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"The Balance of Trade, the Terms of Trade, and the Real Exchange Rate: An Intertemporal Optimizing Framework"

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Abstract

This paper uses an intertemporal optimizing model of a small open economy to analyze how terms of trade changes affect real exchange rates and the trade balance. We consider temporary current, anticipated future, and permanent changes in the terms of trade. The results suggest that the relationship between the terms of trade and the current account (the so-called Harberger-Laursen-Metzler effect) may be quite sensitive to whether or not the model incorporates nontraded goods. Thus, the real exchange rate may be an important variable through which terms of trade shocks are transmitted to the current account.

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Summary

This paper uses an intertemporal optimizing general equilibrium model of a small open economy to address two related questions in international macroeconomics. First, how do terms of trade shocks affect the real exchange rate? Second, in a model with nontraded goods, how do terms of trade changes affect the current account? We consider explicitly (and draw clear distinctions among) temporary current, anticipated future, and permanent changes in the terms of trade. The analysis deals with the effects of exogenous changes in the world terms of trade as well as with the effects of commercial policies (e.g., tariffs) which alter the internal terms of trade faced by domestic agents. We develop our results both in terms of simple, familiar diagrams, as well as analytically.

The main results of the paper suggest that the response of the trade balance to a given disturbance in the terms of trade--the so-called Harberger-Laursen-Metzler effect--may be quite sensitive to whether or not the model incorporates nontraded goods. The paper shows that if the negative welfare effect is sufficiently large relative to the intertemporal substitution effect, a temporary current deterioration in the terms of trade worsens the trade balance, holding constant the path of the real exchange rate. Similarly, if the negative welfare effect is sufficiently large, an anticipated future deterioration in the terms of trade improves the trade balance, holding constant the path of the real exchange rate. Once the adjustment in the equilibrium real exchange rate is taken into account, however, both of these results may be reversed. In other words, a temporary current (anticipated future) deterioration in the terms of trade may actually improve (worsen) the initial trade balance position.

Further, the paper shows that the imposition of a (small) temporary current tariff (from an initial undistorted equilibrium) necessarily improves the current period trade balance, holding constant the real exchange rate. Similarily, if the real exchange rate is held constant, an anticipated future tariff always worsens the current period trade balance. However, both of these results may be reversed once the adjustment in the equilibrium real exchange rate is taken into account. The fundamental reason for the reversal is that the path of the real exchange rate is a key determinant of the real (consumption-based) rate of interest, and hence of real spending and the current account balance.

Finally, a permanent deterioration in the terms of trade always improves the trade balance if initially there is a deficit and the real exchange rate is assumed to be fixed. However, if the permanent deterioration in the terms of trade causes a real depreciation, a further worsening of the initial trade deficit position may result. As a consequence, the real exchange rate is an important variable through which terms of trade shocks are transmitted to the current account.

I. Introduction

This paper uses an intertemporal optimizing general equilibrium model of a small open economy to address two related questions in the area of international macroeconomics. First, how do terms of trade shocks affect the real exchange rate? Second, in a model with nontraded goods, how do terms of trade changes affect the current account? We consider explicitly (and draw clear distinctions among) temporary current terms of trade changes, anticipated future changes, and permanent changes in the terms of trade. We develop our results both in terms of simple, familiar diagrams, as well as analytically.

In order to analyze these questions, it is necessary to extend the traditional two tradable good (importable and exportable) intertemporal optimizing model of a small open economy to allow for a home goods sector. The advantage of incorporating a nontraded good into the set-up is that it becomes possible to examine, within the context of a simple optimizing framework, the determinants of the comovement between terms of trade changes and real exchange rate changes. This is useful for several reasons.

First, at a theoretical level, the terms of trade (the relative price of importables in terms of exportables) and the real exchange rate (the inverse of the relative price of home goods in terms of a traded good, either importables or exportables) are interesting variables in their own right and identifying whether, on theoretical grounds, one expects them to be positively or negatively correlated (as well as the magnitude of the correlation) is a useful task. Second, any expenditure switching policy which alters the internal terms of trade faced by domestic producers and consumers will in general have a nonzero effect on the real exchange rate which policymakers may wish to take into account. This may be equally true of perceived future policies just as much as current policies, and this is so even if the current anticipation of future policies (e.g., an expected future tariff) or exogenous disturbances proves to be false. 1/ Third, the results may shed some light on empirical regularities in the comovement of the terms of trade and the real exchange rate. Finally, as argued below, a potentially important channel through which the terms of trade influence the balance of trade is via the effect of terms of trade changes on the real exchange rate.

The analysis of the effects of terms of trade changes on spending, saving, and the current account has a long history in the open economy literature. The early papers which include Harberger (1950) and Laursen and Metzler (1950) were based on non-optimizing models. Their argument was essentially that a deterioration in the terms of trade would lower real income and hence reduce saving out of any given level of nominal

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1/ In a recent paper, Edwards (1987) highlights the role of anticipated future import tariffs on today's current account.

income, both measured in terms of exportables. If investment, fiscal policies, and nominal income are fixed, the lower saving implies a worsening in the country's current account position. Thus, the Harberger-Laursen-Metzler effect states that a deterioration in the terms of trade will cause a reduction in the current account surplus or more generally, the terms of trade and current account balance will be negatively correlated.

More recent work, which is based on more solid microeconomic foundations, includes the contributions of Sachs (1981), Obstfeld (1982), Svensson and Razin (1983), Stulz (1986), and Frenkel and Razin (1987). These papers show clearly the importance of intertemporal considerations underlying the response of the current account balance to various shocks. The current account is inherently a forward-looking variable (being the difference between saving and investment which are both forward looking) and hence its response to a change in the terms of trade will depend crucially on whether the disturbance is expected to be transitory or permanent or whether it is expected to occur today or in the future. Thus, by deriving the saving decision from the solution to the intertemporal problem of allocating lifetime wealth to consumption in various periods, these models show that the sign (and magnitude) of the correlation between the terms of trade and the current account balance need not be negative and depends critically on agents' expectations concerning the timing and duration of the disturbance to the terms of trade.

One aspect which is ignored by all these papers--and which constitutes the point of departure of the present one--concerns the role of nontraded goods. The existence of a home goods sector turns out to provide an additional and distinct channel through which terms of trade changes affect the current account, namely through their impact on the real exchange rate. More precisely, as shown in Svensson and Razin (1983) and Frenkel and Razin (1987), a terms of trade change has a <u>direct effect</u> (that is, an effect holding constant the time path of the real exchange rate) on the consumption based trade balance because it alters the excess of current GDP over aggregate spending, both measured in real terms. In addition to its effect on the level of national saving and spending, a terms of trade change also alters the composition of total spending among importables, exportables, and home goods. In general, therefore, from an initial position of equilibrium in the home goods sector, the real exchange rate will have to adjust. The movement in the real exchange rate in turn affects the real trade balance. This channel, operating through a change in the real exchange rate, I refer to as the <u>indirect effect</u> of a terms of trade change on the trade balance.

Traditionally, in discussions of the so-called Harberger-Laursen-Metzler effect, only the direct influence of terms of trade changes on aggregate spending is included. In what follows, I show that the indirect effect may be of the same sign or of opposite sign to the direct effect and may be small or large so that, a priori, there is no reason to regard the direct effect as having either greater or less significance than the indirect effect. In discussing the consequences of terms of trade changes for a country's current account position, the total effect, which is the sum of the direct and indirect influences, should be considered. In order to do this, and in particular to gain some insight into the indirect effect itself, we must consider the question of how various shocks to the terms of trade--temporary or permanent, present versus future, will alter a country's real exchange rate.

To anticipate some of the conclusions, we show that for certain parameter configurations, the total effect may be opposite in sign to the direct effect so that in general, the response of the current account to a change in the terms of trade is sensitive to whether or not the model incorporates nontraded goods. This suggests that the real exchange rate is potentially an important variable through which terms of trade shocks are transmitted to the current account. For example, we show that if the welfare effect is large relative to the intertemporal substitution effect, a temporary current deterioration in the terms of trade worsens the trade balance holding constant the real exchange rate, but may improve the trade balance once the response of the real exchange rate is taken into account. Further, we show that the imposition of a temporary (small) tariff (from an initial undistorted equilibrium) necessarily improves the trade balance (and similarly that an anticipated future tariff always worsens the trade balance) holding constant the real exchange rate but may worsen the trade balance (or improve it in the case of an expected future tariff) once the real exchange rate adjusts. Finally, a permanent deterioration in the terms of trade always improves the trade balance if initially there is a deficit and the real exchange rate is assumed to be fixed. However, if the permanent deterioration in the terms of trade causes a real depreciation, a further worsening of the initial trade deficit position may result.

The rest of this paper is organized in the following manner. In Section II, I briefly set out the analytical framework used for the remainder of the paper. The model is similar to the one used in Svensson and Razin (1983) and Frenkel and Razin (1987) except that it allows for one of the goods to be nontraded. In addition, I review the *direct effect of a terms of trade change on the trade balance, that is* the effect holding the real exchange rate constant. In Section III, I consider the effects of terms of trade shocks on the real exchange rate and in Section IV, I use these results in order to determine the total effect of a terms of trade change on the balance of trade. Section V reviews the main results of the paper and presents possible extensions. The paper concludes with a brief technical appendix.

II. The Analytical Framework

Consider a two period model of a small open economy in which there are three goods: an importable, an exportable, and a nontradable good. In this economy, there is a representative agent who maximizes utility subject to the following budget constraints:

$$(1) \quad c_{x0} + p_{m0}c_{m0} + p_{n0}c_{n0} + (1+r_{x,-1})B_{-1} = \overline{Y}_{x0} + p_{m0}\overline{Y}_{m0} + p_{n0}\overline{Y}_{n0} + B_0$$

$$(2) \quad c_{x1} + p_{m1}c_{m1} + p_{n1}c_{n1} + (1+r_{x0})B_0 = \overline{Y}_{x1} + p_{m1}\overline{Y}_{m1} + p_{n1}\overline{Y}_{n1}$$

where c_{xt}, c_{mt}, and c_{nt} denote consumption levels of exportables, importables, and nontradables, respectively; $\overline{Y}_{xt}$, $\overline{Y}_{mt}$, and $\overline{Y}_{nt}$ denote the endowments of exportables, importables, and nontradables respectively; p_{mt} and p_{nt} denote the relative price of importables and nontradables; B_{-1} is the level of initial debt (which may be positive or negative); B_0 represents borrowing between periods zero and one (which if negative, represents net lending) and r_{xt} represents the rate of interest (for borrowing and lending) between periods t-1 and t, t=0,1. The numeraire is chosen to be the exportable commodity so that all assets and liabilities, as well as interest rates are measured in units of the exportable. There is no loss of generality in this choice of numeraire so long as there are no unanticipated relative price changes, since in this case an interest parity relationship will prevail between alternative debt instruments denominated in terms of different commodities. In what follows, relative price changes will be assumed to be fully anticipated.

