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WHEN IS MONEY NEUTRAL UNDER FLEXIBLE EXCHANGE RATES?

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Abstract

The paper studies the conditions for the neutrality of money under flexible exchange rates in an extended real-wage Mundell-Fleming model, with special emphasis on the specification of the behavior functions to correspond to their foundations in closed-economy macrotheory.

It is shown that monetary expansion causes output first to decline, to eventually rise above its original level. However, if interest earnings on foreign securities dominate the trade balance in the expression for the exchange rate, monetary expansion leads to an appreciation of the exchange rate, while having an expansionary output effect. Money is neutral in the long run if either the wealth effect or foreign interest payments is abstracted from; if both are abstracted from, it is neutral also in the short run. Short and long-run neutrality results also if wealth consists only of foreign securities. The above responses hold both for net creditors and – with a minor qualification – debtors.

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1. INTRODUCTION

There appears to be widespread agreement that when the supply of labor is a function of the real wage in a Mundell-Fleming model, money is neutral in the long run under flexible exchange rates, while being non-neutral if labor supply is a function of the nominal wage. The purpose of this paper is to show that in an appropriately specified Mundell-Fleming economy, supplemented with the wealth effect and a supply side, money is neutral in the real wage model only in special cases – and all the national economies are open.

The extended Mundell-Fleming (EMF) model is alive and well and continues to serve as a forecasting tool for most central banks and governments because it works empirically. There are also theoretical reasons for this. As shown by Grandmont (1991), if individuals are heterogeneous, their aggregate demand will have the gross substitutability property and equilibria will be unique and stable, as long as individuals respect their budget constraints. In these models, individuals interact directly and consciously through mechanisms like trading, the passage of information, the building of reputations, organizing into groups for purposes of bargaining etc.

Recent advances in the New Classical Economics (NCE) tradition show promise for the future. They derive the macrofunctions explicitly from microfoundations. However, they suffer from the aggregation problem to an extent that many regard as fatal. The microfoundation basis is built on the optimization by the "representative individual", which has been shown to lead to multiple and generally unstable macro equilibria, unless the individuals have identical homothetic utility functions, or all individuals have homothetic utility functions but the relative income distribution is fixed and thus independent of prices (see Kirman 1992).

Moreover, as argued by Akerlof (2007), the preferences currently commonly described in the microfoundations of these models are two narrowly defined, in failing to incorporate the norms of the decision makers. These norms reflect how the decision makers think they and others should or should not behave, even in the absence of frictions: it is not just about the money, it is also about living up to an ideal about who they think they should be (expressed in e.g. gift giving generating utility, or people feeling their consumption should be in line with their social class or with their perception of responsible behavior). Preferences reflecting such norms, while consistent with the EMF models, yield a macroeconomics with important remnants of the early Keynesian thinking, while retaining the internal rigor of the NCE models (see also Levitt and List, 2007). However, this does not solve the aggregation problem of the NCE models any more than the theoretical issues with respect to which we are trying to improve the EMF model here[1].

The effects of fiscal and monetary policies have been among the most intensively studied topics in international macroeconomics both before and after the classic papers of Mundell (1963) and Fleming (1962). These papers suggest that under perfect capital mobility, monetary expansion is expansionary under flexible exhange rates. This theorem rests critically on the assumption of fixed prices. More recent developments have been in two directions. One has been towards a fully specified supply side (Sachs (1980), Ahtiala (1984)), and the other towards endogenous expectations (Branson and Buiter (1983), Dornbusch and Fischer (1980) and subsequent work). Mathematical tractability has, in the latter case, forced back to primitive supply side proxies, with fixed prices of the domestic good standing for the Keynesian or money wage model, and fixed output for the classical or real wage

model (the supply of labor a function of the money wage and the real wage, respectively). The consensus that emerged from this discussion is that in the real wage model money is neutral in the long run.

