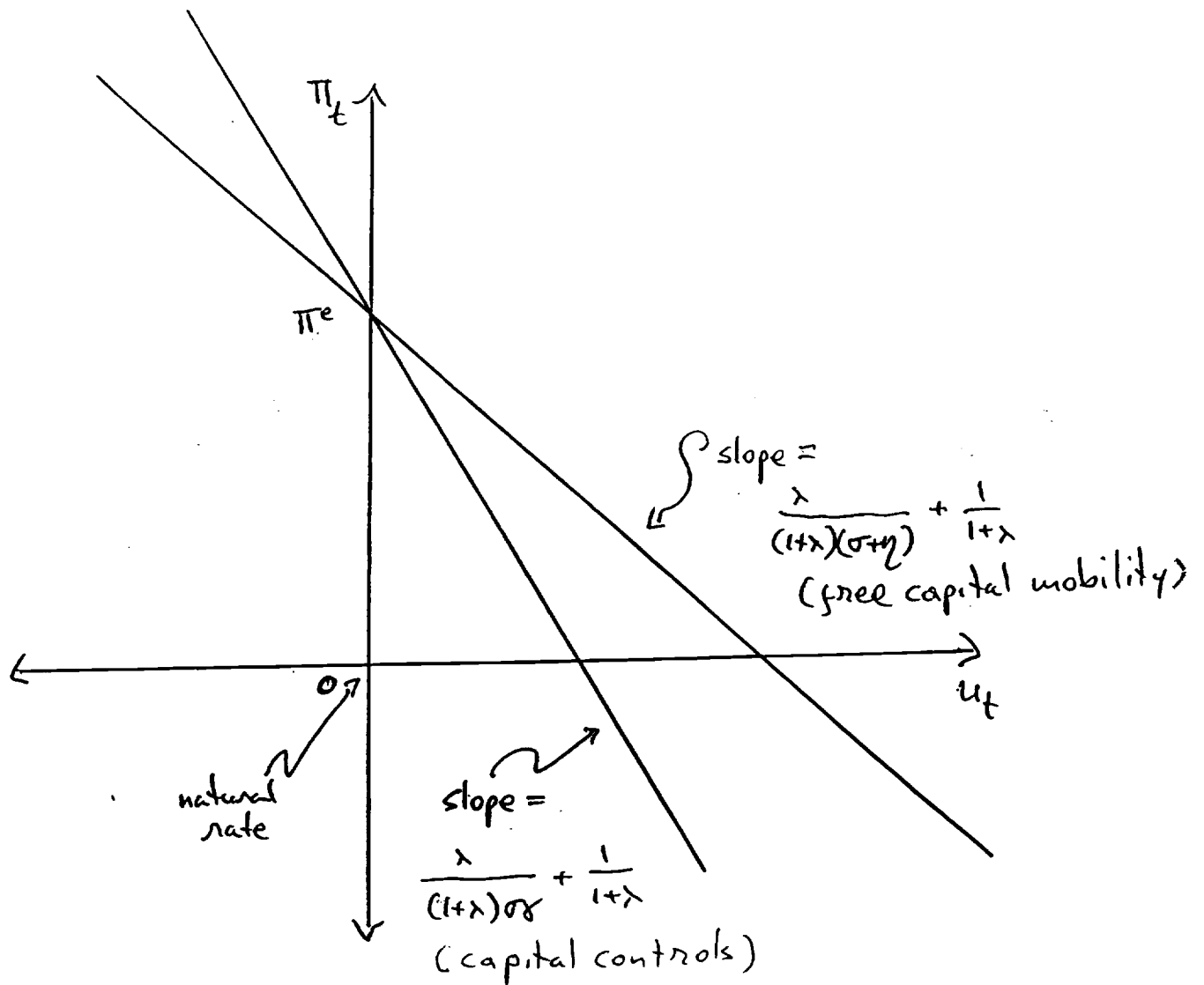


Figure 1 The Open-Economy Phillips Curves

$$\pi_t = \pi_t^e - \left(\frac{\lambda}{(1+\lambda)(\sigma+\eta)} + \frac{1}{1+\lambda} \right) u_t. \quad (20)$$

The flatter line in Figure 1 portrays the open-economy Phillips curve under free capital mobility. Equation (20) shows that the Phillips curve is flatter when the aggregate demand elasticities η (with respect to the real exchange rate) and σ (with respect to the domestic real rate of interest) are larger. The effect of the interest semi-elasticity of money demand (λ) on the slope of the Phillips curve is, however, ambiguous, depending on whether $\sigma+\eta$ exceeds or falls short of unity. The source of this ambiguity is derived from the more fundamental ambiguous effects of excess money-output innovations on the domestic nominal interest rate (18) and spot exchange rates (19).