The real exchange rate will, for the purposes of this paper, be defined as the inverse of the relative price of nontraded goods in terms of exportables, that is $1/p_{nt}$. A rise in p_{nt} denotes a real appreciation and a fall in p_{nt} denotes a real depreciation.

In a model with three goods, there are in general two real exchange rates, one in terms of exportables ($1/p_{nt}$) and the other in terms of importables (p_{mt}/p_{nt}). So long as the relative price of importables in terms of exportables, p_{mt}, in constant, the choice of either definition of the real exchange rate is completely innocuous. This is not the case when the shock being considered is a change in the commodity terms of trade since, in this case, a change in p_{mt} will obviously have different effects on $1/p_{nt}$ and p_{mt}/p_{nt}. In what follows, in considering the real exchange rate effects of various shocks, we consider only the first definition, namely the effect on the relative price of exportables in terms of the home good, $1/p_{nt}$. Simple algebra is then required to determine the effects of these shocks on the alternative definition of the real exchange rate, p_{mt}/p_{nt}, or on any weighted average of the two definitions, such as the consumption based measure of the real exchange rate.

Preferences are defined over the six goods c_{x0}, c_{m0}, c_{n0}, c_{x1}, c_{m1}, and c_{n1} and it will be assumed that the utility function is weakly separable through time. Thus, lifetime utility $U(c_{x0}, c_{m0}, c_{n0}, c_{x1}, c_{m1}, c_{n1})$ may be written as $U(C_0(c_{x0}, c_{m0}, c_{n0}), C_1(c_{x1}, c_{m1}, c_{n1}))$ where $C_0(.)$ and $C_1(.)$ are the subutilities which are functions of the consumption levels of the three commodities in periods zero and one, respectively. In addition, it will be assumed that the subutility functions are themselves homothetic so that, without any further loss of generality, they may be taken to be linearly homogenous functions of the consumption vector in each of the two periods.

With these assumptions, the consumer may be viewed as solving a two stage optimization problem. In the first stage, the consumer chooses levels of c_{xt}, c_{mt}, and c_{nt} to minimize the cost of attaining subutility level C_t. The solution to this problem yields demands for the three goods which are functions of the temporal relative prices, p_{mt} and p_{nt}, and total spending in that period, P_tC_t, where P_t is the price of a unit of subutility (or real spending), C_t. P_t, the consumption based price index, is a function of the relative prices p_{mt} and p_{nt}.

In the second stage, the consumer chooses real spending levels C_0, C_1 to maximize lifetime utility subject to an intertemporal wealth constraint. Solving for B_0 in equations (1) and (2) and noting that spending, P_tC_t, equals $c_{xt} + p_{mt}c_{mt} + p_{nt}c_{nt}$, it follows that the intertemporal constraint becomes:

$$(3)\qquad P_0(p_{m0},p_{n0})C_0 + \alpha_{x1}P_1(p_{m1},p_{n1})C_1$$

$$= \bar{Y}_{x0} + p_{m0}\bar{Y}_{m0} + p_{n0}\bar{Y}_{n0} + \alpha_{x1}[\bar{Y}_{x1} + p_{m1}\bar{Y}_{m1} + p_{n1}\bar{Y}_{n1}]$$

$$- (1+r_{x,-1})B_{-1} = W_0$$

where W_0 is the value of lifetime wealth measured in terms of exportables. We note that the intertemporal budget constraint of the representative agent is identical to the condition that, over the lifetime of this economy (namely during periods zero and one), the present value of the sum of the current account balances equals zero. This condition therefore reflects the assumption of perfect mobility of capital, that is of unlimited borrowing and lending at the world rate of interest, subject only to the economy's intertemporal solvency constraint given by equation (3). 1/ Normalizing the budget constraint, (equation (3)), by dividing by P_0, we have the intertemporal constraint relevant for the second stage of the consumer's problem, viz.:

$$(4) \quad C_0 + \alpha_{c1}C_1 = W_{c0}$$

where $\alpha_{c1} = (P_1/P_0)\alpha_{x1}$ and $W_{c0} = W_0/P_0$.

In equation (4), all variables are measured in real terms, that is in terms of units of period zero subutility, C_0. The solution to the second stage problem yields demands for C_0 and C_1 as functions of the intertemporal relative price, α_{c1}, and real lifetime wealth, W_{c0}. 2/

Having outlined the basic model, we now review the effect of terms of trade changes on the balance of trade, holding constant the relative price of nontraded goods (the inverse of the real exchange rate) in periods zero and one, p_{n0} and p_{n1}. This corresponds to what was labeled earlier as the direct effect of a terms of trade shock and corresponds to the analysis in Svennson and Razin (1983) and Frenkel and Razin (1987). Following these authors, we define the consumption based trade balance in period t $(TA_c)_t$ as

$$(5) \quad (TA_c)_t = (GDP_c)_t - C_t(\alpha_{c1}, W_{c0})$$

where

$$(6) \quad (GDP_c)_t = [\bar{Y}_{xt} + p_{mt}\bar{Y}_{mt} + p_{nt}\bar{Y}_{nt}]/P_t(p_{mt}, p_{nt}), \qquad t = 0,1.$$

1/ In a forthcoming paper, I consider the effects of various terms of trade shocks under the assumption that agents have limited access to the international capital market.

2/ The consumption based discount factor, α_{c1}, is related to the (consumption based) real rate of interest in the usual manner, namely $\alpha_{c1} = (1+r_{c0})^{-1}$. The relationship between the real rate of interest and the exogenous world rate of interest is given by $r_{c0} = \frac{1+r_{x0}}{P_1/P_0} - 1$. Therefore a rise in P_0 or a fall in P_1 raises the real rate of interest.

Consider the effect on the period zero trade balance of a temporary current, anticipated future, and permanent change in the terms of trade. Differentiating partially equation (5) yields the following expressions:

$$(7) \quad \frac{\partial (TA_c)_0}{\partial \log p_{m0}} = \beta_{m0}[(\mu_{m0}-\mu_{c0}) + (1-\gamma)(1-\mu_{m0}) + \gamma\sigma]C_0,$$

$$(8) \quad \frac{\partial (TA_c)_0}{\partial \log p_{m1}} = -\beta_{m1}\gamma\,[(\sigma-1) + \mu_{m1}]C_0,$$

$$(9) \quad \frac{\partial (TA_c)_0}{\partial \log p_m} = [\beta_{m0}(\mu_{m0}-\mu_{c0}) + \beta_{m0} - (\beta_{m0}-\beta_{m1})\,\gamma\,(1-\sigma) - (1-\gamma)\beta_{m0}\mu_{m0} - \gamma\beta_{m1}\mu_{m1}]C_0,$$

where β_{mt} is the share of importables consumption in period t spending, i.e., $\beta_{mt} = p_{mt}c_{mt}/P_tC_t$; μ_{mt} is the ratio of production to consumption of importables in period t, a fraction ranging between zero and one ($\mu_{mt} = \bar{Y}_{mt}/c_{mt}$); μ_{c0} is the ratio of current period real GDP to real spending, i.e., $\mu_{c0} = (GDP_c)_0/C_0$; γ is the share of saving in wealth, i.e., $\gamma = \alpha_{c1}C_1/W_{c0}$ and σ is the intertemporal elasticity of substitution. In the derivation of equations (7), (8), and (9), preferences are assumed to be homothetic so that the elasticity of spending with respect to lifetime wealth is unity.

For the derivation of equations (7), (8), and (9) and an explanation thereof, the reader may consult the references cited previously or the appendix at the end of this paper. The economics of these expressions are postponed until Section IV, where a comparison of the direct and total effects of terms of trade changes on the trade balance is undertaken.

III. Terms of Trade Shocks and the Real Exchange Rate

In this section, we discuss the effects of various terms of trade shocks on the real exchange rate, both in terms of familiar diagrams as well as analytically. Before beginning the detailed discussion of the various mechanisms through which changes in the commodity terms of trade alter the path of real exchange rates, it is worth mentioning three broad channels which recur in the discussion: intratemporal substitution, intertemporal substitution, and welfare effects. We discuss each of these issues in turn.

First, a change in the commodity terms of trade, whether brought about by a change in the world relative price of importables or by policy actions (such as a tariff) affecting the domestic price, leads to substitution among goods within the period. Thus, for example, a deterioration in the terms of trade in period zero leads to increased consumption of exportables and home goods in period zero if the three goods are net (Hicksian) substitutes or decreased consumption if they are net complements, all other things being held constant (including the level of utility, or welfare). This is the <u>intratemporal</u> or simply <u>temporal</u> substitution effect.

Second, if the rise in the relative price of importables is confined to period zero, the real (consumption based) rate of interest also rises. This is so because a temporary current deterioration in the terms of trade (a rise in p_{m0}) raises the consumption based price index, P_0 (by the share, β_{m0}, of c_{m0} in total period zero spending), while tomorrow's price index, P_1, is constant, since p_{m1} and p_{n1} are assumed constant. Since the ratio P_0/P_1 rises, the relative price of today's consumption in terms of tomorrow's goods has risen. This induces substitution of aggregate spending from period zero to period one. This rise in tomorrow's consumption and fall in today's consumption, brought about by the change in the intertemporal relative price and holding other factors constant, we refer to as the <u>intertemporal</u> substitution effect. We note that the key parameter governing the extent of intertemporal substitution is σ, the intertemporal elasticity of substitution 1/ (see equation (A.5) in the appendix).

Third, in addition to these intratemporal and intertemporal effects, a rise in p_{m0} reduces welfare. The magnitude of this <u>welfare</u> effect (sometimes referred to somewhat loosely as a <u>wealth effect</u> in what follows) depends on the volume of imports at initial terms of trade (specifically on the parameter μ_{mt}, which indicates the ratio of production to consumption of importables in period t, t=0, 1: if $\mu_{m0} = 1$, we are in the autarky equilibrium in period zero and changes in p_{m0} do not affect welfare; the volume of imports (relative to consumption of

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1/ The possibility of substituting spending between periods, independent of the time path of income, depends of course not only on σ, a parameter of the agent's utility function, but also on institutional factors which govern the degree to which agents can borrow at a given world rate of interest in international financial markets. If the assumption of perfect capital mobility were relaxed, these other factors would come into play.

importables), and hence the welfare effect, rise as μ_{m0} falls towards zero).