Ahtiala (1998) incorporates a fully specified supply side in a dynamic continuous-time model with perfect foresight rational expectations, the wealth effect, and foreign interest payments, and shows that an open economy has a rising aggregate supply curve also in the real wage model. He shows that monetary expansion is expansionary in the money wage model, but the exchange rate and output dynamics depend on whether the expansion leads to an increase or a decrease in nominal wealth. In the real wage model, it is contractionary in the short run and expansionary in the long run.

The purpose of this paper is to extend the above work by studying the conditions for the long-run neutrality of money in a real wage EMF model where we have attempted to specify the key functions carefully to correspond to their widely accepted foundations in closed-economy macrotheory, under flexible exchange rates, and perfect capital mobility. Specifically, we will focus on the following notions:

1. The demand for money is demand for real balances in terms of the goods to be purchased with those balances, as originally pointed out by Milton Friedman. In an open economy the goods should therefore include imported goods and domestic goods but exclude exported goods. Consequently, real balances should be defined with respect to the expenditure price, as is widely accepted. However, then the transactions variable in the demand function has to be in terms of the same goods – otherwise velocity would not be a pure number, as first argued in Ahtiala (1984).

2. The wealth effect in the expenditure function is necessary for consistency with the notion that saving is a stock adjustment of actual to desired real wealth, and to produce a steady state equilibrium where both the flows and the stocks, including real wealth, are in equilibrium. Moreover, as just stated, this kind of an expenditure function leads to predictions qualitatively similar to those of models based explicitly on the maximization of intertemporal utility subject to a budget constraint, when such market failures as credit constraints are allowed in those models. Finally, the comments made in point 1 apply to expenditures, as well: in the expenditure function, real income, real wealth, and the real interest rate should be defined in terms of the expenditure basket of goods.

3. Imports are specified as a function of expenditures, since part of spending is on imported goods: expenditures in response to an income change should fall on domestic and imported goods in the same basic way as in response to a change in real wealth or the interest rate. The implication of the conventional specification is that all the expenditures of the latter kind fall only on domestic goods, but those of the former kind fall on both domestic and imported goods.

4. Foreign interest payments are incorporated.

5. On the supply side, rational labor is concerned with its real wage in terms of the goods it consumes, rather than those it produces. Therefore the supply of labor should be a function of the real wage in terms of the expenditure basket of goods in the same way as the demand for money and expenditures.

It will be shown that monetary expansion is typically expansionary in the long run after being contractionary in the short run, in agreement with Ahtiala (1998). However, the exchange rate response is sensitive to the assumption that foreign interest receipts are small relative to the trade balance. If they dominate the trade balance, monetary expansion appreciates the exchange rate, while its output effect remains expansionary. These results hold both for net creditors and – with a minor qualification – debtors. The conventional long-run neutrality of money results if the wealth effect or foreign interest earnings are abstracted from; if both are abstracted from, it is neutral also in the short run. Short- and long-run neutrality results also if wealth consists only of foreign securities.

The paper proceeds as follows. The model is developed in Part 2. Part 3 studies the policy effects. Finally, Part 4 is the Conclusion.

2. THE MODEL

Examine the following dynamic continuous-time model of a small open economy with the above features. Foreign goods prices and the foreign interest rate are exogenous, and foreign repercussions are absent. The foreign demand curve for domestically produced goods is, however, negatively sloped. Capital is perfectly mobile. We have:

$$y = x_{\varepsilon}\varepsilon + x_{t}t + x_{g}g \tag{1}$$

$$m - p = \alpha_{y}\left(p^{d} + y - p\right) - \alpha_{r}r \tag{2}$$

$$r = r^* + \hat{\dot{e}} \tag{3}$$

$$\dot{v} = \delta\left\{\dot{e} + \psi\left(x_t t + p^d - e\right) + \varnothing\left[r^* + \left(1/\delta\right)\left(v - \rho m - \zeta b\right) - e\right]\right\} \tag{4}$$

$$x_\varepsilon \varepsilon = \frac{E}{Y}\varepsilon = z_y\left(y + p^d - p\right) - z_r\left(r - \hat{\dot{p}}\right) + z_v\left(v - p\right) + z_\varepsilon\left(p - p^d\right) + z_f\left(e + r^* + f - p\right) \tag{5}$$

