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BRABANT
POSTBOX 90153
5000 LE TILBURG
THE NETHERLANDS

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RESEARCH MEMORANDUM

THE TWIN-DEBT PROBLEM IN AN INTERDEPENDENT WORLD

Rob de Groof
Martin van Tuijl

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Rob de Groof and Martin van Tuijl

Tilburg University, Department of Economics,
P.O. Box 90153, NL-5000 LE Tilburg, Netherlands.

A two-country model with a portfolio choice between money and imperfectly substitutable domestic and foreign bonds, a floating exchange rate and perfect foresight is presented. Account is taken of capital accumulation, government debt and current account dynamics. Numerical methods, including extensive sensitivity analysis, are used to trace the effects and spillover effects of policies aimed at the reduction of both external and government debt. These policies are conducted in a country with nominal wage rigidity, while the passive country is characterized by real wage rigidity.

1 INTRODUCTION

The reduced supply of and an increasing demand for world savings suggest continuously high interest rates in the years to come. The IMF, OECD and BIS recently expressed their concern about the sustainability of the external deficits in view of the persistent large U.S. external deficit, the substantial German external deficit caused by the unification, the increased demand for savings to finance the restructuring of the Eastern European economies and the environmental policies. This question seems relevant, especially to the U.S.. For, total claims to the limited U.S. savings layed by the combined financing needs of private domestic investment and the federal budget deficit, points to an awkward situation. The persistence of this 'savings gap' (cf. Corrigan, 1990), accompanied with a growing budget deficit creates a serious twin-deficit-twin-debt problem (see also, Kremers, 1990).

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In this paper we examine two rather obvious ways to deal with this problem in a world consisting of two interdependent economies.

For that purpose, a two-country perfect foresight model, allowing for intertemporal budget constraints, current account dynamics, wealth effects, capital accumulation, imperfect asset and commodity substitution, floating exchange rates, and international factor immobility is formulated. In his study of a related problem within the context of a symmetrical two-country general equilibrium model, Van de Klundert (1991) suggests that international institutional differences concerning wage formation between the two economic regions, might be highly relevant. Therefore, in search for a more realistic version of the global problem posed by the U.S.' savings gap, we take account of various hypotheses with respect to wage formation.

There are three ways of dealing with the problem of the savings gap: using the printing press, wait and see, or tackle the causes underlying the gap. The awkward situation can produce pressures on the monetary authorities to crank up the printing press. However, money creation does not create savings. The fundamental cause of the external debt, which is the savings gap, can not be eliminated definitely by inflationary finance. For these reasons we will not explore this alternative. That leaves only two options: either to do nothing or to eliminate the savings gap.

In case of an unchanged U.S. position, foreign debt would tend to grow infinitely. Eventually the marketplace might prove to be quite harsh as it goes about financing the U.S.' persistent external deficits. Following Van de Klundert, we will investigate the case, in which the share of U.S.' assets in foreign portfolios exceeds a critical value. This is supposed to result in a 'financial crisis', which is modelled as an exogenous shift in European asset preferences away from U.S. bonds. This 'policy' of wait and see will result in a reduction of the U.S.' external debt. However, the price tag reads: a higher government debt and lower consumption for a long time to come. It will be shown, that in the long run this passive attitude would be profitable in terms of external debt as well as consumption and employment. However, it is questionable, whether from the policy-makers' point of view the long run is a relevant time horizon.

There seems to be only one acceptable active way to eliminate the savings gap. A reduction in the rate of investment would be disastrous, and one can not expect a rise in the savings ratio to do the job quickly and safely enough. So, nothing seems left but to reduce the budget deficit, which can be achieved by either increasing taxes or by cutting government spending. An increase in taxes does not seem to be an attractive alternative in times of a low growth rate and increasing worldwide competition (cf.Chimerine and Young, 1986 and Knoester and Kolodziejak, 1992). Therefore, we will confine ourselves to the case of a reduction in U.S. government spending. A fiscal contraction in the U.S., causing a real depreciation of the dollar, turns out to be an efficacious remedy for the twin-deficit-twin-debt-problem. This finding upholds Van de Klundert's (1991) and Branson's (1988) proposition concerning the possibility to restore international equilibrium by means of fiscal policy.

This conclusion is proof against all kinds of variations in the wage equations. The latter is not true with respect to the effects and spill-over effects of the shocks mentioned above, measured in terms of real output or consumption. Here wage formation proves to play a rather dominant role.

The paper is organized as follows. In section 2 the basic model is presented. Its complexity makes an analytical solution intractable. Instead, a comprehensive set of simulations is carried out. Appendix 1 gives the numerical assumptions with respect to the initial steady state situation. Analytical models sacrifice reality by ruling out several sources of dynamics, in order to keep the analysis manageable. On the other hand, the results of the simulations approach are coefficient specific. To overcome this dilemma, the system has been submitted to extensive sensitivity analysis. Therefore, Appendix 2 contains the intervals of robustness for all behavioural parameters (cf.Karakitsos, 1989). This sensitivity analysis not only gives insight in the generality of the numerical example, but also in how (in)dispensible the various variables are, in connection with the present problem. In section 3 we consider the effects and spill-over effects of the shocks, brought about by the two alternatives mentioned above. This will be done for the basic case, in which nominal wage rigidity is assumed to prevail in one country

and real wage rigidity in the other. Appendix 4 presents a number of figures, which may be of some help to understand the dynamics of the system. In section 4, we report on the consequences of variations in the wage equations. These variations concern the type (nominal or real) of wage rigidity, as well as the Phillips mechanism. The latter relates to the traditional versus the so-called "weak" version of the Phillips mechanism. Section 5 concludes the paper.

2 A TWO-COUNTRY MODEL WITH REAL AND NOMIAL WAGE RIGIDITY AND IMPERFECT GOODS AND FINANCIAL ASSETS SUBSTITUTION

In this section we present a symmetric two-country model by focussing on the equations of country j (j = 1,2); the variables concerning the foreign country contain the subscript k (k = 1,2, $j \neq k$). Country 1 stands for Europe and country 2 for the U.S.. Except for nominal wage formation, the two countries are identical.

