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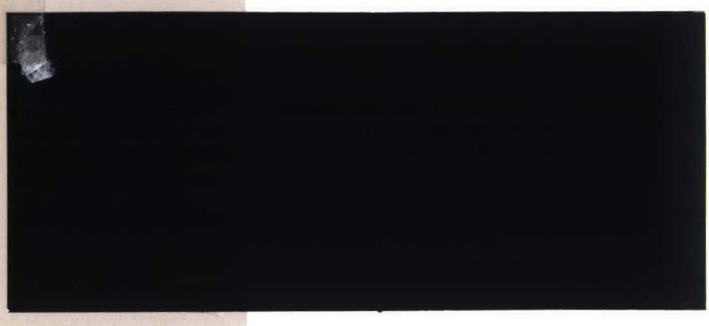

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CHANNELS OF INTERNATIONAL POLICY TRANSMISSION

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CHANNELS OF INTERNATIONAL POLICY TRANSMISSION *

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Abstract

A two-country, intertemporal, perfect-foresight model with micro foundations, floating exchange rates, uncovered interest parity, and nominal wage rigidities is formulated. The benchmark case corresponds to unit elasticities of intertemporal and intratemporal substitution in consumption, no initial holdings of foreign assets and infinite lifetimes. Monetary disinflation and an increase in government spending then have no spill-over effects on foreign consumption and employment and there is no current-account dynamics. Four channels of international policy transmission are then analysed. The first is based on capital gains on holdings of foreign assets. The spill-over effects arising through the second and third channel depend on whether goods are gross substitutes or gross complements and on whether the elasticity of intertemporal substitution is less or greater than one. The final channel assumes finite lifetimes and no bequest motive. It departs from debt neutrality in order to give a more interesting role to wealth effects and current-account dynamics and to assess the difference between tax and debt finance.

*This is a substantially revised and extended version of van der Ploeg (1989). I am grateful for helpful discussions with Anton Barten, Theo van de Klundert and Neil Rankin and for the insightful and constructive comments of an anonymous referee.

Contents

1 Introduction

The assumptions of risk-neutral arbitrage in efficient foreign exchange markets and infinitely flexible exchange rates are 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, which is relevant when one studies the effects of successive reductions in monetary growth as was done for 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 (Dornbusch and Fischer, 1980). In interdependent economies with integrated financial markets and floating exchange rates, a monetary expansion is typically a beggar-thy-neighbour policy. 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 and thus employment and output of the foreign country. A fiscal expansion is a locomotive policy because the incipient capital inflows arising from the upward pressure on interest rates induce 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 an important vehicle for studying issues of international policy coordination (Miller and Salmon, 1985; Currie and Levine, 1985; Oudiz and Sachs, 1985). Non-cooperative monetary disinflation occurs excessively fast, because individual governments ignore the adverse consequences on foreign real income and thus attempt to export inflation and disinflate too fast.

The literature discussed above addresses important and interesting policy issues, but most of it suffers from the use of ad-hoc macroeconomic models. The objective of this paper is to reconsider these issues within the context of two-country models with micro foundations and to conduct a careful analysis of the main channels of international policy transmission in more modern variants of the classic Mundell (1968) model. The advantages

of such an approach are that the present-value 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 expectations are rational, 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. The paper is close in spirit to the work of Rankin (1987, 1988), Svensson (1987) and Svensson and van Wijnbergen (1989), because they also stress the importance of intratemporal and intertemporal substitution in consumption for international policy transmission. The main novelties of the present paper are, however, that (i) the two-period analysis of previous authors is replaced by a continuous-time analysis so that a more satisfactory analysis of wage, exchange-rate and current-account dynamics is feasible; (ii) the effects of capital gains on initial holdings of foreign assets are analysed; (iii) departures from Ricardian debt neutrality are analysed; and (iv) comparisons with policy work on monetary disinflation and international interdependence are made. In contrast to Svensson and van Wijnbergen (1989), the present paper is not restricted to a perfectly pooled equilibrium in which home and foreign consumers hold identical portfolios and consume identical quantities of goods.

Section 2 presents 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 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, 1990; and van der Ploeg, 1988b for a discussion of capital formation in a full-employment setting). If households have infinite lifetimes, Ricardian debt neutrality (Barro, 1974) holds and bond-finance and tax-finance are equivalent. Section 3 starts off with the benchmark case, which corresponds to a unit elasticity of intertemporal substitution, a unit elasticity of intratemporal substitution between home and foreign goods, and no initial holdings of foreign assets. There is then no role for current-account dynamics. The main channel of international transmission familiar from the 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 is the sum of the rate of time preference and the average of future, expected monetary growth rates. 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. Home policy does not affect foreign employment and output. The real exchange rate adjusts to ensure that the balance of trade is continuously in equilibrium. Monetary disinflation does not induce overshooting of the nominal exchange rate. It does lead to transient job losses, but this arises purely from the sluggishness of nominal wages. Section 3 then goes on to analyse three channels of international policy transmission. The first occurs when the foreign country holds home bonds. Monetary disinflation and an increase of government spending at home are associated with an appreciation of the real exchange rate. This boosts the real value of home assets held by foreigners and thus requires a bigger trade surplus at home in order to serve the additional foreign debt. There are real spill-over effects, because abroad both consumption and unemployment increase. The second channel arises when the elasticity of substitution differs from unity. When goods are gross substitutes (complements), the effects of a monetary disinflation on net foreign assets are negative (positive) and thus the spill-over effects on foreign consumption are negative (positive) in the short run and positive (negative) in the long run. The third channel occurs when the elasticity of intertemporal substitution exceeds (is less than) unity, because then the effects on net foreign assets are positive (negative). This channel also allows the nominal interest rate to be influenced by fiscal and foreign policies. Section 3 also analyses the spill-over effects of an increase in government spending. Section 4 relaxes Ricardian debt neutrality by allowing for finite lifetimes and absence of operational intergenerational bequests (Blanchard, 1985). This introduces an additional role for current-account dynamics and non-trivial international spill-over effects of tax-financed changes in monetary growth. Section 4 also considers debt-finance, which gives a non-trivial role for fiscal policy as well. Section 5 concludes the paper.

2 A two-country model with nominal wage rigidities and wealth effects

2.1 The model

The world consists of two economies with identical preferences and technologies. 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. There is perfect substitution between home and foreign government bonds. Risk-neutral arbitrage implies uncovered interest parity. The asset menu consists of bonds and home cash, so there is no currency substitution. A regime of floating exchange rates prevails. Labour is immobile. There is an inelastic supply of labour and a neoclassical labour demand schedule. Wage formation follows an augmented Phillips curve. The government services its debt, spends on home goods, levies lump-sum taxes and finances the resulting deficit by printing or borrowing money. There is perfect foresight.

The representative household maximises the utility function,

$$U(t) \equiv \int_t^{\infty} \exp[-\rho(s-t)][u(C(s)/P_c(s)) + \gamma u(M(s)/P_c(s))]ds \qquad (2.1)$$

where $\gamma > 0$, subject to the household's budget constraint,

$$\dot{N} = rN + WL - T - C - iM, \qquad (2.2)$$

where ρ denotes the subjective rate of time preference, and C, M, N, T, L, W, P_c, r and i denote consumption, real money balances, non-human wealth, taxes, employment, the real wage, the consumers' price index (CPI), the real interest rate and the nominal interest rate, respectively. The real interest rate equals $r \equiv i - p$, where p denotes the rate of inflation in producers' prices. Non-human wealth is the sum of bond holdings, B, money holdings, M, and a fixed stock of capital or land, $K_0 = 1$.