$$x_t t = \frac{T}{Y}t = -t_\varepsilon x_\varepsilon \varepsilon - z_p\left(p^d - e\right) \tag{6}$$

$$p \equiv a p^d + \left(1 - a\right)e \tag{7}$$

$$p^d = \gamma_1 y + \gamma_2 e + \gamma_3 \tag{8}$$

$$\dot{p} \equiv a\dot{p}^d + \left(1 - a\right)\dot{e} \tag{9}$$

$$\dot{p}^d = \gamma_1 \dot{y} + \gamma_2 \dot{e} \tag{10}$$

$$\hat{\dot{q}} = \dot{q}; \dot{q} = \dot{p}^d, \dot{p}, \dot{e}$$

The variables are, all as the logs of the deviations from the stationary state equilibrium: $y \equiv$ real output, $r \equiv$ domestic interest rate, $r^* \equiv$ foreign interest rate, $e \equiv$ price of foreign currency in terms of domestic currency, $p^d \equiv$ domestic goods price, $p \equiv$ expenditure price, $v \equiv$ nominal wealth, $t \equiv$ trade balance, in terms of domestic

goods, $g \equiv$ real government expenditures, $f \equiv$ the amount of foreign securities, in foreign currency, $m \equiv$ nominal money supply, $b \equiv$ the amount of domestic securities, $\varepsilon \equiv$ total private expenditures (consumption plus investment), in terms of domestic goods, $\hat{\dot{q}} \equiv$ expected change in q, $\dot{q} \equiv$ change in q, where q is $p^d, p,$ or e.

Eq. (1) represents aggregate demand for the domestic good and is the sum of private domestic expenditures (ε), the trade balance (t), and government expenditures (g), all in terms of the domestic good. The government purchases domestic goods, the spending being of the balanced-budget variety for simplicity. The coefficients x_i are of course the elasticities of X with respect to the I, the corresponding level variables.

Eq. (2) is the money market equation: The real money supply, in terms of the expenditure basket of goods, equals the demand, which is a function of expenditures in terms of the same basket, as argued in the Introduction, and the nominal interest rate. In the Equation, the expenditure function has been substituted in. We have simplified it, using the conventional specification with the above modification on the deflators for the following reasons. The closest substitute for money is nominal assets, and their return, while positively correlated with the real interest rate, has been found to dominate the effect of the real interest rate through expenditures. Therefore we will use the nominal interest rate. Secondly, time deposits, which are part of "bonds", dominate money as an asset to hold. Therefore wealth does not belong in the demand function for transactions balances (for empirical evidence, see Ando and Shell, 1975, and Goldfeld, 1973).

Eq. (3) is the uncovered interest parity condition: the nominal interest rate is the sum of the given foreign rate and the expected depreciation of the exchange rate.

The change in nominal wealth in Eq. (4) is a function of the change in the exchange rate, the nominal trade balance, and foreign interest earnings, as derived in Appendix 1.

The expenditure equation (5) is obtained as follows. The original equation specifies expenditures, in terms of the expenditure basket of goods, as a function of income in terms of the same basket $\left(y + p^d - p\right)$ i.e., nominal income $\left(y + p^d\right)$ deflated with the expenditure price. Income also includes interest on foreign securities $\left(z_f(\cdot)\right)$, where the amount of foreign securities in terms of foreign currency $\left(f\right)$ is exogenous in the short run but endogenous in the long run due to current account imbalances. Expenditures are also a function of the real interest rate (the nominal rate minus the expected inflation rate of the expenditure price) and real wealth (nominal wealth minus the expenditure price level). These expenditures are inflated into nominal terms with the expenditure price, and the resulting equation is deflated with the domestic good price, as expressed in the fourth term, since the goods market equation (1) is expressed in terms of the domestic good. Finally, the resulting equation is multiplied through by $x_\varepsilon = E / Y$, where E and Y are the levels of expenditures and income, to make it additive with the other terms of equation (1). The resulting "elasticities" $\left(z_i\right)$, defined as a percentage of income rather than of expenditures, are thus normally lower in value than those of the original expenditure function.

