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The Mundellian Trilemma and Optimal Monetary Policy in a World of High Capital Mobility

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Abstract

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Keywords

Mundellian Trilemma, policy independence, capital mobility, instrument shortage, capital Controls

JEL Classification

E3, E5, F3

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1. INTRODUCTION

The Dollar Is Our Currency but Your Problem

John Connally, 1971

Then U.S. Treasury Secretary Connally's statement came shortly before the demise of the Bretton Woods System of pegged exchange rates. The move to floating exchange rates was expected to eliminate or at least alleviate the "Problem" faced especially by European central banks that were coping with large inflows of U.S. dollars corresponding to large U.S. Balance of Payments deficits. According to the influential Mundell-Fleming analysis, an independent monetary policy was feasible only for these central banks under flexible exchange rates given the already high degree of capital mobility ; this was the so-called "impossible trinity" or in today's terminology the "Mundellian Trilemma". Floating exchange rates lived up to expectations in allowing major European central banks to adopt independent monetary policy strategies. Freed of the obligation to intervene in the currency market to maintain a fixed DM/$ parity, the German Bundesbank established a regime of monetary targeting. In terms of broader outcomes, flexible exchange rates fell short of expectations. As Jürgen von Hagen (1993) observed, following two decades of floating rates:

"*When the international monetary system of Bretton Woods broke down in the early 1970s, many economists expected flexible exchange rates would insulate the national economies from monetary and business conditions in other countries. Domestic monetary policy would gain its full autonomy and independence from other countries and could pursue its own goals. Yet it soon turned out that the new exchange rate regime did not eliminate the correlation of monetary fluctuations and business cycles across countries.*"

The move to flexible exchanges rate allowed for central banks to control their instruments and proximate target variables such as policy rates and the monetary base but did not provide for insulation or autonomy of financial markets or institutions.[1]

A half century later, there is a renewed interest in the policy analysis of Robert Mundell (1961), (1968) and J. Marcus Fleming (1962). The concern of much of the recent literature again centers on the Mundellian Trilemma. A particular question is whether there is a financial cycle driven in part, some believe in large part, by monetary policy actions by the U.S. Federal Reserve. Is the U.S. dollar still a central problem for other countries? The Mundellian Trilemma refers most directly to the limitations of monetary policy under a fixed exchange rate. The relevance of the trilemma to the question of an international financial cycle today is instead to the question of the limitations of a regime of flexible exchange rates.

[1] Sceptics like Dunn (1983) questioned whether central banks ever embraced freely floating exchange rates. In his view, fear of the cost of highly variable real exchange rates induced central banks to manage exchange rates to a considerable extent. Later in the 1980s following the Plaza Accord in October 1985 and Louvre Accord in February 1987, the G-5 central banks engaged in co-ordinated foreign exchange market intervention to dampen fluctuations in the value of the U.S. dollar, further deviating from exchange rate flexibility.

Rey ((2013), (2016)) sees the existence of a global financial cycle as a challenge to the validity of the Mundellian Trilemma. She reaches this conclusion because there is "evidence that U.S. monetary policy shocks are transmitted internationally and affect financial conditions even in inflation targeting countries with large financial markets. Hence flexible exchange rates are not enough to guarantee monetary autonomy in a world of large capital flows" (2016, Abstract). The Trilemma has morphed into a dilemma. Davis and Presno (2017) and Klein and Shambaugh (2015) also interpret an effect of the U.S (or other base country) interest rate on the interest rate in a small open economy as "at odds with a basic interpretation of the trilemma," (Klein and Shambaugh (p.49). Davis and Presno interpret the trilemma as stating that "a country with a floating currency should have complete monetary autonomy (p.116)."[2]

Rey (2016) also believes that the "[t]rilemma misleads by assuming that domestic monetary and financial conditions shaping the macroeconomic situation of a country can be conveniently summarized by one single variable, the short-term interest rate." (p. 7). Mundell's and Fleming's analysis half a century ago was conducted in a simple open economy Keynesian model that contained a single interest bearing asset category. Modern DSGE models include only one interest rate for a different reason; these models rely on the assumption of complete Arrow-Debreu markets which makes elaboration of financial structure unnecessary. In Rey's view both approaches fall short in not allowing for financial frictions.

An understanding of the meaning of the Mundellian Trilemma affects the interpretation of empirical findings with respect to the transmission of financial disturbances including policy shocks from the U.S. and other major central banks. For example, Davis and Presno (2017) find that in a Taylor rule estimated for a sample of small open economies, even for those with flexible exchange rates, the coefficient on the foreign interest rate is positive and statistically significant. They interpret this finding as inconsistent with the Mundellian Trilemma. Kalemli-Ozcan (2019) finds that the "assumption that monetary policy will be 'on hold' for countries with floating exchange rate regimes when the center country's monetary policy changes to be at odds with the facts." Her empirical results indicate that instead the small country's policy rate will move in the same direction as the center countries rate but less than one-for-one. Aizenman, Chinn and Ito (2013) construct an index of monetary policy independence where independence depends inversely on the correlation of a country's short-term interest rate with the policy interest rate in the base country—the country to which an open economy's financial system is most closely related[3]. How is the index related to monetary policy independence as the ability for a central bank to choose the level of its policy rate optimally or as a measure of interdependent optimal policies in a highly integrated global economy?

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[2] A clear statement about terminology is useful at the start. By monetary policy independence we mean that a central bank has unimpeded control of its instruments and proximate targets. Insulation of the financial sector is taken to mean that financial markets are shielded from world financial shocks and policy shocks originating in the United States and other major industrial countries. We avoid the terms: monetary independence or autonomy; "monetary" in this context is ambiguous. It is not clear whether these terms refer to central bank actions or to a broader context including banking and credit markets.

[3] Aizenman, Chinn and Ito (2020) estimate this correlation controlling for world economic conditions. They also examine how this measure of policy independence is affected by the implementation of macroprudential policies in the *peripheral* countries—an additional issue in the recent literature on the Trilemma.

The interpretation of the Mundellian Trilemma also impinges on the case for capital controls and macroprudential policies to supplement conventional monetary policy tools. Farhi and Werning (2014), based on the trilemma, argue that, in contrast to the situation with a fixed exchange rate, "with a flexible exchange rate, monetary policy is already independent and there is no prima facie case for restricting international capital mobility. (p.202)." Citing Rey (2013), however, they claim that because the trilemma has morphed into a dilemma—meaning that an independent monetary policy and open capital account are incompatible—there is a role for capital controls even if the exchange rate is flexible. Farhi and Werning follow Rey (2013: p.287) who states that *"independent monetary policies are possible if and only if the capital account is managed, directly or indirectly by macroprudential policies (*author's italics). If macroprudential policies are not sufficient then capital controls must be considered." What is meant here by "independent"? --central bank independence to set its policy rate or some broader concept of insulation of financial markets?

Aizenman (2019, p. 444) believes that "[a] modern incarnation of the trilemma is essential for understanding the evolving financial architecture and for coming up with ways to mitigate financial fragility." In Aizenman's view "Mundell's trilemma does not argue that even with flexible exchange rates countries can insulate themselves from global shocks propagated by large countries (p.451)." The key insight of the trilemma is to point out the scarcity of policy instrument in a small open economy faced with such global shocks. Bernanke (2017) also does not see the existence of a world financial cycle as invalidating the basic Mundellian Trilemma. A floating exchange rate regime affords a central bank the ability to use the standard policy instrument to maximum effect to stabilize the economy. The scarcity of policy instruments though may warrant use of macroprudential policy or outright capital controls to contain spill-over effects caused by US policy shifts.

A trilemma refers a situation in which several options are not mutually feasible. Differences in the interpretation of the Mundellian Trilemma in the context of the transmission of financial disturbances concern not the impossible trinity but the feasible set under a flexible exchange rate. The goal in what follows is to clarify the meaning of the Mundellian Trilemma and assess its implications for monetary policies in a world of high capital mobility. To do this we evaluate the trilemma from the standpoint of the literature on optimal monetary policy. In that literature a policymaker is assumed to minimize a loss function within the context of a particular model. The equations of the model form the constraints on the policymaker's behavior. The specification of an open- economy model depends critically on the assumption made as to how the exchange rate is determined as well as the degree of capital mobility. Following this approach, we can give content to statements about "the theory of the trilemma". Then we can assess whether and in what way the "Mundellian Trilemma" is essential for an understanding of the international transmission mechanism of financial disturbances and U.S. monetary policy actions. We start with Mundell's and Fleming's original analysis within an open-economy Keynesian model of the 1960s in Section 2 and move on to a consideration of the trilemma in modern New Keynesian models in Section 3. In Section 4 we illuminate further aspects of optimal stabilization policies and the trilemma. Here the focus is on the advantages rather than the limitations of a regime of flexible exchange rates. A model acknowledging the role of credit and cross-border capital flows is introduced in Section 5. It serves as the framework for a discussion of feasible combinations of monetary and macroprudential policies to address macroeconomic and financial stability concerns. A summary of our findings and concluding comments appears in Section 6.

