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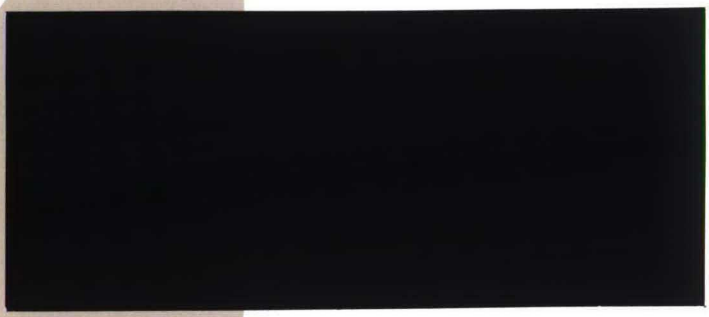

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MONETARY DISINFLATION, FISCAL EXPANSION AND THE CURRENT ACCOUNT IN AN INTERDEPENDENT WORLD

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ABSTRACT

A two-country, intertemporal, perfect-foresight model with micro foundations, Cobb-Douglas preferences and technologies, floating exchange rates, uncovered interest parity, and nominal wage rigidities is formulated. The transient and steady-state effects of a joint and unilateral monetary disinflation and a fiscal expansion are analysed. The foreign repercussions of monetary and fiscal policy do not affect the home economy, so that the multipliers are the same as for a small open economy. Since Ricardian debt neutrality holds, the nominal interest rate is equal to the rate of time preference plus the discounted average of future, expected monetary growth rates and is independent of fiscal policy and foreign policies. Also, monetary disinflation does not lead to overshooting of the nominal exchange rate. To give a non-trivial role to wealth effects, current-account dynamics and the nominal exchange rate, and to allow for more interesting international spill-over effects, the model is extended to allow for finite lifetimes so that Ricardian debt neutrality no longer holds. The transient effects of tax-financed and debt-financed changes in monetary growth and government spending are discussed.

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CONTENTS

1. Introduction

The assumption of risk-neutral arbitrage in efficient foreign exchange markets and infinitely flexible exchange rates is often combined with the assumption of nominal wage rigidity, as incorporated in the expectations-augmented Phillips curve, in modern open economy macroeconomics. Such extended Mundell-Fleming models imply that a monetary disinflation leads to an immediate appreciation of the exchange rate which overshoots its equilibrium value (Dornbusch, 1973). The cumulative output loss is independent of whether a gradualist or cold-turkey disinflation programme is implemented, so that the same model can be used to analyse the effects of successive reductions in monetary growth as was done in the Medium Term Financial Strategy of the Thatcher regime (Buiter and Miller, 1982). A fiscal expansion in such models of small open economies typically has no real effects, because the real exchange rate immediately jumps to its long-run value and the resulting contraction in net exports exactly off-sets the increase in government spending. These models can be extended to allow for wealth effects and current-account dynamics (along the lines of Dornbusch and Fischer, 1980). In interdependent economies with highly integrated financial markets and floating exchange rates, a monetary expansion is typically a beggar-thy-neighbour policy as far as employment and output is concerned. The reason is that the downward pressure on interest rates and incipient capital outflows are choked off by a depreciation of the real exchange rate which reduces net exports of the foreign country. However, the depreciation of the real exchange rate reduces real income at home and increases real income abroad. On the other hand, a fiscal expansion is a locomotive policy as far as employment and output is concerned because the

incipient capital inflows arising from the upward pressure on the interest rate lead to an appreciation of the real exchange rate. Turnovsky (1986), van der Ploeg (1986) and Branson (1988) discuss the own and spill-over effects of unanticipated and anticipated changes in monetary and fiscal policy. Two-country exchange-rate overshooting models have been extensively used to analyse issues of international policy coordination (Miller and Salmon, 1985; Currie and Levine, 1985; Oudiz and Sachs, 1985). One finds that non-cooperative monetary disinflation occurs excessively fast. The reason is that individual governments ignore the adverse consequences on foreign real income and thus attempt to export inflation and disinflate too fast. It is also possible to show that international policy coordination may be counter-productive, because it worsens the problem of maintaining credibility with the private sectors (Rogoff, 1985; van der Ploeg, 1988a). The reason is that, when governments do not cooperate, there is a disincentive to renege and implement a surprise increase in monetary growth as the resulting depreciation of the exchange rate leads to inflation costs. Under international policy coordination there is no such disincentive to renege and therefore governments end up with higher inflation and lower welfare.

The literature discussed above addresses important and interesting policy issues, but it suffers from the use of ad-hoc macroeconomic models. The objective of this paper is to reconsider these policy issues within the context of two-country models with micro foundations. The advantages of such an approach are that the intertemporal budget constraints of the governments and private sectors are modelled in a consistent manner, that wealth effects and current-account dynamics are taken account of, that the welfare

functions are directly related to the utility of the representative consumer, and that the model is less susceptible to the Lucas (1976) critique of econometric policy evaluation. Section 2 formulates a two-country model with imperfect substitution between home and foreign goods, perfect substitution between home and foreign government bonds, no currency substitution, international labour immobility, Cobb-Douglas preferences and technologies, and unemployment caused by nominal wage rigidities. There is no capital formation in order to stay as close as possible to the literature on two-country, real exchange-rate overshooting models (see Giovannini, 1988; Obstfeld, 1988; and van der Ploeg, 1988b for a discussion of capital formation in a full-employment setting). Since households are assumed to have infinite lifetimes, Ricardian debt neutrality (e.g., Barro, 1974) holds and therefore bond-finance and tax-finance are equivalent. It follows that there is only a trivial role for current-account dynamics. In fact, the main channel of international transmission familiar from ad-hoc Mundell-Fleming model disappears as the nominal interest rate is independent of fiscal policy and of changes in foreign policies. The nominal interest rate turns out to be the sum of the pure rate of time preference and the average of future, expected monetary growth rates. Section 3 decomposes the two-country model into global averages and global differences, which permits a tractable analysis, and Section 4 discusses the steady-state properties. One of the key properties of the model is that the large-economy multipliers are the same as the small-economy multipliers, since the repercussions of home policy on the rest of the world do not affect the home economy. A related property is that the real exchange rate adjusts to ensure that the balance of trade is continuously in equilibrium. A similar result has been obtained by Rankin (1987) in a two-period, two-country model. Section 5 argues that

monetary disinflation no longer leads to overshooting of the nominal exchange rate, despite the fact that adjustment in the labour markets is sluggish. Monetary disinflation does lead to transient job losses, but this arises purely from the sluggishness of nominal wages. Section 6 considers a joint and unilateral fiscal expansion. Section 7 extends the model to allow for sluggish core inflation. Although there are now international spill-over effects, the nominal interest rate is unaffected by fiscal policy and by foreign policies. Also, subsequent to a monetary disinflation, the nominal exchange rate does not overshoot but jumps straight to its new value. As far as the cumulative deviations of output from its natural level are concerned, a monetary disinflation has no spill-over effect whilst a fiscal expansion has a beggar-thy-neighbour effect. Section 8 relaxes Ricardian debt neutrality by allowing for finite lifetimes (Blanchard, 1985). This gives a role for current-account dynamics and non-trivial international spill-over effects of monetary policies, because the nominal interest rate and the nominal exchange rate can now be affected by fiscal policies and by foreign policies. Section 9 considers debt finance, which gives a non-trivial role for fiscal policy as well. Section 10 concludes the paper.

2. A two-country model with nominal wage rigidities

The world consists of two economies with identical preferences and identical technologies. The foreign variables are denoted by an asterisk. There is imperfect substitution between home and foreign goods and each country is wholly specialised in the production of a single good. The asset menu of consumers consists of home government bonds, foreign government

bonds and home cash, so that there is no currency substitution. However, there is perfect substitution between home and foreign government bonds. Risk-neutral arbitrage then implies that uncovered interest parity holds. There is a regime of floating exchange rates. The demand side of each economy consists of a representative household with an inelastic supply of labour, Cobb-Douglas preferences over home goods, foreign goods and real money balances, and a unit elasticity of intertemporal substitution. The resulting consumption functions are linear in human plus non-human wealth. The supply of goods in each economy comes from a neoclassical labour demand schedule and production function. There is no labour mobility between the two countries. Wage formation in each country is determined by an augmented Phillips curve, which incorporates the assumption of nominal wage rigidity. The government services its debt, spends on home goods, levies lump-sum taxes and finances the resulting deficit by printing money or by borrowing from the private sector. In fact, it will be assumed that taxes adjust to balance the government's budget continuously and thus to maintain a constant stock of real government debt. Hence, the government's two exogenous policy instruments are nominal money growth and government spending. Changes in non-human wealth therefore equal changes in real money balances plus changes in net foreign assets, where the latter changes follow from the current-account dynamics. Ricardian debt neutrality (e.g., Barro, 1974) ensures that this assumption about tax adjustment is not very restrictive, because any increase in government bonds and non-human wealth is exactly off-set by a decrease in human wealth as any increase in borrowing must eventually be paid for by increases in future taxes. There is perfect foresight.