The result is the tilt of the consumption function, $\dot{C}/C = \sigma(r - \rho)$ where $\sigma \equiv -P_c u'/(Cu'')$ denotes the elasticity of intertemporal substitution. Consumption increases over time and households save relatively more in the early parts of their lives if the interest rate exceeds the rate of time preference. The marginal rate of substitution between consumption and money must equal the opportunity cost of holding money, i, which yields $M = (i/\gamma)^{-\sigma}C$. The semi-elasticity of money demand with respect to the nominal interest rate thus equals the elasticity of intertemporal substitution. Consumption consists of home goods, C_d, and foreign goods, C_m, so that $C \equiv C_d + EC_m$ where E denotes the real exchange rate (price of foreign goods in terms of home goods). Given a homothetic sub-utility function, $C/P_c = v(C_d, C_m)$, one has $v_2/v_1 = E$ or $C_d = \phi(E)C_m, \phi' > 0$ so that

$C_d = (1-\hat{\gamma})C, C_m = \hat{\gamma}C/E$ and $P_c = v(1-\hat{\gamma}, \hat{\gamma}/E)^{-1}$ where $\hat{\gamma}(E) \equiv E/[E+\phi(E)]$. For a given sub-utility level, an appreciation of the real exchange rate reduces demand for home goods and increases demand for foreign goods (substitution effect). Because the CPI falls, real income increases so the demand for both goods increase (income effect). Whether the former or latter effect dominates depends on whether $\hat{\gamma}'$ is negative or positive or on whether the elasticity of substitution of $v(.), \epsilon \equiv (E\phi'/\phi > 0)$, exceeds or is less than unity. Hence, home and foreign goods are gross substitutes when $\epsilon > 1$ and gross complements when $\epsilon < 1$. They are Edgeworth-Pareto substitutes, $V_{12} > 0$ where $V(C_d, C_m) \equiv u[v(C_d, C_m)]$, depending on whether intratemporal substition, ϵ, dominates or is less than intertemporal substitution, σ (Svensson, and van Wijnbergen, 1989).

Firms maximise profits under perfect competition given the production function $Y = f(L, K_0) = L^{\beta}, 0 < \beta < 1$ where Y denotes output. Because the marginal productivity of labour diminishes, both employment and aggregate supply are decreasing functions of the real producers' wage. The other factors are fixed and also paid their marginal products, so profits are zero. Since the focus is on transient unemployment, 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, $(\dot{W}/W) + p = \alpha \log[L/(1-u_n)] + \pi, \quad \alpha > 0$, where u_n denotes the natural rate of unemployment. Core inflation is given by $\pi = \theta$ where θ denotes the monetary growth rate.

The government's present-value budget constraint is

$$D(0) = \int_0^{\infty} \exp[-\int_0^t r(s)ds][T(t) + \theta(t)M(t) - G(t)]dt, \qquad (2.3)$$

where D denotes real government debt issued to home and foreign households and G denotes real government spending on home goods. Solvency requires that the current government debt plus the discounted stream of future levels of government spending has to be paid off by the discounted stream of future lump-sum taxes plus seigniorage revenues. Since Ricardian debt neutrality prevails [1], one may as well assume that lump-sum taxes ad-

[1] An increase in bonds and non-human wealth is exactly off-set by a decrease in human wealth, because any increase in borrowing must eventually be paid for by increases in future taxes. Total wealth and thus consumption are unaffected.

just to maintain a constant stock of government debt, $T = rD + G - \theta M$. Hence, the two exogenous policy instruments are θ and G.

Equilibrium in the money market requires $\dot{M}/M = \theta - p$, 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 requires $Y = C_d + G + C_m^*$, where C_m^* denotes exports. Net holdings of foreign assets, $F \equiv B - D$ are the excess of households' holdings of bonds over government debt. Equilibrium in the world market for government bonds requires $B + EB^* = D + ED^*$ or $F + EF^* = 0$. Interest payments on net foreign assets, rF, plus the balance of trade, $C_m^* - EC_m$, gives the current account, which equals the increase in the nation's wealth, $\dot{F}$. Home (US) agents initially do not hold any foreign (Japanese or European) government bonds, so the initial net foreign debt, $F(0) = F_0 \leq 0$, is predetermined. An unanticipated real depreciation of the dollar increases the relative price of US goods and wipes out the real value of holdings of US bonds held by Japanese and European households (F*(0) falls). Revaluation of initial asset holdings provides an important channel of policy transmission. When the country is solvent, one has

$$-F(t) = \int_t^\infty \exp[-\int_t^s r(s')ds'][C_m^*(s) - E(s)C_m(s)]ds, \tag{2.4}$$

so the nation's current debt has to be paid off by future trade surpluses. Risk-neutral arbitrage ensures uncovered interest parity, $r = r^* + \dot{E}/E$, which was already implicitly assumed in equations (2.2) and (2.3).

The complete two-country model includes foreign analogues of the relationships discussed for the home country above.

2.2 Linearisation

Log-linearisation yields $c_d = c + \hat{\gamma}(\epsilon - 1)e, c_m = c_d - \epsilon e, \dot{c} = \sigma(r - \rho), i = \eta(c - m), \eta \equiv [\rho + \theta(\infty)]/\sigma, \ell = -w/(1 - \beta), y = -w\beta/(1 - \beta), r = r^* + \dot{e}$,

$$\begin{aligned} y = -\beta' w &= \xi_1 c_d + \xi_2 g + \xi_3 c_m^* = (1 - \xi_2)c + \xi_2 g + \xi_3 a + \xi\sigma e, \\ \beta' &\equiv \beta/(1 - \beta) > 0, \quad \xi_1 + \xi_2 + \xi_3 = 1, \end{aligned} \tag{2.5}$$

$$\dot{m} = \theta - p = \theta + r - \eta(c - m), \tag{2.6}$$

$$\dot{w} = \alpha\ell + \pi - p = -\alpha' w + \theta + r - \eta(c - m), \quad \alpha' \equiv \alpha/(1-\beta) > 0, \quad (2.7)$$

$$\dot{c} - \dot{c}^* = \sigma(r - \rho) - \sigma(r^* - \rho) = \sigma\dot{e} \quad (2.8)$$

where small letters (except for i, r, p, π and θ) denote logarithmic deviations from equilibrium values (e.g., $c(t) \equiv \log[C(t)/C(\infty)]$), $\xi_1 \equiv C_d/Y, \xi_2 \equiv G/Y, \xi_3 \equiv C_m^*/Y$ and $\xi \equiv [(\xi_1 - \xi_3)\hat{\gamma}(\epsilon - 1) + \xi_3(\epsilon - \sigma)]/\sigma$. Assume a domestic bias in consumption ($\xi_1 > \xi_3$). Equation (2.8) gives the real exchange rate as a function of the ratio of home consumption to foreign consumption, $\sigma e = a + c - c^*$, where a must be chosen so that the present-value budget constraint of the nation (2.4) is satisfied. This yields $a = -(\rho/\hat{\gamma})F_0/C(0)$ when $\epsilon = \sigma = 1$. When home consumes faster than abroad, or when home households save relatively more in the early part of their life than foreign households, there is a real-interest-rate differential in favour of the home country and the terms of trade is expected to improve. The trade balance (as a fraction of export volume) can be approximated by