All variables are expressed as *percentage deviations from their initial steady-state values*. Exceptions are f and t, which are percentage deviations from steady-state output measured in terms of consumption goods, and r and r_n, which are absolute deviations (* 100 %)

Lower-case letters refer to real variables as well as prices, a capital letter denotes a nominal value. Greek letters denote parameters, which are all defined positively. The parameters ε and φ refer to partial demand elasticities and elasticities of substitution, respectively. For instance, ε_{mr} is the nominal interest rate (r_n) elasticity of the demand for real cash balances (m), and φ_{kl} is the elasticity of substitution between capital (k) and labour (l). The parameter γ refers to a ratio applying to the initial steady state. For instance, γ_{k_b} is the initial steady-state ratio of bonds issued by firms (k) to the total supply of bonds (b). All parameters are defined in Appendix 1.

Exogenous variables are barred. The superscript 'e' refers to expectational variables. In order to save space, we present nominal and real exchange rates as country-specific variables. All initial steady state prices are assumed to equal unity.

The portfolio sub-system of the model draws on Van de Klundert (1991). Agents divide their real non-human wealth (we) into real cash balances (m), domestic bonds (b_{jj}) and foreign bonds (b_{jk}). Asset demand decisions depend on the rates of return on bonds, which are determined by the nominal interest rates (r_n) and the expected change in the nominal exchange rate (Δe^e). The real interest rate (r) equals the difference between the nominal interest rate (r_n) and the expected rate of inflation (Δp_c^e)

$$r_j \equiv r_{n_j} - \Delta p_{c_j}^e \qquad (1)\text{-}(2)$$

The real value of bonds is assumed to be fixed within a period (Haas and Masson, 1986). Bonds are indexed to the consumers' price (CPI), thus constituting sure claims on given amounts of future consumption goods (baskets). Expectations are assumed to be rational. Furthermore, stochastic components are absent. Therefore, agents have perfect foresight.

Transactions demand for (domestic) real cash balances is supposed to increase with real output in terms of consumption goods ($y + p_y - p_c$), exclusively at the expense of domestic bonds. Moreover, we ignore currency substitution (McKinnon, 1990). Under these assumptions, the demand for the pertinent assets as fractions of real non-human wealth can be written as

$$m_j - we_j = \varepsilon_{m_y}(y_j + p_{y_j} - p_{c_j}) - \varepsilon_{m_j r_j}\left(\frac{r_{n_j}}{\tilde{r}}\right) \qquad (3)\text{-}(4)$$

$$b_{jj} - we_j = -\varepsilon_{b_{jj}y}(y_j + p_{y_j} - p_{c_j}) + \varepsilon_{b_{jj}r_j}\left(\frac{r_{n_j}}{\tilde{r}}\right) - \varepsilon_{b_{jj}r_k}\left(\frac{r_{n_k} + \Delta e_j^e}{\tilde{r}}\right) + \underline{b}_{h_j} \qquad (5)\text{-}(6)$$

$$b_{jk} + q_{c_j} - we_j = - \varepsilon_{b_{jk} r_j} \left(\frac{r_{n_j}}{\tilde{r}}\right) + \varepsilon_{b_{jk} r_k} \left(\frac{r_{n_k} + \Delta e^e_j}{\tilde{r}}\right)$$

$$- \frac{\gamma_{b_{jj_b}}}{(1 - \gamma_{b_{jj_b}})} \underline{b}_{h_j} \qquad (7)\text{-}(8)$$

where q_{c_j} and $\tilde{r}$ are the real consumption exchange rate[1] applying to country j, and the *initial* world interest rate, respectively. Since symmetry is assumed in the initial steady-state, interest rates are equal across regions. The numerical assumptions with respect to the asset demand functions satisfy the familiar "adding-up" constraints (Turnovsky 1977).

The supply of real cash balances equals the difference between exogenous money supply ($\underline{M}$) and the CPI (p_c).

$$m_j = \underline{M}_j - p_{c_j} \qquad (9)\text{-}(10)$$

Net investment of firms is completely financed by bond issues. It is assumed that all transactions are paid for at the beginning of the period. So, investment goods are bought against today's prices. As a result, the amount of bonds supplied by firms is determined by the real value, in terms of consumption goods, of capital equipment at the beginning of the next period, thus including net investment of the present period. The supply of government bonds equals outstanding government debt (d), comprising this period's budget deficit as well. For simplicity, it is assumed that bonds issued by firms and the government are perfect substitutes. Therefore, the supply of domestic bonds (b) reads

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1) The real consumption exchange rate, $q_{c_j} = p_{c_k} + e_j - p_{c_j}$, will henceforth be indicated by 'real exchange rate' as distinguished from the 'real production exchange rate', which is $q_{y_j} = p_{y_k} + e_j - p_{y_j}$. The nominal exchange rate, e_j, is expressed in currency of country j per unit of currency of country k.

$$b_j = \gamma_{k_{b_j}} (k_{+1_j} + p_{y_j} - p_{c_j}) + (1 - \gamma_{k_{b_j}}) d_j \qquad (11)\text{-}(12)$$

where p_y denotes the price of home produced goods.
Equilibrium in the international bond-markets is stated by

$$b_j = \gamma_{b_{jj_b}} b_{jj} + (1 - \gamma_{b_{jj_b}}) b_{kj} \qquad (13)\text{-}(14)$$

Finally, real wealth of domestic households consists of real domestic and net foreign assets (f)

$$we_j = \gamma_{m_{we}} m_j + (1 - \gamma_{m_{we}}) b_j + \gamma_{we_y} f_j \qquad (15)\text{-}(16)$$

where

$$\gamma_{we_y} \equiv \kappa + \gamma_{d_y} + \gamma_{m_y},$$

in which κ is the initial steady-state capital-output ratio.
The micro-underpinnings of the foregoing equations concerning the portfolio subsystem, are no more than rudimentary. In this respect, the commodity expenditure equations show close resemblance, as they lack explicit microfoundations in the form of intertemporal choices made by households and firms as well (as, for example, in Van der Ploeg, 1991). As Van de Klundert (1991) observes, a thorough microeconomic foundation of macroeconomics requires an integration of saving, investment and portfolio decisions. Research in this field is still in its infancy (e.g. Rankin, 1991). Moreover, we agree with Allen (1991, p 153), who argues, that optimizing models can not avoid ad hoc qualities either, be it of a different nature than non-optimizing models.

Total private consumption (c) is split up between consumption of home (c_h) and foreign produced (c_m) goods. First, consumers decide upon total consumption expenditure according to

$$c_j = \varepsilon_{cy} (y_j + p_{y_j} - p_{c_j} - t_j) + \varepsilon_{cw} we_j - \varepsilon_{cr} \left(\frac{r_{n_j} - \Delta p^e_{c_j}}{\tilde{r}}\right) \qquad (17)\text{-}(18)$$

Thus, total consumption is positively related to purchasing power of nominal output and real non-human wealth of the private sector, whereas it depends negatively on lump-sum taxes (t) and the real interest rate (r).