The representative household maximises at instant t its utility function,

$$U(t) = {}_{o}\int^{\infty} \exp[-\rho(s-t)]\,[\gamma_1 \log(C_d(s)) + \gamma_2 \log(C_m(s)) + \gamma_3 \log(M(s))]\,ds,$$

$$\gamma_1, \gamma_2, \gamma_3 \geq 0, \qquad \gamma_1 + \gamma_2 + \gamma_3 = 1 \qquad (2.1)$$

subject to the household's budget constraint,

$$dN(s)/ds = r(s)N(s) + W(s)L(s) - T(s) - C_d(s) - E(s)C_m(s) - i(s)M(s) \qquad (2.2)$$

where ρ denotes the subjective rate of time preference, and $U(t)$, $C_d(t)$, $C_m(t)$, $M(t)$, $N(t)$, $T(t)$, $L(t)$, $W(t)$, $r(t)$, $i(t)$ and $E(t)$ denote utility, consumption of home goods, consumption of foreign goods, holdings of real money balances, non-human wealth, lump-sum taxes, employment, the real wage, the real interest rate, the nominal interest rate and the real exchange rate (the price of foreign goods in terms of home goods) at time t, respectively. The real interest rate at time t is defined as $r(t) \equiv i(t) - p(t)$ where $p(t)$ denotes the rate of inflation at time t. Feenstra (1985) provides a justification, based on liquidity costs, for entering money in the utility function. If one defines total consumption (including the interest foregone on money holdings) at time t as

$$C(t) = C_d(t) + E(t)C_m(t) + i(t)M(t), \qquad (2.3)$$

one obtains the first-order conditions, $C_d(t)=\gamma_1 C(t)$, $C_m(t)=\gamma_2 C(t)/E(t)$, $M(t)=\gamma_3 C(t)/i(t)$ and the tilt of the total consumption function, $dC(t)/dt=[r(t)-\rho]C(t)$. These follow from the fact that the marginal rate of substitution between home and foreign goods must equal the real exchange rate and between home goods and real money balances must equal the opportunity cost of holding real money balances, i.e., the nominal interest rate. The assumption of Cobb-Douglas preferences implies a unit elasticity of imports with respect to the relative price of foreign goods and a unit elasticity of money with respect to the nominal interest rate. The tilt says that consumption increases (decreases) over time, i.e., households save relatively more in the early parts of their life, if the real interest rate exceeds (is less than) the subjective rate of time preference. Total consumption at time t can be written as a linear function of total wealth, $C(t)=\rho[N(t)+H(t)]$ where human wealth is the discounted value of the stream of present and future after-tax wage income,

$$H(t) \equiv {}_t\int^{\infty} \exp[-{}_t\int^{s} r(s')ds'] \, [W(s)L(s) - T(s)] \, ds, \qquad (2.4)$$

and non-human wealth is the sum of bond holdings, $B(t)$, money holdings, $M(t)$, and a fixed stock of capital or land, say $K_0=1$.

There is no lag between production, sales and income. Firms produce at home under perfect competition and subject to a Cobb-Douglas production function, say $Y=f(L,K_0)=L^{\beta}$, $0<\beta<1$ where Y denotes output. Because the marginal productivity of labour diminishes, both employment and aggregate supply are decreasing functions of the real producers' wage, $L=L(W)\equiv(\beta/W)^{1/(1-\beta)}$ and $Y=Y(W)\equiv(\beta/W)^{\beta/(1-\beta)}$. The other factors of production,

i.e., capital or land, are fixed and are paid their marginal products, so that profits are zero. Nominal wages are rigid and are above the market-clearing level in the short run, so that households are rationed in their supply of labour and there is unemployment. Hence, effective labour supply is given by labour demand and this is what determines income, human wealth and consumption. Nominal wage rigidity is captured by the augmented Phillips curve,

$$\omega(t) + p(t) = \alpha \log[L(t)/(1-u_n)] + \pi(t), \qquad \alpha > 0, \tag{2.5}$$

where u_n denotes the natural rate of unemployment, $\omega(t) \equiv [dW(t)/dt]/W(t)$ denotes the rate of growth in the real wage, and $\pi(t)$ denotes the rate of core (or trend) inflation. Hence, nominal wage inflation decreases with the unemployment rate and increases one-for-one with core inflation. Core inflation is given by monetary growth, $\pi(t) = \vartheta(t)$ where $\vartheta(t)$ denotes the growth rate in the nominal supply of outside money. Alternatively, core inflation gradually catches up with inflation in the CPI, p_c, that is

$$d\pi(t)/dt = \mu [p_c(t) - \pi(t)], \qquad \mu > 0. \tag{2.6}$$

If the opportunity costs of holding real money balances are ignored, inflation of the ideal cost-of-living index or CPI can be written as a weighted average of inflation of home and foreign prices:

$$\begin{aligned} p_c(t) &= p(t) + \gamma_2 (dE(t)/dt)/E(t) + \gamma_3 (di(t)/dt) i(t) \\ &\cong p(t) + \gamma (dE(t)/dt)/E(t) \end{aligned} \tag{2.7}$$

where the value-share of imports in final expenditures is approximately equal to the parameter γ.

The government's budget constraint can be written as

$$dD(t)/dt = r(t)D(t) + G(t) - T(t) - \vartheta(t)M(t), \qquad D(0)=D_0, \tag{2.8}$$

where $D(t)$ and $G(t)$ denote real government debt issued to home and foreign households and real government spending on home goods at time t, respectively. Integration of (2.8) and solvency of the government's finances gives

$$D(t) = {}_t\int^{\infty} \exp[-{}_t\int^{s} r(s')ds'] \, [T(s) + \vartheta(s)M(s) - G(s)] \, ds, \tag{2.9}$$

so that the current government debt plus the discounted stream of present and future levels of government spending has to be paid off by the discounted stream of present and future lump-sum taxes plus seigniorage revenues. Since debt neutrality prevails, we may as well assume that lump-sum taxes adjust to maintain a constant stock of government debt, $T=rD+G-\vartheta M$, and $D(t)=D_0$ for all $t \geq 0$. Hence, the two exogenous policy instruments are ϑ and G.

Equilibrium in the money market is given by

$$dM(t)/dt = [\vartheta(t) - p(t)] \, M(t), \tag{2.9'}$$

where the initial price level and holdings of real money balances are unconstrained by their past histories as they depend on expectations of future events. Equilibrium in the home goods market at time t is given by

$$Y(t) = C_d(t) + G(t) + C_m^*(t), \tag{2.10}$$

where $C_m^*(t)$ denotes exports of the home country to the foreign country at time t. Net holdings of foreign assets, F, are the excess of households' holdings of bonds over government debt, that is F≡B-D. Equilibrium in the world market for government bonds requires $B+EB^* = D+ED^*$. Interest payments on net foreign assets plus the balance of trade gives the current account, which equals the increase in the nation's wealth:

$$dF(t)/dt = r(t)F(t) + C_m^*(t) - E(t)C_m(t), \qquad F(0)=0. \tag{2.11}$$

Integration of (2.11) and the country's solvency condition gives

$$-F(t) = {}_t\int^{\infty} \exp[-{}_t\int^{s} r(s')ds'] \, [C_m^*(s) - E(s)C_m(s)] \, ds, \tag{2.11'}$$

which says that the nation's current debt has to be paid off by future savings surpluses of the government and private sector. Finally, risk-neutral arbitrage between home and foreign government bonds gives uncovered interest parity,

$$r(t) = r^*(t) + [(dE(t)/dt)/E(t)], \tag{2.12}$$

which was already assumed in equations (2.2) and (2.11).

The complete two-country model also includes foreign analogues of the relationships discussed for the home country above where $E^*=1/E$ and $F^*=-F/E$.