$$b_T \equiv \left(\frac{C_m^* - EC_m}{C_m^*}\right) = c_m^* - e - c_m = a + \{2[(1-\hat{\gamma})\epsilon + \hat{\gamma}] - 1 - \sigma\}e \quad (2.9)$$

so that a debtor-country ($a > 0$) runs balance-of-trade surpluses to service its foreign debt. The (Marshall-Lerner) condition for which a depreciation of the real exchange rate improves the trade balance is that the elasticity of intratemporal substitution between home and foreign goods, ϵ, exceeds $[\frac{1}{2}(1+\sigma) - \hat{\gamma}]/(1-\hat{\gamma})$. Note that when $\epsilon = \sigma = 1$, the real exchange rate does not affect the trade balance. In a pooling equilibrium ($\hat{\gamma} = \frac{1}{2}$) the Marshall-Lerner condition requires the elasticity of intratemporal substitution, ϵ, to exceed the elasticity of intertemporal substitution, σ, that is the goods must be Edgeworth-Pareto substitutes. The current account gives the increase in the wealth of the nation, $\dot{f} = \rho f + \xi_3 b_T$ where $f \equiv F/Y$.

Equations (2.6) and (2.8) yield $di/dt = \eta[i - \sigma\rho - (1-\sigma)r - \theta]$, so that

$$i(t) = \sigma\rho + \int_t^\infty [\theta(s) + (1-\sigma)r(s)]\eta \exp[-\eta(s-t)]ds. \quad (2.10)$$

The nominal interest rate equals an average of the pure rate of time preference and an average of all future expected real rates of interest *plus* a weighted average of all future, expected monetary growth rates. [2]

2.3 Steady-state properties

In the long run the real wage, employment and output are at their natural rates, $w = \ell = y = 0$, and inflation is given by monetary growth, $p = \theta$. The long-run world real interest rate equals the rate of time preference, $r = r^* = \rho$, and nominal interest rates equal $i = \rho + \theta$. In the long run the inflation differential equals the rate of depreciation of the nominal exchange rate and relative purchasing power parity holds. The steady-state levels of consumption and the real exchange rate follow from the conditions for equilibrium in the home and foreign goods markets:

$$c(\infty) = \left(\frac{-\xi_2 g - \left(\frac{\xi_2 \xi}{1-\xi_2}\right)(g + g^*) - (\xi_3 + \xi)a}{1 - \xi_2 + 2\xi} \right) \tag{2.11}$$

$$e(\infty) = [\xi_2(g^* - g) + (\xi_1 - \xi_3)a]/[\sigma(1 - \xi_2 + 2\xi)]. \tag{2.12}$$

An increase in government spending induces an excess demand for goods, which 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. If $\epsilon = \sigma = 1$ and thus $\xi = 0$, foreign government spending has no effect on home consumption. However, if the elasticity of intratemporal substitution in consumption exceeds (is less than) unity or the elasticity of intertemporal substitution is less than (exceeds)

[2] In fact, a referee pointed out that an exact expression for (2.10) can be obtained. It follows from forward integration of the Bernouilli equation, $di/dt = \{i^2 - [\theta + r - \sigma(r - \rho)]i\}/\sigma$:

$$i(t) = (\rho\sigma) \int_t^\infty exp[-(1/\sigma) \int_t^s (\theta(s') + (1 - \sigma)r(s'))ds']ds\}.$$

unity, $\xi > 0$ and foreign government spending depresses (increases) home consumption. Hence, if $\sigma = 1$, the spill-over effects are negative or positive depending on whether the goods are gross substitutes or complements. In a perfectly pooled equilibrium it depends on whether goods are Edgeworth-Pareto substitutes ($\xi > 0$) or complements ($\xi < 0$). Svensson (1987) and Rankin (1988) also point to the importance of the degree of substitutability in consumers' preferences for the direction of international spill-over effects within the context of a two-period, two-country model with micro foundations. Cobb-Douglas preferences are very special, since they are on the borderline between gross complements and gross substitutes and yield no spill-over effects. A country with foreign debt ($a > 0$) runs trade surpluses through an appreciation of its real exchange rate and a cut in consumption. Because in the long run $m = c - (\rho + \theta)/\eta$, the effects of fiscal policy on consumption are the same as on real money balances. An increase in monetary growth leads to an equal increase in the nominal interest rate and a fall in real money balances. Seigniorage revenues increase so taxes fall and human wealth increases.

An increase in 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, an increase in government spending may increase welfare despite the crowding out. The effect on foreign welfare is usually negative; if $\epsilon = 1$ and $\sigma \leq 1$ or if $\epsilon \geq 1$ and $\sigma = 1$ the effect is negative. An increase in monetary growth has under floating exchange rates no long-run international spill-over effects; it simply reduces money balances and welfare. The full liquidity rule, $\theta = -\rho$, drives the nominal interest rate to zero and maximises asymptotic welfare.

2.4 Transient properties

The predetermined state variable is $x \equiv m - w$ whilst the non-predetermined state variable is m. After some algebraic manipulation, one obtains:

$$\dot{x} = \alpha'(m - x), \quad x(0) = 0 \tag{2.13}$$

$$\dot{m} = \xi_4(\rho + \theta + \eta m) + \sigma\eta\Omega[\xi_2(1 - \xi_2 + \xi)g + (1 - \xi_2)(\xi_3 + \xi)a] +$$

$$\psi(m - x) + \xi\Omega[\beta'(\alpha' + \sigma\eta)(m^* - x^*) + \sigma\eta\xi_2 g^* - \beta'\dot{m}^*] \tag{2.14}$$

where $\psi \equiv (1-\xi_4)(\alpha'+\sigma\eta) > 0, \Omega \equiv [\sigma(1-\xi_2)(1-\xi_2+2\xi)+\beta'(1-\xi_2+\xi)]^{-1} > 0, 0 < \xi_4 \equiv \sigma(1-\xi_2)(1-\xi_2+2\xi)\Omega < 1$, and similarly for abroad where $a^* = -a$. The real exchange rate and level of consumption are given by:

$$e = [\beta'(x - x^* - m + m^*) - \xi_2(g - g^*) + (\xi_1 - \xi_3)a]/(1 - \xi_2 + 2\xi)\sigma \quad (2.15)$$

$$c = \left(\frac{(1-\xi_2+\xi)[\beta'(x-m)-\xi_2 g]+\xi[\beta'(x^*-m^*)-\xi_2 g^*]-(1-\xi_2)(\xi_3+\xi)a}{(1-\xi_2)(1-\xi_2+2\xi)}\right).$$

(2.16)

The model reduces to a four-dimensional state-space system with two predetermined state variables, x and x^*, and two non-predetermined state variables, m and m^*. The assumption of perfect foresight means that the model must satisfy the saddlepoint property (e.g., Buiter, 1984), so there must be two eigenvalues with negative and two eigenvalues with positive real parts.