2. MUNDELL'S and FLEMING'S POLICY ANALYSIS

Mundell and Fleming carried out their analysis within an open-economy version of the Keynesian *IS-LM* model. The model in this section is a version of that model simplified to consider the issues set out in the introduction.

A Simple Mundell-Fleming Model

This version of the Mundell-Fleming model consists of two equations: the standard open-economy *IS* relation and the uncovered interest parity (*UIP*) condition which assumes perfect capital mobility up to risk premia (ε and *VIX*).[4]

$$y_t = a_0 - a_1 r_t + a_2 q_t + a_3 g_t + a_4 y_t^f + v_t \qquad (2.1)$$

$$r_t = r_t^f + E_t q_{t+1} - q_t + \varepsilon_t + VIX_t \qquad (2.2)$$

Where: y is output; r is the domestic interest rate; r^f is the foreign (U.S. or other center country) interest rate; g is a measure of fiscal policy; y^f is foreign income; v is a white noise shock to output demand; q is the nominal exchange rate expressed as units of the domestic currency per unit of the foreign currency: Eq_{+1} is the expectation of *q* one period ahead: *VIX* is a world risk shock and ε is a white noise shock reflecting domestic disturbances to *UIP.*

All variables are natural logarithms except interest rates. Both the domestic and foreign price level are assumed to be fixed. The expectation of the exchange rate one period ahead will be taken as zero, and this term will be omitted from this point.

The policymaker's loss function is assumed to be

$$L_t = \frac{1}{2} y_t^2 \qquad (2.3)$$

Equations (2.1) and (2.2) are sufficient to analyze policy if the interest rate is taken to be the policy instrument. Mundell (1961) made this assumption. When considering the case of perfect capital mobility and a fixed exchange rate he found it necessary to instead define monetary policy as an open market purchase or sale of government securities. As he explains, "monetary policy cannot in any meaningful sense be defined as an alteration in the interest rate when capital is perfectly mobile because the authorities cannot change the interest rate. Nor can monetary policy be defined, under

[4] In the original non-stochastic Mundell-Fleming model exchange rate expectations are static so that equation (2.2) reduces to $r_t = r_t^f$. Dornbusch (1976, 1980) introduces an arbitrage condition, essentially a form of the UIP equation, where a difference between the domestic and foreign interest rate is matched by a requisite expected exchange rate adjustment. See also Sohmen (1969, p. 114, fn. 29)

conditions of perfect capital mobility, as an increase in the money supply since the central bank has no power over the money supply either… when the exchange rate is fixed (Mundell (1968; p.258).”

If monetary policy is defined as open market purchases and sales, or, in cases where feasible, as control of the money supply, then then money market equilibrium (*LM*) equation must be brought in explicitly.

$$M_t = m(r_t)MB_t = b_0 + b_1 y_t - b_2 r_t + \eta_t \qquad (2.4)$$

The money supply (*M*) is equal to the money multiplier (*m*), which depends positively on the interest rate, times the monetary base (*MB*). The monetary base consists of the central bank’s holdings of domestic bonds (*D*) plus foreign reserves (*F*). The demand for money depends on output, the nominal interest rate and a white noise shock (η).

The Trilemma in the Simple Mundell-Fleming Model

If the exchange rate is fixed, the *UIP* condition determines the domestic interest rate given the foreign interest rate, value of the fixed rate, and the risk premia. If the interest rate is the policy instrument there is no scope for an independent monetary policy. If monetary policy is instead taken to be control of the money supply the result is the same. The *UIP* condition fixes the domestic interest rate. An open market purchase, for example, will put downward pressure on the interest rate, but that will cause a fall in the foreign reserve component of the base. In the new equilibrium the monetary base and hence the money supply will be unchanged (D will rise but F will fall).

The Effect of a Change in the Foreign Interest Rate

Rey ((2013), (2016)), Davis and Presno (2017), and Klein and Shambaugh (2015) all express the view that a positive response of the policy rate in the small country to the U.S. policy rate, for example, is inconsistent with the Mundellian trilemma.

To begin, assume that the interest rate is the operating target. Consider the effect of a reduction in the U.S. interest rate (r^f)[5]. Because the exchange rate is flexible, the domestic interest rate is not pinned down by the UIP condition. The trilemma implies that a small open economy can follow an independent monetary policy. Monetary policy could be “on hold”, the assumption referred to by Kalemli-Ozkan (2019). In this case uncovered interest parity would be maintained solely by an appreciation of the small country’s exchange rate. The small country would not, however, be insulated from the U.S. policy change. The expansionary U.S. monetary policy would be a “beggar thy neighbor” policy and prompt a decrease in output if there is no policy response, as pointed out by Mundell (1968, p. 269)[6]. Alternatively, the central bank in the small country could choose an optimal interest rate (r^*) to stabilize output. This implies

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[5] From this point on, for simplicity of exposition, we will refer to r^f as the U.S. policy rate.

[6] See also Dornbusch (1980; pp. 201-202). Both Mundell and Dornbusch reach this conclusion from analysis within a two-country version of the Mundell-Fleming framework. Sohmen (1969) objects to this characterization of “beggar-thy-neighbor” pointing out that in a system with flexible rates policymakers in the small country “are

$$\frac{dr_t^*}{dr_t^f} = \frac{a_2}{a_1 + a_2} > 0 \qquad (2.5)$$

The central bank lowers the interest rate to counteract the contractionary effect of an appreciation in the exchange rate. The small country's rate will move in the same direction as the U.S. rate but less than one-for one. This is the empirical finding of Kalemli-Ozcan (2019) and other studies cited in the Introduction. It is consistent with the trilemma.

To maintain equilibrium (equation 2.4) in the money market at the lower domestic interest rate, the central bank would have to carry out open market purchases (increases in D) to increase the money supply by

$$-b_2 \frac{a_2}{a_1 + a_2} dr_t^* > 0 \qquad \text{with } dr^* < 0. \quad (2.6)$$

If the central bank was using the money supply as its operating target, the case considered by Fleming (1962) and Mundell (1968), output will fall if no policy action is taken in response to a fall in the U.S. interest rate. A flexible exchange rate will not insulate the small economy from the change in policy in the U.S. The change in the optimal setting for the money supply is

$$-\frac{dM_t^*}{dr_t^f} = b_2 \frac{a_2}{a_1 + a_2} > 0 \qquad (2.7)$$

The optimal policy will increase the money supply by the same amount that it would increase endogenously if the interest rate was the operating target[7]

An analysis of the effects of a world risk (*VIX*) shock would yield results analogous to those for a change in the U.S. interest rate. A flexible exchange rate would not insulate the small open economy from the effect of the shock. A flexible exchange rate would allow the central bank in the small open economy to follow an independent monetary policy. If the interest rate is the operating target, for example, an appropriate adjustment in the rate can offset the effect on output from the world risk shock.

Mundell's and Fleming's original analysis is consistent with an interpretation of the trilemma as implying that a flexible exchange rate allows for an independent monetary policy defined as *control* of the domestic interest rate or money supply. Their analysis does not imply *insulation* of a small open economy from changes in U.S. monetary policy or world risk shocks. In the simple Mundell-Fleming model this independence of monetary policy allows the central bank to achieve it domestic stabilization goal. That will not be the case in more complex models and is not an implication of the trilemma.

Financial Structure in the Mundell Fleming Model

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always perfectly free to adopt whatever expansionary policies they consider appropriate—in contrast with a system of fixed rates, in which their freedom of action may be seriously impaired" (p.214).

[7] This equivalence is consistent with the finding in Friedman (1975).

Rey (2016) claims that the trilemma "misleads by assuming that monetary and financial conditions in an economy can be summarized by a single short-term interest rate." She points to a shortcoming of mainstream monetary policies models in the early years of the 21st century. Understanding how this situation came to be is important to understanding the task of integrating financial markets and institutions into current monetary policy models.

The Mundell-Fleming model was an open- economy version of the Keynesian *IS-LM* model. As such it contained only two assets, one of which was interest bearing. This assumed that all long-term assets were perfect substitutes and lumped together as "bonds." If the interest rate was not the long-term rate, Keynes's speculative demand for money made no sense nor did Tobin's demand for money as behavior toward risk[8]. For the open economy, Mundell (1968, p. 251) states that "The assumption of perfect capital mobility can be taken to mean that all securities in the system are perfect substitutes." Keynes's assumption for domestic securities is extended to securities in all currencies. Unlike many models in the early 21st century the interest rate was not a short-term rate such as the U.S. federal funds rate or other policy rate.