3. Global averages and differences: A linear state-space representation

Log-linearisation of the home part of the model yields $c_d=c$, $c_m=c-e$, $i = \gamma_3 C/M \cong \eta(c-m)$, $\eta \equiv \rho+\vartheta(\infty)$, $\ell=-w/(1-\beta)$, $y=-w\beta/(1-\beta)$, $r=r^*+(de/dt)$, $p_c=p+\gamma(de/dt)$,

$$y = -\beta' w = \xi_1 c + \xi_2 g + \xi_3(c^*+e) = (1-\xi_2)c + \xi_2 g, \quad \beta' \equiv \beta/(1-\beta) > 0,$$

$$\xi_1, \xi_2, \xi_3 \geq 0, \quad \xi_1 + \xi_2 + \xi_3 = 1, \tag{3.1}$$

$$\dot{m} = \vartheta - p \cong \vartheta + r - \eta(c-m), \tag{3.2}$$

$$\dot{w} = \alpha\ell + \pi - p \cong -\alpha' w + \pi + r - \eta(c-m), \qquad \alpha' \equiv \alpha/(1-\beta) > 0, \tag{3.3}$$

$$\pi = \vartheta \quad \text{or} \quad \dot{\pi} = \mu[\eta(c-m) - r + \gamma \dot{e} - \pi], \tag{3.4}$$

$$\dot{c} - \dot{c}^* = (r-\rho) - (r^*-\rho) = \dot{e} \tag{3.5}$$

and

$$\dot{U} = \rho U - \gamma_1 c - \gamma_2(c-e) - \gamma_3 m = \rho U - \gamma_1 c - \gamma_2 c^* - \gamma_3 m, \tag{3.6}$$

where small letters (except for i, r, ω, p, p_c, π and ϑ) denote logarithmic deviations from the equilibrium values (e.g., $c(t) \equiv \log[C(t)/C(\infty)]$), $\xi_1 \equiv C_d(\infty)/Y(\infty)$, $\xi_2 \equiv G(\infty)/Y(\infty)$ and $\xi_3 \equiv C^*_m(\infty)/Y(\infty)$. Note that the expression for the nominal interest rate is the only one that needed to be linearised. Equation (3.5) gives the real exchange rate as the ratio of home consumption to foreign consumption, $e = c - c^*$. Hence, when the home country consumes faster than the foreign country and therefore when home households save relatively more in the early part of their life than foreign households, there must be a real-interest-rate differential in favour of the home country and consequently the real exchange rate is expected to and must depreciate. It follows that the balance of trade is continuously in balance, $C^*_m(t) - E(t)C_m(t) = 0$ for all $t \geq 0$, and there is therefore no current-account dynamics. This follows from both the home and foreign government's budget being continuously in balance (e.g, Buiter, 1987), from the Ricardian debt neutrality proposition (see Section 8 for an extension) and from both countries having the same rate of time preference.

Combination of equations (3.2) and (3.5) and forward integration yields an interesting expression for the nominal interest rate:

$$i(t) = \rho + \int_t^{\infty} \vartheta^e(s,t)\ \eta \exp[-\eta\ (s-t)]ds \qquad (3.7)$$

where $\vartheta^e(s,t)$ denotes the expectation of $\vartheta(s)$ formed at time $t \leq s$. Hence, the nominal interest rate at any given point of time equals the long-run real interest rate (equal to the pure rate of time preference) <u>plus</u> a weighted average of all future, expected monetary growth rates. In particular, the nominal interest rate does not depend on fiscal policy and does not depend

on foreign policies. If there is an unanticipated, permanent change in monetary growth of $\Delta\vartheta$ at time t, then the nominal interest rate immediately jumps to its new equilibrium value $\Delta i(s) = \Delta\vartheta$, $s \geq t$.

Since the two-country model is symmetric, it is possible to decouple the dynamics into two independent sub-systems for the global averages and global differences, respectively (Aoki, 1981). Global averages are denoted by a superscript ^{a} (e.g., $m^{a} \equiv \frac{1}{2}(m+m^{*})$) and global differences are denoted by a superscript ^{d} (e.g., $m^{d} \equiv m-m^{*}$). The predetermined state variable will be $x \equiv m-w$ whilst the non-predetermined state variable(s) will be m (and π). After some algebraic manipulation, the sub-system of global averages can be written as:

$$\dot{x}^{a} = \alpha'(m^{a}-x^{a}) - \pi^{a} + \vartheta^{a}, \qquad x^{a}(0)=0 \tag{3.8}$$

$$\dot{m}^{a} = \psi(m^{a}-x^{a}) + \eta\xi_4 m^{a} - (1-\xi_4)\pi^{a} + \vartheta^{a} + \xi_4\rho + \eta\xi_5 g^{a}, \tag{3.9}$$

$$\dot{\pi}^{a} = -\mu[\psi(m^{a}-x^{a}) + \eta\xi_4 m^{a} + \xi_4(\pi^{a}+\rho) + \eta\xi_5 g^{a}], \ \Delta\pi^{a}(0) = -\mu\Delta m^{a}(0) \tag{3.10}$$

or $\pi^{a}=\vartheta^{a}$, where $\psi \equiv (1-\xi_4)(\alpha'+\eta) > 0$, $0<\xi_4 \equiv (1-\xi_2)/(1-\xi_2+\beta')<1$, $\xi_5 \equiv \xi_2/(1-\xi_2+\beta')>0$ and $c^{a}=[\beta'(x^{a}-m^{a})-\xi_2 g^{a}]/(1-\xi_2)$. Similarly, the sub-system of global differences can be written as:

$$\dot{x}^{d} = \alpha'(m^{d}-x^{d}) - \pi^{d} + \vartheta^{d}, \qquad x^{d}(0)=0 \tag{3.11}$$

$$\dot{m}^{d} = \psi(m^{d}-x^{d}) + \eta\xi_4 m^{d} - (1-\xi_4)\pi^{d} + \vartheta^{d} + \eta\xi_5 g^{d}, \tag{3.12}$$

$$\dot{\pi}^d = -\mu\{\psi(m^d-x^d) + \eta\xi_4 m^d + \xi_4\pi^d + \eta\xi_5 g^d + \xi_6[\psi-\alpha')(m^d-x^d)$$

$$+\eta\xi_4 m^d + \xi_4\pi^d + \eta\xi_5 g^d]\}, \quad \Delta\pi^d(0) = -\mu[\Delta m^d(0)-2\gamma\Delta e(0)] \qquad (3.13)$$

or $\pi^d=\vartheta^d$, where $\xi_6=2\gamma\beta'/(1-\xi_2)>0$ and $e=c^d=[\beta'(x^d-m^d)-\xi_2 g^d]/(1-\xi_2)$. The home and foreign counterparts follow immediately from the global averages and global differences; e.g., $m=m^a+\frac{1}{2}m^d$ and $m^*=m^a-\frac{1}{2}m^d$.

Consider first the case where core inflation equals monetary growth in both countries ($\pi=\vartheta$, $\pi^*=\vartheta^*$). The two sub-systems for the global averages and global differences are then completely identical. In fact, analogous sub-systems hold for the home and foreign economy. For this case each country is thus completely insulated from the rest of the world, so that neither monetary nor fiscal policy has any international spill-over effects on output or employment (see Sections 5 and 6). This is a direct consequence of the nominal interest rate being independent of foreign policies (see equation (3.7)), because in the ad-hoc, two-country Mundell-Fleming models familiar from the textbooks the main transmission channel is through the nominal interest rate. It follows that the impact, interim and final multipliers of economic policy are the same for a large open economy as for a small open economy. This is in sharp contrast to ad-hoc two-country models with nominal wage rigidities (e.g., Turnovsky, 1986; van der Ploeg, 1986; Branson, 1988). Rankin (1987) obtains a similar result for a two-period, two-country, Mundell-Fleming model with micro foundations, Cobb-Douglas preferences and Ricardian debt neutrality. However, the real exchange rate and therefore foreign real income and foreign inflation can be affected by a change in home policy. It follows that the only channel of international

interdependence is through the real exchange rate and thus the CPI, so that each country has an incentive to export CPI-inflation by appreciating its currency.