3 Channels of international policy transmission

3.1 The benchmark case

The benchmark case is when the elasticities of intertemporal and intratemporal substitution in consumption are unity ($\epsilon = \sigma = 1, \xi = 0$) and when initially neither country holds any foreign assets ($a = 0$). The balance of trade is then continuously in balance ($b_T = 0$) and there is no current-account dynamics. Additional assumptions for this result to hold are that the government budgets of both countries are continuously in balance (cf., Buiter, 1989), Ricardian debt neutrality holds, and both countries have the same rate of time preference. The nominal interest rate equals the rate of time preference plus a weighted average of all future monetary growth rates, so is unaffected by fiscal or foreign policies. An unanticipated, permanent increase in monetary growth thus leads immediately to an equal increase in the nominal interest rate. In ad-hoc, two-country Mundell-Fleming models familiar from textbooks (also see, for example, Turnovsky, 1986; van

der Ploeg, 1986; Branson, 1988; Miller and Salmon, 1985; Oudiz and Sachs, 1985) the main channel of international transmission is through the nominal interest rate, but here this channel does not exist. This is why each country is insulated from the rest of the world and neither monetary nor fiscal policy has any international spill-over effects on output or employment. Hence, the impact, interim and final multipliers of economic policy are the same for a large open economy as for a small open economy. Rankin (1987) obtains a similar result for a two-period model with micro foundations. 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 interdependence is through the real exchange rate, so that each country has an incentive to export CPI-inflation by appreciating its currency [3].

There is a negative root $(-\alpha'\xi_4)$ corresponding to the predetermined variable x or x^* and a positive root (η) corresponding to the non-predetermined variable m or m^* so the saddlepoint property is satisfied. This property is reflected in the phase diagram (see Fig. 1). Below the 45^o or $\dot{x} = 0$ locus the real wage is excessively low, so employment and output are above their natural rates, the nominal wage is rising faster than monetary growth and real liquidity, x, is falling. The $\dot{m} = 0$ locus is flatter than the 45^o line, since it has a slope $\beta'/[(1-\xi_2)(\eta/(\alpha'+\eta)) + \beta'] < 1$. Below the $\dot{m} = 0$ locus prices are rising faster than the money supply so real money balances, m, are falling. Along the stable arm, SS, the nominal interest rate is constant and thus $m - c$ is constant, so SS satisfies

$$m - m(\infty) = \left(\frac{\beta'}{1-\xi_2+\beta'}\right)[x - x(\infty)] < x - x(\infty). \tag{3.1}$$

Hence along SS m increases more slowly than x so 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 is exactly the same.

[3] An increase in foreign government spending induces an increase in the relative price of foreign goods, which reduces home consumption of foreign goods and welfare. This externality suggests that, in the absence of international policy coordination, government spending is too high as the adverse effects on the other country are ignored (van der Ploeg, 1988a). If core inflation gradually adjusts to CPI-inflation, there are spill-over effects on foreign output and employment as well (van der Ploeg, 1989).

3.1.1 Monetary disinflation

Consider the situation where the foreign country initially has no inflation ($\theta^* = 0$) and the home country has positive inflation ($\theta > 0$). The rate of depreciation of the nominal exchange rate initially equals home monetary growth. The home country then disinflates by bringing down its monetary growth to zero. 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, the nominal interest rate falls immediately on impact to its new equilibrium value inducing agents to hold more money balances (jump from E to A). The price level falls on impact, which increases the real wage and depresses employment and output. Subsequently, the downward pressure on wages arising from unemployment boosts employment and output until they are back to their natural rates (A to E'). The fall in seigniorage implies an increase in taxes, which together with the increase in the real interest rate diminishes human wealth, consumption and aggregate demand. Over time falling prices boost real money balances and non-human wealth until consumption has recovered to its old equilibrium level. The temporary rise in the real interest rate corresponds to a short-run Mundell effect.

There are no international spill-over effects apart from the ones on foreign consumption of home goods and foreign CPI-inflation, so 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. During the transient period there is a real-interest-rate differential in favour of the home country, so the real exchange rate is expected to depreciate during the adjustment period and must appreciate 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 the trade balance is always 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, the foreign consumers' price index temporarily rises and then falls back to its original level. There are no international spill-over effects on output, employment and the real interest rate. 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 Cobb-Douglas preferences 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.

The effects of an anticipated monetary disinflation at home are given by path EA_1A_2E'. From equation (2.11) 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 a temporary increase in foreign consumers' prices and fall in foreign imports, 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.

3.1.2 Increase in government spending

An unanticipated, permanent increase in home government spending leads to path $E'BE$. On impact the price level rises, which erodes the real value of the rigid nominal wage and boosts aggregate employment and output. 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 reduce human wealth. Subsequently, the boom raises nominal wages faster than prices so 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 real interest rate falls on impact and subsequently recovers to the pure rate of time preference. This is consistent with falling consumption. Nominal interest rates are unaffected. The story is almost the same as for a multilateral increase in government spending, 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, so 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 foreign welfare falls. 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 a temporary fall in the home real interest rate.

3.2 Revaluation of initial foreign asset holdings

Now assume that the US (home) initially has a net foreign debt and holds no Japanese (foreign) government bonds whilst Japan (abroad) holds US government bonds, so $F < 0$ and is predetermined [4]. In that case, a previously unanticipated change in US policy affects the constant a, through an initial jump in $C(0)$, and thus the real exchange rate. From (2.16) one has

$$a = \bar{a}[1 - c(0)] = \left(\frac{\bar{a}}{1 - \xi_2 - \xi_3\bar{a}}\right)[\beta' m(0) + \xi_2 g(0)] + \bar{a} \qquad (3.2)$$

and the perfect-foresight solution of (2.13)-(2.14) yields

$$m(0) = -(\xi_3\xi_5/\eta)a - \int_0^\infty \exp(-\eta t)[\xi_4\theta(t) + \xi_5\xi_2 g(t)]dt \qquad (3.3)$$

where $\bar{a} = -(\rho/\xi_3)[F_0/Y(0_-)] > 0$ and $\xi_5 \equiv \eta/(1 - \xi_2 + \beta')$. Note that a is not affected by Japanese policy, so US policy affects Japanese real outcomes but (given that $\epsilon = \sigma = 1$) not vice versa. If one restricts attention to permanent changes in policy, one can solve (3.2)-(3.3):

[4] It is assumed that bonds are real. If they are nominal, then there are also revaluation effects due to jumps in the price level.

$$b_T = a = \bar{a} + \left(\frac{-\beta' \xi_4 \theta + \xi_2(\eta - \beta' \xi_5) g}{\eta(1 - \xi_2 - \xi_3 \bar{a}) + \xi_3 \xi_5 \beta' \bar{a}} \right) \bar{a}. \tag{3.4}$$

There is still no current-account dynamics, as the trade surplus generates just sufficient revenues to service US foreign debt, nominal interest rates are unaffected by fiscal policy, and the nominal exchange rate jumps immediately to its new equilibrium level.