Still, this financial structure was inadequate. As Mundell and Fleming were writing, Keynesian and monetarist economists were working to improve the financial sectors of monetary policy models. Some important examples of this research agenda are: Tobin (1969), (1982), Gurley and Shaw (1960), deLeeuw and Gramlich (1969), Brunner and Meltzer (1972) and Ando and Modigliani (1969). In the open-economy context, the portfolio-balance approach developed by Black (1973), Branson and Henderson (1985) among others expanded the asset structure of the Mundell-Fleming model. As part of this research program, additional channels for the transmission of monetary policy effects were explored: credit (through the balance sheet and bank lending channel), wealth effects and disintermediation in the mortgage market. In the two decades, after Mundell's and Fleming's papers, many mainstream models incorporated a broad view of monetary policy across interest rate and credit channels.

Extensions of the Mundell-Fleming Framework

Aizenman (2019) states that the Mundellian Trilemma was "a cornerstone of the open economy neo-Keynesian paradigm (p.451)". The trilemma was a central feature in much of the literature on stabilization policy in open economies during the decades following Mundell's and Fleming's contributions. Marston (1985), in his survey of this literature, notes, however, that many additional assumptions are required for Mundell's more striking propositions to hold in expanded neo-Keynesian *AS-AD* models. With respect to insulation, Marston points out that while "flexible rates are widely thought to insulate an economy from foreign disturbances … insulation applies only in special cases" and

[8] An authoritative source on this point is Hicks (1946), "The rate of interest in Mr. Keynes *General Theory* is the long rate."

that "in general flexible rates do not even insulate the economy from foreign monetary disturbances (pp. 907-08)[9]"

Because flexible exchange rates (or fixed rates) failed to insulate an economy from many shocks, a literature developed on optimal foreign exchange market intervention—managed floating[10]. Policies to stabilize the domestic economy from foreign monetary disturbances such as U.S. policy shocks or world risk premium shocks were particularly difficult to design in a world of perfect capital mobility. These shocks displaced the exchange rate and affected aggregate demand as in the original Mundell-Fleming model. In extended neo-Keynesian frameworks they also affected aggregate supply via the cost of intermediate imports and money wages through indexation. The trilemma held as central banks could still control the domestic money supply or interest rate but that was not sufficient to achieve domestic goals of price and output stability. As Harry Johnson (1967; p.203) expressed the view in the 1960s of what a flexible exchange rate could achieve relative to a fixed rate: "[a] floating exchange rate, by contrast, provides more scope for the pursuit of an independent monetary policy. It does not of course insulate the economy from the influence of favorable or unfavorable developments in foreign markets, or from the impact of short-run or long-run capital movements; but it does permit the economic authorities to attempt to prevent such developments from giving rise to fluctuations in the level of economic activity."

The problems posed by disruptive capital flows led to consideration of policies such as interest equalization taxes and dual exchange rate systems [Fleming (1974), Marion (1981) and Dornbusch (1986)] in the decades following the demise of the Bretton Woods System. Such measures were adopted by several European and Latin American countries.

3. A MODERN INCARNATION of MUNDELL'S TRILEMMA

To assess the relevance of the Mundellian Trilemma to current debates, the analysis must be set in a modern open-economy framework. We begin with a simple version of the New Keynesian model. At a later point features are added to the model that enable us to address financial frictions in incomplete financial markets.

A Canonical New Keynesian Model

This simple open-economy model consists of three equations.

$$y_t = E_t y_{t+1} - a_1 r_t + a_2 q_t + v_t \qquad (3.1)$$

[9] An additional point made by Marston (1985: pp.907-912) is that to analyze foreign shocks, including foreign monetary policy shifts, it is necessary to take account of their context in the foreign economy with implications for the small open economy. Monetary policy shifts do not take place in a vacuum. Monetary policy shifts in major economies may destabilize emerging markets but lack of a policy response to financial shocks in major economies would also have destabilizing effects in emerging markets. In the context of recent U.S. monetary policy, this point is explored in Canzoneri et al. (2021).

[10] In addition to Marston (1985) examples of this literature are Aizenman and Frenkel (1985), Turnovsky (1983), (1987) and Benavie and Froyen (1991).

$$\pi_t = \beta E_t \pi_{t+1} + \kappa y_t + b q_t + u_t \qquad (3.2)$$

$$r_t = r_t^f + E_t q_{t+1} - q_t + \varepsilon_t + VIX_t \qquad (3.3)$$

In addition to the symbols defined in the previous section: π is the rate of inflation and *u* is a white noise (cost-push) shock to inflation. Additionally, *q*, *r* and r^f are now defined as the real exchange rate and interest rates and *y* is the output gap (output minus potential output)[11].

Equation 3.1 is the *IS* equation specifying aggregate demand. It differs from the *IS* equation in the original Mundell-Fleming model in having more explicit microeconomic foundations[12]. Equation 3.2 is the New Keynesian Phillips Curve. It embodies some source of nominal rigidity that produces a trade-off between inflation and the output gap. This open economy Phillips Curve allows for an exchange rate channel which is explained later in this section. Equation 3.3 is the *UIP* condition carried over from the previous section.

A common New Keynesian policy framework is one of flexible inflation targeting. The policymaker uses discretion to minimize a period loss function of the form:

$$L_t = \frac{1}{2}(y_t^2 + \mu \pi_t^2) \qquad (3.4)$$

The policy instrument in the model is the interest rate (*r*)[13].

The Effects of Foreign Interest Rate and World Risk Shocks

Crucial to issues concerning the Mundellian Trilemma are the effects of the U.S. interest rate (r^f) and international risk shocks (*VIX*) within the model, as well as the scope for monetary policy under flexible exchange rates. These will be examined initially assuming that there is no exchange rate channel in the Phillips Curve ($b=0$ in equation 3.2).

Note that with the assumption that all disturbances in the model are white noise and the absence of any lagged endogenous variables results in $E_t y_{t+1} = E_t \pi_{t+1} = E_t q_{t+1} = 0$. Given this property and $b=0$ in 3.2, the only effect of foreign interest rate or world risk shocks on the output gap or inflation will come through the *IS* equation—through the demand-side. Thus, the policymaker delivers the same optimal policy response to such shocks as in the previous section:

$$dr_t^* = \frac{a_2}{a_1 + a_2} dr_t^f \qquad (3.5)$$

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[11] In the cases we consider the expected inflation rate will be zero. The distinction between real and nominal interest rates will not be necessary. This follows from the fact that all shocks to the model will be assumed to be white noise. The foreign inflation rate will also be assumed to be zero so there will be no distinction between real and nominal exchange rates.

[12] For the derivation of the open-economy New Keynesian IS equation, see Guender (2006).

[13] The treatment of optimal policy here assumes policy is conducted by discretion. Policy under commitment is an alternative framework. Distinctions between the two frameworks do not bear on the issues considered here.

This interest rate adjustment stabilizes the output gap and if there is no exchange rate in the Phillips Curve, the inflation rate is undisturbed.

The assumption that there is no exchange rate channel in the Phillips Curve *(b=0* in equation 3.2) was the assumption in the first generation of open-economy New Keynesian models such as Clarida, Gali, and Gertler (2001), (2002). Some, not all, later models include an exchange rate in the Phillips Curve arguing that there are a number of plausible channels[14]. With an exchange rate channel in the Phillips Curve, the effects of foreign interest rate and world risk shocks are best considered within the overall inflation targeting framework. Doing so will also clarify the relationship of Mundell's Trilemma to modern targeting strategies.

Consistent with the loss function given by equation 3.4, the flexible inflation targeting policymaker implements a target rule of the form[15]

$$\theta y_t = -\pi_t \qquad (3.6)$$

$$\theta^* = \frac{a_1+a_2}{\mu(\kappa(a_1+a_2)+b)}. \qquad (3.7)$$

Consider first the case in which there is no exchange rate channel in the Phillips Curve. Equation 3.8 reduces to

$$\theta^{**} = \frac{1}{\mu\kappa} \qquad (3.8)$$

The optimal target rule depends only on the relative weight on the two target variables in the loss function and on the slope of the Phillips Curve. The demand-side (*IS*) parameters play no role. This is because the demand-side variables, including the foreign variables r^f and *VIX* can be offset without cost by appropriate interest rate adjustments. The policy problem is just to achieve the optimal response to a domestic supply shock (*u*).