The determinant of the Jacobian of each sub-system, $-\alpha'\eta\xi_4$, is negative, so that there is one stable root corresponding to the predetermined variable x or x^* and one unstable root corresponding to the non-predetermined variable m or m^*. Hence, this perfect-foresight system satisfies the saddlepoint property (e.g, Buiter, 1984). This property is reflected in the phase diagram for the home economy (see Fig. 1). Below the 45° or dx/dt=0 locus the real wage is excessively low, so that employment and output are above their natural rates, the nominal wage is rising faster than monetary growth and real liquidity, x, is falling. The dm/dt=0 locus is flatter than the 45° line, that is it has a slope $\beta'/[(1-\xi_2)(\eta/(\alpha'+\eta))+\beta'] < 1$. Below the dm/dt=0 locus prices are rising faster than monetary growth and real money balances, m, are falling. Along the stable arm, SS, the nominal interest rate is constant and thus m-c is constant, so that SS lies on

$$m-m(\infty) = \left[\frac{\beta'}{1-\xi_2+\beta'}\right] [x-x(\infty)] < x-x(\infty) \qquad (3.14)$$

and thus along SS m increases more slowly than x and thus real wages fall along SS. It also follows that the stable arm, SS, is flatter than the two loci. The phase diagram for the foreign economy (and for the global averages or global differences) is exactly the same.

Next consider the case where core inflation gradually responds to changes in inflation in the CPI. The sub-system of global averages now differs from the sub-system of global differences and therefore there are international spill-over effects on output and employment as well. The saddlepoint property requires each sub-system to have two stable eigenvalues associated with the backward-looking variables x^a and π^a (or x^d and π^d) and one stable eigenvalue associated with the forward-looking variable m^a (or m^d). Core inflation is backward-looking but non-predetermined, because $\Delta\pi(0) = -\mu[\Delta m(0) - \gamma\Delta e(0)]$ (see Section 7). The transient properties of these three-dimensional sub-systems will be analysed in Section 7 with the aid of numerical simulation.

4. Steady-state properties

In the long run the real wage, employment and output are at their natural rates, $w(\infty)=\ell(\infty)=y(\infty)=w^*(\infty)=\ell^*(\infty)=y^*(\infty)=0$, and inflation is entirely determined by monetary growth, $p(\infty)=p_c(\infty)=\pi(\infty)=\vartheta(\infty)$ and $p^*(\infty)=p_c^*(\infty)=\pi^*(\infty)=\vartheta^*(\infty)$. The world real interest rate is in the long run given by the subjective rate of time preference, $r(\infty)=r^*(\infty)=\rho$, and nominal interest rates are given by $i(\infty)=\rho+\vartheta(\infty)$ and $i^*(\infty)=\rho+\vartheta^*(\infty)$. It follows that in the long run the inflation differential equals the rate of depreciation of the nominal exchange rate, so that relative purchasing power parity holds in the long run. The steady-state levels of consumption and the real exchange rate follow from the conditions for equilibrium in the home and foreign goods markets, that is $c(\infty)=c_d(\infty)=c_m^*(\infty)=-\xi_2 g(\infty)/(1-\xi_2)$, and $e(\infty)=\xi_2[g^*(\infty)-g(\infty)]/(1-\xi_2)$. An increase in government spending leads to an excess demand

for goods, which eventually is choked off by an appreciation of the real exchange rate. The resulting reductions in consumption and exports completely crowd out the increase in government spending, so that fiscal policy is neutral in the long run. The drop in total consumption also leads to a fall in real money balances. An increase in monetary growth leads to an equal increase in the nominal interest rate and a fall in the demand for real money balances and non-human wealth, $m(\infty)=x(\infty)=n(\infty)=-[(\rho+\vartheta(\infty))/\eta]-[\xi_2/(1-\xi_2)]g(\infty)$. If κ denotes the ratio of non-human wealth to human wealth, then the change in long-run human wealth is given by $h(\infty)=-[\xi_2/(1-\xi_2)]g(\infty)+[(\rho+\vartheta(\infty))\kappa/\eta]$. An increase in government spending leads to a fall in real money balances and seigniorage revenues, so that taxes have to increase by more than the increase in government spending and human wealth falls. An increase in monetary growth leads to an increase in seigniorage revenues, so that taxes fall and human wealth increases. Finally, asymptotic utility of the representative household is given by

$$U = -[\xi_2/(1-\xi_2)\rho][(1-\gamma_2)g(\infty) + \gamma_2 g^*(\infty)] - (\gamma_3/\rho\eta)[\rho+\vartheta(\infty)]. \qquad (4.1)$$

An increase in home government spending reduces welfare, because it crowds out private consumption and holdings of real money balances. However, if government spending is not of the hole-in-the-ground variety and instead yields direct utility, an increase in home government spending may increase welfare despite the crowding out. An increase in foreign government spending induces an increase in the relative price of foreign goods, i.e., a depreciation of the home real exchange rate, and thus a fall in home consumption of foreign goods, which reduces home welfare. This is the only form of persistent externality between the two countries and shows that, as

far as welfare is concerned, a fiscal expansion is a beggar-thy-neighbour policy. It follows that, in the absence of international policy coordination, the fiscal stance of each country is too loose as the adverse consequences on the other country are ignored (van der Ploeg, 1987). An increase in monetary growth has no international spill-over effects in the long run, because there is an equal increase in the rate of depreciation of the nominal exchange rate. However, the increase in the opportunity cost of holding money balances reduces money balances and welfare. The full liquidity rule drives the nominal interest rate to zero, i.e., $\vartheta=-\rho$, and maximises asymptotic welfare. International spill-over effects do arise when there is capital accumulation, because then an increase in monetary growth reduces the world real interest rate and increase capital and output at home and abroad (see van der Ploeg, 1988b).

5. Monetary disinflation

Both countries are initially in long-run equilibrium with positive rates of inflation ($\vartheta=\vartheta^*>0$). Consider the situation where both countries simultaneously engage in a previously unanticipated, permanent disinflation by reducing their monetary growth rates to zero ($\vartheta=\vartheta^*=0$). In the long run world inflation drops to zero, nominal interest rates fall and holdings of real money balances increase. In fact, equation (3.7) shows that the nominal interest rates at home and abroad immediately jump down to their new equilibrium values. Since this is a global monetary disinflation, there are no transient or long-run effects on the nominal and real exchange rates or

on the current account. Here, as in Section 6, it is assumed that core inflation equals monetary growth ($\pi=\pi^*=0$).

The expected excess supply of goods induced by the global monetary contraction leads to an immediate fall in prices and the instantaneous fall in nominal interest rates lead to an immediate increase in holdings of real money balances (a jump from E to A on SS in Fig. 1). Since nominal wages are rigid, the real wage rises on impact and therefore world output and employment fall on impact. Afterwards, the transient increase in unemployment reduces the nominal wage and real wage until output and employment have increased back to their natural rates again (movement from A to E' along SS). The expected fall in seigniorage revenues implies an expected increase in taxes. This, together with the rise in the real interest rate, implies a fall in human wealth. This fall in human wealth dominates the increase in non-human wealth, so that consumption and aggregate demand fall on impact. Subsequently, the gradual rise in real money balances and non-human wealth ensures that consumption recovers to its old equilibrium level. The world interest rate temporarily rises, which corresponds to a short-run Mundell effect. Welfare increases in the long run, but in the short run the fall in consumption may temporarily reduce welfare.

Now consider the situation where the foreign country initially has no inflation ($\vartheta^*=0$) and the home country has a positive rate of inflation ($\vartheta>0$). This implies that the rate of depreciation of the home country's nominal exchange rate initially equals the home monetary growth rate. The home country then disinflates by bringing down its monetary growth to zero

(ϑ=0). In the long run its inflation rate falls to zero, its nominal interest rate falls to the foreign country's interest rate, its holdings of real money balances increases to the foreign level, and its nominal exchange rate is stable. In fact, it follows from (3.7) that the nominal interest rate falls immediately on impact to its new equilibrium value. The phase diagram is already presented in Fig. 1 (path EAE'). There are no international spill-over effects apart from the externality on foreign consumption of home goods, so that each economy is insulated from the rest of the world even though there is nominal wage rigidity and unemployment. This is in sharp contrast to the conclusions derived from extended, two-country Mundell-Fleming models. Since during the transient period there is a real-interest-rate differential in favour of the home country, the home country's real exchange rate is expected to depreciate during the adjustment period and therefore appreciates on impact. The resulting fall in home exports ($c_m^*=c^*+e=c$) exactly matches the fall in the value of home imports ($e+c_m=c$), so that the balance of trade is continuously in equilibrium. It follows that, as far as welfare is concerned, monetary disinflation is a beggar-thy-neighbour policy in the short run as foreign consumption of home goods temporarily falls. Since on impact the real exchange rate appreciates (i.e., the home price level rises), the foreign consumers' price index temporarily rises and then falls back to its original level. However, as far as output and employment is concerned, there are no international spill-over effects. On impact the nominal interest rate falls and chokes off the excess supply of money, which is induced by the fall in the price level and the resulting boost in the real supply of money and by the fall in consumption and demand for real money balances. Since the nominal interest rate immediately jumps down and removes the differential with the foreign nominal

interest rate, the nominal exchange rate appreciates on impact exactly to the new equilibrium value and is therefore neither expected to depreciate, nor to appreciate during the adjustment period. Hence, the familiar result of monetary disinflation causing overshooting of the nominal exchange rate (Dornbusch, 1976; Buiter and Miller, 1982; Turnovsky, 1986; van der Ploeg, 1986) does not hold in this model with micro foundations and Ricardian debt neutrality.