II. Capital Controls

Let us now consider the extreme case where capital flows are completely restricted. In this case, the interest parity (4) will no longer hold, and trade balance will be equilibrated fully by the market clearing exchange rate.

The final form of the aggregate demand equation (1), derived from the structural equation, will have to be modified. We can write the original structural equation as:

$$y_t^d = (\tilde{d}_t^A + A_y y_t^d + A_r r_t) + (d_t^X + X_y y_t^d + X_q q_t). \quad (21)$$

where the first parenthetical expression refers to domestic absorption (A), and the second to net trade balance (X). The autonomous component of absorption is denoted by \tilde{d}_t^A , the income elasticity of absorption by A_y (> 0), and interest elasticity of absorption by A_r (< 0). Similarly, d_t^X denotes the autonomous component of trade balance, X_y (< 0) the income

elasticity of trade balance, and $X_q (> 0)$ the real exchange rate elasticity of trade balance. To arrive at the final form (1), we simply solve for y_t^d as a function of r_t and q_t . Define the sum of marginal propensities to save and import, $1 - A_y - X_y$, as α . Notice that $d_t = (\bar{a}_t^A + d_t^X)/\alpha$, $\eta = X_q/\alpha > 0$, and $\sigma = -A_r/\alpha > 0$.

In the presence of full capital controls, the net trade balance (X) is zero. Hence, $d_t^X + X_y y_t^d + X_q q_t = 0$, which can be rewritten as

$$d_t^X - \mu y_t^d + \alpha \eta q_t = 0, \quad (1)'$$

where $\mu = -X_y$ and $\alpha \eta = X_q$. Substituting this into the structural equation (21) for aggregate demand, we can modify the final form as

$$y_t^d = d_t^A - \sigma \gamma r_t, \quad (1)''$$

where $d_t^A = \bar{a}_t^A/(1 - A_y)$ and $\gamma = (1 - A_y - X_y)/(1 - A_y) < 1$. As an analogue to (5b), we specify the stochastic process for d_t^A as

$$d_t^A = g_y + d_{t-1}^A + \epsilon_{dt}^A, \quad (5b)'$$

where ϵ_{dt}^A is assumed to have similar properties as ϵ_{dt} .

We lay out the solutions for the flex-price and full-fledged equilibria in Appendix B. Here, we focus on the effect of capital controls on output y_t and the inflation rate π_t . The full-fledged equilibrium output and inflation are given respectively by

$$y_t = y_t^e + \left(\frac{\sigma \gamma}{\lambda + \sigma \gamma} \right) (1 + \lambda)(1 - \theta) \left[\epsilon_{mt} - \left(\frac{\lambda + \sigma \gamma}{\sigma \gamma} \right) \epsilon_{yt} + \left(\frac{\lambda}{\sigma \gamma} \right) \epsilon_{dt}^A \right]. \quad (13)'$$

where $y_t^e = y_t^s$.

$$\pi_t = \pi_t^e + (1-\theta) \left[\epsilon_{mt} - \left(\frac{\lambda + \sigma\gamma}{\sigma\gamma} \right) \epsilon_{yt} + \left(\frac{\lambda}{\sigma\gamma} \right) \epsilon_{dt}^A \right]. \quad (16)'$$

where $\pi_t^e = g_m - g_y$.