Having decided upon total consumption, consumers choose between home (c_d) and foreign (c_m) produced goods and services, by maximizing a CES utility function

$$c_{d_j} = c_j - \varphi_{hm} (p_{y_j} - p_{c_j}) \qquad (19)\text{-}(20)$$

$$c_{m_j} = c_j - \varphi_{hm} (p_{y_k} + e - p_{c_j}) \qquad (21)\text{-}(22)$$

The accumulation of capital (k) is described by

$$\Delta k_j = \delta (i_j - k_j) \qquad (23)\text{-}(24)$$

where δ and i denote the rate of depreciation and gross investment, respectively. Firms produce under perfect foresight and maximize the present value of the cash flow. Account is taken of installation costs of newly installed capital. These are assumed to be such, that the costate variable associated with the the state variable k, coincides with the average "Q" or Tobin's Q (Hayashi, 1982). The rate of investment then, is a function of the latter. Under these conditions, the functions with respect to gross investment, the behaviour of Q and the demand for labour (l) are given by the first order conditions, resulting from the application of the maximum principle

$$i_j = k_j + \frac{\alpha}{\delta} Q_j \qquad (25)\text{-}(26)$$

$$Q_{+1_j} = (1 + \tilde{r} + \delta) Q_j + r_{n_j} - \Delta p^e_{y_j} + \frac{\tilde{r} + \delta}{\varphi_{kl}} (k - y) \qquad (27)\text{-}(28)$$

$$l_j = y_j - \varphi_{kl} (w_j - p_{y_j}) \qquad (29)\text{-}(30)$$

where w is the money wage[2]. Equations (27)-(28) reflect the above assumption, that firms finance their investment outlays on the domestic market for loans. The term $r_n - \Delta p^e_y$ represent the discount rates, which are relevant for investment, since we assume investment outlays to fall entirely on the domestic sector. The last terms on the right hand side of equations (27)-(28) reflect the assumption of linear homogeneous CES production functions, with φ_{kl} representing the elasticity of substitution between capital and labour (1).

Under the assumptions above, the equations for output read

$$y_j = \lambda\, l_j + (1 - \lambda)\, k_j \qquad (31)\text{-}(32)$$

Equilibrium in the goods markets is represented by

$$y_j = \gamma_{c_h}\, c_{h_j} + \gamma_i\, i_j + \gamma_{g_h}\, g_{h_j} + \gamma_{b_h}\, c_{m_k} + \gamma_{b_{g_h}}\, g_{m_k} \qquad (33)\text{-}(34)$$

Here g_h and g_m denote exogenous government expenditure on home and foreign produced goods, respectively.

The labour markets are assumed to be segmented internationally. Furthermore, they do not clear in the short run, due to rigidity of either nominal wages or real consumers' wages. Empirical evidence points, at least for the short and medium term, to a high degree of *nominal* wage rigidity in the U.S. and *real* wage rigidity in Europe (Branson and Rotemberg, 1980, Attenasio *et al.*, 1987, Van der Ploeg, 1988). For expositional purposes we assume inertia on the labour market causing (almost) perfect short-run nominal and real wage rigidity in the U.S. and Europe, respectively. According to Attenasio *et al.* (1987), empirical evidence does not reject the existence of an error-correction mechanism in the wage relation, ensuring consumers' wages to return to their long-run equilibrium value. We assume a stylized version of this mechanism to apply, so that nominal wages adapt gradually to the labour market situation (Phillips mechanism), as well as to the development of CPI. So,

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2) Equations (25) through (30) can easily be checked, by taking the linearized and discrete-time form of the first order conditions derived by, for instance, Meijdam (1991, pp 29-30).

in the long run unemployment is at its natural rate. As mentioned, we investigate the role of wage formation, by modifying the wage equations in a number of ways. Assuming country-specific labour supply to be exogenous, these conditions imply

$$\Delta w_j = (1 - \zeta_j)\ \Delta w_{j_{-1}} + \zeta_j\ \Delta p_{c_j} + \eta\ l_j - \eta(1 - \zeta_j)\ l_{j_{-1}} \qquad (35)\text{-}(36)$$

in which ζ and η denote the real wage inertia coefficient and the Phillips coefficient, respectively.

Government outlays, total real government expenditure plus interest payments on outstanding debt, are financed by lump-sum taxes (t), the issue of bonds, or by means of the 'printing press' ($\Delta \underline{M}_j$). The selling of bonds raises government debt, which immediately becomes clear from writing the government budget *identity* (Buiter 1986) as

$$d_j = (1 + \tilde{r}_j)\ d_{j_{-1}} + r_j + \gamma_{d_y}^{-1}\ (g_j - t_j) - \gamma_{m_y}\ \gamma_{d_y}^{-1}\ \Delta \underline{M} \qquad (37)\text{-}(38)$$

where g indicates total real government expenditure. Equations (37)-(38) reflect the above assumption of government bonds being indexed to the CPI. In order to prevent government debt from escalation, we specify a feedback rule for taxes. We chose not to use a feedback rule for government expenditure, because this variable is intended to serve as a policy instrument. A sensible tax rule was introduced by Buiter (1987). Here, it takes the form

$$t_j = \gamma_{d_y}\ \beta\ d_j\ ,\quad \beta > \tilde{r} \qquad (39)\text{-}(40)$$

where β denotes the tax rule feedback coefficient.

The real current account surplus of a country (Δf_j), by definition equals the sum of its balance of trade surplus and its capital income account surplus. Under flexible exchange rates, this sum equals the capital account deficit, and, consequently, the increase in country j's net real foreign asset position.

$$\Delta f_j = \Phi\ (r_k - r_j + \Delta q_{c_j}) + \tilde{r}\ \Phi\ (q_{c_j} + b_{jk_{-1}} - b_{kj_{-1}})$$

$$+ \gamma_{b_h} (c_{m_k} - c_{m_j} - q_{y_j}) + \gamma_{b_{g_h}} (g_{m_k} - g_{m_j} - q_{y_j})$$

$$+ (1 - \gamma_{b_{jj_b}}) \kappa (\Delta Q^* - \Delta Q) \qquad (41)-(42)$$

in which

$$\Phi \equiv (1 - \gamma_{b_{jj_b}})(\kappa + \gamma_{d_y})$$

and q_{y_j} represents the real production exchange rate.