For the case in which there is an exchange rate channel in the Phillips Curve (*b>0*), both the supply shocks and demand-side shocks (including foreign shocks) will affect both the output gap and the inflation rate. The policy problem is to balance the effect of each so as to minimize the loss function. Consequently, the optimal policy parameter (θ^*) in the target rule also depends on the *IS* parameters.

The presence of an exchange rate channel in the Phillips Curve leads to a marked change in the central bank's optimal response to a change in US policy:

[14] See, for example, the discussion in Monacelli (2013).

[15] The target rule is derived from constrained optimization. The central bank minimizes the period loss function subject to the constraints of the model which, for *b>0*, consist of both the Phillips Curve and the IS relation. The real exchanger rate is eliminated from the constraints through substitution of the *UIP* condition. The choice variables are the target variables – the rate of inflation and the output gap. For *b=0* the only constraint is the Phillips Curve.

$$\frac{dr_t^*}{dr_t^f} = \frac{a_2(a_1 + a_2) + \mu(b + a_2\kappa)(b + \kappa(a_1 + a_2))}{(a_1 + a_2)^2 + \mu(b + \kappa(a_1 + a_2))^2} < 1 \tag{3.9}$$

Whereas only IS parameters suffice to deliver the optimal instrument response in equation (3.5), the optimal instrument response now depends on all parameters of the model. Moreover, the effect of the foreign (U. S.) interest rate on the policy rate increases

$$\frac{dr_t^*}{dr_{t,b>0}^f} > \frac{dr_t^*}{dr_{t,b=0}^f} \ .$$

The Trilemma and Focus on a Single Short-term Interest Rate

As noted in the introduction, Rey (2016) believes that the Mundellian Trilemma misleads in assuming that monetary and financial conditions in a country can be summarized by a single short-term interest rate. It was argued in the previous section that in the Mundell-Fleming open-economy *IS-LM* model, the interest rate is best interpreted as a long-term rate. Moreover, in this type of Keynesian model in which, as James Tobin (1982; p. 173) put it, the asset demand functions are admittedly, "only loosely linked to optimizing behavior of individual agents ," generalization to additional assets was pursued in the decades following Mundell's and Fleming's work.

In contrast, the interest rate in the type of New Keynesian model in this section is, in Woodford's (2011) words, a short-term interest rate "under the control of the central bank". In Woodford's version of the New Keynesian framework, there is no need to identify any other specific financial instruments; he assumes the existence of complete Arrow- Debreu asset markets. Financial structure is fully represented by a single interest rate that measures the stochastic discount factor. [Woodford (2003; pp.64-74)][16]. The problems for financially fragile open economies caused by stops and starts of capital flows resulting from world risk shocks and monetary policy shocks in the United States do not exist in a setting of complete markets. The need is to break away from this structure and develop a role for financial markets and institutions including a role for financial frictions. Tobin (1982, p.174) recognized this, writing that it was the absence of a complete set of Arrow-Debreu markets for securities and goods that "sets the stage for macroeconomic theory and policy."

The Theory of the Trilemma

Ilzetzki, Reinhart and Rogoff (2017), referring to the "macroeconomic trilemma" complain that "[t]he theory does not specify clearly what independent monetary policy might entail." Does it pertain to targeting money, credit, interest rates or to inflation targeting? Rey (2016), as quoted in the

[16] Not all versions of the New Keynesian model are based on the assumption of complete markets. Some derivations simply postulate the existence of riskless one-period bond. In general, given the assumption in these models of identical households, Woodford (2003: p.64) points out that "it makes no real difference what one assumes about the number of financial markets that are open."

Introduction, claims that the fact that U.S. monetary policy shocks are transmitted to inflation targeting countries with well-developed financial markets challenges the validity of the Mundellian Trilemma. With respect to inflation targeting, the focus in this section on a particular framework can help clarify what the "theory of the trilemma" is and the theory's implications for the transmission of U.S. monetary and other financial shocks. In addition to the conclusions reached in the previous section, analysis within the New Keynesian open-economy model implies:

- With a flexible exchange rate, the policymaker can use the interest rate instrument to implement a flexible inflation targeting strategy whereas with a fixed exchange rate this is not possible.
- In a very simple version of the model (no exchange rate channel in the Phillips Curve), the target rule is independent of foreign or other demand-side shocks with a flexible exchange rate. This result is, however, not robust. With an exchange rate channel in the Phillips curve or other variations, foreign shocks will affect the target rule[17]. Model solutions for inflation and the output gap will depend on demand-side shocks, including foreign interest rate and risk shocks.
- A flexible exchange rate will not insulate the small open economy from foreign shocks. The policy rate in the small open economy will not be "on hold" in the presence of foreign financial or monetary policy shocks. Under the optimal flexible inflation targeting strategy, the policy rate in the small open economy may well be correlated with the U.S. policy rate.

4. TWO FURTHER ASPECTS OF OPTIMAL STABILIZATION POLICIES and the TRILEMMA

Narrow Versus Broad Mandate

The triangle that describes the Mundellian Trilemma allows policymakers to choose any two objectives from a set of three. In the literature these choices are often described in stark terms, i.e. corner solutions such as a pure float and perfect capital mobility. In reality such corner solutions are rare as pointed out by Fischer (2001) at the turn of the millennium and more recently by Itzetzki et al. (2017). While capital market integration has been progressing rapidly since the early 1990s the world has not witnessed a wholesale adoption of pure floats as an exchange rate arrangement. In fact, Itzetzki et al. (2017) report that current exchange rate arrangements in about 80 percent of nearly 200 countries fall far short of being flexible. In these countries monetary policy considerations are to some extent guided by efforts to manage the exchange rate. Such intermediate policy choices in practice are consistent with the view in the academic literature that exchange rate stability should rank as an additional, albeit secondary, ultimate policy objective (Blanchard et al. (2010)).

In this section we explore the implications of adding exchange rate stability to the central bank's loss function in the New Keynesian model of Section 3. We begin by amending the loss function:

[17] For example, Ravenna and Walsh (2006) consider a cost channel which introduces the interest rate into the Phillips Curve and thus indirectly an exchange rate channel.

$$L_t = \frac{1}{2}(y_t^2 + \mu\pi_t^2 + \delta q_t^2) \qquad (4.1)$$

The variability of the real exchange rate now ranks as a subsidiary policy objective ($0<\delta<\mu$).

Optimal policy under discretion results in a target rule that establishes a linear relationship among the three target variables:

$$\frac{\delta\theta^*}{a_1+a_2} q_t + \theta^* y_t + \pi_t = 0 \qquad (4.2)$$

where $\theta^* = \frac{1}{\mu(\frac{b}{a_1+a_2}+\kappa)}$.

Greater emphasis on stability of the exchange rate translates into a greater relative weight on q_t in the rule.

A broader mandate for the central bank also has flow-on effects on the way it responds to a change in monetary policy in the center (US).

$$\frac{dr_t^*}{dr_t^f} = \frac{\delta + a_2(a_1+a_2) + \mu(b+a_2\kappa)(b+\kappa(a_1+a_2))}{\delta + (a_1+a_2)^2 + \mu(b+\kappa(a_1+a_2))^2} < 1 \qquad (4.3)$$

Given that the central bank now puts some emphasis on avoiding fluctuations in the real exchange rate vis-à-vis the center, its policy stance follows more closely the policy stance abroad. Compared to the previous cases, the reaction of the domestic policy instrument to a policy change abroad increases:

$$\frac{dr_t^*}{dr_{t,b>0,\delta>0}^f} > \frac{dr_t^*}{dr_{t,b>0}^f} > \frac{dr_t^*}{dr_{t,b=0}^f}.$$

The three scenarios considered share one common feature. In each case the adjustment of the policy instrument by the central bank tracks the policy change in the center. Yet the central bank retains *autonomy* over setting its policy instrument following a policy change abroad. Its optimal response is contingent on the structure of the economy, the monetary policy transmission process, and its own ultimate policy objectives. For this reason, dr^*/dr^f should not be considered as an accurate measure of monetary policy independence. As Bernanke (2017, p. 27) puts it: "strong *financial* correlations across countries are entirely compatible with the standard Mundell-Fleming model" (italics added for emphasis).

A Fixed versus a Flexible Exchange Rate

As pointed out in the Introduction, recent consideration of the Mundellian Trilemma has focused on the limitations of a system of flexible exchange rates in insulating open economies from center country monetary policy actions and other world financial shocks. Describing Rey's (2016) view of the transmission of center country monetary policy shocks, Aizenman (2019) interprets this view as the irrelevance of the exchange rate regime (p. 450). Rey (2016; p.24) sees flexible exchange rates as not enough to guarantee monetary autonomy. This leads to her view that the trilemma has morphed into a dilemma.