The trade balance in Eq. (6) is specified as a function of expenditures, as argued in the Introduction, and the real exchange rate ($p^d - e$), the foreign currency price of

foreign goods being constant.The equation has been multiplied through by $x_t \equiv T/Y$ for the same reason as the expenditure equation.

Eq. (7) defines the expenditure price as a weighted average of domestic and foreign goods prices.[2] Eq. (8) is the reduced-form expression for the supply side, as derived in Appendix 2. Since the consensus on the neutrality of money holds under ultra-rational labor behavior, we assume that the supply of labor is a function of the real wage in terms of the expenditure basket of goods. It is shown in the Appendix that γ_1 is positive and finite in this model. This implies that there is no fixed natural rate of unemployment in an open economy, but the aggregate supply curve is rising. The γ_2 equals unity. Thus the domestic good price rises proportionately to depreciation in the real-wage model.

Equations (9) and (10) are Equations (7) and (8), respectively, differentiated with respect to time. Finally, rational expectations are imposed by assuming that $\hat{\dot{p}}^d, \hat{\dot{p}}$, and $\hat{\dot{e}}$, equal $\dot{p}^d, \dot{p}$, and $\dot{e}$, respectively.

The model reduces to three differential equations in y, e, and v:

$$\begin{bmatrix} \dot{y} \\ \dot{e} \\ \dot{v} \end{bmatrix} = \begin{bmatrix} \eta\Omega_1 & \eta\Omega_2 & \eta\Omega_6 \\ \Omega_3/\alpha_r & 1/\alpha_r & 0 \\ \Omega_5 & \Omega_7 & \phi \end{bmatrix} \begin{bmatrix} y \\ e \\ v \end{bmatrix} + \begin{bmatrix} -\eta X_g g & +s_1 \\ -m/\alpha_r & +s_2 \\ \left[\delta\psi t_\varepsilon/\left(1-t_\varepsilon\right)\right] X_g g - \left(\delta/\alpha_r\right) m & +s_3 \end{bmatrix} \qquad (11)$$

where

$$\eta \equiv 1/\left[a\left(1-t_{\varepsilon}\right)\gamma_1 z_r\right]>0$$

$$\Omega_1 \equiv 1-\left(1-t_{\varepsilon}\right)\left[z_y-\gamma_1 A\right]+\gamma_1 z_p>0$$

$$\Omega_2 \equiv \left(1-t_{\varepsilon}\right)\left(z_v+z_f\right)>0$$

$$\Omega_3 \equiv \alpha_y+\gamma_1\left[\alpha_y(1-a)+a\right]>0$$

$$\Omega_5 \equiv \delta\left\{\Omega_3/\alpha_r-\psi\left[\gamma_1\left(z_p-1+t_{\varepsilon}\right)+t_{\varepsilon}\right]/\left(1-t_{\varepsilon}\right)\right\}$$

$$\Omega_6 \equiv -\left(1-t_{\varepsilon}\right)\left(z_v+z_f/\delta\right)<0$$

$$\Omega_7 \equiv \delta\left[\left(1/\alpha_r\right)-\phi\right] \qquad \left(>0\right)$$

$$A \equiv \left(1-a\right)\left(x_{\varepsilon}-z_y\right)+a\left(z_v+z_f\right) \qquad \left(>0\right)$$

$s_i \equiv$ parameters and exogenous variables.

Of the parameter combinations, Ω_1 is positive if an increase in income increases the demand for output by less than the income increase, i.e. if the national income multiplier is finite. We assume this to be the case specifically because the demand rise is dampened by the effects of the ensuing price rise on real wealth, expenditures, and the trade balance. The Ω_2 is the effect of the exchange rate on the

excess supply of output. It is positive in the real wage model ($\gamma_2 = 1$) due to the wealth effect: depreciation of the exchange rate increases the domestic price level proportionally (Eq. 8), which leaves the real exchange rate unchanged and reduces real wealth, real domestic interest earnings, and total demand. Ω_3 is the effect of income on the demand for nominal cash balances. It is positive, because the income and price elasticities of the demand for money are both positive.[3]

The Ω_6 is negative as the effect of nominal wealth on the excess supply of goods. The Ω_7 is positive: we will assume for the time being that the terms involving interest payments on foreign securities (ϕ, z_f) are dominated by the rest of the terms in the expressions.