Monetary disinflation in the US requires an increase in net exports to Japan (provided $\xi_3 \bar{a}$ is not too large), because the associated real appreciation of the dollar boosts the real value of Japanese holdings of US assets. The additional interest income from the US permits Japan to run a trade deficit. This manifests itself through a fall in Japanese supply and an increase in Japanese consumption, whereas in the US the adverse effects of disinflation on unemployment are attenuated. The additional demand in Japan derives from a fall in the price level, which boosts the real value of the wage and depresses employment and output. Over time nominal wages fall in Japan until equilibrium in the labour market is restored. Hence, when allowance is made for capital gains on foreign holdings of home assets, a disinflation at home causes transitory unemployment abroad.

An increase in US government spending leaves the nominal exchange rate unaffected, but induces a real appreciation of the dollar and an increase in the real value of US assets held by Japan. Japan can afford a trade deficit, since it receives additional interest income from the US (as $\eta - \beta' \xi_5 = \eta \xi_4 > 0$). The fall in the Japanese price level induces a fall in supply, causing transient unemployment, and an increase in the consumption level of Japan. The temporary boom in the US is less than when the US did not have any foreign debt. Hence, if $\epsilon = \sigma = 1$, an increase in US government spending is a beggar-thy-neighbour policy when the US has a foreign debt but a locomotive policy when the US holds foreign assets. This channel of international transmission occurs through capital gains on Japanese holdings of US assets. Similar effects have previously been analysed within the context of ad-hoc Keynesian, two-country models with imperfect substitution between home and foreign assets (Allen and Kenen, 1980).

3.3 Gross substitutes and gross complements

Now assume that initially neither country holds foreign assets and that the elasticity of intertemporal substitution is unity ($a = 0, \sigma = 1$). Equation (2.10) shows that the nominal interest rate remains unaffected by fiscal or foreign policies and is entirely determined by the rate of time preference plus a weighted average of future monetary growth rates. A permanent reduction in monetary growth then immediately leads to an equal fall in the nominal interest rate and an appreciation of the nominal exchange rate to its new equilibrium level. Equation (2.9) shows that the temporary appreciation of the real exchange rate induces short-run trade deficits and accumulation of foreign debt when goods are gross substitutes ($\epsilon > 1, \xi > 0$) and short-run trade surpluses and accumulation of foreign assets when goods are gross complements. In the long run there must, of course, be a trade surplus to service the accumulated foreign debt when goods are gross substitutes, but a trade deficit when goods are gross complements. The effects on consumption and thus on real money balances are negative in the short run and positive in the long run when goods are gross substitutes, but positive in the short run and negative in the long run when goods are gross complements. If in the short run real money balances fall, then prices increase, real wages fall and employment increases. Hence, the short-run spill-over effects on foreign employment and employment are in the opposite direction of those on foreign consumption. When goods are gross substitutes, foreign prices increase over time and thus there is a temporary fall in foreign real interest rates. If goods are gross complements, there is a temporary increase in foreign real interest rate. These results are confirmed by the numerical simulations presented in Table 1 (using the package of Markink and van der Ploeg, 1989). The real exchange rate misadjusts when goods are gross substitutes, because a long-run trade surplus must be associated with a depreciation of the real exchange rate. When goods are gross complements, the real exchange rate overshoots its long-run value.

An increase in government spending leaves nominal interest rates unaffected. The nominal exchange rate immediately jumps to its new long-run value. When goods are gross substitutes ($\epsilon = 2$), it leads to short-run trade surpluses, build-up of foreign assets and a long-run trade deficit, so foreign consumption and real money balances first increase and then fall whilst foreign unemployment temporarily increases. The real and nominal exchange rates depreciate on impact. Table 2 shows that all these effects are reversed when goods are gross complements ($\epsilon = 0.5$).

3.4 Role of intertemporal substitution

Now assume that initially neither country holds foreign assets and that the elasticity of intratemporal substitution between home and foreign goods is unity ($a = 0, \epsilon = 1$). Equation (2.10) shows that a high elasticity of intertemporal substitution causes overshooting of the nominal interest rate and consequently undershooting of the nominal exchange rate, because the temporary increase in real interest rates reinforces the fall in the current nominal interest rate when $\sigma > 1$. Equation (2.9) shows that the appreciation of the real exchange rate which occurs on impact must be associated with short-run trade surpluses and accumulation of foreign assets when $\sigma > 1$. In the long run the interest income derived from foreign assets permits a trade deficit. It follows that foreign consumption increases in the short run, but must decrease in the long run, and that the real exchange rate overshoots its long-run value. The fall in foreign prices causes transient unemployment abroad. A low elasticity of intertemporal substitution ($\sigma < 1$) gives rise to undershooting of the nominal interest rate, overshooting of the nominal exchange rate, misadjustment of the real exchange rate, and accumulation of foreign debt associated with short-run trade deficits and a long-run trade surplus. The spill-over effects for abroad are transient over-employment, falls in short-run consumption, and an increase in long-run consumption. In general, there are two effects of disinflation. The first is an appreciation of the currency, which induces agents to substitute away from home goods so foreign output increases (intratemporal substitution). The second is a fall in inflation and increase in real interest rates, so agents substitute in favour of future goods and current output falls (intertemporal substitution). Such saving shows up in current-account surpluses. When intertemporal substitution dominates intratemporal substitution, disinflation causes transient unemployment abroad which contradicts conventional Mundell-Fleming results. The precise condition for this to happen in a perfectly pooled equilibrium is that σ exceeds ϵ, or that home and foreign goods are Edgeworth-Pareto complements (Svensson and van Wijnbergen, 1989). Table 1 confirms the above discussion with numerical simulations.

When the elasticity of intertemporal substitution exceeds unity, an increase in government spending leads to a build-up of foreign debt, a long-run trade surplus, a small fall in foreign consumption in the short run and an increase in the long run, some transient over-employment abroad. When the degree of intertemporal substitution is less, these effects are reversed. Table 2 illustrates the role of intertemporal substitution.

4 Departures from Ricardian debt neutrality

4.1 Finite lives and current-account dynamics

So far, the current account played a trivial role because the model satisfied debt neutrality and consequently government debt and net foreign assets did not affect consumption and aggregate demand. Here departures from debt neutrality are considered, which can arise when one assumes capital market imperfections, distortionary taxes, or lack of an intergenerational bequest motive combined with a positive birth rate arising through finite lives (Blanchard, 1985) or population growth (Weil, 1989). The extension that follows adopts the assumption of finite lives. It introduces a channel of international transmission, which arises even when $\epsilon = \sigma = 1$ and $a = 0$. Each economy consists 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 the life insurance market is efficient. At each instant s a cohort of size δ is born, whose size at instant $t \geq s$ equals $\delta \exp[-\delta(s-t)]$, so the population at instant t equals $\int_t^\infty \delta \exp[-d(s-t)]ds = 1$. Population aggregates are obtained as the sum of the products of the consumption of each surviving cohort with its size. This yields the aggregate consumption function $C(t) = (\rho + \delta)[N(t) + H(t)]$, where human wealth is given by

$$H(t) \equiv \int_t^\infty \exp[-\int_t^s (r(s') + \delta)ds'][W(s)L(s) - T(s)]ds. \qquad (4.1)$$