The view taken here is that the Mundellian Trilemma should be interpreted to mean that with flexible exchange rates the central bank can pursue an independent monetary policy; it gains control of its proximate targets. In this we agree with Obstfeld (2015, p.20) that it is "not really fruitful to ask whether the exchange rate regime materially influences the scope of monetary independence. Of course it does…. The trilemma remains valid (2015, p.20)[18]." In the context of current central bank operating procedures this means that the central bank controls its policy rate (or policy rates). To return to an example in the Introduction, the collapse of the Bretton Wood System freed the German Bundesbank from its responsibility to maintain a fixed DM/$ parity. This enabled the Bundesbank to use its discount and Lombard rates to pursue a policy of targeting monetary aggregates.

In this section we conduct an exercise to evaluate the advantage in terms of stabilization goals that results from flexible versus fixed exchange rates. Along this dimension, how relevant is the exchange rate regime?[19] Our exercise includes consideration of center country policy monetary policy shocks, shocks to risk premia, as well as conventional supply and demand shocks. In the flexible exchange rate case, we assume that the central bank pursues a policy of flexible inflation targeting, optimizing under discretion.

The model employed in the exercise is the open-economy New Keynesian model from Section 3, composed of equations 3.1-3.3. Two alternative loss functions are employed; equation 3.4 in which the target variables are the inflation rate and the output gap and, alternatively equation 4.1 which adds the real exchange rate as an additional target. The target rules corresponding to these loss functions are equations (3.6, 3.7) and 4.2, respectively.

If a country chooses a fixed exchange rate it adjusts its policy setting in rule-like fashion to ward off any pressure on the exchange rate. Enforcing the exchange rate target requires that the central bank reacts immediately and strongly to external shocks in the UIP relation that cause deviations of the exchange rate from target. Under the flexible exchange rate alternative, the central bank is assumed to act with discretion and minimize either the loss function 3.4 (narrow mandate) or 4.1 (broad mandate).

The interpretation of our exercise is aided by referring once again to the case of Germany at the end of the Bretton Woods era. As determined by the German constitution, the Bundesbank had sole responsibility for monetary policy while the federal government determined the exchange rate regime. The government choice to adhere to the Bretton Woods system had been made some years in the past partly, perhaps primarily, on the basis of broad considerations of international relations. The exercise here can be viewed from the Bundesbank's perspective as an attempt to assess losses in terms of

[18] The recent study by Eichengreen *et al*. (2020) is supportive this view,

[19] To be clear, neither Rey (2016) or others who are reconsidering the Mundellian Trilemma claim that the exchange rate regime is irrelevant in general or in terms of achieving stabilization goals. Our exercise is an assessment of the role of the exchange rate regime along a dimension that they often don't assess.

conventional economic stabilization goals in the fixed exchange rate system compared to an independent monetary policy.

Results from the exercise are presented in Tables 1 and 2. The model is calibrated, not estimated. The parameters chosen are given in a footnote to the table. The numerical calculations show the responses of the target and policy variables to the shocks in the model. These include the standard demand shock *(v)* to the *IS* equation 3.1; a cost-push shock (*u*) to the Phillips Curve 3.2; and foreign interest rate (r^f), world risk premium (*VIX*), and country-specific risk premium (*ε*) shocks to the *UIP* equation 3.3. All shocks are assumed to be white noise initially with unit variance.

Results from the first comparison between exchange rate targeting and flexible inflation targeting are shown in Tables 1 and 2. From Table 1, it can be seen that under exchange rate targeting *IS* shocks feed directly through to the output gap. Shocks to the *UIP* condition impact output via a one-to-one effect on the interest rate. Then via the output effect in the Phillips Curve each of these shocks feeds through to inflation. The exchange rate is, of course, perfectly stabilized. Loss calculated from equation 3.4 is 2.62.

Table 2 provides the results for flexible inflation targeting under a narrow mandate (equation 3.4) and, alternatively, a broad mandate (equation 4.1)[20]. With a flexible exchange rate, the central bank has policy independence and can choose the *combination* of interest rate and exchange rate adjustments that result in an optimal outcome in the wake of each shock. The bank can also choose the optimal interest rate adjustment, taking into account the resulting exchange rate change, in the presence of *IS* and cost-push shocks. To give one example, if the foreign interest rate rises by one percentage point, the optimal policy under flexible inflation targeting for a central bank operating with a narrow mandate is to raise the policy rate by 0.33 percentage points letting the exchange rate rise by 0.67 percentage points. With a broad mandate where the exchange rate adjustment is assumed to be costly (δ=0.1μ) the interest rate is increased by more (0.45) and the exchange rate rises by less (0.55).

The ability under flexible exchange rates to conduct an independent interest rate policy, consistent with the Mundellian Trilemma, is a considerable advantage in our exercise. The value of the loss function for the narrow mandate is 0.98 compared to 2.62 for a fixed exchange rate—a reduction of 63%; for the broad mandate which rewards exchange rate stability the reduction is still 51%. These and other numbers that form our exercise depend on parameters and values in the loss functions that are somewhat arbitrary. The model is, however, simple enough that the effect of changing these values can be easily assessed. If, for example, the loss weight on exchange rate variability were increased in the equation 4.1, the stabilization gain from exchange rate flexibility would be lower. If the weight on the inflation objective were increased (μ>1) the relative advantage of exchange rate flexibility would also decline. The reduction in output variance, the main gain coming as a result of exchange rate flexibility, would count for less in the loss function.

[20] Losses in Tables 1 are calculated for equation 3.4. If equation 4.1 is used instead, the only difference results from the change in scaling of the weights (μ=0.9524 compared to 1.0). The resulting value of loss function equals 2.49 compared to 2.62.

The variance of the shocks also weighs into the relative advantage of flexibility of the exchange rate. The recent literature reconsidering the Mundellian Trilemma focuses primarily on concern about the international transmission of financial market shocks and policy shifts by the center countries. Table 3 shows results from an exercise in which we increase the volatility of foreign interest rate (r^f) and the risk premiums shocks in the model (*VIX* and ε). The variance of each of these shocks is assumed to be 4.0 while the other shocks are kept to unit variance. For this configuration of shocks, the central bank that is able to choose the optimal adjustment in the domestic interest rate and willingly accepts the resulting exchange rate adjustment can improve economic performance considerably. The value of the loss function for the narrow mandate is 1.02 compared to 4.46 for the fixed exchange rate case—a reduction of 77%.

Notice that the increase in the volatility of international risk premia and foreign monetary policy shocks has very little impact on the domestic economic performance, measured by inflation and the output gap, if the optimal monetary policy response is forthcoming. The loss function under the narrow mandate rises from 0.98 t0 1.02. An increase in the world risk premium (VIX), for example, leads to an increase in the policy rate and increase in the exchange rate (currency depreciation) with countervailing effects on the domestic output and, excepting the exchange rate channel, on inflation.

5. BEYOND THE TRILEMMA

Mundell's and Fleming's analysis indicates that a flexible exchange rate regime allows for an independent interest rate policy. Especially in the case of financially fragile emerging market countries, that may not be sufficient to avoid becoming enmeshed in a financial cycle driven by U.S. monetary policy shocks and changing risk perceptions of global investors and transmitted by large capital flows in and out of these countries' financial systems. This is where the literature on the financial cycle moves the focus to macro-prudential policy instruments and capital controls.

The exercise in the previous section examined the advantages of a flexible exchange rate in responding to shocks such as changes in a foreign (e.g. U.S.) interest rate or global risk premium shock. It did not show that interest rate policy alone would achieve a desirable outcome in the presence of large shocks from these sources. It is also the case that interest rate policy in this type of model may be more realistic in an economy with well-developed financial markets. The assumed link between the policy rate and market rates in the model may be weak in economies with thin financial markets, an argument advanced by Kalemli-Ozcan (2019).

In this context, as noted by Aizenman (2019), the "scarcity of policy instruments relative to policy goals implies complex country-specific tradeoffs between policy goals (p.444)." The particular sources of financial instability and nature of the remedies vary across the authors who are generally concerned about financial vulnerability to the world financial cycle. Capital flows are one vulnerability but the emphasis on the types of flow varies. Rey (2016) focuses on U.S. dollar debt flows; Kalemli-Ozcan on aggregate debt flows. Caballero (2014) extends the concern to portfolio equity flows. Ghosh, Ostroy, and Quresh (2016) and Forbes and Warnock ((2012), (2020)) are most concerned about extreme capital flows, “surges and stops; flights and retrenchments.”