Evidently, the exchange rates are related as follows

$$e_k = - e_j \qquad (43)$$

$$q_{c_k} = - q_{c_j} \qquad (44)$$

The macroeconomic real exchange rate by definition equals

$$q_{c_j} \equiv p_{c_k} + e_j - p_{c_j} \qquad (45)$$

The presence of both home and foreign produced goods causes the real *consumption* exchange rate, q_c, to be different from the real *production* exchange rate, q_y:

$$q_{y_j} = p_{y_k} + e_j - p_{y_j}$$

however, it can be verified that

$$q_{c_j} = (2 \gamma_{h_c} - 1) q_{y_j}$$

assuming 'local good preference' ($\gamma_{h_c} > 1/2$), q_{c_j} and q_{y_j} are positively related, so that there is no need to distinguish carefully between these two types of real exchange rates.
The consumers' price index is defined as

$$p_{c_j} \equiv \gamma_{h_c} p_{y_j} + (1 - \gamma_{h_c})(p_{y_k} + e_j) = p_{y_j} + (1 - \gamma_{h_c}) q_{y_j} \qquad (46)\text{-}(47)$$

The system is completed by a definitional equation for real government expenditure (in terms of consumption goods)

$$g_j \equiv \gamma_{g_h} (g_{h_j} + p_{y_j}) + \gamma_{b_{g_h}} (g_{m_j} + p_{y_k} + e_j)$$

$$-(\gamma_{g_h} + \gamma_{b_{g_h}}) p_{c_j} \qquad (48)\text{-}(49)$$

There are 49 equations in 48 endogenous variables, viz. r_n, r, m, b_{jj}, b_{jk}, b, we, c, c_h, c_m, i, Q, y, w, l, k, d, g, t, f, p_c, p_y, e, q_c.
Invoking Walras' law, one of the equilibrium equations is redundant. As a result, equation (14), which is the condition for equilibrium in the market for foreign bonds, can be eliminated.
The model contains eight backward-looking state variables viz. k, w, d and f, since these are constrained by their history. The five remaining state variables, p_y, Q and $e_j = e_k^{-1}$ are unconstrained by their past values and are forward-looking. For saddlepoint stability to hold, one should therefore have eight stable roots and three unstable roots.

3 TWO ALTERNATIVE ATTITUDES TOWARDS THE U.S 'S DEFICITS-DEBTS PROBLEM

As mentioned before, two ways of dealing with the twin-deficit-twin-debt problem are studied: to let things take their course, which by assumption leads to a financial crisis, or to cut U.S.' government spending. In this

section, the international transmission effects of the unanticipated once-and-for-all shocks, connected with these alternatives, will be analyzed. This will be done by passing in review the results of numerical exercises. The simulations have been carried out with the PSREM package for policy simulation of linear dynamic models with constant coefficients and rational expectations of future events, developed by Van der Ploeg and Markink (1991). The simulation of similar nonlinear models generally takes a lot of computing time. We have experimented with the full nonlinear model, using the SIMPC package developed by Don (1990). It was found to have the same properties as the linear version of the model. To avoid potential computing constraints, we chose to use the linear version. The numerical assumptions, along with the results of the sensitivity analyses, are presented in Appendix 1. The consequences of the shocks mentioned above, are shown in Table 1.

The first column summarizes the effects and spill-over effects of a preference shift towards European bonds (b_{h_1} = 10) as a consequence of *a financial crisis*. So, on impact the demand for European bonds increases at the expense of the demand for U.S. bonds, leading to a fall in the European and a rise in the U.S. real interest rate. As a consequence, U.S.' real interest payments and government debt increase (see figure 1a). On the contrary, the U.S.' external debt position improves (figure 1b), owing to a real depreciation of the dollar (figure 1c). The latter implies a strengthening of the U.S.' competitiveness and, therefore, a significant trade balance surplus. Increased net exports cause an upward pressure on U.S. producers' price and, because of nominal wage rigidity, a downward pressure on the real producers' wage. So, in the short run, U.S.' real output and employment increase. In Europe the fall in the real interest rate boosts private expenditure and, therefore, real output and employment. The required supply-side adjustment comes from a decreased real producers' wage. A real appreciation of the ECU causes European CPI and, hence, the nominal as well as the producers' wage to fall, while European producers' prices increase.

When describing effects and spill-over effects of shocks in the medium run (t = 4), one should distinguish carefully between the *level* and the *movement* of a variable. The *level* is represented by the relative

deviation of a variable from its initial steady-state value, while the *movement* is the period-to-period change of this level.

In the present case, the medium-term picture for the U.S. can be sketched as follows. There is a further improvement of the external debt position (figure 1b), notwithstanding a real appreciation of the dollar, as compared with the first period (figure 1c). However, a lower, but still high real interest rate causes government debt to rise even further. Production and employment have decreased. The reasons are: a decumulation of capital brought about by crowding out of investment in the past, and an increased real producers' wage, due to a deflationary pressure on the producers' price. The latter comes from a low level of investment and consumption, due to a high real interest rate and a high real exchange rate of the dollar. In Europe, real output is still above its initial level. It has even risen somewhat, because the effect of capital accumulation dominates the effect of the rise in the European real producers wage. The latter follows from the real depreciation of the ECU (figure 1c), exerting an upward pressure on the CPI and, thus, on money wages, which exceeds the rise in the producers' price.

In the long run, the twin-debt will be reduced at last; both U.S's government and external debt get below their initial values (figures 1a and 1b). The U.S. acquire a considerable surplus on their capital income account. The reason is, that the real interest rate in Europe has risen fast, choking off excess demand in the goods market. The opposite holds for the U.S.. Europe has to service its long-term external debt by maintaining a trade balance surplus. A real depreciation of the ECU (figure 1c), takes care of the required strengthening of Europe's competitiveness.

The second column of Table 1, summarizes the consequences of *a cut in U.S. government spending* ($g_{d_2} = -10$). It can be seen, at a glance, that this policy measure can do the job: it instantly and continually reduces the twin-debt problem (figures 2a and 2b). The price to be paid for that is lower real output and employment in the short and medium run. On the contrary, U.S. private consumption benefits from this measure continually.