The determination of the effect of terms of trade shocks on the relative price of home goods (the inverse of the real exchange rate) simply involves using the market clearing conditions in the market for nontradable goods in each of the two periods. These are:

$$(10) \quad c_{n0}(p_{n0}, p_{m0}, P_0C_0(\alpha_{c1}, W_{c0})) = \bar{Y}_{n0} \quad \text{and}$$

$$(11) \quad c_{n1}(p_{n1}, p_{m1}, P_1C_1(\alpha_{c1}, W_{c0})) = \bar{Y}_{n1}.$$

There are three types of shock which may be considered in the context of this simple model. A temporary current shock, an anticipated future shock, and a permanent shock. In each of the three cases, the equilibrium condition in both periods, equations (10) and (11), will be disturbed since, although p_{m0} (p_{m1}) does not appear directly as an argument in the demand for c_{n1} (c_{n0}), real wealth, W_{c0}, and the real discount factor, α_{c1}, appear in both equations (10) and (11) and from equations (3) and (4), the budget constraint and normalized version thereof, W_{c0} and α_{c1} are both functions of the four temporal relative prices in the system, p_{m0}, p_{m1}, p_{n0}, and p_{n1}.

Differentiating equations (10) and (11), we obtain:

$$(12) \quad (\eta_{n_0p_{n0}} + \beta_{n0})\hat{p}_{n0} + (\eta_{n_0p_{m0}} + \beta_{m0})\hat{p}_{m0} + \eta_{c_0\alpha}\hat{\alpha}_{c1} + \hat{W}_{c0} = \hat{Y}_{n0},$$

$$(13) \quad (\eta_{n_1p_{n1}} + \beta_{n1})\hat{p}_{n1} + (\eta_{n_1p_{m1}} + \beta_{m1})\hat{p}_{m1} + \eta_{c_1\alpha}\hat{\alpha}_{c1} + \hat{W}_{c0} = \hat{Y}_{n1},$$

where $\eta_{n_tp_{nt}}$, $\eta_{n_tp_{mt}}$ are the elasticities of demand for the nontradable good with respect to its own price and the terms of trade respectively; $\eta_{c_t\alpha}$ is the elasticity of real spending C_t, with respect to the discount factor, α_{c1}; β_{nt} is the share of nontradable goods consumption in period t spending, i.e., $\beta_{nt} = p_{nt}c_{nt}/P_tC_t$; and a circumflex above a variable denotes a proportional change. In the derivations of equations (12) and (13), we assume unitary elasticities of consumption with respect to spending and of total spending with respect to wealth.

The system of equations (12) and (13) can be solved to yield an equilibrium path of the real exchange rate as a function of the underlying shocks (to the terms of trade, to the world real discount factor, and to supply). 1/ In what follows, we abstract from supply shocks and shocks to the world interest rate 2/ and consider the equilibrium response of p_{n0} and p_{n1} to various terms of trade shocks. For this purpose, consider Figure 1. 3/ The N_0N_0 and N_1N_1 schedules represent the loci of combinations of p_{n0} and p_{n1} which clear the period zero and period one markets for home goods, respectively. These schedules are drawn for given values of the exogenous variables, p_{m0} and p_{m1}. For convenience, it is assumed that initially, $p_{n0} = p_{n1}$. Using equations (12) and (13) along with the Slutsky decomposition, the slopes of the two schedules are shown in the appendix to be

$$(14)\quad \left.\frac{d\log p_{n1}}{d\log p_{n0}}\right|_{N_0N_0} = \frac{\beta_{m0}\sigma_{nm} + \beta_{x0}\sigma_{nx} + \beta_{n0}\gamma\sigma}{\gamma\beta_{n1}\sigma} \text{ and}$$

$$(15)\quad \left.\frac{d\log p_{n1}}{d\log p_{n0}}\right|_{N_1N_1} = \frac{(1-\gamma)\beta_{n0}\sigma}{\beta_{m1}\sigma_{nm} + \beta_{x1}\sigma_{nx} + \beta_{n1}(1-\gamma)\sigma},$$

respectively, where σ_{ij} is the Allen elasticity of substitution between goods i and j. It is easily verified that both schedules are positively sloped and that the N_0N_0 schedule is necessarily steeper than the N_1N_1 schedule. 4/

1/ Government spending shocks could be easily accomodated in our framework as well. In the small country setting, changes in government spending do not affect the terms of trade or world interest rates, but they do alter the time path of the real exchange rate. There is, therefore, a decomposition of the effects of fiscal policy on the current account into a direct (since changes in government spending directly affect national saving) and indirect (since changes in government spending affect p_{n0} and p_{n1} which indirectly affect national savings) component. This decomposition is analagous to the decomposition of the Harberger-Laursen-Metzler effect into its direct and indirect parts.

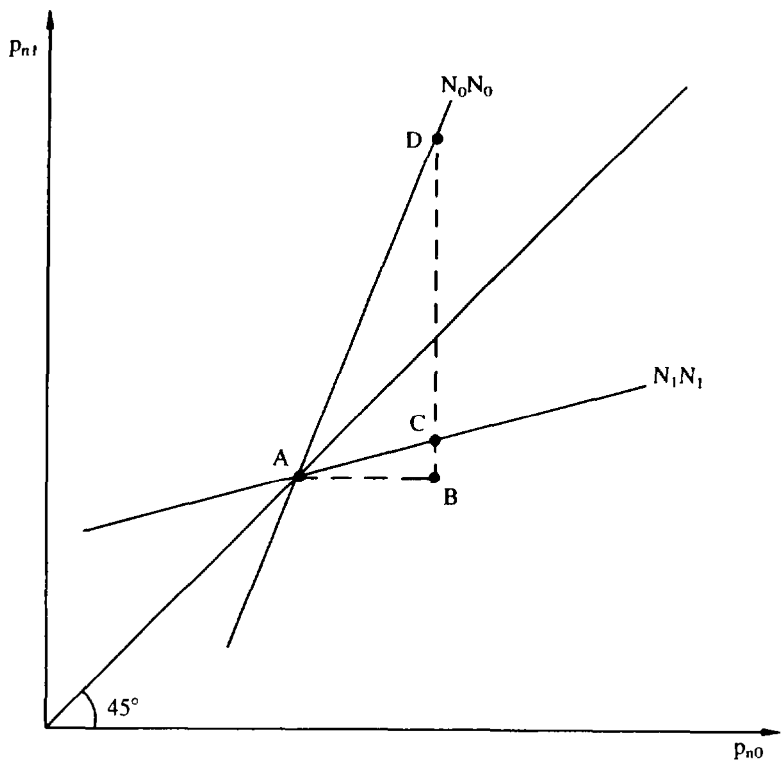
2/ The effect of shocks to the world rate of interest on the current account also have an interpretation in terms of direct and indirect effects since they too alter equilibrium in the home goods markets and thereby affect the path of the real exchange rate.

3/ This diagram has had extensive previous use (see, for instance, Dornbusch (1980) and Edwards (1987)).

4/ Edwards (1987) uses notions of stability--completely external to the model--in order to rank the two slopes. We show here that the model itself has sufficient structure to enable the two slopes to be ranked.

Figure 1

The Determination of the Time Path of the Equilibrium Real Exchange Rate



To gain some intuition into these results, consider a rise in p_{n0} from A to B in Figure 1. This creates excess supply for c_{n0} and excess demand for c_{n1}. In the period zero market, the excess supply comes about via a temporal substitution effect away from home goods and in favor of both tradable goods ($\beta_{m0}\sigma_{nm}+\beta_{x0}\sigma_{nx}$) and an intertemporal substitution effect ($\beta_{n0}\gamma\sigma$). In the period one market, however, the excess demand results exclusively from the intertemporal substitution effect ($(1-\gamma)\beta_{n0}\sigma$), since p_{n0} is not an argument in the demand for c_{n1} function. These excess demands correspond to the numerators of equations (14) and (15). 1/

It is noteworthy that, in each ease, the intertemporal substitution effects derive from changes in the consumption based rate of interest: a rise in p_{n0} raises the consumption based rate of interest which induces substitution of aggregate spending (part of which falls on home goods) from period zero to period one.

With excess supply for c_{n0} and excess demand for c_{n1} at point B, we need a rise in p_{n1} to clear both markets. This is so because a rise in p_{n1} lowers the consumption based rate of interest. This raises demand for c_{n0} by the amount $\gamma\beta_{n1}\sigma$ (which appears in the denominator of equation (14)) and reduces the demand for c_{n1} by $\beta_{n1}(1-\gamma)\sigma$ (which appears in the denominator of equation (15)). In addition, there is a temporal substitution effect, $\beta_{m1}\sigma_{nm}+\beta_{x1}\sigma_{nx}$, which also reduces the demand for c_{n1} (and raises demand for tradable goods). This temporal substitution term, along with the intertemporal effect, appear in the denominator of equation (15). This argument establishes that both the N_0N_0 and N_1N_1 schedules are positively sloped.

We now must show that from point B in Figure 1, a larger rise in p_{n1} (to point D) is necessary to clear the period zero market than is required to clear the period one market (to point C). To verify that the N_1N_1 schedule is indeed steeper than the N_0N_0 schedule, note that the difference between the two slopes is given by

$$(16)\quad \left.\frac{d\log p_{n1}}{d\log p_{n0}}\right|_{N_0N_0} - \left.\frac{d\log p_{n1}}{d\log p_{n0}}\right|_{N_1N_1} =$$

1/ It is relevant to note that there are no welfare effects arising from movements along the N_0N_0 and N_1N_1 schedules. This follows from the assumption that the home goods sector clears in each period.

$$\frac{[\beta_{m0}\sigma_{nm} + \beta_{x0}\sigma_{nx} + \beta_{n0}\gamma\sigma][\beta_{m1}\sigma_{nm} + \beta_{x1}\sigma_{nx}] + \beta_{n1}(1-\gamma)\sigma[\beta_{m0}\sigma_{nm}+\beta_{x0}\sigma_{nx}]}{[\beta_{m1}\sigma_{nm} + \beta_{x1}\sigma_{nx} + \beta_{n1}(1-\gamma)\sigma]\ \gamma\beta_{n1}\sigma} > 0$$

which is unambiguously positive. To gain some intuition concerning this result, consider a benchmark case in which the path of aggregate real spending is flat over the life cycle, so that $\gamma = 1-\gamma$. (The result holds in the general case as well, as equation (16) shows.)

In this case, the intuition is very clear. First, recall from the previous analysis that at point B, the size of the disequilibrium in the period zero market (the numerator of equation (14)) is larger than the size of the disequilibrium in the period one market (given by the numerator of equation (15)), the difference between the two consisting of the temporal substitution effect. Second, recall that a rise in p_{n1} (which is needed to clear both markets) has a greater impact on the period one market (this effect is given by the denominator of equation (15)) than on the period zero market (given by the expression in the denominator of equation (14)), the difference being once again the temporal substitution effect. Thus, at point B, the magnitude of the disequilibrium in the period zero market exceeds the magnitude of the disequilibrium in the period one market and, to eliminate a disequilibrium of given size requires a larger rise in p_{n1} in the period zero market than in the period one market. For both these reasons, the N_0N_0 schedule is steeper than the N_1N_1 schedule.

Having discussed the diagrammatric apparatus, we now turn to the analysis of terms of trade shocks. We discuss temporary current, anticipated future, and permanent shocks to the terms of trade.