It is easy to show that when nominal wages are flexible and immediately clear the labour market ($\alpha' \to \infty$), all variables jump instantaneously to their new equilibrium values.

Before the effects of a fiscal expansion are discussed, it is worthwhile to briefly discuss the effects of an anticipated monetary disinflation at home (path EA_1A_2E' in Fig. 1). From equation (3.7) it is clear that the nominal interest falls on impact and continues to fall until the cut in monetary growth is implemented. Since there are no spill-over effects on the foreign nominal interest rate (nor for that matter on any other foreign variable, except for an increase in foreign consumers' prices and a fall in foreign imports in the transient period), there is during the announcement period a nominal interest-rate-differential in favour of the home country and thus the nominal exchange rate is expected to appreciate during this period. Before the cut in monetary growth is implemented, prices fall on impact and continue to fall afterwards. Hence, real money balances rise over the announcement period. Since real wages already rise during the adjustment period, the economy suffers from a recession before the cut in monetary growth is even implemented.

6. Fiscal expansion

Initially both economies are in long-run equilibrium ($\vartheta=\vartheta^*=g=g^*=0$). Both governments then simultaneously engage in an unanticipated, permanent fiscal expansion ($g=g^*>0$). The transient effects are summarised by the path E'BE in Fig. 1. Obviously, there are no effects on the exchange rate or current account. On impact the price levels rise, which erodes the real value of the rigid nominal wage and boosts aggregate employment and output in both countries. On impact the increase in government spending raises aggregate demand, but there is some crowding out of private consumption as the erosion of real money balances reduces non-human wealth and the fall in real wages and increase in taxation causes a fall in human wealth. Subsequently, the boom raises nominal wages faster than prices so that real wages rise and employment and aggregate supply fall back to their natural rates. Aggregate demand also falls, because both non-human and human wealth continue to fall during the adjustment period. The world real interest rate falls on impact and subsequently recovers to the pure rate of time preference. This is consistent with falling consumption levels. Nominal interest rates are unaffected.

Now consider the case where the home goverment implements an unanticipated, permanent fiscal expansion (see Fig. 3). The story is almost the same as for the multilateral fiscal expansion, because the exchange rate insulates the home country from feedback of foreign repercussions. The real exchange rate appreciates on impact and undershoots its new equilibrium value, because the real-interest-rate differential is in favour of the foreign country and therefore the private sector expects the real exchange rate to appreciate during the adjustment period. The nominal exchange rate

is unaffected (see equation (3.7)), so that the appreciation of the real exchange rate arises entirely from increases in the home price level. The resulting fall in the real value of consumption of home goods plus foreign goods exactly equals the fall in consumption under a multilateral fiscal expansion. The increase in the relative price of home goods means that the foreign country's consumption of home good falls, so that foreign welfare falls. Hence, as far as welfare is concerned, a fiscal expansion is a beggar-thy-neighbour policy. Foreign producers' prices are unaffected, but foreign consumers' prices increase on impact and subsequently continue to rise to the new equilibrium level. Foreign interest rates and the home nominal interest rate are unaffected, but there is (as with the joint fiscal expansion) a temporary fall in the home real interest rate.

7. Sluggish core inflation

Sections 5 and 6 assumed that core inflation was given by monetary growth, but here it is assumed that core inflation is given by a weighted average of past inflation rates in the consumers' price index. The nominal interest rate and nominal exchange rate will display the same behaviour as in Sections 5 and 6, but there will be some international spill-over effects through the real exchange rate affecting foreign consumers' prices, foreign wages and thus foreign employment and output. The numerical simulations presented in Tables 1 and 2 illustrate these differences. As far as monetary disinflation is concerned, there is still no overshooting of the nominal exchange rate. The jump appreciation of the real exchange rate leads on impact to an immediate fall in core inflation at home and increase in core

inflation abroad. The downward jump in the price level on impact reinforces the downward jump in core inflation on impact. In fact, core inflation overshoots its new value on impact. Subsequently, nominal wage inflation falls as core inflation falls and this is the reason that home employment and output quickly recover and the home economy even becomes overheated. The result is that the real exchange rate recovers and eventually depreciates. Foreign nominal wages increase in the beginning, leading to unemployment, but after the real exchange rate has depreciated foreign nominal wages can fall, leading to over-employment. There is a cyclical adjustment towards the new equilibrium.

As far as a fiscal expansion is concerned, there is an appreciation of the real exchange rate and an increase in the home price level on impact leading, on balance, to an increase in core inflation both at home and abroad. On impact the erosion of the real wage, due to the increase in the price level, boosts home employment and output. This process continues afterwards. The eventual rise in foreign wages arising from the increase in foreign core inflation leads to falls in foreign employment and output. The nominal exchange rate is unaffected by the fiscal expansion at home.

The cumulative output gain is easily shown to be given by (cf., Buiter and Miller, 1982):

$$ {}_0\int^{\infty} y(t)\, dt = [\beta\Delta\vartheta/(\alpha\mu)] + (\beta\gamma/\alpha)\,[\xi_2/(1-\xi_2)]\,(\Delta g-\Delta g^*) \qquad (7.1) $$

which follows from $-{}_0\int^{\infty} w(t)dt=[\pi(t)\mu^{-1}+w(t)-\gamma e(t)]_0^{\infty}/\alpha'$. Note that the cumulative output loss is independent of the policy paths pursued, so that it does not matter whether a gradualist or cold-turkey policy is adopted. The cumulative percentage output loss arising from a monetary disinflation

of one percentage point is called the sacrifice ratio, $\beta/(\alpha\mu)$. The sacrifice ratio increases when labour markets are less flexible (small α) and when core inflation adapts sluggishly to changes in the cost of living (small μ). The cumulative output gain arising from a fiscal expansion increases when the share of government in total output (ξ_2) is large, when labour markets are less flexible and when the share of imports (γ) is large, because under these conditions the resulting appreciation of the real exchange rate is large and the effect on output, through the wedge between producers' and consumers' prices, is large.

8. Finite lives and current-account dynamics

So far, the analysis focussed on the transient effects of monetary disinflation and fiscal expansion. The current account was irrelevant, because the model satisfied the Ricardian debt neutrality proposition (see Barro, 1974) and therefore government debt and net foreign assets did not affect consumption and aggregate demand. A corollary of this set-up was that the real exchange rate always adjusted to keep the balance of trade and current account continuously in balance, so that there was no feedback from foreign repercussions due to changes in home policy on the home economy. Hence, the large-economy multipliers are exactly the same as the small-economy multipliers. Obviously, these are not realistic features of a model that attempts to describe the real world. It is, of course, the case that, if core inflation is given by a weighted average of past inflation rates in the consumers' price index rather than given by monetary growth, there are

international spill-over effects on employment and output and the large-economy multipliers will differ from the small-economy multipliers (see Section 7), but there will still be no explicit role for the dynamics of the government budget constraint and the current account. Also, the nominal exchange rate and interest rate will still be unaffected by fiscal policies. This Section therefore relaxes the assumption of Ricardian debt equivalence and thereby allows the current account to play a non-trivial role. This is achieved when one assumes capital market imperfections, distortionary taxes, or lack of an intergenerational bequest motive combined with either finite lives (Blanchard, 1985) or population growth (Weil, 1986). The extension of the model that follows adopts the assumption of finite lives.