The nature of the problem caused by swings in capital flows is also subject to differences in emphasis. The focus on debt flows reflects a concern about the direct effect of these shifts on the stability of financial institutions, especially banks. A related problem is the effect of exchange rate volatility resulting from these shifting capital flows. If a substantial amount of accumulated debt is denominated in foreign currency, exchange rate depreciations caused by “stops and flights” will have de-stabilizing balance sheet effects as emphasized by Cespedes et al. (2004). Thus, additional policy goals in a world of high capital mobility may include exchange rate stability or broader measures of financial stability related to control of the volume and composition of capital flows.

An Extension of the New Keynesian Model

To address these added concerns, we adopt a broader objective function that includes undesirable debt capital flows (LF_t-LF^*) as well as the real exchange rate:[21]

$$L_t = \frac{1}{2}(y_t^2 + \mu\pi_t^2 + \delta((LF_t - LF^*)^2 + q_t^2)) \qquad (5.1)$$

To illustrate how surges and reversals of capital flows caused by shifts in monetary policy abroad or risk sentiment affect policymaking, we need a richer modeling framework, one that goes beyond the canonical open economy New Keynesian model of Section 3. Below we sketch out a somewhat more elaborate yet highly stylized New Keynesian model. Similar in spirt to Friedman (2013), this expanded model features a credit market. This credit market has a domestic and an international component that make up the demand for credit obligations (short-term debt) and a domestic supply component. Equilibrium in the credit market establishes a relationship between the market interest rate that drives aggregate demand and the policy rate chosen by the central bank. We retain the assumption of uncovered interest rate parity because capital flows other than hot money such as government bonds, private equity flows, and foreign direct investment are large enough to ensure – bar a risk premium - the equality of expected yields on domestic and foreign assets. The expanded framework allows us to consider the triggers of undesirable capital movements and how macro-prudential policy could be combined with monetary policy to achieve optimal stabilization outcomes.

The model consists of the following equations:[22]

$$\pi_t = \kappa y_t + bq_t + u_t \qquad (5.2)$$

[21] For simplicity, the central bank places the same relative weight on the variability of undesirable capital flows as on the variability of the real exchange rate. The target for undesirable capital flows (LF^*) is deemed consistent with economic fundamentals.

[22] We continue to assume that all shocks are white noise which allows us to ignore the forward-looking expectations.

$$y_t = -a_1\rho_t + a_2 q_t + v_t \quad (5.3)$$

$$C^D = d(\rho_t - r_t) + z_t^d \quad (5.4)$$

$$C^S = -s\rho_t + z_t^s \quad (5.5)$$

$$LF_t = LF^* + l_1\left(\rho_t - \tau_t - \rho_t^f\right) - l_2 VIX_t \quad (5.6)$$

$$CAP_t = c_1(\rho_t - \left(\rho_t^f + \varepsilon_t - q_t\right)) \quad (5.7)$$

$$CAP_t + LF_t + FXI_t + TB_t = 0 \quad (5.8)$$

$$LF_t + C_t^D + C_t^{CB} = C_t^S \quad (5.9)$$

The open-economy Phillips curve (eq. 5.2) remains unchanged. The market interest rate ρ_t (rather than the policy instrument (r_t) affects the demand for goods in the *IS* relation (eq.5.3). The credit market is described by equations 5.4 and 5.5.[23] Domestic investors' demand for short-term credit obligations increases as the spread between the risky market rate rises relative the riskless interest rate, which is taken to be the policy instrument. The supply of short-term credit obligations reflects the extent to which households and firms borrow: it is inversely related to the cost of credit, measured by the market rate of interest. Both credit market relations are subject to a stochastic disturbance (z_t^d,z_t^s). Equations 5.6 and 5.7 represent capital flows of which there are two types. LF_t denotes flows of short-term debt, termed hot money, that enter or exit the domestic credit market. As shown by equation 5.6, these flows (relative to a target level LF^*) depend on the difference between the domestic and foreign market interest rate and on the level of risk appetite VIX_t in world financial markets.[24] The central bank can manage these undesirable capital flows by applying the macro-prudential policy tool (τ) which is an interest equalization tax. In contrast, CAP_t represents debt other than hot money, equity, and foreign direct investment flows on the capital account. These capital movements respond to the difference in expected yields in the domestic economy relative to those abroad with $c_1 \to \infty$ equating expected yields (after allowing for a risk premium). The two remaining equations represent the balance of payments equilibrium condition (eq. 5.8) and the equilibrium condition in the market for short-term credit (eq. 5.9).[25] FXI_t denotes foreign exchange market intervention, another potential instrument available to the central bank though not examined here.

Accordingly, we analyze the conduct of optimal discretionary policy in three different scenarios: one where the central bank relies solely on its standard policy tool (*r*) to stabilize its ultimate targets through steering the market determined interest rate and the real exchange rate. In the second scenario the central bank calibrates the use of its standard tool with the application of an interest equalization

[23] Forward-looking expectations typically influence the behavior of agents in credit markets. But this channel does not come into play here due to the assumption of white noise shocks.
[24] Shifts in global risk sentiment now drive only hot money flows. A lower value of *VIX* implies greater risk appetite amongst international investors and hence leads to a larger capital inflow.
[25] As the focus of our analysis is on capital flows we set the trade balance (TB_t) equal to zero. We also abstract from unconventional monetary policy through purchases of credit obligations by the central bank ($C_t^{CB} = 0$).

tax to regulate the flow of hot money. The final scenario considers the case where the central bank is intent on reducing real exchange variability through a wider application of the interest equalization tax to include all capital flows.

The central bank uses discretion in choosing policy settings for its instruments. The target rule that underlies optimal or near optimal (Case 3) policy is case-specific and depends on the set of instruments available to the central bank and on the manner in which they are used.[26]

Case 1: Target rule when only r_t is used:

$$\frac{\delta}{a_1+a_2}(l_1(LF_t - LF^*) - q_t) = \left(\frac{b}{a_1+a_2} + \kappa\right)\mu\pi_t + y_t \qquad (5.10)$$

Case 2: Target rule when both r_t and τ_t are used:

$$\frac{\delta}{a_1+a_2}(-q_t) = \left(\frac{b}{a_1+a_2} + \kappa\right)\mu\pi_t + y_t \qquad (5.11)$$

Case 3: $\tau_t = \rho_t - \rho_t^f$ applies to all capital flows and central bank sets r_t . This implies greater stability of the real exchange rate as $q_t = \varepsilon_t$. The underlying target rule is:

$$\frac{1}{\mu\kappa}y_t = -\pi_t. \qquad (5.12)$$

Policy Outcomes

Policy outcomes under each of the three scenarios are obtained by combining the respective target rule with the equations of the model (equations 5.2 – 5.9). For each scenario we assume that uncovered interest parity holds up to risk premia ($c_1 \to \infty$).

a. Case 1: The policy rate (*r*) is the instrument: If the policy interest rate is the only instrument the shortage of instruments relative to targets is exacerbated by the addition of the control of capital flows as a goal. The shortage existed in the simpler model with a goal of exchange rate stability added to the traditional goals of stabilization of inflation and the output gaps.

Table 4 shows policy outcomes when the policymaker optimizes by applying the target rule given by equation 5.10. The value of the loss function (Loss) increases by 94% relative to Loss under the narrow mandate in Table 2. For the broad mandate which includes exchange rate stability, the increase in loss is 55%. The greatest portion of this increase comes from higher variance in the output gap which rises by a factor of 7.2 (from 0.11 to 0.79).

[26] The target rules are again derived from constrained optimization. The central bank minimizes the objective function eqn. 5.1 subject to the constraints of the model and availability of policy instruments. Further details on the derivation of the target rules appear in an appendix available upon request from the authors.

To elucidate the additional considerations that result from adding the goal of controlling capital flows and the role of an instrument with that focus, we concentrate initially on the effects of one shock, the *IS* shock. In the original Mundell-Fleming model there is one goal, output stability, and one instrument. Assuming control of the interest rate, an *IS* shock is simply offset with the appropriate adjustment of the rate; output is unaffected. In the extended Keynesian *AS-AD* framework there is an additional goal of price stability. Still, an appropriate adjustment in the interest rate will fully insulate both price and output unless the exchange rate affects the aggregate supply schedule.[27]

If we move on the New Keynesian model the situation is similar to that in the *AS-AD* framework. There are two goals, in this case the output gap and inflation rate. If the exchange rate does not enter the Phillips Curve ($b = 0$), then, as in the Mundell-Fleming model, both goals are met in the case of an *IS* shock by the appropriate adjustment of the policy interest rate. If there is an exchange rate channel in the Phillips Curve, there is a trade-off between the two goals. This is the case even if exchange rate stability is not itself a policy goal. This is the "narrow mandate case" in Table 2. Some displacement of output lessens the exchange rate change and resulting effect on the inflation goal. This trade-off broadens if we add the third goal of exchange rate stability with results shown in the "broad mandate" case in Table 2.