1. <u>Temporary current terms of trade changes</u>

Consider a temporary current deterioration in the terms of trade, i.e., $\hat{p}_{m0} > 0$ and $\hat{p}_{m1} = 0$. The rise in the relative price of imports in period zero affects both the N_0N_0 and the N_1N_1 schedules. In the appendix we show that the horizontal shifts of these loci are, respectively:

$$(17)\qquad \left.\frac{d\log p_{n0}}{d\log p_{m0}}\right|_{N_0N_0} = \frac{-\beta_{m0}[\sigma_{nm}-\{(1-\gamma)(1-\mu_{m0}) + \gamma\sigma\}]}{-[\beta_{m0}\sigma_{nm}+\beta_{x0}\sigma_{nx}+\beta_{n0}\gamma\sigma]} \text{ and}$$

$$(18)\qquad \left.\frac{d\log p_{n0}}{d\log p_{m0}}\right|_{N_1N_1} = \frac{-\beta_{m0}(1-\gamma)[\sigma-(1-\mu_{m0})]}{\beta_{n0}(1-\gamma)\sigma}.$$

As usual, the numerators of equations (17) and (18) indicate the magnitudes of the excess supply created by a proportional rise in p_{m0} in the period zero and period one markets, respectively. The denominators indicate the magnitude by which a (proportional) change in p_{n0} affects excess demand for c_{n0} or c_{n1}. Accordingly, the denominator in equation (17) is negative since a rise in p_{n0} creates negative excess demand for c_{n0} but the denominator in equation (18) is positive since a rise in p_{n0} creates positive excess demand for c_{n1}. The mechanism in the first case involves both temporal and intertemporal effects--and hence temporal and intertemporal elasticities of substitution--whereas in the second case, the only mechanism is the intertemporal substitution.

Consider now the numerators of equations (17) and (18). Turning first to expression (17), it can be seen that whether the N_0N_0 schedule shifts to the right or to the left depends only on whether $\sigma_{nm} \gtrless [(1-\gamma)(1-\mu_{m0}) + \gamma\sigma]$. The intuition of this result can be seen by focusing on equation (10). There we see that a rise in p_{m0} affects the demand for c_{n0} via three separate channels: (i) a temporal substitution effect since p_{m0} enters directly as an argument in the demand for c_{n0} function; (ii) the price index effect since a rise in p_{m0} raises the consumption based price index, P_0, and hence raises the value of spending P_0C_0; and (iii) the real spending effect since a rise in p_{m0} alters both the real (consumption based) rate of interest and the real value of wealth (see equations (3) and (4)) and hence affects the demand for real spending in period zero, C_0. We consider each of these three effects in turn.

The size of the temporal substitution effect depends of course on whether importables and nontradables are gross substitutes or gross complements in demand. In the former case, a rise in p_{m0} creates positive excess demand for c_{n0}, and conversely. The magnitude of this effect simply depends on the elasticity of c_{n0} with respect to p_{m0} which can be shown to be equal to $\beta_{m0}(\sigma_{nm}-1)$ (by using the Slutsky decomposition). Obviously, the gross substitutability or complementarily of the two goods is determined by whether $\sigma_{nm} \gtrless 1$.

The price index effect is always positive. A percentage rise in p_{m0} raises P_0, the consumption based price index, by β_{m0}, the expenditure share of importables in period zero spending. The rise in P_0 raises total spending $P_0C_0(.)$ and, assuming a unitary elasticity of demand with respect to total expenditure, creates an excess demand for c_{n0} equal to β_{m0} times $\hat{p}_{m0}$.

Further, the real spending effect is always negative, i.e., a temporary current deterioration in the terms of trade always reduces current period real spending. There are two channels at work here: a real wealth effect and an intertemporal substitution effect. From the budget constraint (equation (3)), we see that a rise in p_{m0} raises the value of wealth (in terms of exportables) by the amount $(1-\gamma)\beta_{m0}\mu_{m0}$ but that real wealth, W_{c0}, actually falls by the amount $(1-\gamma)\beta_{m0}\mu_{m0} - \beta_{m0}$ due to the increase in the price index, P_0, used to deflate wealth, W_0. Given the assumption of unitary spending elasticities with respect to wealth, the real wealth effect lowers demand for c_{n0} by the amount $(1-\gamma)\beta_{m0}\mu_{m0} - \beta_{m0}$. Second, the rise in p_{m0} lowers the real discount factor and this reduces the demand for C_0 by the product of β_{m0} and the elasticity of C_0 with respect to α_{c1} which is simply $\gamma(\sigma-1)$. Summing these two effects, we obtain the real spending effect as $-\beta_{m0}\{(1-\gamma)(1-\mu_{m0}) + \gamma\sigma\}$, which is unambiguously negative. This result accords with intuition since, in the case of a temporary current deterioration in the terms of trade, real wealth falls, and the real rate of interest rises. These two effects are mutually reinforcing as they affect real spending, C_0. The proportional effects on C_0 and c_{n0} are the same given the assumption of homotheticity.

Finally, as is easily verified, the sum of the temporal substitution, price index, and real spending effects yields precisely the numerator of the expression in equation (17). As can be seen from that expression, if importables and home goods are net complements in demand ($\sigma_{nm} < 0$), the N_0N_0 schedule necessarily shifts to the left. If on the other hand, $\sigma_{nm} > 0$, the temporal substitution effect is positive and mitigates the other effects. The N_0N_0 schedule will shift to the right if $\sigma_{nm} > [(1-\gamma)(1-\mu_{m0}) + \gamma\sigma]$ and conversely. Note further that the real wealth effect plays no role if $\mu_{m0} = 1$. This is the case in which, at the initial terms of trade, the small country is close to the autarky equilibrium. In this case, only the relative magnitude of the temporal and intertemporal (compensated) elasticities (i.e., whether $\sigma_{nm} \gtrless \gamma\sigma$) determines the direction of the shift in the N_0N_0 schedule.

Consider now the market clearing condition in period one, equation (11). A rise in p_{m0} affects the demand for home goods next period (period one) only via the real spending effect. In contrast to the period zero equilibrium condition, there is neither a temporal substitution effect nor a price index effect. This result is due to the joint assumption that preferences are weakly separable and homothetic.

Real spending in period one, C_1, is influenced according to two separate channels: the rise in p_{m0} raises the consumption based rate of interest which in turn raises the demand for c_{n1} (the intertemporal substitution effect), while the negative real wealth effect lowers the demand for c_{n1}. Specifically, the intertemporal substitution effect is equal to the product of the change in the consumption based discount factor, $-\beta_{m0}$, and the elasticity of period one real spending with respect to the rate of interest, $-[(1-\gamma)\sigma + \gamma]$. The sum of this intertemporal substitution effect and the real wealth effect, given previously as $\beta_{m0}[(1-\gamma)\mu_{m0}-1]$, yields precisely the expression in the numerator of equation (15). As can be seen, the real spending effect on the demand for c_{n1} is ambiguous, reflecting a conflict between the negative wealth and positive intertemporal substitution effects. If $\mu_{m0} = 1$ so that, at the initial terms of trade the economy is close to the autarky equilibrium, the N_1N_1 schedule necessarily shifts to the left. This is so because, in the neighborhood of the autarky equilibrium, the temporary terms of trade deterioration raises the demand for c_{n1} through the intertemporal substitution channel alone; there is no mitigating wealth effect.

In Figure 2, we depict graphically two possible equilibria. In both panels, we assume that the terms of trade shock occurs around the autarky equilibrium, that is $\mu_{m0} = 1$. In panel a, the temporal elasticity is assumed to exceed the intertemporal elasticity. In this case, the rise in p_{m0} shifts the N_0N_0 to the right. In panel b, the N_0N_0 schedule shifts to the left, reflecting the assumption that $\sigma_{nm} < \gamma\sigma$. Thus in panel b, the effect on the demand for c_{n0} of the rise in the real rate of interest more than offsets the temporal substitution effect. In both panels, the N_1N_1 schedule shifts to the left. As can be seen in panel a, the equilibrium moves from point A to point B and a temporary deterioration in the terms of trade necessarily leads to a real appreciation in both periods. In panel (b), the equilibrium moves from point A to point B' and there is a fall in p_{n0} and a rise in p_{n1}. This result is, however, not general as experimenting with the figure will reveal. The analysis is therefore capable of generating a wide range of paths for the real exchange rate in response to a temporary terms of trade shock. The phenomenon of equilibrium overshooting, whereby the real exchange rate moves more in period zero than in period one and which has been suggested by Edwards (1987) as a possible response of the real exchange rate to the imposition of an anticipated future tariff, can also occur in the case of a temporary current terms of trade change (this case is illustrated in panel a). Finally, note that although the shock is confined to period zero, part of the adjustment in the real exchange rate occurs in period one when there is no change in any "fundamental."

In the appendix, we derive the following general result for the equilibrium response of p_{n0} (the inverse of today's real exchange rate) to a temporary current deterioration in the terms of trade 1/

$$(19) \quad \frac{d\log p_{n0}}{d\log p_{m0}} = [\sigma_{nm} - \{(1-\gamma)(1-\mu_{m0}) + \gamma\sigma\}]\Delta_1 + [\sigma_{nm} - (1-\mu_{m0})]\Delta_2$$

where

$$\Delta_1 = \frac{\beta_{m0}[\beta_{m1}\sigma_{nm} + \beta_{x1}\sigma_{nx}]}{[\beta_{m0}\sigma_{nm}+\beta_{x0}\sigma_{nx}][\beta_{m1}\sigma_{nm}+\beta_{x1}\sigma_{nx}+\beta_{n1}(1-\gamma)\sigma]+\beta_{n0}\gamma\sigma[\beta_{m1}\sigma_{nm}+\beta_{x1}\sigma_{nx}]}$$

$$\Delta_2 = \frac{\beta_{m0}\beta_{n1}(1-\gamma)\sigma}{[\beta_{m0}\sigma_{nm}+\beta_{x0}\sigma_{nx}][\beta_{m1}\sigma_{nm}+\beta_{x1}\sigma_{nx}+\beta_{n1}(1-\gamma)\sigma]+\beta_{n0}\gamma\sigma[\beta_{m1}\sigma_{nm}+\beta_{x1}\sigma_{nx}]}$$

and $\Delta_1 \geqq 0$, $\Delta_2 \geqq 0$ by the negative semi-definiteness of the Slutsky substitution matrix.

Thus, we have the following propositions:

Proposition 1: The nature of the response of the real exchange rate to a temporary current disturbance of the terms of trade depends on the relative magnitudes of the temporal, intertemporal and welfare effects. Specifically, a temporary current deterioration in the terms of trade always causes a contemporaneous real depreciation if importables and home goods are Hicksian complements. This is because in this case, all three effects lead to a lower current demand for home goods. However, if nontradables and importables are Hicksian substitutes, then there is a conflict between the temporal substitution effect (which favors a contemporaneous real appreciation) and the (net) intertemporal and welfare effects which favor a real depreciation. 2/

Proposition 1a: Autarky

If the economy is initially close to the autarky equilibrium, then the welfare effect is zero. It follows that the response of the real exchange rate depends only on the relative magnitude of the temporal and intertemporal effects.