Comparing the equilibrium values for the capital controls case with those under free capital flows, we can highlight a crucial difference. Under capital controls, the demand shock ϵ_{dt}^A has a positive effect on y_t and π_t through its negative effect on the domestic real rate of interest r_t . In contrast, it has no such effect in the case of free capital flows since the real interest rate there is nailed down by the world rate of interest. The effects of monetary and supply shocks can be discerned by inspecting the same equations.⁶

The Phillips Curve Under Capital Controls

Substituting equation (13)' into equation (16)' and defining $u_t = -(y_t - y_t^e)$ as before, we can express the Phillips curve under capital controls as follows:

$$\pi_t = \pi_t^e - \left(\frac{\lambda}{(1+\lambda)\sigma\gamma} + \frac{1}{1+\lambda} \right) u_t. \quad (20)'$$

The steeper line in Figure 1 portrays the Phillips curve under capital controls. In other words, fluctuations in inflation rates will be associated with smaller variations in unemployment.

The intuition behind the steeper slope has to do with the impact effect of capital controls on aggregate demand. Comparing the aggregate demand functions under capital controls (1)" and under free capital mobility (1), we observe that in the former case the interest semi-

⁶Since $\sigma\gamma/(\lambda + \sigma\gamma) < (\sigma + \eta)/(\lambda + \sigma + \eta) < 1$, the monetary shock ϵ_{mt} has a smaller effect on $y_t - y_t^e$ (through a stronger negative effect on r_t) under capital controls while the supply shock ϵ_{yt} will have a bigger negative effect on $y_t - y_t^e$. As far as the effects on $\pi_t - \pi_t^e$ is concerned, the monetary shocks work the same way under both capital mobility and capital controls while the supply shocks have more pronounced negative effects under capital controls.

elasticity becomes smaller ($\sigma\gamma < \sigma$ since $\gamma = 1 - X_y/(1 - A_y) < 1$) and the real exchange rate effect disappears ($0 < \eta$) from the reduced form equation for aggregate demand due to the zero net trade balance restriction under capital controls.

On the other hand, capital controls do not alter the mechanisms underlying the determination of prices (i.e., the price setting equation (3) and the money market equation (2)). Combined with the structural change in aggregate demand, restrictions on capital flows will generate less variations in unemployment rates (excess output capacity) at the expense of more variations in inflation rates.

Indeed, a comparison between equations (20) and (20)' reveals that the difference in the slopes of the Phillips curve under free capital mobility and capital controls depends solely on the aggregate demand parameters $\sigma + \eta$ versus $\sigma\gamma$, and not on the money market parameter λ and the price setting parameter θ .

Naturally, the natural rate of unemployment (= 0 in our case) and the expected rate of inflation (π^e) are unaffected by structural changes such as capital controls. This is reflected by the intersection of the two Phillips curves at the point $(0, \pi^e)$. While the various shocks will move economy away from this point along the respective Phillips curve (depending on the capital mobility regime), changes in the expected rate of inflation due to permanent changes in the relative money-output growth rates ($g_m - g_y$) will shift the Phillips curve around.

III. Policy Implications

There exist three types of gains from trade: trade of goods/services for goods/services; trade of goods/services for assets (intertemporal trade); and trade of assets for assets (for diversification of risk). Evidently, capital controls limit the potential gains from the last two

types. However, there are second-best and other suboptimal (due to, say, non-market-clearing) situations where capital controls can improve efficiency.

When, for example, taxation of foreign-source income from capital is not enforceable, it proves efficient to 'trap' capital within national borders so as to broaden the tax base and to alleviate other tax distortions (see Razin and Sadka (1991)).

This paper introduces another argument in favour of constraints on capital mobility. We show that capital controls alter the inflation-unemployment tradeoffs. In particular, output/employment variations are reduced at the expense of bigger variations in inflation rates. When the policy maker puts heavier weight on stable employment than on stable inflation, his/her objective can be attained more easily under capital controls.

Appendix A: Derivation of the Full-fledged Equilibrium Solution

This appendix derives the solution for the full-fledged equilibrium (13)–(19), taking as given the flex-price equilibrium.

1. Derivation of p_t (15)

To get the solution for the domestic price level (15), we simply substitute (5c) and (8) into (3).

2. Derivation of q_t (14)

Substituting (4) and (7) into (1), using the definitions of real exchange rate $q_t = s_t + p^* - p_t$ and real interest rate $r_t = i_t - E_t(p_{t+1} - p_t)$, and subtracting $(\lambda + \sigma)E_t q_{t+1}^e$ and adding $(\lambda + \sigma)q_t^e$, we get

$$\eta(q_t - q_t^e) = (\lambda + \sigma)[E_t(q_{t+1} - q_{t+1}^e) - (q_t - q_t^e)] + (1 + \lambda)(1 - \theta)(e_{mt} - e_{yt}). \quad (\text{A.1})$$

Observe, from (5a), (5b), and (7) and the properties of ϵ_{yt+1} and ϵ_{dt+1} , that $E_t q_{t+1}^e = q_t^e$.