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 earn income when they are alive. The return on aggregate non-human wealth does not contain a life insurance premium, because this constitutes a transfer from those who die to those who survive. Substitution into (2.2) gives $\dot{C} = [r - \rho]C - \delta(\delta + \rho)N$. Now government bonds, and in particular net foreign assets, affect aggregate consumption behaviour. The assumption of finite lives drives a wedge between the discount rate to calculate human wealth, $r + \delta$, and the one used to calculate

non-human wealth, r. This wedge allows the burden of higher taxation to be passed on to future, yet unborn generations, so that Ricardian debt neutrality no longer holds. Linearisation yields when $\epsilon = \sigma = 1, a = 0$: (2.6), (2.13),

$$\beta'(x - m) = \xi_1 c + \xi_2 g + \xi_3(c^* + e) \tag{4.2}$$

$$\dot{f} = \rho' f + \xi_3(c^* + e - c), \quad f(0) = 0 \tag{4.3}$$

$$\dot{c} = r - \rho - \delta(\delta + \rho)[(\gamma/\eta)(m - c) + (1 - \xi_2)^{-1}(f + d)], \tag{4.4}$$

where $\rho' \equiv r(\infty)$ and $d \equiv D/Y$ denotes the government debt-GDP ratio. The variables f, x and x^*, are predetermined, whilst m, m^*, c, c^* and e are non-predetermined.

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 equilibrium in asset markets yields:

$$f(\infty) = \frac{1}{2}(1 - \xi_2)(\gamma/\eta^2)(\theta - \theta^*) + \frac{1}{2}(d^* - d) \tag{4.5}$$

$$r(\infty) = [\rho - \frac{1}{2}\delta'(\theta + \theta^*) + \delta''(d + d^*)]/(1 + \delta') \tag{4.6}$$

$$i(\infty) = [\rho + \theta + \frac{1}{2}\delta'(\theta - \theta^*) + \delta''(d + d^*)]/(1 + \delta') \tag{4.7}$$

where $\delta' \equiv \delta(\delta + \rho)\gamma/\eta^2$ and $\delta'' = \frac{1}{2}(1 - \xi_2)^{-1}\delta(\delta + \rho)$. Steady-state equilibrium in the goods markets and current account yields:

$$e(\infty) = \left(\frac{\xi_2(g^* - g) + \frac{1}{2}\rho' \left(\frac{\xi_1 - \xi_2}{\xi_3}\right)[d - d^* + (1 - \xi_2)\left(\frac{\gamma}{\eta^2}\right)(\theta^* - \theta)]}{1 - \xi_2} \right) \tag{4.8}$$

$$c_d(\infty) = c(\infty) = \left(\frac{-\xi_2 g - \frac{1}{2}\rho'[d - d^* + (1-\xi_2)\left(\frac{\gamma}{\eta^2}\right)(\theta^* - \theta)]}{1-\xi_2} \right) \quad (4.9)$$

$$c_m(\infty) = \left(\frac{-\xi_2 g^* - \frac{1}{2}\rho'(\xi_1/\xi_3)[d - d^* + (1-\xi_2)\left(\frac{\gamma}{\eta^2}\right)(\theta^* - \theta)]}{1-\xi_2} \right). \quad (4.10)$$

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 long-run holdings of net foreign assets increase. This is associated with a trade deficit, because the interest receipts on net foreign assets allow home individuals to consume more and foreigners to consume less. The reduction in net exports is accompanied by an appreciation of the real exchange rate. 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. 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.

A tax-financed increase in home government spending leads to no long-run 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. Since taxes vary to keep government debt constant, the steady-state and transient effects are exactly as discussed in Sections 2.3 and 3.1.2.

The cumulative output gain follows from equation (2.13):

$$\begin{aligned} \int_0^\infty y(t)dt &= \beta' \int_0^\infty [x(t) - m(t)]dt = -(\beta/\alpha)\int_0^\infty \dot{x}(t)dt = -\left(\frac{\beta}{\alpha}\right) m(\infty) \\ &= \left(\frac{\beta}{\alpha}\right)\left\{\left(\frac{\xi_2 g + \frac{1}{2}\rho'[d - d^* + (1-\xi_2)\left(\frac{\gamma}{\eta^2}\right)(\theta^* - \theta)]}{1-\xi_2}\right)\right. \\ &+ \left.\left(\frac{\theta + \frac{1}{2}\delta'(\theta - \theta^*) + \delta''(d + d^*)}{\eta(1+\delta')}\right)\right\} \end{aligned} \quad (4.11)$$

A monetary disinflation reduces the cumulative deviation of foreign output from its natural level, less so under finite lives. A monetary expansion is thus a locomotive policy. In contrast to short-run Mundell-Fleming analysis, an increase in government spending does not affect the foreign cumulative output loss. The effects of a tax-financed increase in government spending on the home cumulative output loss again do not depend on whether expected lifetimes are finite or infinite. The cumulative output loss does not depend on whether a gradualist or "cold-turkey" policy is adopted. The cumulative output loss increases when labour markets are less flexible (low α) and when the share of government is large.

Table 1 presents the effects of a monetary disinflation when there is a life expectancy of 50. In contrast to the case of infinite lives, the nominal exchange rate appreciates and overshoots its new equilibrium value by 12.5%. The explanation is, however, very different from the one offered by two-country extensions of Dornbusch's (1976) model. The initial trade deficits lead to accumulation of foreign debt, so that in the long run the real exchange rate has to depreciate in order to generate a trade surplus sufficiently large to finance the interest on the accumulated foreign debt. Hence, on impact the real exchange rate misadjusts. The long-run build-up of foreign debt causes a fall in home consumption and a corresponding increase in foreign consumption. This is in sharp contrast with the case of infinite lives, where disinflation does not affect long-run levels of consumption and foreign debt. In addition, under finite lives the home price level has to fall about 10% less and the foreign price level has to increase a bit in the long run. In contrast to the case of infinite lives, there is a lasting Mundell effect, since the nominal interest rate falls 13% less than the rate of inflation. At home the cumulative output loss or *sacrifice ratio* is 59.41%, whereas abroad the cumulative output gain is 0.59%. This reflects the fact that a disinflation causes transient employment gains abroad, whereas with infinite lives foreign employment is unaffected.

4.2 Bond-finance

So far, taxes adjusted 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, taxes are increased when the government debt increases, $T = T_0 - \nu D, \nu > r$

where T_0 denotes autonomous taxes and ν denotes the reaction coefficient. It follows from (2.3) that

$$\dot{d} = (\rho' - \nu)d + \xi_2(g - y) - (1 - \xi_2)(\gamma/\eta)\theta, \quad d(0) = d_0. \tag{4.12}$$

Expressions (4.5)-(4.11) hold with $d(\infty) = [\xi_2 g - (1 - \xi_2)\left(\frac{\gamma}{\eta}\right)\theta]/(\nu - \rho')$. A smaller reaction coefficient (ν) leads to a larger government debt which *ceteris paribus* 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 a depreciation of the long-run real exchange rate (see (4.5)-(4.10)).