It is relevant to note that the autarky case applies precisely to the analysis of tariffs. Specifically, suppose that the government

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1/ The result for p_{n1} is given in the appendix.

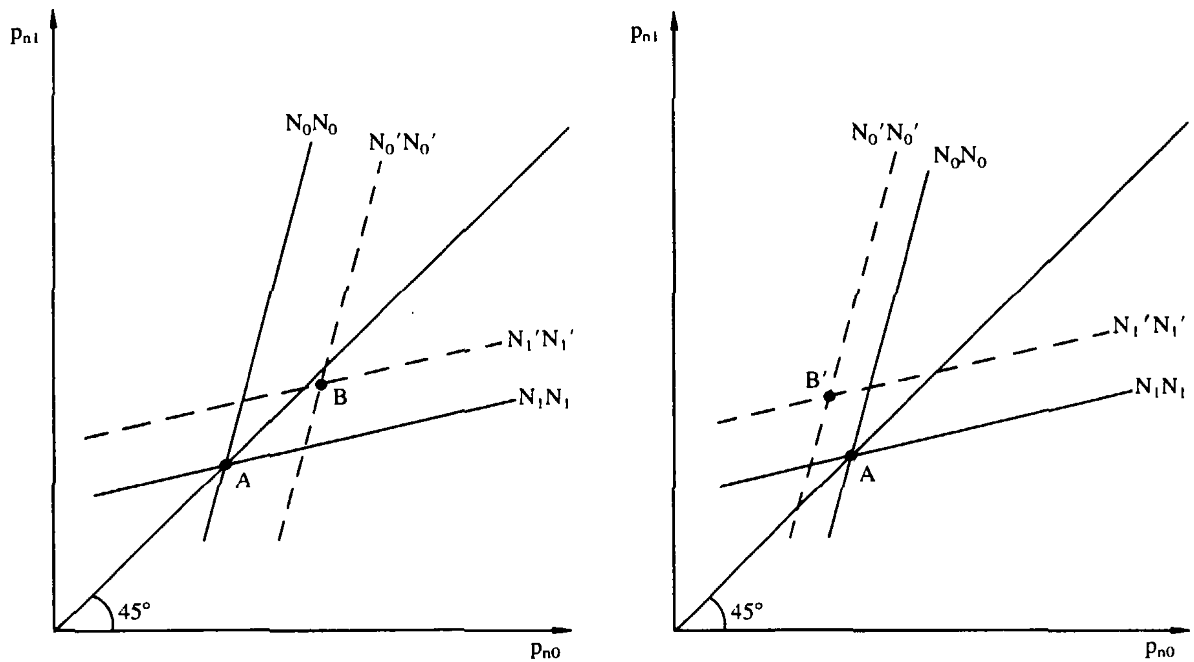
2/ If $\sigma_{nm} > \max\{[1-\gamma)(1-\mu_{m0}) + \gamma\sigma], (1-\mu_{m0})\}$, a temporary current terms of trade deterioration always causes a real appreciation.

Figure 2

The Effect of a Temporary Current Deterioration in the Terms of Trade on the Path of the Real Exchange Rate

Panel a

Panel b



Data: $\sigma_{nm} > \gamma\sigma$
$\mu_{m0} = 1$

Data: $\sigma_{nm} < \gamma\sigma$
$\mu_{m0} = 1$

imposes a tariff (in period zero only and from an initial, zero tariff equilibrium) and redistributes the revenue in a lump sum fashion. Then the effect of the tariff on the real exchange rate is identical to the effect of a temporary rise in the world relative price of importables, in the neighborhood of the autarky equilibrium. The reason is of course that both events have the same effect on the internal terms of trade of this small country and neither has any welfare effect to first order.

Proposition 1b: Complete Specialization

If the economy is currently completely specialized in the production of exportables and home goods, then the welfare loss associated with the terms of trade deterioration is maximized. We can distinguish three cases.

Case 1: Suppose preferences over lifetime spending are logarithmic. In this case, the intertemporal elasticity of substitution is equal to unity. Then, a temporary current deterioration in the terms of trade causes a real appreciation if and only if importables and nontradables are gross substitutes. The intuition of this result is that if $\sigma = 1$, then the real interest rate elasticity of current period real spending is equal to zero. Further, with $\mu_{m0} = 0$, the welfare effect, which is proportional to (minus) the ratio of imports to consumption of importables, $-(1-\mu_{m0})$, is in this case proportional to (minus) one. Now there is a real appreciation if and only if the temporal substitution effect (which is proportional to σ_{nm}, the elasticity of substitution between home goods and importables) dominates the sum of the intertemporal and welfare effects. The former equals zero while the latter is proportional to (minus) one. It follows that if σ_{nm} exceeds unity, there is a real appreciation, and vice-versa. This is equivalent to the criterion that there is a real appreciation if and only if nontradables and importables are gross substitutes. Finally, it is relevant to note that this criterion is the same as the condition given in Dornbusch (1974), in the context of a static model, and it emerges as a special case (namely when $\mu_{m0} = 0$ and $\sigma = 1$) in the intertemporal framework used here.

Case 2: Suppose $\sigma < 1$. Then a temporary current deterioration in the terms of trade, which raises the real rate of interest, raises real spending in period zero. The (gross) intertemporal substitution effect therefore favors a real appreciation today. Therefore, in comparison to the first case, there will be a real appreciation even if σ_{nm} falls short of unity by a margin, where the margin depends positively on the difference between the intertemporal elasticity of substitution parameter and unity.

Case 3: Suppose $\sigma > 1$. In this case, the intertemporal effect lowers real spending in period zero and therefore favors a real depreciation. It follows that in comparison to the first case, there will be a real appreciation only if σ_{nm} exceeds unity by a margin, where the margin depends positively on the degree of intertemporal substitution.

The three cases suggest that although a rise in p_{m0} always raises the real rate of interest, this real interest rate change may have very different effects on real spending and hence on the real exchange rate. Whether a rise in the real rate of interest raises, lowers or leaves current spending unchanged depends on whether the intertemporal elasticity of substitution falls short of, exceeds, or is equal to unity.

2. An anticipated future terms of trade change

Consider now the effect of an anticipated future deterioration in the terms of trade on the path of the real exchange rate. Setting $\hat{p}_{m1} > 0$ and $\hat{p}_{m0} = 0$ in equations (12) and (13), and using the Slutsky decomposition, we can compute the horizontal shifts in the two equilibrium schedules, N_0N_0 and N_1N_1. These are

$$\text{(20)} \qquad \left.\frac{d\log p_{n0}}{d\log p_{m1}}\right|_{N_0N_0} = \frac{\beta_{m1}\gamma[\sigma-(1-\mu_{m1})]}{\beta_{m0}\sigma_{nm}+\beta_{x0}\sigma_{nx}+\beta_{n0}\gamma\sigma} \text{ and}$$

$$\text{(21)} \qquad \left.\frac{d\log p_{n0}}{d\log p_{m1}}\right|_{N_1N_1} = \frac{-\beta_{m1}[\sigma_{nm}-\{(1-\gamma)\sigma+\gamma(1-\mu_{m1})\}]}{\beta_{n0}(1-\gamma)\sigma}.$$

Consider first equation (20). A rise in p_{m1} affects the period zero equilibrium condition via two channels. By lowering the real consumption based interest rate, the future deterioration in the terms of trade causes substitution of aggregate spending (part of which falls on nontraded goods) from period one to period zero. The magnitude of this effect is governed by the intertemporal elasticity of substitution, σ, and is positive in terms of its impact on today's relative price of home goods, p_{n0}. On the other hand, the future deterioration in the terms of trade lowers wealth. The wealth effect lowers spending in period zero, and hence reduces the demand for home goods today. The magnitude of this effect, which is negative in terms of its impact on today's relative price of home goods, is proportional to the ratio of imports to consumption of importables in period one, $(1-\mu_{m1})$. Overall, the N_0N_0 locus shifts to the right if the intertemporal substitution effect outweighs the wealth effect, that is if $\sigma > (1-\mu_{m1})$, and conversely. 1/

1/ We note that in comparison to the effect of a current deterioration in the terms of trade, there is no temporal substitution or price index effect in the case of an anticipated future disturbance.

Consider now the N_1N_1 schedule. From equation (21), we see that an anticipated future deterioration in the terms of trade affects tomorrow's market for nontradable goods in a way which is analogous to the effect of a current terms of trade shock on today's home goods market. The only real difference arises from changes in the values of the various elasticities over time, which are in turn functions of the underlying parameters: the expenditure shares, the temporal and intertemporal elasticities of substitution, the average saving propensity, and the ratio of imports to consumption of importables. Accordingly, we see that a rise in p_{m1} may induce substitution in favor of or against home goods, c_{n1}, as a result of the temporal substitution effect. The magnitude of this effect is of course governed by the temporal price elasticity, $\beta_{m1}\sigma_{nm}$. If $\sigma_{nm} > 0$, the goods are net substitutes and a rise in p_{m1} creates excess demand for c_{n1}, and conversely. In addition to the temporal substitution effect, there is a negative effect on aggregate real spending, C_1, which tends to reduce the demand for c_{n1}. This effect operates through two channels: a negative real wealth effect, which equals $-\beta_{m1}\gamma(1-\mu_{m1})$ and a negative intertemporal substitution effect, which equals $-\beta_{m1}(1-\gamma)\sigma$. The latter effect reflects the fall in the real rate of interest due to the increase in the price of importables which is expected in the future. Thus, the overall shift in the N_1N_1 schedule reflects the sum of the temporal substitution effect (which may be positive or negative) and the negative real spending effect.

In Figure 3, we consider a benchmark case in which in period one, the economy operates close to the autarky equilibrium, so that μ_{m1} is close to unity. In this case, we can readily see that the rise in p_{m1} necessarily causes the N_0N_0 schedule to shift to the right. In panels a and b, we consider two possibilities for the N_1N_1 schedule. In panel a, the temporal elasticity of substitution is assumed to exceed the (absolute value of the) compensated elasticity of period one real spending with respect to the rate of interest. In that case, the rise in p_{m1} causes excess demand for c_{n1} and the N_1N_1 schedule shifts to the left. In panel b, we consider the opposite case in which $\sigma_{nm} < (1-\gamma)\sigma$.

In panel a, the equilibrium moves from point A to point B and the real exchange rate necessarily appreciates today as well as tomorrow. However, in general whether p_{n0} rises more or less than p_{n1} (it can do either) depends on the relative magnitude of σ and σ_{nm}, the temporal and intertemporal elasticities of substitution. Thus, as in the case of a temporary current shock to the terms of trade, the real exchange rate may either over- or undershoot its new long-run value. Furthermore, it is noteworthy that even though no "fundamental" has changed in period zero, part of the adjustment of the real exchange rate occurs in that period.