Further extending the loss function to include stability of a capital flow measure (*LF-LF**) while still allowing only the policy interest rate as an instrument widens the conflicts among goals. For the case of an *IS* shock this can be seen in Table 4. A 1-unit *IS* (v) shock displaces the output gap by 0.8 units compared to zero in the original Mundell-Fleming model. A positive *IS* shock calls for an increase in the interest rate to stabilize output, but that policy response would induce an undesirable capital inflow. For this reason, as well as the effects of the interest rate adjustment on the exchange rate and consequently the inflation rate, the optimal policy response is only a partial offset. A flexible exchange rate allows for an independent monetary policy, but the shortage of instruments is acute.

b. Case 2: The policymaker has both the policy interest rate (r) and an interest- equalization tax (τ) as policy instruments: The addition of an interest equalization tax as a policy instrument partially alleviates the instrument shortage.

Table 5 shows the policy outcomes for this case when the policymaker optimizes by applying the target rule 5.11. The interest equalization tax instrument (τ) enables the policymaker to set the flow of debt capital at the desired level (*LF=LF**) without requiring changes in the policy interest rate. This frees traditional monetary policy to achieve the same stabilization outcomes for the target variables and the policy rate under a broad mandate as shown in Table 2.

The implementation of the interest equalization tax also reduces the response of the domestic market interest rate (ρ) to a 1-unit change in the foreign market rate (ρ^f) to 0.45 from 0.86 for Case 1 where the policy rate is the sole instrument. Additionally, in this case a 1-unit *IS* shock displaces the output gap by 0.21 compared to 0.8 in Case 1. Due in large part to the freedom to offset demand shocks by an adjustment in the policy rate, the variance of the output gap is 0.10 when an interest equalization tax is available compared to 0.79 when the policy rate is the only instrument.

[27] On this point, see Aizenman and Frenkel (1985) and Benavie and Froyen (1991).

In assessing the results in Table 5, it should be kept in mind that the interest equalization tax has been made very flexible in the model. It is also assumed to be effective; evasion has not been considered. The costs of changing the tax have been ignored[28]. Instrument costs have been ignored for the policy rate as well. There are no doubt costs of changing either but there are likely greater costs to tax changes.

c. Case 3: The policymaker controls the interest rate and sets the interest equalization tax (τ) such that $q_t = \varepsilon_t$. This policy scenario is motivated by a concern with exchange rate volatility resulting from swings in overall capital flows. Among the potential problems are balance sheet effects for countries with large amounts for foreign currency denominated indebtedness. There are also broader concerns about fluctuations in competitiveness resulting from rapid swings in currency values. In this case the tax is applied to all capital flows, including those underlying equation 5.7. The policymaker sets the tax $\tau_t = \rho_t - \rho_t^f$ with the result that the real exchange rate is fixed up to an assumed unobserved stochastic term ($q_t = \varepsilon_t$). The target rule in this case is given by 5.12.

Policy outcomes under this scenario are shown in Table 6. In evaluating the results, note that fixing the real exchange rate up to the epsilon term nearly replicates a closed economy setting. The target rule 5.12 *is* the optimal rule for the closed economy case. Other than via epsilon, the exchange rate channel in the Phillips Curve is shut down. It follows that the policy rate (*r*) is free to move to completely offset *IS* shocks and shocks to world risk attitudes (*VIX)*. Neither the policy rate nor the market interest rate needs to react to the foreign interest rate (ρ^f). None of these shocks affects the output gap or inflation rate. The use of a capital control instrument in this way achieves the insulation from a world financial shock that a flexible exchange rate by itself fails to deliver.

A downside to the near replication of the closed economy setting is deterioration in the output inflation tradeoff. Less is achieved along the inflation dimension for a given change in the output gap because the reinforcement through an exchange rate adjustment is lost. Consequently, in the case of a productivity disturbance (*u*), the optimal policy allows the effect to pass through almost completely to inflation rather than disturb the output gap, real exchange rate and debt capital flow (*LF*). Further, while the variance in the output gap is low in Case 3, the variance of inflation is higher than in the case of no interest equalization tax (Table 2, broad or narrow mandate). A central bank that placed a higher weight on inflation stabilization than is assumed here would find this policy scenario unappealing.

The broader application of the interest equalization tax in Case 3 also affects the tradeoff between the two financial stability goals. Compared to Case 2, the optimal policy in Case 3 fails to completely stabilize the debt capital flow (*LF*) but improves the stability of the real exchange rate. Overall, the gain in the output gap and exchange rate stability outweigh the increase in variability of the debt capital flow, leading to a lower loss in Case 3 relative to Case 2[29].

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[28] Evidence on the effectiveness of capital controls is provided by Landi and Schiavone (2021). Engel (2015) discusses rationales for controls and problems with their implementation. Blanchard (2017) introduces an interest equalization tax into a simple portfolio model.

[29] In line with the literature on the Mundellian Trilemma, we retain the assumption that *UIP* holds. Thus, we do not explore a role for foreign exchange market intervention (FXI) in equation 5.8. Capital controls are considered as a complementary stabilization policy in models in which foreign exchange market intervention is effective in Ghosh,

6. CONCLUSION

In the view advanced here, the Mundellian Trilemma pertains to the ability of a central bank to carry out an independent monetary policy. In a regime of flexible exchange rates, the central bank has control over its instruments and proximate targets even within a world of high capital mobility. In contrast, with a fixed rate the trilemma constrains policy. Understanding this point is necessary to interpret empirical findings about the effects of foreign interest rate and other financial shocks on the domestic policy rate. The Mundellian Trilemma does not imply insulation of the financial system of a small open economy from world financial shocks or monetary policy shifts in the United States or other major world economies. In Section 2 of the paper, we document that the distinction between monetary policy independence and insulation from foreign shocks was well understood by Mundell, Fleming, and others in the early years after the Mundell-Fleming model came into use and during the first decades after the collapse of the Bretton Woods system and move to flexible exchange rates.

Monetary policy independence under flexible exchange rates is shown to have considerable advantages relative to a regime of fixed exchange rates. In simple models such as the original Mundell-Fleming model, the optimal adjustment of the interest rate can completely offset the effect on the domestic economy from foreign interest rate shocks and shocks to the world risk premium. In more complex models the ability to optimally balance the exchange rate and interest rate adjustment to maintain UIP in the face of such shocks reduces losses associated with them. A regime of flexible exchange rates also frees the policy rate to respond optimally to *IS* and supply-side shocks. In Section 4 we carry out several policy experiments within a simple New Keynesian open-economy model to illustrate these advantages.

The Mundellian Trilemma has been called misleading in that it represents monetary policy and financial market conditions solely by a short-term interest rate. In Section 2 and 3 we have argued that this feature of monetary policy models in the decade prior to the financial crisis resulted from the common assumption in those models of complete Arrow-Debreu markets for securities. This assumption, which had little to do with the Mundellian Trilemma, made financial structure indeterminate and irrelevant in the models. There are promising signs that this deficiency in the workhorse models has been recognized. Still, in both the open and closed economy research the task going forward is to fully incorporate incomplete financial markets and financial frictions into mainstream monetary policy models.

Because a regime of flexible exchange rates does not by itself provide insulation of a country's financial markets from the world financial cycle, macro-prudential instruments, including controls on international capital flows, have a potential role in monetary stabilization policy. There is a shortage of instruments. Because a flexible exchange rate regime *does* allow an independent monetary policy, use of these instruments must be evaluated together with optimal use of traditional monetary policy instruments. Moreover, the concerns that motivate the use of these additional instruments vary for

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Ostry and Chamon (2016) and Liu and Spiegel (2015). Blanchard, *et al.* (2015) examine the effectiveness of FXI as a separate policy to relieve exchange rate pressure from capital flow shocks.

different types of economies. In Section 5 we consider three policy scenarios to illustrate the usefulness of one such policy, an interest equalization tax. These scenarios indicate that the tax can improve on policy outcomes relative to the use of the interest rate as the sole instrument. We consider the use of the interest equalization tax to control a debt capital flow or alternatively applied to all capital flows to stabilize the real exchange rate. There is a tradeoff between the two financial stability goals and between either of them and the traditional domestic elements of the dual mandate, the output gap and the inflation rate.