We guess a solution of the form $q_t = q_t^e + \kappa(\epsilon_{mt} - \epsilon_{yt})$ and apply it to (A2.1).

$$\eta\kappa(e_{mt} - e_{yt}) = (\lambda + \sigma)E_t[\kappa(e_{m_{t+1}} - e_{y_{t+1}}) - \kappa(e_{mt} - e_{yt})] + (1 + \lambda)(1 - \theta)(e_{mt} - e_{yt}).$$

Since $E_t(\epsilon_{m_{t+1}} - \epsilon_{y_{t+1}}) = 0$, we can obtain $\kappa = (1 + \lambda)(1 - \theta)/(\lambda + \sigma + \eta)$ from the above equation. This value of κ in our guess solution yields the solution for the real exchange rate (14).

3. *Derivation of y_t (13) and i_t (18)*

Substituting the solutions for p_t and q_t from (15) and (14) just derived above into the aggregate demand equation (1) while using the interest parity (4) yields the solutions for y_t (13) and i_t (18).

4. *Derivation of π_t (16)*

Applying the definition of the expected rate of inflation, $\pi_t = E_t(p_{t+1} - p_t)$, to (4.15) derived in step 1 and (9) yields the solution for the inflation rate (16).

5. *Derivation of r_t (17)*

Using i_t derived in step 3 and π_t in step 4 and the Fisher equation yields the solution for the domestic real rate of interest r_t .

6. *Derivation of s_t (19)*

Using the solutions for p_t derived in step 1 and q_t in step 2 and applying them to the definition of the real exchange rate $q_t = s_t + p^* - p_t$ yields a solution for the nominal exchange rate s_t .

Appendix B: Solutions for the Capital Controls Model

This appendix provides the solution to (1)', (1)", (2) and (3), subject to the stochastic processes (5) and (5b)'. The flex-price equilibrium conditions are

$$y_t^e = y_t^s. \quad (\text{B.1})$$

$$q_t^e = \frac{1}{\alpha\eta}(\mu y_t^s - d_t^X). \quad (\text{B.2})$$

$$p_t^e = \lambda \left[\frac{1}{\sigma\gamma}(d_t^A - y_t^s) + g_m - g_y \right] + m_t^s - y_t^s. \quad (\text{B.3})$$

$$\pi_t^e = g_m - g_y. \quad (\text{B.4})$$

$$r_t^e = \frac{1}{\sigma\gamma}(d_t^A - y_t^s). \quad (\text{B.5})$$

$$i_t^e = \frac{1}{\sigma\gamma}(d_t^A - y_t^s) + g_m - g_y. \quad (\text{B.6})$$

$$s_t^e = m_t^s + \left(\frac{\mu}{\alpha\eta} - \frac{\lambda + \sigma\gamma}{\sigma\gamma} \right) y_t^s - \left(\frac{1}{\alpha\eta} d_t^X - \frac{\lambda}{\sigma\gamma} d_t^A \right) - p^* + \lambda(g_m - g_y). \quad (\text{B.7})$$

To solve the full-fledged equilibrium, we use the flex-price solution to obtain the equilibrium price p_t and inflation rate π_t . We then use the Fisher equation along with the aggregate demand and money market equilibrium equations (1)" and (2) to get the solutions for the real interest rate r_t and output y_t simultaneously. From the trade balance equation (1)', we can calculate the real exchange rate q_t . The nominal interest rate i_t and the nominal

exchange rate s_t are then derived from the Fisher equation and the definition of the real exchange rate respectively. Below, we lay out the solution for the full-fledged equilibrium.