It is assumed that each economy is made up of identical consumers with constant life expectancy, $1/\delta$, and no intergenerational bequest motive. Consumers maximise expected utility, which means that they maximise utility using the discount rate $\rho+\delta$ instead of ρ where $\delta \geq 0$ denotes the instantaneous probability of death. The individual consumer receives (pays) at every period of his life a premium at the rate δ and at the time of death the individual's net wealth (debt) goes to (is cancelled by) the life insurance companies. This premium is actuarially fair, so that the life insurance market is efficient. At each instant t a cohort of size δ is born. Since δ is also the probability of death, the size at instant t of a cohort born at instant $s \leq t$ equals $\delta\exp[-\delta(s-t)]$ and the population at instant t therefore equals $\int_{t}^{\infty} \delta \exp[-\delta(s-t)]ds=1$. Population aggregates are then obtained as the sum of the products of the consumption of each surviving cohort with its size. This results in the aggregate consumption function $C(t)=(\rho+\delta)[N(t)+H(t)]$, where human wealth is now given by

$$H(t) \equiv {}_t\int^{\infty} \exp[-{}_t\int^{s}(r(s')+\delta)ds'][W(s)L(s) - T(s)]ds. \qquad (8.1)$$

Human wealth is the discounted stream of after-tax wage income, where the discount rate is augmented with the probability of death in order to allow for the fact that individuals only expect to earn income when they are alive. The return on aggregate non-human wealth does not contain a life insurance premium, because such a premium constitutes a transfer from those who die to those who survive. Substitution of these results into (2.2) and (2.3) gives

$$dC(t)/dt = [r(t) - \rho]\, C(t) - \delta(\delta+\rho)\, N(t). \qquad (8.2)$$

This shows that government bonds, and in particular net foreign assets, affect aggregate consumption behaviour, so that the current account need no longer be in continuous balance. The assumption of finite lives drives a wedge between the discount rate to calculate human wealth, $r(t)+\delta$, and the discount rate used to calculate government debt, net foreign assets and non-human wealth, $r(t)$. This wedge allows the burden of higher taxation to be passed on to future, yet unborn generations, so that the Ricardian debt neutrality proposition no longer holds and therefore the current account plays a non-trivial role.

The linearised version of the resulting two-country model with finite lives and gradual adaptation of core inflation to increases in the cost-of-living can be summarised by:

$$\beta'(x-m) = \xi_1 c + \xi_2 g + \xi_3(c^*+e), \qquad (8.3)$$

$$\beta'(x^*-m^*) = \xi_1 c^* + \xi_2 g^* + \xi_3 (c-e), \tag{8.4}$$

$$\dot{f} = \rho' f + \gamma_2 (c^*+e-c), \qquad f(0)=0, \tag{8.5}$$

$$\dot{x} = \vartheta - \pi - \alpha'(x-m), \qquad x(0)=0, \tag{8.6}$$

$$\dot{x}^* = \vartheta^* - \pi^* - \alpha'(x^*-m^*), \qquad x^*(0)=0, \tag{8.7}$$

$$\dot{\pi} = \mu[\eta(c-m) - r + \gamma \dot{e} - \pi], \quad \Delta\pi(0) = -\mu[\Delta m(0) - \gamma \Delta e(0)], \tag{8.8}$$

$$\dot{\pi}^* = \mu[\eta(c^*-m^*) - r + (1-\gamma) \dot{e} - \pi^*], \quad \Delta\pi^*(0) = -\mu[\Delta m^*(0) + \gamma \Delta e(0)], \tag{8.9}$$

$$\dot{m} = r + \vartheta - \eta (c-m), \tag{8.10}$$

$$\dot{m}^* = r - \dot{e} + \vartheta^* - \eta (c^*-m^*), \tag{8.11}$$

$$\dot{c} = r - \rho - \delta (\delta+\rho) [(\gamma_3/\eta)(m-c) + f], \tag{8.12}$$

and

$$\dot{c}^* = r - \dot{e} - \rho - \delta (\delta+\rho) [(\gamma_3/\eta)(m^*-c^*) - f], \tag{8.13}$$

where $\rho' \equiv r(\infty)$ and $f \equiv F/C$. The ratio of net foreign assets to home consumption, f, and real liquidity at home, x, and abroad, x^*, are backward-looking, predetermined variables, whilst real money balances at home, m, and abroad, m^*, consumption at home, c, and abroad, c^*, and the real exchange

rate, e, are forward-looking, jump variables. Core inflation at home, π, and abroad, π^*, are backward-looking variables, even though the initial jumps in the price levels and the real exchange rate imply initial jumps in core inflation (cf., Buiter and Miller, 1982).

As before, the long-run levels of the real wage, output and employment are at their natural rates and long-run inflation is given by monetary growth. Steady-state asset market equilibrium follows from (8.10)-(8.13) and yields:

$$f(\infty) = \tfrac{1}{2}(\gamma_3/\eta^2)\ (\vartheta-\vartheta^*) \tag{8.14}$$

$$r(\infty) = [\rho - \tfrac{1}{2}\delta'\ (\vartheta+\vartheta^*)]/(1+\delta') \tag{8.15}$$

$$i(\infty) = [\rho + \vartheta + \tfrac{1}{2}\delta'\ (\vartheta-\vartheta^*)]/(1+\delta') \tag{8.16}$$

where $\delta' \equiv \delta(\delta+\rho)\gamma_3/\eta^2$. Steady-state equilibrium in the goods markets and current account follows from (8.3)-(8.5) and (8.14) and yields:

$$e(\infty) = -[\xi_2/(1-\xi_2)](g-g^*) - \tfrac{1}{2}(\rho'/\eta^2)(\gamma_3/\gamma_2)[(\xi_1-\xi_3)/(1-\xi_2)]\ (\vartheta-\vartheta^*), \tag{8.17}$$

$$c_d(\infty) = c(\infty) = -[\xi_2/(1-\xi_2)]\ g + \tfrac{1}{2}(\rho'/\eta^2)(\gamma_3/\gamma_2)[\xi_3/(1-\xi_2)]\ (\vartheta-\vartheta^*) \tag{8.18}$$

$$c_m(\infty) = -[\xi_2/(1-\xi_2)]\ g^* + \tfrac{1}{2}(\rho'/\eta^2)(\gamma_3/\gamma_2)[\xi_1/(1-\xi_2)]\ (\vartheta-\vartheta^*) \tag{8.19}$$

and

$$x(\infty) = m(\infty) = c(\infty) - (i(\infty)/\eta).$$

An increase in home monetary growth increases the long-run opportunity cost of holding real money balances, $i(\infty)$, and reduces the long-run real interest rate. This is the Mundell effect. As a result private sector agents switch out of money into bonds, so that the long-run holdings of net foreign assets increase. This is associated with a trade deficit, because the interest payments on net foreign assets held by home agents allow home individuals to consume more and foreign individuals to consume less. The reduction in net exports is induced by an appreciation of the real exchange rate, when the value-share of imports in total expenditures does not exceed 50 percent ($\gamma < \frac{1}{2}$ or $\xi_1 > \xi_3$), and by a depreciation of the real exchange rate, when the share of imports exceeds 50 percent. The increase in seigniorage revenues permits a cut in taxation, which combined with the fall in the real interest rate raises long-run home human wealth. This, combined with the increase in bond holdings, ensures that total wealth and consumption at home increase in the long run despite a possible fall in real money balances. A global increase in monetary growth leaves net foreign assets, exchange rates, consumption, exports and imports unaffected in the long run. It simply leads to a fall in the world real interest rate, an increase in nominal interest rates and a fall in real money balances. Hence, asymptotic welfare falls in both countries.