The endogenous-variable Jacobian (D_1) is negative with commonly obtained parameter values. Since it equals the product of the eigenvalues, this implies that either all the eigenvalues are negative (global stability), or two are positive and one is negative (saddlepoint stability). The trace is positive. This rules out global stability. The equilibrium is therefore saddlepoint stable, with one negative and two positive eigenvalues.

3. THE POLICY EFFECTS

The steady-state effects are obtained by constraining $\dot{y}, \dot{e},$ and $\dot{v}$ to zero.

We obtain:

$$y = \left(1 / D_2\right)\left(\phi / \psi\delta\right)\left(1 - t_\varepsilon\right)\left(1 - \delta\right)z_v m + s_4 \quad \left(> 0\right) \tag{12}$$

$$e = \left(1/D_2\right)\left\{\left(z_v + z_f/\delta\right)\left[t_\varepsilon + \gamma_1\left(z_p - 1 + t_\varepsilon\right)\right] - \left(\phi/\psi\delta\right)\Omega_1\right\}m + s_5 > 0 \qquad (13)$$

$$p^d = \left(1/D_2\right)\left\{\left(z_v + z_f/\delta\right)\left[\gamma_1\left(z_p - 1 + t_\varepsilon\right) + t_\varepsilon\right] + \left(\phi/\psi\delta\right)\left\{\gamma_1\left(1 - t_\varepsilon\right)\left(1 - \delta\right)z_v - \Omega_1\right\}\right\}m + s_6 \qquad (14)$$

$$v = \left(1/D_2\right)\left\{\left(z_v + z_f\right)\left[t_\varepsilon + \gamma_1\left(z_p - 1 + t_\varepsilon\right)\right] + \left(\phi/\psi\delta\right)\Omega_1\right\}m + s_7 \quad \left(>0\right), \qquad (15)$$

where $D_2 \equiv -\left[a\alpha_r z_r \gamma_1\left(1 - t_\varepsilon\right)/\psi\delta\right]D_1 \quad > 0$

The insights we are looking for can be obtained more simply by means of a comparative statics exercise. In doing so we can avoid much complication associated with an explicit treatment of the dynamics, for which the reader is referred to Ahtiala (1998).

First examine the short-run or flow equilibrium effects of monetary expansion, which are obtained from the goods and money market equations in Eq. (11). In this "equilibrium", the goods and money markets clear, but real wealth need not equal its desired value.

$$y = -\left(1/D_3\right)\Omega_2 m < 0 \qquad (16)$$

$$e = \left(1/D_3\right)\Omega_1 m > 0 \qquad (17)$$

where $D_3 \equiv \Omega_1 - \Omega_2\Omega_3$ is positive as a condition for the stability of the flow equilibrium.

The unanticipated monetary expansion depreciates the exhange rate, as the central bank purchases bonds from foreigners at the exogenous interest rate, given that the desired bond portfolio of domestic agents remains unchanged. The depreciation increases domestic goods prices proportionately, since $\gamma_2 = 1$, leaving the real exchange rate (and thereby the real domestic currency value of foreign assets and their interest yield) unchanged for a given level of income. However, it reduces the real value of domestic nominal assets and their interest earnings. The decline in real wealth and real income causes expenditures on domestic and imported goods to decline. Thus output and imports decline: monetary expansion is contractionary in the short run.