Instead of examining the effects of a change in long-run government debt, given fiscal and monetary policy, 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 4.1, as can be witnessed from Tables 1 and 2, because the assumption of finite lives means that taxes can be passed on to future, yet unborn generations. A bond-financed cut in monetary growth leads to less seigniorage revenues and thus to an accumulation of government debt which eventually leads to more conventional taxes. This is why consumption falls on impact, but it falls by less than with a tax-financed cut as people discount future taxes by more for they may possibly not be around to pay them. Consequently, the home price level and the levels of employment and output fall by smaller amounts than with a tax-financed cut in monetary growth. Less crowding out of private consumption in the short run implies that the initial trade deficits are larger and consequently in the long run there is a higher foreign debt and a greater loss in the nation's wealth than with tax finance. More interest payments on foreign debt must be financed through a larger trade surplus in the long run. This is why the long-run depreciation of the real exchange rate and the corresponding long-run fall in home consumption and increase in foreign consumption are one-and-a-half

times as much as with tax finance. The nominal exchange rate still overshoots. It appreciates by much less in the long run, because there is a smaller (greater) fall (increase) in the long-run home (foreign) price level. The real exchange rate misadjusts by a greater amount. Because the increased stock of government bonds must be willingly held, there is a larger rise in the long-run world real interest rate than with tax finance. The home cumulative output loss is smaller, whilst the foreign cumulative output gain is higher than with tax finance. The short-run Mundell-Fleming analysis is confirmed, because monetary disinflation boosts foreign employment and output and consequently a monetary expansion must be a beggar-thy-neighbour policy.

A bond-financed increase in government spending almost completely eradicates crowding out of private consumption, because households now know that new generations will be around to service the taxes required to service and redeem the accumulated government debt. The home price level and consequently home output rises by more than with tax finance, whilst in contrast to with tax finance the foreign price level and foreign output rise in the short run. Combined with the initial appreciation of the real exchange rate, transient trade deficits and a build-up of foreign debt occur. In the long run there must be a trade surplus to generate the revenues that are required to service the foreign debt. This is why in the long run the real exchange rate appreciates by less and home consumption falls by more than with tax finance, whilst in contrast to with tax finance foreign consumption increases. The long-run home price level rises by much more now, which is the main reason why the long-run nominal exchange rate depreciates. Table 2 also confirms that the cumulative output gain at home is much higher than with tax finance and that now there is small cumulative output gain abroad. This result confirms the locomotive property of a bond-financed increase in government spending, familiar from traditional Mundell-Fleming analysis.

5 Concluding remarks

A two-country, intertemporal, perfect-foresight model with micro foundations, floating exchange rates, uncovered interest parity, and nominal-wage sluggishness has been formulated. The present-value budget constraints of governments and private agents have been modelled in an internally consistent manner. When the elasticity of intertemporal substitution and the elasticity of intratemporal substitution between home and foreign goods are unity, when initially neither country holds foreign assets, and when Ricar-

dian debt neutrality holds, 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 trade balance, so there is no role for current- account dynamics, the nominal interest rate is unaffected by fiscal or monetary policies, and the nominal exchange rate immediately jumps to its new equilibrium level. These somewhat surprising results follow from both government budgets being continuously in balance and from both countries having the same rate of time preference.

When one departs from this benchmark case, one can identify five channels of international policy transmission. The first occurs when foreigners holds home bonds, because then the appreciation of the real exchange rate associated with a monetary disinflation and a fiscal expansion boosts the real value of home assets held by foreigners. A bigger trade surplus is required to generate the revenues necessary to service the higher foreign debt, hence home consumption falls and foreign consumption increases. The capital gains on home assets held by foreigners also leads to transitory unemployment abroad. The second channel is opened up when goods are gross substitutes or gross complements. In the former case monetary disinflation causes accumulation of foreign debt, a long-run trade surplus, higher foreign employment and lower foreign consumption in the short run, higher foreign long-run consumption, temporary falls in the foreign real interest rate, and misadjustment of the real exchange rate. In the latter case one has accumulation of foreign assets, transitory unemployment abroad and overshooting of the nominal exchange rate. An increase in government spending leads to accumulation of foreign assets when goods are gross substitutes and to foreign debt when goods are gross complements.

The third channel allows the elasticity of intertemporal substitution to be different from unity and the nominal interest rate to be influenced by fiscal and foreign policies. When this elasticity is greater than one, disinflation means that there is an accumulation of foreign assets, foreign consumption increases and then falls, foreign unemployment increases temporarily, and the nominal interest rate overshoots, but if the elasticity of intertemporal substitution is less than one, these effects are the other way round. An increase in government spending leads for elasticities of intertemporal substitution higher than one to a build-up of foreign debt, but for elasticities less than one to a build-up of foreign assets. For a perfectly pooled equilibrium it is essential to determine whether the elasticity of intertemporal substitution exceeds or is less than the elasticity of intratemporal substitution, because

this determines whether a monetary disinflation or an increase in government spending leads to a build-up of foreign debt or assets. A monetary disinflation leads to two effects. The first is an appreciation of the currency, so agents substitute away from home goods and foreign output increases. The second is that home inflation falls, so the real interest rate rises and agents substitute in favour of future goods so current output falls. The saving of the nation shows up in current-account surpluses. Hence, if intertemporal substitution dominates intratemporal substitution, or in a perfectly pooled equilibrium if home and foreign goods are Edgeworth-Pareto complements, disinflation causes transient unemployment abroad which contradicts the familiar Mundell-Fleming results. A potential fourth channel of international transmission occurs when core inflation catches up with CPI-inflation in a gradual fashion, because then changes in the real exchange rate affect consumers' prices, wage and thus employment and output abroad (van der Ploeg, 1989).

To give a non-trivial role to wealth effects and current-account dynamics and to allow for a fifth channel of international spill-over effects, the benchmark model was extended to allow for finite lifetimes so that Ricardian debt neutrality no longer holds. Tax-financed monetary disinflation leads to a build-up of foreign debt, misadjustment of the real exchange rate and the trade balance, overshooting of the nominal exchange rate and a build-up of foreign debt. For a comparison between tax-financed and debt-financed changes in monetary growth and government spending it is essential to allow for the present-value budget constraints of private agents and governments and the implied dynamics in the current account. Debt finance leads to less crowding out of private consumption in the short run, but to a bigger build-up of foreign debt and consequently more crowding out of private consumption in the long run. The cumulative output loss at home is smaller whilst the cumulative output gain abroad arising from a bond-financed disinflation is higher than with tax finance.

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Fig 1: Monetary disinflation.