Issues related to the Mundellian Trilemma remain important because of the scarcity of policy instruments relative to policy objectives. With their mandates broadening to include financial stability objectives, the task of central banks to operate in an evolving complex world environment has become more challenging. This is especially true for central banks in small open economies in light of the growing importance of a world financial cycle. The Global Financial Crisis and the current pandemic have exposed the vulnerability of global supply chains and financial markets to financial and real shocks. These developments justify increased concern about financial stability issues by central bankers and underscore the need for additional policy tools such as measures to moderate extreme swings in capital flows.

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Table 1: The Target Variables and the Policy Instrument under a Fixed Exchange Rate

	y_t	π_t	r_t	q_t	$Var(y_t)$	$Var(\pi_t)$	$Var(r_t)$	$Var(q_t)$
u_t	0	1	0	0	1.61	1.01	2.99	0
v_t	1	0.1	0	0	$Loss = Var(y_t) + \mu Var(\pi_t)$ = 2.62			
r_t^f	-0.45	-0.045	1	0	$\mu = 1$			
ε_t	-0.45	-0.045	1	0				
VIX_t	-0.45	-0.045	1	0				

Notes:

1. The central bank achieves the exchange rate target by adhering to the following instrument rule: $r_t = \tau(q_t - \bar{q}) + 1.5\pi_t$ where $\tau = 1000$ and $\bar{q} = 0$. The response to the rate of inflation is necessary to satisfy the Blanchard-Kahn conditions for determinacy.
2. An alternative way of evaluating a fixed exchange rate regime consists of adding the variance of the real exchange rate to the loss function and assigning a large weight to it. For instance, letting *δ=100, μ=1* in the loss function $Var(y_t) + \mu Var(\pi_t) + \delta Var(q_t)$ and implementing optimal policy under discretion yields the same loss score of 2.62 reported in the table. The behavior of the target variables and the policy instrument is virtually identical to that under the instrument rule.
3. The reported results are based on parameter values used in earlier studies (Svensson (2000), Guender (2006)). They are:
$$a_1 = 0.45, a_2 = 0.195, b = 0.1, \kappa = 0.1.$$
All shocks are white noise and have unit variance.
4. Coefficients and loss scores have been rounded to two decimal places except in cases where rounding would have yielded identical numbers when in fact there were subtle differences.

Table 2: Variances and Losses under a Flexible Exchange Rate: Narrow vs Broad Mandate

Narrow Mandate	y_t	π_t	r_t	q_t	$Var(y_t)$	$Var(\pi_t)$	$Var(r_t)$	$Var(q_t)$
u_t	-0.24	0.94	0.37	-0.37	0.059	0.92	2.69	3.72
v_t	0.037	-0.15	1.49	-1.49	$Narrow\ Mandate\ Loss = Var(y_t) + \mu Var(\pi_t)$ = 0.98			
r_t^f	-0.02	0.07	0.33	0.67	$\mu = 1$			
ε_t	-0.02	0.07	0.33	0.67				
VIX_t	-0.02	0.07	0.33	0.67				
Broad Mandate	y_t	π_t	r_t	q_t	$Var(y_t)$	$Var(\pi_t)$	$Var(r_t)$	$Var(q_t)$
u_t	-0.20	0.95	0.30	-0.30	0.11	0.92	2.19	2.48
v_t	0.21	-0.10	1.22	-1.22	$Broad\ Mandate\ Loss = \mu Var(y_t) + \mu Var(\pi_t) + \delta Var(q_t) =$ 1.22			
r_t^f	-0.10	0.045	0.45	0.55	$\mu = 0.9524$, $\delta = 0.1\mu$			
ε_t	-0.10	0.045	0.45	0.55				
VIX_t	-0.10	0.045	0.45	0.55				

Notes:

1. See notes to previous table.
2. For a broad mandate the relative weights on the target variables in the loss function have been scaled to avoid inflating the loss scores.

Table 3: The Effect of Greater Volatility of External Shocks ($\sigma_j^2 = 4,\ j = r^f,\ \varepsilon,\ \lambda$)

Flexible Exchange Rate			
Narrow Mandate			
$Var(y_t)$	$Var(\pi_t)$	$Var(r_t)$	$Var(q_t)$
0.062	0.95	3.66	7.78
Narrow Mandate $Loss = Var(y_t) + \mu Var(\pi_t)$ = 1.02 $\mu = 1$			
Broad Mandate			
$Var(y_t)$	$Var(\pi_t)$	$Var(r_t)$	$Var(q_t)$
0.20	0.94	4.03	5.18
Broad Mandate $Loss = \mu Var(y_t) + \mu Var(\pi_t) + \delta Var(q_t) = 1.57$ $\mu = 0.9524$, $\delta = 0.1\mu$			
Fixed Exchange Rate			
$Var(y_t)$	$Var(\pi_t)$	$Var(r_t)$	$Var(q_t)$
3.42	1.03	11.98	0
$Loss = Var(y_t) + \mu Var(\pi_t)$ = 4.46 $\mu = 1$			

Table 4: Responses, Variances, and Losses under a Flexible Rate: One Policy Instrument (r_t)

	y_t	π_t	ρ_t	q_t	LF_t	r_t	$Var(y_t)$	$Var(\pi_t)$	$Var(\rho_t)$	$Var(q_t)$	$Var(LF_t)$	$Var(r_t)$
u_t	-0.05	0.99	0.08	-0.08	0.31	0.77	0.79	0.99	0.86	0.91	2.15	19.8
v_t	0.80	0.05	0.31	-0.31	1.23	3.09	$Loss = Var(y_t) + \mu Var(\pi_t) + \delta(Var(q_t) + Var(LF_t))$ = 1.90					
ρ_t^f	-0.36	-0.02	0.86	0.14	-0.56	0.61	$\mu = 0.909091;\ \delta = .1\mu$					
ε_t	0.12	0.10	0.11	0.89	0.46	1.15						
VIX_t	-0.06	-0.015	0.09	-0.09	-0.13	-0.07						
z_t^d	-					2.0						
z_t^s	-					-2.0						

Note: The following parameter values are used in the expanded New Keynesian model: $l_1 = 4, l_2 = 0.5, d = 0.5, s = 0.5$. The preference parameter μ is adjusted to avoid inflating the loss score under a broader mandate. It is scaled so that, irrespective of mandate, the relative weights on the target variables sum to 2.

Table 5: Responses, Variances, and Losses under a Flexible Rate: Two Instruments $(r_{t,}, \tau_t)$

	y_t	π_t	ρ_t	q_t	LF_t	r_t	τ_t	$Var(y_t)$	$Var(\pi_t)$	$Var(\rho_t)$	$Var(q_t)$	$Var(LF_t)$	$Var(r_t)$	$Var(\tau_t)$
u_t	-0.20	0.95	0.30	-0.30	-	0.61	0.30	0.10	0.92	1.98	2.18	0	15.9	2.10
v_t	0.21	-0.10	1.22	-1.22	-	2.44	1.22	$Loss = Var(y_t) + \mu Var(\pi_t) + \delta(Var(q_t) + Var(LF_t))$ = 1.12 $\mu = 0.909091;\ \delta = .1\mu$						
ρ_t^f	-0.10	0.04	0.45	0.55	-	0.90	-0.55							
ε_t	-0.10	0.04	0.45	0.55	-	0.90	0.45							
VIX_t	-	-	-	-	-	-	-0.125							
z_t^d	-	-	-	-	-	2.0	-							
z_t^s	-	-	-	-	-	-2.0	-							

Table 6: Responses, Variances, and Losses under a Flexible Rate: Two Instruments ($r_{t,}, \tau_t = \rho_t - \rho_t^f$)

	y_t	π_t	ρ_t	q_t	LF_t	r_t	τ_t	$Var(y_t)$	$Var(\pi_t)$	$Var(\rho_t)$	$Var(q_t)$	$Var(LF_t)$	$Var(r_t)$	$Var(\tau_t)$
u_t	-0.099	0.99	0.22	-	-	0.44	0.22	0.01	0.99	5.19	1	0.25	29.78	6.19
v_t	-	-	2.22	-	-	4.44	2.22	$Loss = Var(y_t) + \mu Var(\pi_t) + \delta(Var(q_t) + Var(LF_t))$ = 1.03						
ρ_t^f	-	-	-	-	-	-	-1.0	$\mu = 0.909091;\ \delta = .1\mu$						
ε_t	-0.01	0.099	0.46	1.0	-	0.91	0.46							
VIX_t	-	-	-	-	-0.50	-1.0	-							
z_t^d	-	-	-	-	-	2.0	-							
z_t^s	-	-	-	-	-	-2.0	-							