The decline in imports turns the trade balance towards, and the current account into, surplus. The current account surplus increases the amount of foreign securities and thereby real wealth, which increases expenditures and output. The new foreign securities differ from the domestic securities, whose decline, in real terms, they make up for in the private sector's portfolio: They also cause an increase in foreign interest earnings. This has a dual effect: in addition to increasing real income, they add to the current account surplus. The increase in income, together with the wealth effect, increases imports, which moves the system towards current account equilibrium and appreciates the exchange rate, whose pattern is the conventional overshoot mode: The multiplier of m in Eq. (17) is greater than unity, while that in Eq. (13) is smaller than unity, as long as $\delta < 1$ and there are domestic securities in the country. However, the foreign interest earnings have increased current account receipts. Thus current account equilibrium calls for a greater trade balance deficit and imports. The equilibrium is therefore attained at greater income, nominal wealth, and exchange

rate levels than initially. Consequently, the steady state effect of monetary expansion is *expansionary*. Thus output first declines, to rise above its original level. The reason is the wealth effect and foreign interest receipts. Because this reversal of output from an initial decline to a net increase holds only for the steady state effects, its practical significance should not be exaggerated, however.

The above holds for a net creditor. For a net debtor, f is foreign debt so that ϕ, δ, and z_f are all negative (see Eq. (5) and Appendix 1). As seen, the same qualitative policy effects hold, as long as z_v dominates z_f or z_f / δ in the expressions: A policy leading to an increase in assets has similar effects on expenditures and the current account as one leading to a decline in liabilities.

The conventional long-run neutrality of money obtains if either $z_f = \phi = 0$, or $z_v = 0$: if foreign interest earnings or the wealth effect were zero. If foreign interest earnings are zero, the whole adjustment falls on the wealth effect. Again, the real value of domestic assets declines initially. The trade balance surplus during the transition does not lead to an increase in foreign interest earnings. Thus no increase in income and current account receipts takes place due to foreign interest earnings. Nominal wealth increases by the trade balance surplus, until real wealth and output have reached their original levels. The exchange rate also overshoots its long-run value.

If the wealth effect is zero, the adjustment falls on foreign interest earnings in a corresponding way. Now the real interest earnings on domestic securities decline, which leads to a decline in aggregate demand and a current account surplus. This increases foreign assets and foreign interest earnings, until the original total output level is attained. The exchange rate remains depreciated also because foreign

interest earnings cause current account equilibrium to be reached sooner, after a smaller appreciation.

However, if both z_v and z_f are zero, monetary expansion has no real effects even in the short run, the exchange rate and domestic goods prices rising proportionately to the monetary increase. Now the declines in the real value of, and real interest earnings on, domestic securities have no effect on total demand so that the current account adjustment does not work: the coefficient matrix in Eq. (11) is singular so that we are left with Eqs. (16) and (17). There, Ω_2 is zero, making the multiplier of Eq. (16) zero and of Eq. (17) one: Monetary expansion has no real effects. It only increases the exchange rate and domestic goods prices proportionally. The simultaneous absence of the wealth and foreign interest effects is therefore necessary for the monetarist policy effect in a more general model (for more general conditions in another model, see Ahtiala, 1984).

However, the long-run exchange rate response is sensitive to the assumption that foreign interest receipts are small relative to the trade balance. If this is not the case and the multiplier of (m) in Eq. (13) is negative, monetary expansion leads to an *appreciation* of the exchange rate. The output effect remains expansionary, however. The reason is as follows. The initial depreciation caused a decline in real wealth, leading to a trade balance surplus. The surplus causes the stock of foreign securities to increase. This may increase their interest income by so much that current account equilibrium calls for the trade balance to decline below its initial level. This would require the exchange rate to appreciate "below" its initial value. While this may be a theoretically interesting detail, we are sceptical about its practical significance except maybe near trade balance equilibrium.[4,5]

Neutrality of money would also result if wealth consisted only of foreign securities ($\delta = 1$; Eq. (12)). In this case, there would be no domestic securities whose real value or real interest earnings would decline in response to the depreciation. Real wealth and real interest earnings would now be independent of the exchange rate in Eq. (5), as both their nominal domestic currency value and their deflator would change proportionally to this rate. The exchange rate would depreciate proportionally to the monetary expansion. These results hold also if imports are specified only as a function of income and the real exchange rate.

Of course, prices rise in response to monetary expansion.