In the short run, the decreased issue of government bonds lowers the real interest rate in the U.S., boosting domestic private expenditure. Meanwhile, a real depreciation of the dollar (figure 2c) induces an

increase in U.S. net exports, leading to a decline in external debt. Nevertheless, on impact, the negative effect of the fiscal contraction on total expenditure dominates. This is accompanied by a rise in the real producers' wage, due to a fall in the producers' price. In Europe, the producers' wage falls because of a real appreciation of the ECU, choking off the increase in CPI and thus in money wages. The budget cut and the connected fall in the interest rate decreases the U.S.' government debt.

The U.S.' government debt continues to decline in the medium run (figure 2a), in spite of a rise (movement) in the real interest rate. The reasons are, a still low level of the interest rate and the lasting effect of the fiscal contraction. The U.S.' external debt also keeps falling (figure 2c), owing to a surplus on the capital income account. To be sure, the surplus on the capital income account has fallen, due to a somewhat less favourable real interest rate differential and a real appreciation of the dollar. Real output in the U.S. increases because of capital accumulation and a decline in the producers' wage. Nevertheless, real output is still below its initial level. In Europe the real depreciation of the ECU causes the CPI and, thus, money wage to rise.

These tendencies are reinforced in the long run by a decrease in the real interest rate in the U.S. and an increase in the real interest rate in Europe. The U.S.' government debt falls gradually to a new steady-state level (figure 2a). The same is true for U.S.' external debt (figure 2b). The aforementioned interest rate differential, typical for portfolio models, is accompanied by a real depreciation of the dollar (figure 2c). Nevertheless, the U.S.' trade balance shows a deficit, due to crowding in of private expenditure. On the other hand, Europe needs this trade balance surplus, in order to service its debt. Crowding in of capital in the U.S. and crowding out of capital in Europe explain the rise and fall in real output in the U.S. and Europe, respectively. So, in the long run the U.S. fiscal contraction proves to be a so-called beggar-thy-neighbour policy.

TABLE 1

Effects and spill-over effects of a financial crisis ($\underline{b}_{h_1} = 10$) and reductions in U.S. government spending ($g_{d_1} = -10$)

Type of shock	$\underline{b}_{h_1} = 10$			$g_{d_2} = -10$		
Period	1	4	∞	1	4	∞
Europe						
Real output (y_1)	1.51	1.53	-2.06	0.08	0.04	-0.13
Inflation (Δp_{c_1})	-3.15	1.20	0	0.05	0.04	0
Employment (l_1)[1]	2.16	1.63	0	0.12	0.06	0
consumption domestic goods (c_{d_1})	4.24	4.21	-7.48	0.15	-0.08	-0.65
consumption foreign goods (c_{m_1})	21.69	15.89	-23.04	1.11	0.71	0.18
Real interest rate (r_1)	-0.99	-0.84	0.87	-0.04	-0.00	0.06
Nominal interest rate (r_{n_1})	0.28	0.33	0.87	0.04	0.03	0.06
Government debt (d_1)	-0.62	-1.41	1.80	-0.02	-0.02	0.13
U.S.						
Real output (y_2)	2.01	0.09	2.06	-0.66	-0.34	0.47
Inflation (Δp_{c_2})	3.25	-0.69	0	-0.54	-0.03	0
Employment (l_2)	2.86	0.54	0	-0.95	-0.55	0
consumption domestic goods (c_{d_2})	0.09	-1.73	7.47	0.83	1.52	2.97
consumption foreign goods (c_{m_2})	-17.37	-13.40	23.04	-0.12	0.73	2.15
Real interest rate (r_2)	0.73	0.62	-0.87	-0.16	-0.13	-0.20
Nominal interest rate (r_{n_2})	0.46	0.32	-0.87	-0.18	-0.17	-0.20
Government debt (d_2)	0.44	1.02	-1.80	-1.35	-3.38	-4.54
World						
Real exchange rate ($q_{c_1} = -q_{c_2}$)	-4.19	-2.80	3.73	-0.23	-0.19	-0.20
U.S. foreign debt ($f_1 \equiv -f_2$)	-10.08	-16.46	-86.30	-0.17	-0.39	-2.80

4 THE ROLE OF WAGE FORMATION

The assumption of nominal and real wage rigidity holding for the U.S. and Europe respectively, only partly investigates the role of wage formation in the two regions distinguished.

In this section we give a more complete picture of this role, by summarizing the most important qualitative deviations from the reference situation, caused by alternative assumptions with respect to wage formation. These assumptions not only concern the type of wage rigidity, but the Phillips mechanism as well. As for the latter, apart from the standard specification used in section 3, we also take a "weak" version

Table 2
Short-term deviations from the reference situation (Table 1), due to alternative assumptions with respect to wage formation

Europe	U.S.	$\underline{b}_{h_1}$ y_1	$\underline{b}_{h_1}$ y_2	g_{d_2} y_1	g_{d_2} y_2
R/ST	R/ST		-		
R/ST	R/W		-		
R/W	R/ST		-		
R/W	R/W		-		
R/ST	N/W		-		
R/W	N/ST				
R/W	R/W				
N/ST	N/ST	-			
N/ST	N/W	-			
N/W	N/ST	-			
N/W	N/W	-			

into consideration. In this weak Phillips mechanism, only a *change* in the level of unemployment induces *ceteris paribus* changes in the nominal wage rate.[3)]

It is found, that the conclusions with respect to the elimination of the twin-debt are untouched by the use of alternative specifications of the wage equations. The same is true with respect to the long-term spill-over effects, with the exception of employment. For, the weak Phillips mechanism permits long-term effects on employment, due to hysteresis.

However, in the *short run* the spill-over effects are affected by the alternative assumptions. Table 2 depicts them for the regions' real output. For all possible combinations of wage rigidities and Phillips mechanisms, the *qualitative* (signs) deviations from the reference situation (Table 1, p 14) are presented. The indications R, N, ST and W stand for Real wage rigidity, Nominal wage rigidity, Standard and Weak version of the Phillips mechanism respectively.

Inspection of Table 2 learns, that the type of wage rigidity is predominant; the type of the Phillips mechanism does not matter. In case of a financial crisis, the U.S' real output shows a fall instead of a rise, if real instead of nominal wage rigidity prevails in the U.S.. The reason is, that the real depreciation of the dollar increases CPI, causing the U.S.' producers' wage to rise. A cut in U.S. government spending decreases instead of increases European real output, if nominal instead of real wage rigidity prevails in Europe. For, the choking off of the increase in CPI, due to the real appreciation of the ECU, will then not be passed through in the money wage.