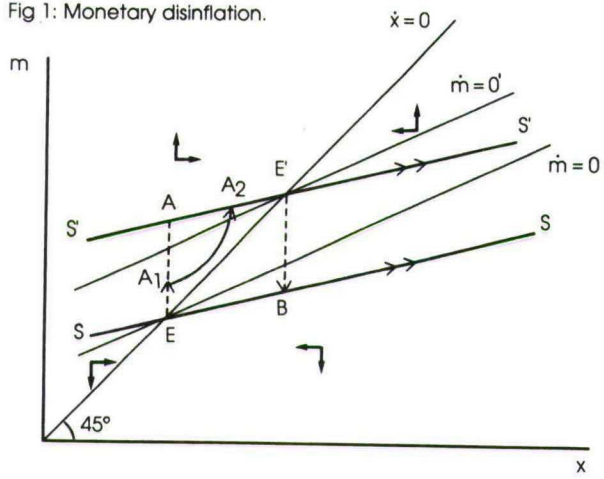

Table 1: Monetary disinflation ($\theta = -1$)

	Benchmark ($\sigma = \epsilon = 1$, $\delta = a = 0$, $\nu = \infty$)		Gross complements ($\epsilon = 0.5$, $a = -3.69$)		Gross substitutes ($\epsilon = 2$, ($a = 1.34$)		High EIS ($\sigma = 2$, $a = -5.18$)		Low EIS ($\sigma = 0.5$, $a = 0.60$)		Finite lives ($\delta = 0.02$)			
											Tax finance ($\nu = \infty$)		Debt finance ($\nu = 0.075$)	
Time	0	∞	0	∞	0	∞	0	∞	0	∞	0	∞	0	∞
Home output, y	-24	0	-19.30	0	-31.14	0	-67.46	0	-9.39	0	-20.38	0	-19.26	0
Foreign output, y^*	0	0	-4.71	0	7.14	0	-11.24	0	2.02	0	2.73	0	3.60	0
Home consumption, c	-32	0	-33.57	1.14	-29.62	-0.60	-113.21	1.73	-9.40	-0.27	-24.22	-5	-21.91	-7.5
Foreign consumption, c^*	0	0	1.57	-1.14	-2.38	0.60	8.28	-1.73	-0.42	0.27	0.69	5	1.03	7.5
Home real money balances, m	8	40	6.43	41.14	10.38	39.40	22.49	81.72	3.13	19.73	6.79	29.71	6.42	24.56
Foreign real money balances, m^*	0	0	1.57	-1.14	-2.38	0.60	3.75	-1.73	-0.67	0.27	-0.91	-0.29	-1.20	-0.44
Home nominal interest rate, i	-1	-1	-1	-1	-1	-1	-1.70	-1	-0.63	-1	-0.78	-0.87	-0.71	-0.80
Foreign nominal interest rate, i^*	0	0	0	0	0	0	0.06	0	0.01	0	0.04	0.13	0.06	0.20
Home real interest rate, r	9.6	0	8.03	0	11.22	0	23.42	0	4.48	0	8.36	0.13	7.97	0.20
Foreign real interest rate, r^*	0	0	1.57	0	-1.62	0	-2.38	0	-0.67	0	-1.04	0.13	-1.38	0.20
Home CPI-inflation, p_c	-6.76	-1	-6.45	-1	-7.08	-1	-16.70	-1	-2.93	-1	-5.38	-1	-4.94	-1
Foreign CPI-inflation, p_c^*	-3.84	0	-4.15	0	-3.52	0	-10.74	0	-1.30	0	-2.68	0	-2.30	0
Real exchange rate, e	-32	0	-38.83	-1.42	-25.90	0.14	-63.33	-0.86	-16.77	0.13	-32.30	2.5	-32.38	3.75
Nominal exchange rate	-40	-40	-43.69	-43.69	-38.66	-38.66	-82.07	-84.31	-20.57	-19.34	-40	-27.5	-40	-21.25
Trade balance, b_T	0	0	19.61	-2.84	-29.74	1.51	58.15	-4.32	-7.78	0.66	-7.38	12.5	-9.43	18.75
Net foreign assets, f	0	0	0	-34.08	0	-18.08	0	51.79	0	-7.97	0	-150	0	-225.
Home government debt, d	0	0	0	0	0	0	0	0	0	0	0	0	0	150.
Foreign government debt, d^*	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Parameters: $\alpha = 0.375$, $\alpha' = 1.5$, $\beta = 0.75$, $\beta' = 3$, $\rho = 0.025$, $\gamma = 0.25$, $\hat{\gamma}(1) = 0.4$, $\xi_1 = 0.45$, $\xi_2 = 0.25$, $\xi_3 = 0.3$.

Note: The effects on the home and foreign price level correspond to $-m$ and $-m^*$.

Table 2: Increase in government spending ($g = 1$)

	Benchmark ($\sigma = \epsilon = 1$, $\delta = a = 0$, $\nu = \infty$)		Gross complements ($\epsilon = 0.5$, $a = -0.47$)		Gross substitutes ($\epsilon = 2$, ($a = 0.17$)		High EIS ($\sigma = 2$, $a = -0.31$)		Low EIS ($\sigma = 0.5$, $a = 0.16$)		Finite lives ($\delta = 0.02$)* Debt finance ($\nu = 0.075$)	
Time	0	∞	0	∞	0	∞	0	∞	0	∞	0	∞
Home output, y	0.2	0	0.16	0	0.26	0	0.28	0	0.16	0	0.23	0
Foreign output, y^*	0	0	0.04	0	-0.06	0	0.05	0	-0.03	0	0.03	0
Home consumption, c	-0.07	-0.33	-0.05	-0.34	-0.09	-0.33	0.14	-0.34	-0.18	-0.33	0.00	-0.417
Foreign consumption, c^*	0	0	-0.01	0.01	0.02	-0.01	-0.03	0.01	0.01	0	0.01	0.083
Home real money balances, m	-0.07	-0.33	-0.05	-0.34	-0.09	-0.33	-0.09	-0.34	-0.05	-0.33	-0.08	-0.505
Foreign real money balances, m^*	0	0	-0.01	0.01	0.02	-0.01	-0.02	0.01	0.01	0	-0.01	-0.005
Home nominal interest rate, i	0	0	0	0	0	0	0.00	0	-0.01	0	0.00	0.002
Foreign foreign interest rate, i^*	0	0	0	0	0	0	-0.00	0	0.00	0	0.00	0.002
Home real interest rate, r	-0.08	0	-0.07	0	-0.09	0	-0.10	0	-0.07	0	-0.09	0.002
Foreign real interest rate, r^*	0	0	-0.01	0	0.01	0	-0.01	0	0.01	0	-0.01	0.002
Home CPI-inflation, p_c	0.05	0	0.05	0	0.05	0	0.07	0	0.03	0	0.06	0
Foreign CPI-inflation, p_c^*	0.03	0	0.03	0	0.03	0	0.04	0	0.02	0	0.04	0
Real exchange rate, e	-0.07	-0.33	-0.51	-0.82	0.06	-0.15	-0.07	-0.33	-0.05	-0.34	-0.07	-0.292
Nominal exchange rate	0	0	-0.47	-0.47	0.17	0.17	0.01	0.02	0.01	-0.01	0	0.208
Trade balance, b_T	0	0	-0.16	0.02	0.25	-0.01	-0.24	0.02	0.13	-0.01	-0.06	0.208
Net foreign assets, f	0	0	0	-0.28	0	0.15	0	-0.22	0	0.13	0	-2.5
Home government debt, d	0	0	0	0	0	0	0	0	0	0	0	5
Foreign government debt, d^*	0	0	0	0	0	0	0	0	0	0	0	0

Parameters: $\alpha = 0.375$, $\alpha' = 1.5$, $\beta = 0.75$, $\beta' = 3$, $\rho = 0.025$, $\gamma = 0.25$, $\hat{\gamma}(1) = 0.4$, $\xi_1 = 0.45, \xi_2 = 0.25$, $\xi_3 = 0.3$.

Note: The effects on the home and foreign price level correspond to $-m$ and $-m^*$. Tax-financed increases ($\nu = \infty$) in government spending under finite lives ($\delta = 0.02$) yield the benchmark outcomes.

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