In panel b, the new equilibrium is at point B' at which p_{n0} rises and p_{n1} falls. This result is, however, not general as experimenting with the diagrammatic apparatus will reveal.

Returning now to the general case (i.e., $\mu_{m1} \neq 1$), we show in the appendix that the equilibrium response of today's relative price of nontraded goods to an anticipated future deterioration in the terms of trade 1/ is given by:

$$(22) \qquad \frac{d\log p_{n0}}{d\log p_{m1}} = \Delta_3[\sigma-(1-\mu_{m1})] + \Delta_4 \, [\sigma_{nm}-(1-\mu_{m1})],$$

where

$$\Delta_3 = \frac{\gamma\beta_{m1}(\beta_{m1}\sigma_{nm}+\beta_{x1}\sigma_{nx})}{(\beta_{m0}\sigma_{nm}+\beta_{x0}\sigma_{nx})(\beta_{m1}\sigma_{nm}+\beta_{x1}\sigma_{nx}+\beta_{n1}(1-\gamma)\sigma)+\beta_{n0}\gamma\sigma(\beta_{m1}\sigma_{nm}+\beta_{x1}\sigma_{nx})}$$

$$\text{and } \Delta_4 = \frac{\gamma\beta_{m1}\beta_{n1}\sigma}{(\beta_{m0}\sigma_{nm}+\beta_{x0}\sigma_{nx})(\beta_{m1}\sigma_{nm}+\beta_{x1}\sigma_{nx}+\beta_{n1}(1-\gamma)\sigma)+\beta_{n0}\gamma\sigma(\beta_{m1}\sigma_{nm}+\beta_{x1}\sigma_{nx})}$$

and where $\Delta_3 \geqq 0$ and $\Delta_4 \geqq 0$ by the negative semi-definiteness of the Slutsky substitution matrix. From equation (22), it is clear that

$$\frac{d\log p_{n0}}{d\log p_{m1}} \gtrless \text{ as } \left\{ \begin{array}{l} \sigma_{nm} \gtrless (1-\mu_{m1}) \text{ and} \\ \sigma \gtrless (1-\mu_{m1}). \end{array} \right.$$

In comparison to expression (19), equation (22) reveals that high values of both the temporal (σ_{nm}) and intertemporal (σ) elasticities of substitution are mutually reinforcing in their effect on today's real exchange rate in response to an anticipated future deterioration in the terms of trade whereas they have opposing effects in the case of a temporary current terms of trade shock. This fact reflects the different real interest rate effects of current and anticipated future changes in the terms of trade.

The analysis of anticipated future shocks to the terms of trade yields proposition 2.

Proposition 2: An anticipated future terms of trade change will in general alter the real exchange rate in the present, that is in periods

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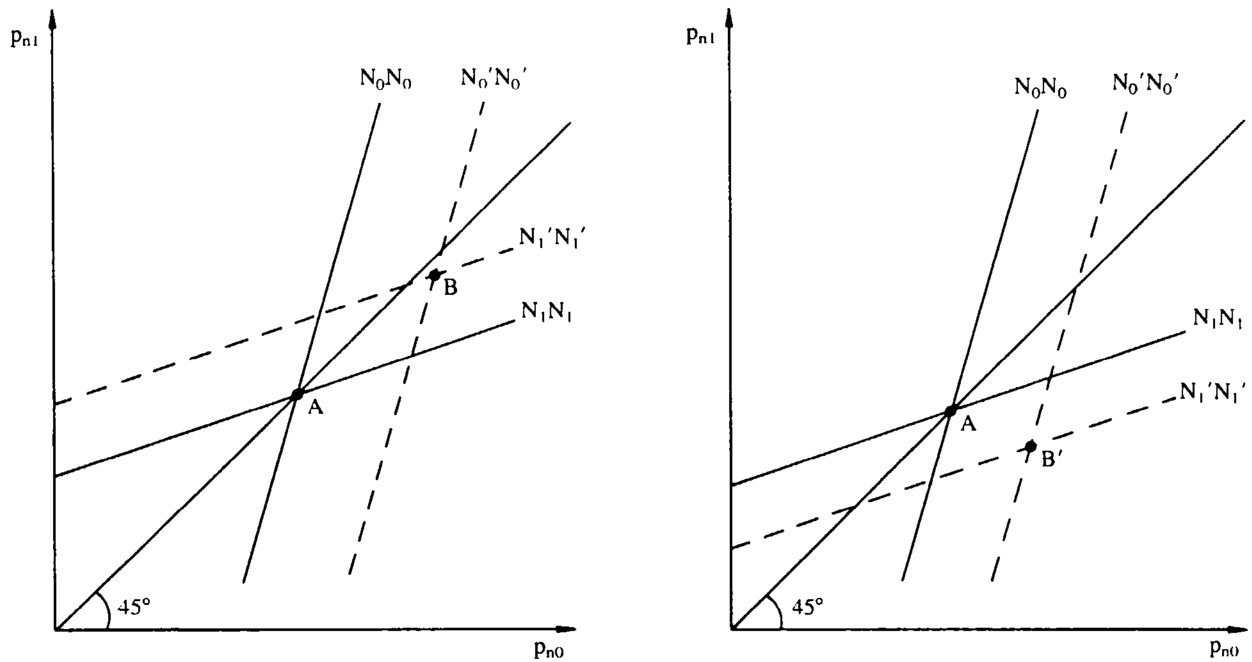
1/ For the response of p_{n1}, see the appendix.

Figure 3

The Effect of an Anticipated Future Deterioration in the Terms of Trade on the Path of the Real Exchange Rate

Panel a　　　　　　　　　　Panel b



Data: $\sigma_{nm} > (1 - \gamma)\, \sigma$; $\mu_{m1} = 1$　　　　Data: $\sigma_{nm} < (1 - \gamma)\, \sigma$; $\mu_{m1} = 1$

before any "fundamental" has changed. A future deterioration in the terms of trade will cause a real appreciation today if the temporal elasticity of substitution between importables and nontradables, σ_{nm}, and the intertemporal elasticity of substitution, σ, both exceed the critical value, $(1-\mu_m)$, which equals the ratio of imports to consumption of importables. Further, once this critical value is attained, the larger are both elasticities of substitution, σ and σ_{nm}, the larger is the magnitude of the real appreciation. Finally, if both elasticities fall short of the critical value, an anticipated future deterioration in the terms of trade causes a real depreciation today.

Two special cases may be of interest. Suppose $\mu_{m1} = 0$ so that the home economy is completely specialized in the production of exportables and home goods in period one.

Case 1: $\sigma_{nm} = 1$, in which case importables and nontradables are neither gross substitutes nor gross complements. Then a sufficient condition for an expected future deterioration in the terms of trade to lead to a real appreciation today is that real spending in the two periods be gross substitutes, and vice-versa. This parameter configuration highlights the separate role of intertemporal substitution and shows clearly that even if the demand for home goods is independent of the terms of trade temporally, terms of trade shocks nonetheless affect the real exchange rate. This contrasts with earlier analyses carried out in the context of static models (e.g., Dornbusch (1974)) where intratemporal substitution is the only mechanism by which terms of trade changes after the real exchange rate.

Case 2: $\sigma = 1$. In this case, the elasticity of C_0 with respect to the rate of interest is zero. Here, a sufficient condition for $\frac{d\log p_{n0}}{d\log p_{m1}}$ to be positive is that importables and home goods be gross substitutes, and vice-versa. This situation highlights the separate role of temporal substitution.

Before turning to an analysis of the effects of permanent terms of trade shocks, it is worth mentioning, in analogy to previous remarks concerning the effects of tariffs that, around the autarky equilibrium ($\mu_{m1} = 1$), the effect of an anticipated future terms of trade deterioration is identical to the effect of the anticipation of the imposition of a tariff (with lump sum redistribution of the proceeds), assuming that initially there are no distortions in the economy.

Having analyzed the case of temporary (current and future) shocks to the terms of trade, we now have all the necessary ingredients to address the question of permanent shocks.

3. Permanent terms of trade changes

The effect of a permanent deterioration in the terms of trade can be found by setting $\hat{p}_{m0} = \hat{p}_{m1} = \hat{p}_m$ in equations (12) and (13) and using the Slutsky decomposition. Assuming that the expenditure share and production-consumption ratio of importables do not vary over time, the horizontal shifts in the N_0N_0 and N_1N_1 schedules are

$$(23)\qquad \left.\frac{d\log p_{n0}}{d\log p_m}\right|_{N_0N_0} = \frac{\beta_m[\sigma_{nm}-(1-\mu_m)]}{\beta_m\sigma_{nm}+\beta_{x0}\sigma_{nx}+\beta_{n0}\gamma\sigma} \text{ and}$$

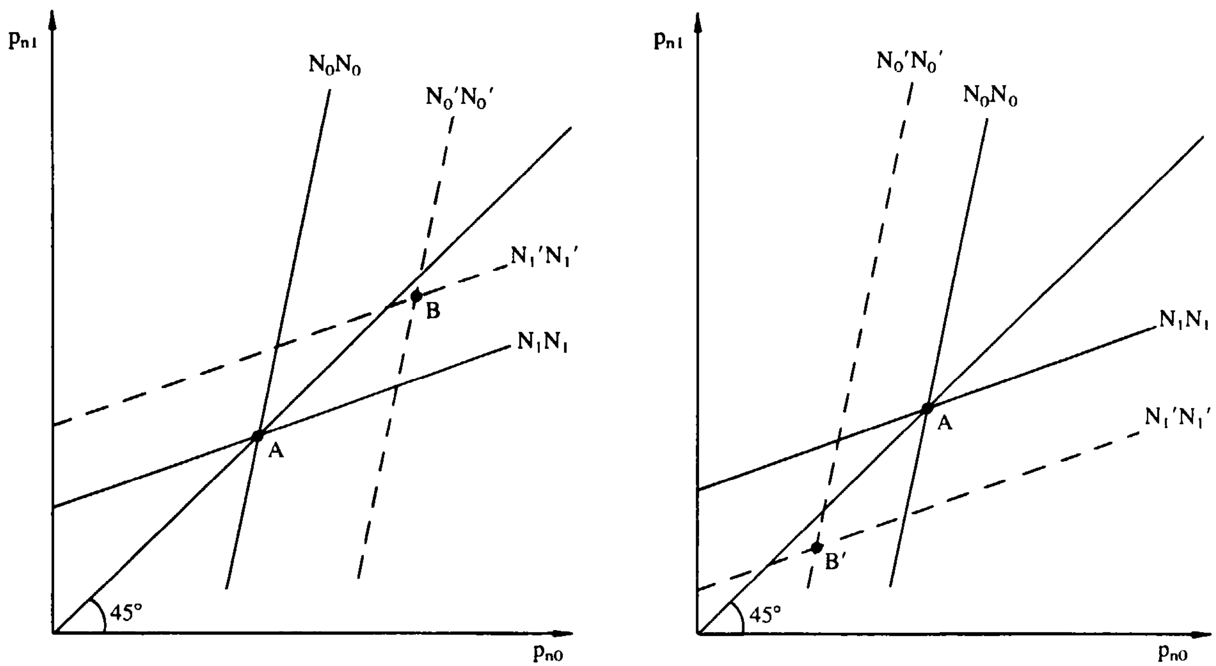
$$(24)\qquad \left.\frac{d\log p_{n0}}{d\log p_m}\right|_{N_1N_1} = \frac{-\beta_m[\sigma_{nm}-(1-\mu_m)]}{\beta_{n0}(1-\gamma)\sigma}.$$