$$y_t = y_t^e + \left(\frac{\sigma\gamma}{\lambda + \sigma\gamma} \right) (1 + \lambda)(1 - \theta) \left[e_{mt} - \left(\frac{\lambda + \sigma\gamma}{\sigma\gamma} \right) e_{yt} + \left(\frac{\lambda}{\sigma\gamma} \right) e_{dt}^A \right]. \quad (\text{B.8})$$

$$q_t = q_t^e + \left(\frac{\mu}{\alpha\eta} \right) \left(\frac{\sigma\gamma}{\lambda + \sigma\gamma} \right) (1 + \lambda)(1 - \theta) \left[e_{mt} - \left(\frac{\lambda + \sigma\gamma}{\sigma\gamma} \right) e_{yt} + \left(\frac{\lambda}{\sigma\gamma} \right) e_{dt}^A \right]. \quad (\text{B.9})$$

$$p_t = p_t^e - (1 - \theta) \left[e_{mt} - \left(\frac{\lambda + \sigma\gamma}{\sigma\gamma} \right) e_{yt} + \left(\frac{\lambda}{\sigma\gamma} \right) e_{dt}^A \right]. \quad (\text{B.10})$$

$$\pi_t = \pi_t^e + (1 - \theta) \left[e_{mt} - \left(\frac{\lambda + \sigma\gamma}{\sigma\gamma} \right) e_{yt} + \left(\frac{\lambda}{\sigma\gamma} \right) e_{dt}^A \right]. \quad (\text{B.11})$$

$$r_t = r_t^e - \left(\frac{1}{\lambda + \sigma\gamma} \right) (1 + \lambda)(1 - \theta) \left[e_{mt} - \left(\frac{\lambda + \sigma\gamma}{\sigma\gamma} \right) e_{yt} + \left(\frac{\lambda}{\sigma\gamma} \right) e_{dt}^A \right]. \quad (\text{B.12})$$

$$i_t = i_t^e + \left(\frac{\lambda(1 - \sigma\gamma)}{\lambda + \sigma\gamma} \right) (1 - \theta) \left[e_{mt} - \left(\frac{\lambda + \sigma\gamma}{\sigma\gamma} \right) e_{yt} + \left(\frac{\lambda}{\sigma\gamma} \right) e_{dt}^A \right]. \quad (\text{B.13})$$

$$s_t = s_t^e + \left[\left(\frac{\mu}{\alpha\eta} \right) \left(\frac{\sigma\gamma}{\lambda + \sigma\gamma} \right) (1 + \lambda) - 1 \right] (1 - \theta) \left[e_{mt} - \left(\frac{\lambda + \sigma\gamma}{\sigma\gamma} \right) e_{yt} + \left(\frac{\lambda}{\sigma\gamma} \right) e_{dt}^A \right]. \quad (\text{B.14})$$

Comparing the full-fledged equilibrium under capital controls (B.8)-(B.14) with the corresponding equilibrium under free capital flows (13)-(19), we can assess the significant role that capital mobility plays in the Mundell-Fleming model.

References

- Campbell, John Y., and Clarida, Richard H. 1987. The Term Structure of Euromarket Interest Rates: An Empirical Investigation. Journal of Monetary Economics 19 (January): 25-44.
- Clarida, Richard H., and Gali, Jodi. 1994. Sources of Exchange Rate Fluctuations, Carnegie-Rochester Conference Series on Public Policy 41 (December): 1-56.
- Dornbusch, Rudiger. 1976. Expectations and Exchange Rate Dynamics, Journal of Political Economy 84 (December): 1161-1176.
- Edison, Hali J., and Pauls, B. Dianne. 1993. A Re-assessment of the Relationship between Real Exchange Rates and Real Interest Rates: 1974-90, Journal of Monetary Economics 31 (April): 165-87.
- Flood, Robert, and Nancy P. Marion. 1982. The Transmission of Disturbances Under Alternative Exchange-Rate Regimes With Optimal Indexing, Quarterly Journal of Economics 67 (February): 43-66.
- Frenkel, Jacob, and Assaf Razin. 1987. Fiscal Policies and the World Economy, MIT Press.
- Meese, Richard A. and Rogoff, Kenneth. 1988. Was It Real? The Exchange Rate-Interest Differential Relation over the Modern Floating Rate Period. Journal of Finance 43 (September): 933-48.
- Razin, Assaf, and Efraim Sadka. 1991. Efficient Investment Incentives In The Presence of Capital Flight, Journal of International Economics 31: 171-181.