5 CONCLUDING REMARKS

It is shown that the U.S. twin-debt can immediately and continually reduced by a fiscal contraction. In terms of real output, consumption and employment, this measure proves to be a beggar-thyself policy in the short

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3) As changes in the labour supply are not taken into consideration here, the two options with respect to the weak Phillips mechanism in literature, i.c. the change in the unemployment rate and the rate of change in employment, do coincide.

run. In the long run the model does not permit any effect on employment, while in terms of real output as well as real consumption, the cut in government expenditure is a beggar-thy-neighbour policy.

A passive "policy", resulting in a financial crisis in the form of a preference shift against U.S. bonds, will not bring about a simultaneous reduction of both debt positions in the short or medium run. The best that can be accomplished is a reduction in the external debt at the cost of an increasing government debt. Furthermore, the price of this irresolution is less real consumption for a long time. Only in the long run a simultaneous reduction of the twin-debt will be attained.

Our conclusions with respect to the elimination of the twin-debt are in line with those reached by Van de Klundert (1991). This suggests, that the type of wage rigidity is not of overriding importance, at least as far as the twin-debt problem is concerned. Gordon (1988), Garretsen and Lensink (1989) and Van der Ploeg (1992) cast some doubt on whether from 1982 on, European wage formation can be characterized by real rather than nominal wage rigidity. This raises the question of whether the above conclusion of wage formation being of minor importance, stretches to the situation of nominal wage rigidity in both regions. We showed, that such is the case. The same holds for a two-sided real wage rigidity and a one- or two-sided weak Phillips mechanism for that matter. This means, that the financial markets dynamics are predominant.

The above results apply within the boundaries, given by the sensitivity analysis of Appendix 2. This analysis proves the above conclusions to be fairly robust. The system shows a relative sensitivity to the elasticity of substitution between home and foreign produced consumption goods. In case of a cut in U.S. government expenditure, the long-run zone between the lower boundary and the reference value of this parameter is relatively narrow. A value of this elasticity below its critical value, creates a situation, in which for a large number of years the effect of the real dollar depreciation dominates the effect of the trade flows. The U.S., therefore, run a current account deficit, raising their external debt.

An interesting extension of the analysis would be a disaggregation of the model, by allowing for a tradables and a non-tradables sector. There are reasons to presume, that such a disaggregation would make a

difference (see De Groof and Schaling, 1991, and De Groof and Van Tuyl, 1991). One obvious but probably not the only reason is that in a meso model, the notion 'fiscal contraction' requires further specification. For, a fiscal contraction may fall on tradables or nontradables, triggering different transmission mechanisms, which may lead to different macroeconomic (spill-over) effects. Another point for further research is the extension of the asset menu of the portfolio by allowing for (partial) financing capital investment by the issue of equities.

REFERENCES

Allen, P.R., 1991, Open economy macroeconomics, a review essay, *Journal of Monetary Economics*, 27, 151-156.

Attenasio, O., P. Manasse and F. van der Ploeg, 1987, *Interdependence in the OECD Economies: An Econometric model of the Group of Seven*, London School of Economics, Working Paper, no 914, 1987.

Branson, W., 1988, International adjustment and the dollar: policy illusions and economic constraints, in: W. Guth, ed., *Economic Policy Coordination*, IMF, Washington D.C., 44-84.

Buiter, W., 1986, Fiscal prerequisites for a viable managed exchange rate regime: A non-technical eclectic introduction, *Praeadviezen voor de Vereniging voor de Staathuishoudkunde*, (Stenfert Kroese, Leiden), 99-117.

Buiter,W., 1987, Fiscal policy in open interdependent economies, in: A. Razin and E. Sadka, eds., *Economic policy in theory and practice*, Macmillan, London, 101-104.

Corrigan, E.G., 1990, The U.S. savings gap and global imbalances, *De Economist*, 138, no 4, 1990, 464-471.

Chimerine, L. and R.M. Young, 1986, Economic Surprises and Messages of the 1980's, *The American Economic Review*, 76, nr. 2, 31-36.

Don Econometrics, Manual SIMPC 3.0, The Hague, September, 1990.

Gordon, R.J., 1988, Wage gaps versus output gaps: Is there a common story for all of Europe? in: H. Giersch, ed., *Macro and micro policies for more growth and employment*, J.C.B. Mohr, Tübingen.

Garretsen, H. and R Lensink, 1989, International policy coordination and European wage rigidity, *De Economist*, 137, 76-90.

De Groof, R.J. and E. Schaling, 1991, Monetary and fiscal policy in interdependent two-sector economies, *De Economist* 139, 427-444.

De Groof, R.J. and M.A. van Tuijl, 1991, Financial integration and fiscal policy in interdependent two- sector economies with real and nominal wage rigidity, *European Journal of Political Economy*, forthcoming, 1993.

Haas, R.D. and P.R. Masson, 1986, MINIMOD: specification, simulation and results, *IMF Staff papers*, 33, no 4, 722-767.

Hayashi, F., 1982, Tobin's marginal q and avarage q: a neoclassical interpretation, *Econometrica*, 50, 213-224.

Karakitsos, E., 1989, Monetary policy, exchange rate dynamics and the labour market, *Oxford Economic Papers*, 41, 410-433.

Van de Klundert, Th., 1991, Reducing external debt in a world with imperfect asset and commodity substitution, *European Journal of Political Economy*, 7, 17-40.

Knoester, A. and A.M.M. Kolodziejak, 1992, Effects of taxation in economic models, a survey, *Economic Modelling*, 9, 352-364.

Kremers, J.J.M., 1990, External imbalances and fiscal policy in the United States, Japan and Germany: the role of stock-flow dynamics, in: G. Kraus (ed.), *Public finance and steady economic growth*, Proceedings of the 45th congres of the IIPF, 1990.

Meijdam, A.C., 1991, *Rational Disequilibrium Dynamics, a New classical Synthesis*, Ph.D. thesis, Tilburg University.

McKinnon, R.I., 1990, Why floating exchange rates fail: A reconsideration of the liquidity trap, *Open Economies Review*, 1, 229-250.

Van der Ploeg, F., 1988, International interdependence and policy coordination in the OECD economies, *Greek Economic Review*, 10, 1-48.

Van der Ploeg, F., 1991, Money and capital in interdependent economies with overlapping generations, *Economica*, 58, 233-256.

Van der Ploeg, F. and A.J. Markink, 1991, Dynamic policy in Linear models with rational expectations of future events, A computer package, *Computer Science in Economics and Management*, 4, 175-199.