Thus, a permanent deterioration in the terms of trade has two effects: first, by permanently raising the relative price of importables, the terms of trade change permanently alters the temporal composition of spending. The magnitude of the temporal substitution effect, which may be positive or negative, is governed by σ_{nm}, the elasticity of substitution between importables and nontradables. Second, the permanent deterioration in the terms of trade lowers welfare. The magnitude of this welfare effect, which is always negative in terms of its impact on the demand for c_{n0} or c_{n1}, is governed by $(1-\mu_m)$, the (assumed constant) ratio of imports to consumption of importables. Clearly, we see that the N_0N_0 schedule shifts to the right and the N_1N_1 schedule to the left if $\sigma_{nm} > (1-\mu_m)$, and conversely. These two cases are illustrated in Figure 4. In panel (a), we assume $\sigma_{nm} > (1-\mu_m)$. In that case, a permanent deterioration in the terms of trade leads to a real appreciation in both periods. In panel (b), we assume $\sigma_{nm} < (1-\mu_m)$ so that the permanent terms of trade deterioration leads to a real depreciation in both periods. The intuition of this result is clear: if $\sigma_{nm} > (1-\mu_m)$, the positive substitution effect outweighs the negative wealth effect so that the rise in p_m raises (permanently) the demand for nontradables. Given the supply, a rise in both p_{n0} and p_{n1} is necessary to clear the home goods sector. Conversely, if $\sigma_{nm} < (1-\mu_m)$, the negative welfare effect dominates and a permanent deterioration in the terms of trade lowers permanently the demand for home goods, resulting in a real depreciation in both periods.

Figure 4

The Effect of a Permanent Deterioration in the Terms of Trade on the Path of the Real Exchange Rate

Panel a | Panel b



Data: $\sigma_{nm} > (1 - \mu_m)$

Data: $\sigma_{nm} < (1 - \mu_m)$

Finally, panel a illustrates the phenomenon of equilibrium overshooting while panel b illustrates equilibrium undershooting. These results are, however, not general since point B in panel a could obviously be located above the 45 degree line, and conversely for point B' in panel b.

In the appendix, we show that the equilibrium response of today's relative price of nontraded goods to a permanent deterioration in the terms of trade is given by:

$$(25) \qquad \frac{d\log p_{n0}}{d\log p_m} = \Delta_5[\sigma_{nm} - (1-\mu_m)]$$

where

$$\Delta_5 = \frac{\beta_m[\beta_m\sigma_{nm}+\beta_{x1}\sigma_{nx}+\beta_{n1}\sigma]}{[\beta_m\sigma_{nm}+\beta_{x1}\sigma_{nx}+\beta_{n1}(1-\gamma)\sigma][\beta_m\sigma_{nm}+\beta_{x0}\sigma_{nx}]+\beta_{n0}\gamma\sigma[\beta_m\sigma_{nm}+\beta_{x1}\sigma_{nx}]} \geq 0.$$

Equation (25) reveals that the effect of a permanent terms of trade change on the real exchange rate is very similar to the effect derived in the context of static (one period) models. Specifically, if $\mu_m = 0$, so that the economy does not produce importables, then a permanent deterioration in the terms of trade raises the relative price of home goods today if importables and nontraded goods are gross substitutes ($\sigma_{nm} > 1$), and vice-versa. Note that this is precisely the condition given in Dornbusch (1974) in the context of a static model.

Finally, if we assume that $\mu_m = 1$, so that at the initial terms of trade the economy operates close to the autarky equilibrium, then a permanent deterioration in the terms of trade has exactly the same effect as the imposition of a permanent tariff (with lump sum redistribution of the proceeds) from an initial equilibrium with zero tariffs. If importables and nontradables are net substitutes ($\sigma_{nm} > 0$) there is a real appreciation, and vice-versa.

The analysis of permanent terms of trade changes leads to the following proposition:

<u>Proposition 3</u>: The effect of a permanent terms of trade disturbance on the real exchange rate depends on the relative magnitude of the temporal elasticity of substitution between importables and nontradables, σ_{nm}, and the ratio of imports to consumption of importables, $(1-\mu_m)$. If the value of σ_{nm} exceeds this critical ratio, a permanent terms of trade deterioration causes a real appreciation in both periods, and conversely. The absence of intertemporal considerations from the analysis is a consequence of the assumption of constant expenditure shares. With

this assumption, a permanent terms of trade change does not alter the real rate of interest.

IV. The Harberger-Laursen-Metzler Effect in the Presence of Nontraded Goods

The effect of various shocks to the terms of trade on the path of the real exchange rate is an important ingredient in the analysis of the Harberger-Laursen-Metzler effect. In particular, the total effect of a terms of trade change on the trade balance can be decomposed into a direct effect (holding constant the path of the real exchange rate) and an indirect effect (operating through changes in the real exchange rates caused by the shock to the terms of trade which in turn feed back to alter the trade balance). Accordingly, we may write:

$$(26) \qquad \frac{d(TA_c)_0}{d\log p_{m0}} = \frac{\partial(TA_c)_0}{\partial\log p_{m0}} + \sum_{t=0}^{1} \frac{\partial(TA_c)_0}{\partial\log p_{nt}} \frac{d\log p_{nt}}{d\log p_{m0}},$$

$$(27) \qquad \frac{d(TA_c)_0}{d\log p_{m1}} = \frac{\partial(TA_c)_0}{\partial\log p_{m1}} + \sum_{t=0}^{1} \frac{\partial(TA_c)_0}{\partial\log p_{nt}} \frac{d\log p_{nt}}{d\log p_{m1}},$$

$$(28) \qquad \frac{d(TA_c)_0}{d\log p_{m}} = \frac{\partial(TA_c)_0}{\partial\log p_{m}} + \sum_{t=0}^{1} \frac{\partial(TA_c)_0}{\partial\log p_{nt}} \frac{d\log p_{nt}}{d\log p_{m}},$$

where $\frac{\partial(TA_c)_0}{\partial\log p_m}$, $\frac{\partial(TA_c)_0}{\partial\log p_{m1}}$, $\frac{\partial(TA_c)_0}{\partial\log p_m}$ are given in equations (7), (8), and (9), respectively, and correspond to the <u>direct</u> effect of a terms of trade change and where the terms inside the summation signs represent the <u>indirect</u> effect of a terms of trade change on the balance of trade.

To gain insight into the indirect effect, we need to determine how real exchange rate changes affect the consumption based trade balance. Differentiating equation (5), the following expressions are easily derived:

$$(29) \qquad \frac{\partial(TA_c)_0}{\partial\log p_{n0}} = \beta_{n0}\,[(1-\mu_{c0}) + \gamma\sigma]C_0,$$

$$(30) \qquad \frac{\partial (TA_c)_0}{\partial \log p_{n1}} = -\beta_{n1}[\gamma\sigma]C_0.$$

As can be seen from equation (29), a temporary current rise in the relative price of home goods, p_{n0}, affects the consumption based trade balance via two separate channels: a real income effect $\beta_{n0}(1-\mu_{c0})$ and a real spending effect $\beta_{n0}\gamma\sigma$. The real income effect is positive if $\mu_{c0} < 1$, i.e., if at the initial terms of trade the country has a trade deficit and is negative if $\mu_{c0} > 1$, that is if initially the country has a trade surplus. The reason is clear: if $\mu_{c0} < 1$, there is excess demand for tradables in period zero so that a fall in their relative price (a rise in p_{n0}) raises real income. Conversely, if $\mu_{c0} > 1$, there is excess supply of tradables in period zero so that a fall in their relative price lowers real GDP.

The only mechanism through which a change in p_{n0} affects real spending, C_0, is purely via intertemporal substitution. This is so because of the assumption that the home goods market clears in each period. Since nontraded goods are neither in excess demand nor excess supply, there is no aggregate wealth effect due to a change in their relative price. However, a rise in p_{n0} raises the real rate of interest relevant for consumption decisions and this reduces spending (and therefore improves the trade balance) by the product of the change in the discount factor, which equals β_{n0}, and the compensated elasticity of spending with respect to the interest rate, which equals $\gamma\sigma$.

Consider now equation (30). A rise in p_{n1} affects the period zero trade balance only by altering real spending, C_0 (since there is no effect of a change in p_{n1} on current real income, $(GDP_c)_0$). Again, and for the same reason as above, real spending is affected only by altering the intertemporal terms of trade. The rise in p_{n1} raises the discount factor α_{c1} by the magnitude β_{n1} and this raises current period real spending by the product of β_{n1} and the compensated spending elasticity, $\gamma\sigma$. The increase in real spending corresponds to a worsening of the period zero trade balance.

We are now in a position to derive the total effect of a terms of trade change on the trade balance. We consider first the case of permanent shocks and then move on to determine the effects of temporary (current and anticipated future) terms of trade changes.

1. Permanent terms of trade changes

To sharpen the analysis, we will consider a benchmark case in which expenditure shares and production-consumption ratios are stationary. 1/ To motivate this assumption, recall from the definition of the real discount factor, that a permanent rise in the relative price of importables raises the real rate of interest if β_{m0}, the period zero expenditure share of importables, exceeds β_{m1}, the period one expenditure share, and vice-versa. If $\beta_{m0} = \beta_{m1}$, then a permanent deterioration in the terms of trade leaves the real interest rate unchanged. Thus, in contrast to temporary terms of trade shocks which always alter the real rate of interest, our assumption of constant expenditure shares implies that in the case of permanent shocks, the main channels influencing the behavior of the trade balance are temporal substitution and welfare effects, rather than intertemporal effects.