4. CONCLUSION

We have developed an extended Mundell-Fleming model where both real balances and income in their demand function are specified in terms of the expenditure basket of goods, to determine whether money is neutral under flexible exchange rates. In addition, foreign interest earnings are incorporated, imports specified as a function of expenditures as part of expenditures, and the wealth effect incorporated in the expenditure function. Finally, labor supply is specified as a function of the real wage in terms of the expenditure basket of goods.

It was shown that monetary expansion is typically expansionary in the long run after being contractionary in the short run both for net creditors and – with a minor qualification – net debtors. The response of the exchange rate is, however, sensitive

to the assumption that foreign interest receipts are small relative to the trade balance. If this is not the case, monetary expansion appreciates, rather than depreciates, the exchange rate, while remaining expansionary. The conventional long-run neutrality of money is achieved if one abstracts from the wealth effect or that of foreign interest payments; If both are abstracted from, money is neutral also in the short run, the current account adjustment mechanism being invalid. Short- and long-run neutrality results also if wealth consists only of foreign securities. If one does not find the absence of such effects in a small open economy realistic, he also has to conclude that money is not neutral in that economy.

While the supply side regime has an important effect on the policy responses, the same is not true of wage rigidities. Wage rigidities are a special case of the model as long as the labor market is demand-constrained, and do not cause qualitative changes in the results.

While most of the features we have discussed turned out to have qualitative effects, we do not know how important they are, as many of the elasticities have been estimated from models we claim to be internally inconsistent. There are therefore interesting avenues for empirical work on many of the key functions of an open economy, specifically that of the money demand function, along the lines we have argued for. On the theoretical side, we certainly have not explored all the avenues in trying to improve our understanding of the open economy.

APPENDIX 1. The Change in Nominal Wealth

Eq. (4) is derived from the following model. Nominal wealth (v) consists of money (m), domestic bonds (b) and foreign bonds (f) in terms of domestic currency, all in logs:

$$v = \rho m + \zeta b + \delta\left(e + f\right) \qquad \text{(A1)}$$

Differentiating (A1) with respect to time gives, observing that monetary policy is executed by discretionary and discrete open market operations:

$$\dot{v} = \delta\left(\dot{e} + \dot{f}\right) \qquad \text{(A2)}$$

The change in foreign bonds ($\dot{f}$) is a function of the nominal trade balance and the interest earnings on foreign securities, both in foreign currency:

$$\dot{f} = \psi\left(x_t t + p^d - e\right) + \phi\left(r^* + f\right) \qquad \text{(A3)}$$

Substituting (f) from (A1) into (A3), and the resulting equation into (A2) gives Eq. (4).

APPENDIX 2. The Supply Side

Equation (8) is a semi-reduced form of the following supply side specification:

$$y = \tau n + \kappa \bar{c} \qquad \text{(B1)}$$

$$w^d = \ln Y_N + p^d \qquad \text{(B2)}$$

$$w^s = \beta n + \pi p \qquad \text{(B3)}$$

$$w^s = w^d \qquad \text{(B4)}$$

$$p \equiv a p^d + (1-a) e \qquad \text{(7)}$$

Eq. (B1) is the production function, where output is a function of employment (n) and the given capital stock (c). In Eq. (B2), the demand wage w^d is the value of the marginal product of labor, Y_N being the partial of Y with respect to N, the respective level variables. The supply wage w^s in Eq. (B3) is a function of employment and the expenditure price, as called for by rational labor behavior, and π equals unity. Eq. (B4) is the equilibrium condition for the labor market and Eq. (7) the definition of the expenditure price.

We obtain from Eqs. (B1) through (7), observing that $Y_N = \tau Y / N$:

$p^d = \gamma_1 y + \gamma_2 e + \gamma_3$, where (B5)

$\gamma_1 \equiv \left(\beta - \tau + 1\right) / \tau\left(1 - a\pi\right)$

$\gamma_2 \equiv \pi\left(1 - a\right) / \left(1 - a\pi\right)$

$\gamma_3 \equiv -$ (ln $\tau + \left(\beta + 1\right)\kappa c / \tau$) $/ \left(1 - a\pi\right)$

The π equals unity in the real wage model. Therefore the denominators of the expressions for the γ_i in Eq. (B5) are always positive and finite. This produces the often neglected fact that the classical dichotomy breaks down in an open model, making the model simultaneous, with a rising aggregate supply curve: there is no fixed natural rate of unemployment in this model. The reason is that when p^d rises due to an increase in aggregate demand, all else equal, the labor supply curve shifts up by only ap^d, or by less than the demand curve, since imported goods prices remain unchanged. We find that γ_1 is always positive except if $\beta = 0; \tau = 1.$ The γ_2 is unity in the real wage model.