Van der Ploeg, F., 1992, Fiscal stabilisation and monetary integration in Europe: a short run analysis, *De Economist*, 140, 16-45.

Rankin, N., 1991, *Exchange rate risk and imperfect capital mobility in an optimising model*, Discussion Paper, no 9116, CentER for Economic Research, Tilburg University.

Turnovsky S., 1977, *Macroeconomic analysis and stabilization policy*, Cambridge University Press, chapter 3.

APPENDIX 1 NUMERICAL ASSUMPTIONS

Parameter values for the reference situation

Partial demand elasticities:

$\varepsilon_{m_j r_j}$	= 0.3	interest-elasticity of real cash balances
$\varepsilon_{b_{jj} y}$	= 0.0833	income elasticity of domestic bonds
$\varepsilon_{b_{jj} r_j}$	= 0.05	elasticity of domestic bonds held by residents with respect to the domestic nominal interest rate
$\varepsilon_{b_{jj} r_k}$	= 0.05	elasticity of domestic bonds held by residents with respect to the expected yield on foreign bonds
$\varepsilon_{b_{jk} rj}$	= 0.10	elasticity of foreign bonds held by residents with respect to the domestic nominal interest rate
$\varepsilon_{b_{jk} r_k}$	= 0.2	elasticity of foreign bonds held by residents with respect to the expected yield on foreign bonds
ε_{cy}	= 0.8	elasticity of private consumption with respect to the purchasing power of nominal output
ε_{cr}	= 0.225	interest-elasticity of private consumption
ε_{cw}	= 0.1	(real) wealth-elasticity of private consumption

Elasticities of substitution:

φ_{hm}	= 2.5	between home and foreign produced consumption goods
φ_{kl}	= 0.55	between capital and labour

Other behavioural parameters:

α	= 0.125	acceleration coefficient
β	= 0.5	tax rule feedback coefficient
ς_1	= 0.999	nominal wage inertia coefficient for Europe
ς_2	= 0.001	nominal wage inertia coefficient for the U.S.
η	= 0.1	Phillips coefficient

Initial steady-state ratio of:

γ_{k_b}	= 0.8	bonds issued by firms to total supply of bonds
γ_{m_y}	= 0.25	real cash balances to real output in terms of consumption goods
$\gamma_{b_{jj_b}}$	= 0.8	holdings of domestic bonds to total bonds holdings of residents
γ_{b_h}	= 0.1333	private sector imports to output
$\gamma_{b_{g_h}}$	= 0.0267	government imports to output
γ_{c_h}	= 0.5333	private consumption of home produced goods by residents to output
γ_{g_h}	= 0.14	government expenditure on home produced goods government output
γ_i	= 0.1667	gross capital investment to output
γ_{h_c}	= 0.8	consumption of home produced goods to total consumption
γ_{d_y}	= 0.75	government debt to real output in terms of consumption goods
$\gamma_{m_{we}}$	= 0.0625	real cash balances to real wealth
γ_{we_y}	= 4	real wealth to real output in terms of consumption goods

Other non-behavioural parameters

δ	= 0.0556	rate of technical obsolescence

κ = 3 capital-output ratio

λ = 0.7 wage share

$\tilde{r}$ = 0.0444 real interest rate in the initial steady state

APPENDIX 2 SENSITIVITY ANALYSIS

Table A2.1 summarizes the results of the sensitivity analysis, by presenting the intervals of robustness of the behavioural parameters with respect to the *signs* of the U.S.' external and government debt.

The sensitivity analysis with respect to the *signs* of the spill-over effects in terms of *real output*, gives almost the same intervals of robustness as those in Table A2.1. One exception worth mentioning is the nominal inertia coefficient for the U.S., ζ_2. The upper boundary of this parameter is 0.65, in the case of the financial crisis.

Table A2.1 Intervals of robustness with respect to the U.S.' twin-debt

parameter	value in the reference situation	t=1	t→∞
φ_{kl}	0.55	0.01 - 1	0.01 - 1
φ_{hm}	2.5	1 - 1000	2 - 1000
ε_{cy}	0.8	0.6 - 1	0.6 - 1
ε_{cw}	0.1	0 - 0.4	0 - 0.225
ε_{cr}	0.225	0.12 - 0.5	0.12 - 0.4
α	0.125	0.01 - 0.2	0.01 - 0.2
β	0.5	0.1 - 1.33	0.1 - 1.33
η	0.1	0.02 - ∞	0.02 - ∞
$\varkappa_1$	0.999	0 - 1	0 - 1
$\varkappa_2$	0.001	0 - 1	0 - 1
ε_{my}	1	0.6 - 1.2	0.6 - 1.2
ε_{mr}	0.3	0.05 - 0.6	0.05 - 0.6
$\varepsilon_{b_{jj}r_j}$ *)	0.05	0.03 - 0.25	0.03 - 0.25
$\varepsilon_{b_{jk}r_k}$ *)	0.2	0.04 - 0.8	0.04 - 0.8

*) With corresponding changes in $\varepsilon_{b_{jk}r_j}$ or $\varepsilon_{b_{jj}r_k}$, obeying the adding-up constraints

robustness as those in Table A2.1. One exception worth mentioning is the nominal inertia coefficient for the U.S., ζ_2. The upper boundary of this parameter is 0.65, in the case of the financial crisis.