A tax-financed increase in home government spending leads to no changes in net foreign assets or interest rates. It leads to an increase in the home price level and an appreciation of the real exchange rate, which induce a fall in home consumption and exports. There is complete crowding out. The

steady-state effects are exactly as discussed in Sections 4 and 7. In fact, the transient effects of a tax-financed change in government spending are also as discussed in Sections 4 and 7. The reason is that taxes vary to keep government debt constant. The cumulative output gain is given by (cf., expression (7.1)):

$$_0\int^{\infty} y(t)dt = [\beta\Delta\vartheta/(\alpha\mu)] + (\beta\gamma/\alpha)\,[\xi_2/(1-\xi_2)]\,(\Delta g - \Delta g^*) +$$

$$\tfrac{1}{2}(\beta\gamma/\alpha)(\rho'/\eta^2)(\gamma_3/\gamma_2)[(\xi_1-\xi_3)/(1-\xi_2)]\,(\Delta\vartheta-\Delta\vartheta^*). \qquad (8.20)$$

As far as the cumulative deviation of foreign output from its natural level is concerned, it is clear that under infinite lives a monetary disinflation has no spill-over effect whilst under finite lives and a domestic bias in consumption ($\gamma<\frac{1}{2}$) it has a small positive spill-over effect, due to the appreciation of the long-run real exchange rate of the foreign country. This means that a monetary expansion is, as in the Mundell-Fleming analysis, a beggar-thy-neighbour policy. However, in contrast to the short-run Mundell-Fleming analysis, a fiscal expansion is also a beggar-thy-neighbour policy as far as the cumulative output loss is concerned. In addition, the effects of a fiscal expansion do not depend on whether lifetimes are finite or infinite. As before the cumulative output loss increases when labour markets are less flexible and core inflation behaves in a more sluggish manner for a disinflation and when the shares of imports and of government are large for a cut in government spending.

Table 1 also presents the effects of a monetary disinflation when there is a life expectancy of 50. In contrast to the special case of infinite

lives, the nominal exchange rate overshoots its new equilibrium value. The explanation is, however, very different from the one offered by the two-country extensions of Dornbusch's (1976) model. The initial appreciation of the real exchange rate outweighs the "income" effects and thus causes transient balance-of-trade deficits and an accumulation of foreign debt. Hence, in the long run the real exchange rate has to depreciate in order to generate a balance-of-trade surplus sufficiently large to finance the interest on foreign debt. The long-run fall in foreign assets causes a fall in home consumption and a corresponding increase in foreign consumption. This means that the home price level has to fall less than under finite lives and that the foreign price level has to fall in the long run. This combined with the long-run depreciation of the real exchange rate implies that the nominal exchange rate overshoots its new equilibrium value. In contrast to the case of infinite lives, there is a lasting Mundell effect.

The transient effects of a change in government spending are also independent of whether expected lifetimes are finite or infinite (see Table 2), but this only holds for the case of a constant government debt (tax finance) as will be discussed in the next Section.

9. Government debt and current-account dynamics

So far, taxes adjust to have a zero public sector borrowing requirement. It may be more reasonable to assume that the government deficit is financed by borrowing. In order to ensure solvency of the government's finances, it is assumed that taxes are increased when the government debt increases:

$$T(t) = T_o(t) - \nu D(t), \quad \nu > r \tag{9.1}$$

where T_o denotes autonomous taxes and ν denotes the reaction coefficient. It follows from (2.8) that

$$\dot{d} = (r-\nu)d + (\xi_2/\xi_1)(g-c) - (\gamma_3/\eta)\vartheta, \quad d(0) = d_o \tag{9.2}$$

and that (8.12) and (8.13) are replaced by

$$\dot{c} = r-\rho-\delta(\delta+\rho)\,[d + (\gamma_3/\eta)(m-c) + f] \tag{9.3}$$

and

$$\dot{c}^* = r-\dot{e}-\rho-\delta(\delta+\rho)\,[d^* + (\gamma_3/\eta)(m^*-c^*) - f] \tag{9.4}$$

where $d \equiv (D/C)-[D(\infty)/C(\infty)]$. Hence, the main difference is that changes in government debt can affect non-human wealth and thus private consumption.

Steady-state asset market equilibrium yields

$$f(\infty) = \tfrac{1}{2}\,(\gamma_3/\eta^2)(\vartheta-\vartheta^*) + \tfrac{1}{2}\,(d^*-d) \tag{9.5}$$

and

$$r(\infty) = [\rho - \tfrac{1}{2}\delta'(\vartheta+\vartheta^*) + \tfrac{1}{2}\,(d+d^*)]/(1+\delta') \tag{9.6}$$

whilst steady-state equilibrium in the goods market and current account yields

$$e(\infty)= [\xi_2/(1-\xi_2)](g^*-g) + \tfrac{1}{2}(\rho'/\gamma_2)[(\xi_1-\xi_3)/(1-\xi_2)][(\gamma_3/\eta^2)(\vartheta^*-\vartheta)+d-d^*], \tag{9.7}$$

$$c(\infty)=-[\xi_2/(1-\xi_2)]\, g + \tfrac{1}{2}\,(\rho'/\gamma_2)[\xi_3/(1-\xi_2)][(\gamma_3/\eta^2)(\vartheta-\vartheta^*) + d^*-d] \tag{9.8}$$

and

$$c_m(\infty) = -[\xi_2/(1-\xi_2)]g^* + \tfrac{1}{2}(\rho'/\gamma_2)[\xi_1/(1-\xi_2)][(\gamma_3/\eta^2)(\vartheta-\vartheta^*)+d^*-d] \tag{9.9}$$

where

$$d(\infty) = \{(\xi_2/\xi_1)[g-c(\infty)] - (\gamma_3/\eta)\vartheta\}/(\nu-r). \tag{9.10}$$

Hence, a smaller reaction coefficient leads to a larger government debt which pushes up interest rates throughout the world and leads to an increase in foreign debt in the long run. The direct effect is an increase in long-run non-human wealth at home and abroad. Human wealth is cut at home as taxes are increased when government debt is increased. This outweighs the increase in non-human wealth, since home consumption and imports must fall in the long run in order to generate a trade surplus to finance the extra interest payments on foreign debt. Foreign consumption of home and of foreign goods increase by the same amount as home consumption falls. The result of this excess demand for foreign goods is, as long as there is a

domestic bias in consumption ($\gamma<\frac{1}{2}$ or $\xi_1>\xi_3$), a depreciation of the long-run real exchange rate.

So far, the effects of a change in long-run government debt, given fiscal and monetary policy, have been considered. It may be more natural to examine the effectiveness of fiscal and monetary policy when government debt is endogeneous. These results will be different from the long-run multipliers discussed in Section 8, because the assumption of finite lives means that taxes can be passed on to future, yet unborn generations and thus Ricardian debt neutrality no longer holds. For example, a cut in monetary growth leads to less seigniorage revenues and thus leads to a larger government debt which reinforces the accumulation of foreign debt and reinforces the upward pressure on the real interest rate. The long-run depreciation of the real exchange rate (for $\gamma<\frac{1}{2}$) and the fall in home consumption are also reinforced. Similarly, a fiscal expansion implies a larger government debt and thus an accumulation of foreign debt and an increase in the real interest rate. The appreciation of the real exchange rate is attenuated and the fall in home consumption is reinforced. In addition, imports of the home country fall.

These steady-state properties are also reflected in the simulations reported in Tables 1 and 2. For the case of a monetary disinflation, the long-run real exchange rate depreciates by more than twice as much as under tax finance in order to generate a sufficiently large trade surplus to service the additional foreign debt. Similarly, the loss in the nation's wealth implies greater long-run falls in home consumption and increases in foreign consumption. There is a smaller (greater) fall in the long-run home (foreign) price level than under tax finance, which means that the nominal

exchange rate appreciates by much less in the long run. For the case of a fiscal expansion, the real exchange rate appreciates by much less than under tax finance as a trade surplus has to be generated in order to service the foreign debt that has now been accumulated. The long-run home price level rises by much more now, which is the main reason of the depreciation of the long-run nominal exchange rate. The results confirm the short-run Mundell-Fleming analysis, because on impact both a monetary disinflation and a fiscal expansion increase foreign output and employment and therefore a monetary expansion is a beggar-thy-neighbour policy and a fiscal expansion is a locomotive policy in the short run.

10. Concluding remarks

A two-country, intertemporal, perfect-foresight model with micro foundations, Cobb-Douglas preferences and technologies, floating exchange rates, uncovered interest parity, and nominal wage rigidities has been formulated. Taxes adjust to maintain a constant stock of government debt. The intertemporal budget constraint of the governments and private sector have been modelled in an internally consistent manner. Nominal wage rigidity has been incorporated in an augmented Phillips curve. When core inflation equals monetary growth, there are no international spill-over effects so that the multipliers for monetary growth and government spending are the same for a small open economy as for a large open economy.

In addition the real exchange rate adjusts to maintain continuous equilibrium in the balance of trade, so that there is no role for current-account dynamics. These somewhat surprising results follow from both the home and foreign government's budget being continuously in balance, from Ricardian debt neutrality and from both countries having the same rate of time preference. Monetary disinflation does not lead to overshooting of the nominal exchange rate, although it does lead to overshooting of the inflation rate. When core inflation adapts sluggishly to increases in the cost of living, there is the possibility of international spill-over effects. As far as the cumulative deviation of output from its natural rate is concerned, a monetary disinflation has no international spill-over effect whilst a fiscal expansion is, in contrast to standard, short-run Mundell-Fleming analysis, a beggar-thy-neighbour policy.