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NOTES

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[1] Another branch of the NCE tradition based on intertemporal utility maximization to derive, inter alia, the consumption function, incorporates the future repayment of any debt (see the work of Obstfeld and Rogoff, e.g. 1995). However, the absence of market failures in many versions of these models leads to several conclusions that practical policy-makers find hard to accept as descriptions of "normal" situations. Moreover, when it comes to current account imbalances, countries are concerned mainly with their debt–GDP ratios. As long as this ratio is below a number approaching unity (the good housekeeping limit of the EU being 60 %), countries and firms take on new debt without planning to repay it, but roll over their maturing debts.Of course, the inclusion of the repayment of the debt in the optimization is relevant for countries with critically high debt/GDP ratios.

Of course, the NCE approach has recently been modified by imposing ad hoc market failures like credit constraints or Blanchard-type non-neutrality. Then, when the models are made to account correctly for the critical rigidities and imperfections in the economy, their predictions need not substantially differ from those of the EMF model, as Dornbusch (1990) has pointed out. Moreover, Buiter (1990) has argued that if the

effects of wealth accumulation are included in a consumption function which is not forward-looking, results qualitatively similar to the Blanchard model are obtained.

[2] Of course, the model would have the same properties if the two composite goods were traded goods and non-traded goods, where the traded good price would be e and the non-traded good price p^d. The expenditure price p would be as in Eq. (7).

[3] Decompose Equation (2), with Equations (7) and (8) substituted in. Given the level of y, a decline in e a) increases real balances by 1, b) by increasing real income in terms of the expenditure basket of goods, leaves the demand for real balances unchanged, as the increase in p^d equals that in e in Eq. (2). There is thus an excess supply of real balances.

[4] Branson and Buiter (1983) specify the demand for money, in terms of the expenditure basket of goods, as a function of real income in terms of the domestic good, and characterize the supply side as either a fixed price of domestic output $(\gamma_1 = \gamma_2 = 0)$ or as fixed output $(\gamma_1 \to \infty)$. In their fixed output case they get the same price effects as the money wage version $(\gamma_2 = 0)$ of our model with $\alpha_y < 1$. They assume that $\Omega_2 < 0$. We would get the last condition as a result in the money wage model, whereas in the real wage model the opposite holds.

Argy and Salop (1979) specify the demand for money like Branson and Buiter and assume that the government's expenditure elasticity for the demand for imports is the same as that of the private sector. They obtain a neutral income effect from monetary expansion in the real wage model, which results from the absence of the wealth effect.

Krugman et al. (1978) study the short-term effects of devaluation. They keep nominal wages fixed in domestic currency and get a contractionary output effect from devaluation, based on such factors as an initial trade balance deficit, differences in marginal consumption propensities from profits and wages, and export taxes.

[5] Other earlier studies have obtained zero income responses in the real wage model with both fiscal and monetary policy. This results from the absence of the wealth effect $(z_v = 0)$, of foreign interest payments ($\phi = z_f = 0$), of the effect of the exchange rate on the demand for money (zero rather than unity), and/or from the specification of the classical model as implying a constant labor supply rather than the real wage model $(\gamma_1 \to \infty)$ (Dornbusch, 1975, Dornbusch and Fischer, 1980, Allen and Kenen, 1980). This is consistent with Eq. (12). Ahtiala (1987) obtains an overshooting appreciation with a decline in nominal wealth in response to foreign monetary expansion.

Of course, many of these conditions hold in the closed economy version of our model so that money is neutral in that version.