APPENDIX 3 FIGURES

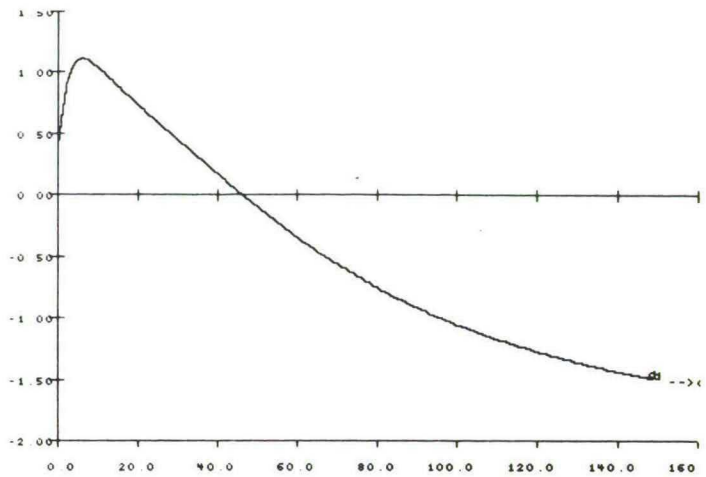

Figure 1a Effects of $\underline{b}_{h_1}$ = 10 on U.S. government debt

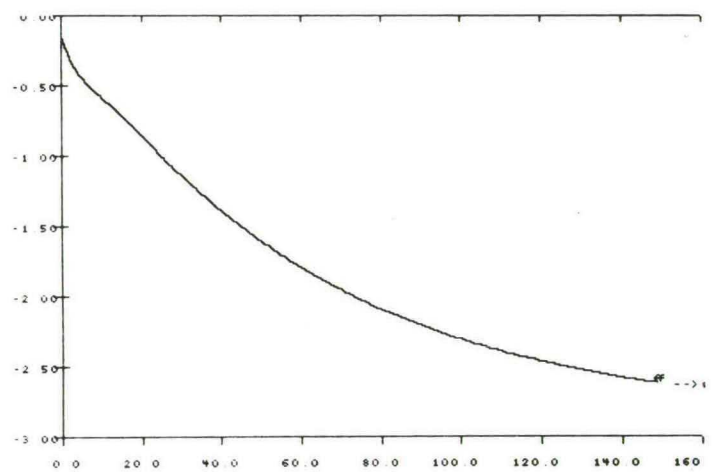

Figure 1b Effects of $\underline{b}_{h_1}$ = 10 on U.S. external debt

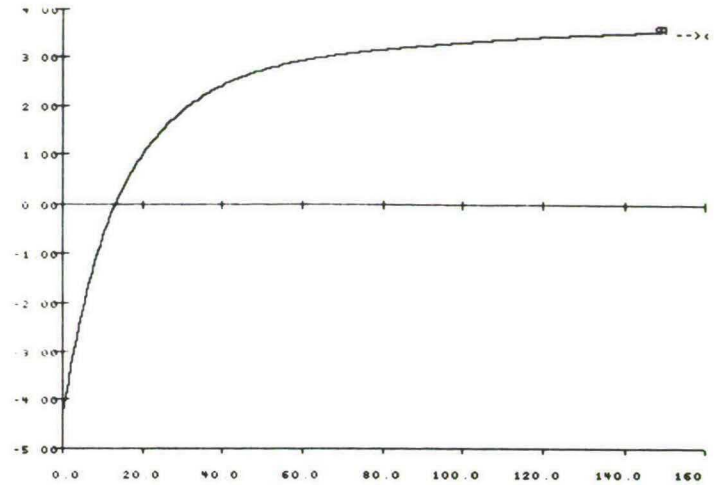

Figure 1c Effects of $\underline{b}_{h_1}$ = 10 on the real exchange rate

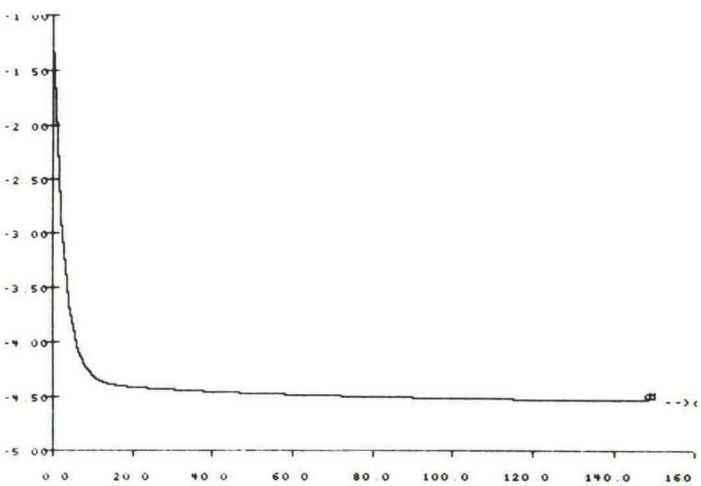

Figure 2a Effects of g_{d_2} = -10 on U.S. government debt

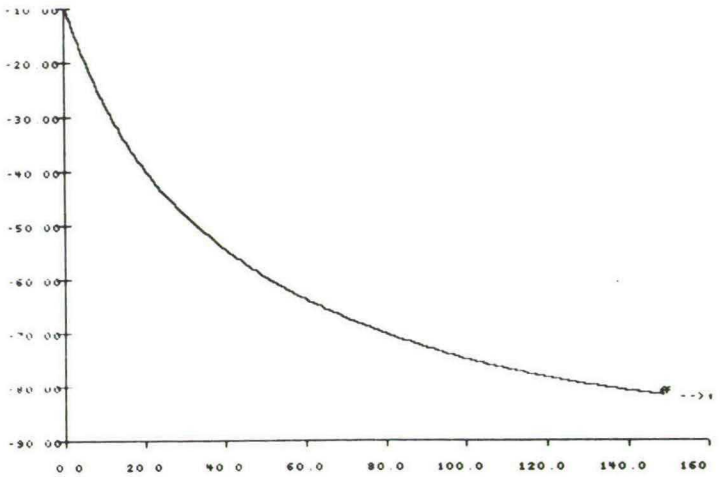

Figure 2b Effects of g_{d_2} = -10 on U.S. external debt

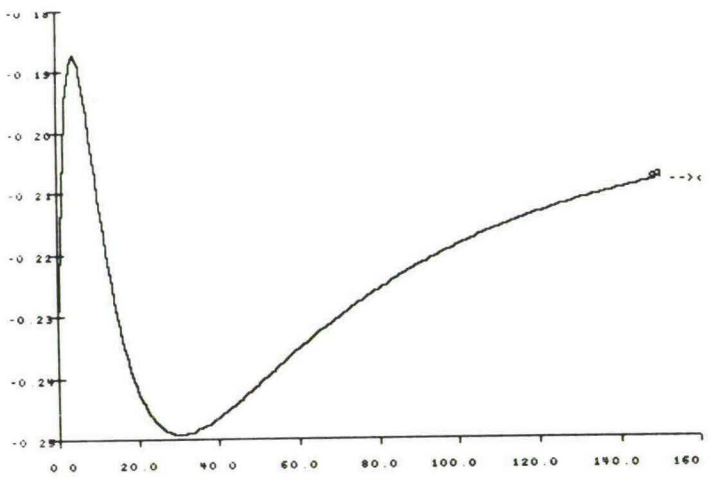

Figure 2c Effects of g_{d_2} = -10 on the real exchange rate

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