To give a non-trivial role to wealth effects and current-account dynamics and to allow for more interesting international spill-over effects, the model was extended to allow for finite lifetimes so that Ricardian debt neutrality no longer holds. Now a monetary disinflation has a positive (negative) effect on the cumulative deviation of foreign output from its natural rate, when there is a domestic (import) bias in consumption. Hence, in line with the Mundell-Fleming analysis, a monetary expansion is a beggar-thy-neighbour policy. Monetary disinflation now does lead to overshooting of the real exchange rate. A comparison between tax finance and debt finance of changes in monetary growth and government spending illustrates the importance of allowing for the intertemporal budget constraints of private sector agents and governments and the implied dynamics in the current account.

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Fig 1: Monetary disinflation.

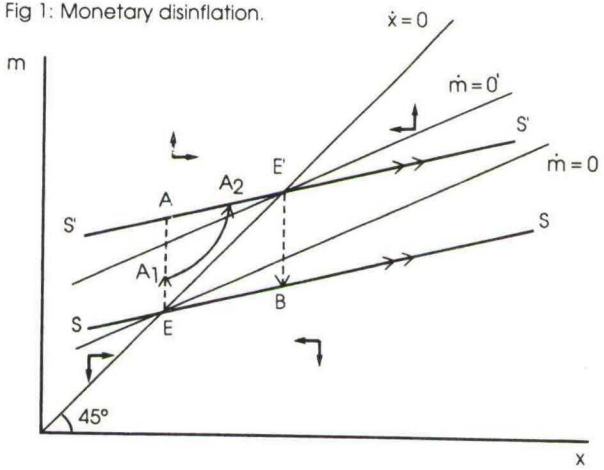

Table 1: Monetary Disinflation ($\Delta\vartheta=-1$)

	INFINITE LIVES					FINITE LIVES (δ = 0.02)					
	$\pi=\vartheta$		$\dot{\pi} = \frac{1}{2}(p_c-\pi)$			TAX FINANCE			DEBT FINANCE (ν= 0.075)		
Time	0	5	0	5	∞	0	5	∞	0	5	∞
Home output (y)	-24	-5.36	-24	4.25	0	-20.35	3.53	0	-19.28	3.33	0
Foreign output (y*)	0	0	0	1.16	0	2.70	0.28	0	3.56	0.03	0
Home consumption (c)	-32	-7.14	-32	5.67	0	-24	7.29	-6.67	-21.86	7.72	-15.88
Foreign consumption (c*)	0	0	0	1.54	0	0.46	-2.21	6.67	0.90	-3.24	15.88
Home real money balances (m)	8	32.86	8	45.68	40	6.78	38.28	28.04	6.43	35.92	16.18
Foreign real money balances (m*)	0	0	0	1.54	0	-0.90	-3.80	1.37	-1.19	-5.66	7.94
Home nominal interest rate (i)	-1	-1	-1	-1	-1	-0.77	-0.78	-0.87	-0.71	-0.70	-0.80
Foreign nominal interest rate (i*)	0	0	0	0	0	0.03	0.04	0.13	0.05	0.06	0.20
Home real interest rate (r)	9.60	2.14	17.12	1.31	0	15.44	1.14	0.13	14.93	1.04	0.20
Foreign real interest rate (r*)	0	0	-5.12	0.96	0	-6.57	0.85	0.13	-7.02	0.77	0.20
Home inflation (p_c)	-6.76	-2.29	-9.23	-2.17	-1	-7.41	-1.80	-1	-6.86	-1.64	-1
Foreign inflation (p_c^*)	-3.84	-0.86	-3.78	-1.10	0	-2.20	-0.92	0	-1.71	-0.82	0
Home core inflation (π)	-1	-1	-10.40	-4.76	-1	-9.85	-3.92	-1	-9.69	-3.63	-1
Foreign core inflation (π^*)	0	0	6.40	-1.78	0	6.91	-1.13	0	7.07	-0.89	0
Real exchange rate (e)	-32	-7.14	-32	4.13	0	-32.31	3.04	3.33	-32.39	2.76	7.94
Nominal exchange rate	-40	-40	-40	-40	-40	-40	-39.05	-23.34	-40	-38.81	-0.29
Net foreign assets (f)	0	0	0	0	0	0	-11.46	-200	0	-14.27	-476.47
Home government debt (d)	0	0	0	0	0	0	0	0	0	46.49	367.47
Foreign government debt (d*)	0	0	0	0	0	0	0	0	0	9.76	-176.47
Home human wealth (H/C)	-40	-40	-40	-40	-40	-30.77	-19.54	165.30	-28.29	-60.42	76.94
Foreign human wealth (H*/C*)	0	0	0	0	0	1.36	-9.87	-194.70	2.09	-21.61	-292.06

Parameters: $\alpha = 0.375$, $\alpha' = 1.5$, $\beta = 0.75$, $\beta' = 3$, $\eta = \rho = 0.025$, $\gamma_1 = 0.45$, $\gamma_2 = 0.3$, $\gamma_3 = 0.25$, $\gamma = 0.4$,

$\xi_1 = 0.45$, $\xi_2 = 0.25$, $\xi_3 = 0.3$.

Table 2: Fiscal Expansion ($\Delta g=1$)

	INFINITE LIVES AND $\pi=\vartheta$			FINITE LIVES (δ = 0.02) AND $\dot{\pi} = \frac{1}{2}(p_c-\pi)$					
				TAX FINANCE *			DEBT FINANCE (ν = 0.075)		
Time	0	5	∞	0	5	∞	0	5	∞
Home output (y)	0.20	0.04	0	0.20	-0.01	0	0.28	-0.02	0
Foreign output (y*)	0	-0.04	0	0	-0.04	0	0.06	-0.06	0
Home consumption (c)	-0.07	-0.27	-0.33	-0.07	-0.35	-0.33	0.09	-0.31	-0.73
Foreign consumption (c*)	0	0	0	0	-0.05	0	0.03	-0.14	0.39
Home real money balances (m)	-0.07	-0.27	-0.33	-0.07	-0.35	-0.33	-0.09	-0.52	-0.92
Foreign real money balances (m*)	0	0	0	0	-0.05	0	-0.02	-0.19	0.20
Home nominal interest rate (i)	0	0	0	0	0	0	0	0.01	0
Foreign nominal interest rate (i*)	0	0	0	0	0	0	0	0	0
Home real interest rate (r)	-0.08	-0.02	0	-0.10	-0.02	0	-0.13	-0.03	0
Foreign real interest rate (r*)	0	0	0	-0.01	0	0	-0.04	-0.01	0
Home inflation (p_c)	0.05	0.01	0	0.06	0.01	0	0.10	0.02	0
Foreign inflation (p_c^*)	0.03	0.01	0	0.05	0.01	0	0.08	0.01	0
Home core inflation (π)	0	0	0	0.02	0.03	0	0.03	0.05	0
Foreign core inflation (π^*)	0	0	0	0.01	0.02	0	0.02	0.04	0
Real exchange rate (e)	-0.07	-0.27	-0.33	-0.07	-0.29	-0.33	-0.07	-0.31	-0.14
Nominal exchange rate	0	0	0	0	0	0	0	0.02	0.98
Net foreign assets (f)	0	0	0	0	0	0	0	-0.23	-11.76
Home government debt (d)	0	0	0	0	0	0	0	2.85	19.17
Foreign government debt (d*)	0	0	0	0	0	0	0	0.19	-4.36
Home human wealth (H/C)	0	0	0	0	0	0	0.19	-2.41	-7.21
Foreign human wealth (H*/C*)	0	0	0	0	0	0	0.04	-0.37	-7.21

Parameters: $\alpha = 0.375$, $\alpha' = 1.5$, $\beta = 0.75$, $\beta' = 3$, $\eta = \rho = 0.025$, $\gamma_1 = 0.45$, $\gamma_2 = 0.3$, $\gamma_3 = 0.25$, $\gamma = 0.4$, $\xi_1 = 0.45$, $\xi_2 = 0.25$, $\xi_3 = 0.3$.

* This yields the same outcome irrespective of whether expected lifetimes are finite or infinite.

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