Substituting the relevant expressions into equation (28) and assuming that all expenditure shares and production-consumption ratios are constant, the total effect of a terms of trade change on the period zero real trade balance is given by

$$(31) \qquad \frac{d(TA_c)_0}{d\log p_m} = \beta_m[1-\mu_{c0}]C_0 + \beta_n[1-\mu_{c0}]C_0[\sigma_{nm}-(1-\mu_m)]\Delta_5.$$

Consider the first term in equation (31), which represents the direct effect. As can be seen, the sign of the direct effect is determined solely by the initial trade balance position of the country: it is positive if at the initial relative price structure, the economy runs a trade deficit ($\mu_{c0} < 1$) and it is negative if the country has a trade surplus ($\mu_{c0} > 1$). If initially the trade account is balanced, then the permanent rise in the relative price of imports lowers real income and spending by the same amount and the trade balance is unchanged.

The second term in equation (31) is the indirect effect and its sign depends on two factors: the first is whether $\sigma_{nm} \gtrless 1-\mu_m$, and the second is whether $\mu_{c0} \gtrless 1$. The sign of the expression $[\sigma_{nm} - (1-\mu_m)]$ determines the sign of the change in the relative price of home goods as a result of the deterioration in the terms of trade. If $\sigma_{nm} > 1-\mu_m$, the permanent rise in p_m leads to a permanently lower real exchange rate, and conversely. The term $[1-\mu_{c0}]$ translates the change in the real exchange rate into a change in the balance of trade. If $\mu_{c0} < 1$ so

1/ The ingredients necessary for consideration of the general case are given in the appendix.

that, initially, the country has a trade deficit, then the real exchange rate and the trade balance are negatively correlated, and vice versa. 1/

The analysis suggests that, in contrast to previous work which assumed no nontraded goods, the real exchange rate is a potentially important mechanism for the transmission of terms of trade disturbances to the current account. Specifically, our model suggests that if $(1-\mu_m) > \sigma_{nm}$, so that a terms of trade deterioration causes a real depreciation, the direct and indirect effects of the terms of trade change will be opposite in sign. 2/ In fact, for certain values of the parameters, the direct effect may be small and the indirect effect may be large so that the latter may even outweigh the former. Factors favoring this outcome include a large value for β_n, the expenditure share of home goods in total spending, relative to β_m, the expenditure share of importables.

Specifically, while the assumption of no nontraded goods (β_n close to zero) implies that from an initial position of trade deficit, a permanent terms of trade deterioration always improves the trade balance, the analysis here suggests that a comovement consisting of (i) deteriorating terms of trade; (ii) negative and worsening trade balance; and (iii) real depreciation is a theoretical possibility. 3/ Similarly, a comovement consisting of (i) improving terms of trade; (ii) positive and improving trade balance; and (iii) real appreciation is also possible. These types of comovement would be difficult to explain in the context of models without nontraded goods. Thus, we have:

Proposition 4: The response of the current account to a permanent terms of trade change will be qualitatively similar in models with and without nontraded goods if the elasticity of substitution between home goods and importables, σ_{nm}, exceeds the ratio of imports to consumption of importables, $1-\mu_m$. For values of σ_{nm} falling short of this critical ratio, the behavior of the trade balance may differ qualitatively in the two types of model. For example, a deterioration in the terms of trade may lead to a worsened trade balance (from an initial position of deficit), and an improvement in the terms of trade may lead to an increase in the

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1/ Note that if $\mu_{c0} = 1$, so that the trade account is in balance, then both the direct and indirect effects are zero and a permanent terms of trade change leaves the balance of trade unaffected.

2/ This condition states that the real income effect of a terms of trade change outweighs the temporal substitution effect. It is necessarily satisfied if importables and nontradables are Hicks complements but is compatible with their being Hicks substitutes as well. Note that if the economy does not produce importables, the condition states that $\sigma_{nm} < 1$.

3/ Note that this is an equilibrium phenomenon and has nothing to do with lags in the adjustment of the current account to relative price changes, which underly the "J curve."

trade surplus. In the first case, the worsened trade balance will be accompanied by a real depreciation while in the second case the larger surplus will be accompanied by a real appreciation.

Finally, we note that the analysis carried out here is relevant not only for exogenous shocks to the world terms of trade but also for any commercial policy induced changes which alter the domestic terms of trade. Specifically, if we evaluate equation (31) around the autarky equilibrium ($\mu_m = 1$), the resulting expression gives the effect of the imposition of a permanent tariff with lump sum redistribution of the proceeds, assuming that initially, there are no tariffs.

2. Temporary terms of trade changes

We now turn to a discussion of the effects of temporary (current and anticipated future) terms of trade shocks. The analysis brings to the forefront a third channel by which terms of trade changes affect the trade balance--in addition to the wealth and temporal substitution channels which played a role in the interpretation of permanent shocks--namely, the intertemporal substitution channel.

To sharpen the analysis, we consider in what follows a benchmark case in which, in the initial equilibrium, the trade account is balanced. This assumption implies that there are no real GDP revaluation effects associated with initial trade account imbalances. 1/ Accordingly, in what follows, assume $\mu_{c0} = 1$. Substituting the relevant expressions into equations (26) and (29) yields:

$$(32) \qquad \frac{d(TA_c)_0}{d\log p_{m0}} = \beta_m \gamma[\sigma-(1-\mu_m)]\ C_0 + \beta_n \gamma\sigma[\sigma_{nm}-\sigma]\ C_0\ \Delta_6,$$

$$(33) \qquad \frac{d(TA_c)_0}{d\log p_{m1}} = -\frac{d(TA_c)_0}{d\log p_{m0}},$$

where $\Delta_6 = \beta_m[\beta_m\sigma_{nm} + \beta_x\sigma_{nx} + \beta_n\sigma]^{-1} > 0.$

These equations reveal that the effects of temporary terms of trade changes can be decomposed into two components: a direct effect (the first term in equation (32))--that is the effect holding constant the path of the real exchange rate--and an indirect effect, which involves the endogenous real exchange rate changes caused by the terms of trade

1/ The ingredients necessary for consideration of the general case are given in the appendix.

disturbance (the second term in equation (32)). Equations (32) and (33) also show that current and anticipated future terms of trade changes have effects on the period zero trade balance which are equal and opposite in sign. This symmetry stems from the assumption of constant expenditure shares, production-consumption ratios, and initial trade balance.

Let us consider first the direct effect in equation (32). A rise in p_{m0} has three effects on the period zero trade balance. First, real GDP falls by the amount $\beta_m(1-\mu_m)$, that is in proportion to the (assumed constant) volume of imports. This is the negative real income effect associated with a deterioration in the terms of trade. Second, the rise in p_{m0} raises the consumption based rate of interest which lowers real spending, C_0. The magnitude of this effect is governed by the product of β_m, which equals the fall in the real discount factor, and $\gamma\sigma$, the compensated elasticity of C_0 with respect to the discount factor. Third, the rise in p_{m0} lowers lifetime real wealth. The proportional fall in lifetime wealth is a fraction, $(1-\gamma)$, of the the fall in current period real GDP, $\beta_m(1-\mu_m)$. The fall in real wealth lowers the volume of spending, C_0, by the amount $\beta_m(1-\gamma)(1-\mu_m)$, given the assumption of homotheticity. Summing these three effects yields precisely the first expression in equation (32).

The direct effect is therefore positive or negative according to whether $\sigma \gtrless (1-\mu_m)$. This result shows that, in response to a temporary deterioration in the terms of trade, the trade balance need not behave as a "shock absorber" and move into deficit. 1/ The reason is of course that a terms of trade shock is a particular kind of real income shock. Like a negative supply shock, a deterioration in the terms of trade lowers real income. Unlike a negative supply shock, a deterioration in the terms of trade raises the real rate of interest (for this small open economy). The rise in the rate of interest reduces real spending via the intertemporal substitution channel. If this force is sufficiently powerful, that is if $\sigma > (1-\mu_m)$, then a temporary adverse movement in the terms of trade will actually cause the trade balance to move into surplus. 2/

Consider now the indirect effect in equation (32). Simple algebraic manipulations reveal that this effect may be written as the

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1/ This role of the current account is emphasized in Sachs (1981).
2/ In the case of logarithmic utility, $\sigma = 1$, and the trade account necessarily moves into surplus (cannot move into deficit).

product of two terms: $\frac{d\log(p_{n0}/p_{n1})}{d\log p_{m0}}$ and $\frac{\partial(TA_c)_0}{\partial \log p_{n0}}$. From the discussion in the appendix, it is straightforward to show that

$$\text{(34)} \qquad \frac{d\log\,(p_{n0}/p_{n1})}{d\log\,p_{m0}} = [\sigma_{nm} - \sigma]\Delta_6.$$

Equation (34) states that the effect of a temporary current deterioration in the terms of trade on the rate of increase in the real exchange rate between periods zero and one depends on the relative magnitudes of the temporal and intertemporal elasticities of substitution. The intuition of this result is as follows. A rise in p_{m0} induces susbstitution among goods within period zero. The magnitude of this substitution is governed by σ_{nm}, the temporal elasticity of substitution between nontradables and importables. If the goods are Hicksian substitutes, so that $\sigma_{nm} > 0$, the impact of this temporal substitution on the intertemporal real exchange rate ratio, p_{n0}/p_{n1}, is positive, and conversely.

In addition, however, a rise in p_{m0} raises the consumption based rate of interest and induces substitution of aggregate spending (part of which falls on home goods) from period zero to period one. This intertemporal substitution effect is unambiguously negative in terms of its impact on the price ratio, p_{n0}/p_{n1}. Its magnitude is governed by σ, the intertemporal elasticity of substitution.

Thus, we see that if $\sigma_{nm} > \sigma$, so that the temporal susbstitution effect dominates the intertemporal substitution effect, the rise in p_{m0} raises the price ratio p_{n0}/p_{n1} and the sign of the indirect effect is necessarily positive. Conversely, if a temporary current deterioration in the terms of trade leads to a flatter time profile for the real exchange rate (so that p_{n0}/p_{n1} falls), which will occur if $\sigma_{nm} < \sigma$, then the sign of the indirect effect is negative. It is relevant to note that the direction in which the time path of the real exchange rate changes in response to a temporary terms of trade disturbance (indicated by equation (34)) is a key determinant of the movement in the real rate of interest. The change in the latter is of course crucial for determining the effect of the terms of trade change on real spending and hence on the real trade balance.

The previous analysis suggests that the direct and indirect effects of temporary terms of trade disturbances depend on different parameters of the model. Specifically, the sign of the direct effect depends on the relative magnitude of the intertemporal elasticity of substitution, σ, and the share of imports in the consumption of importables, $1-\mu_m$. On the other hand, the sign of the indirect effect depends on the relative magnitudes of the temporal and intertemporal elasticities of substitution, σ and σ_{nm}. This observation shows that the direct and indirect effect may in fact be opposite in sign. Furthermore, for certain parameter configurations, equation (32) reveals that the latter may dominate the former. This suggests that--as in the case of permanent shocks--the real exchange rate may be an important variable through which terms of trade shocks are transmitted to the current account.

To fix ideas, consider for example a situation in which a temporary current deterioration in the terms of trade would--in a model without nontraded goods--worsen the period zero trade balance. This is the result if the current account acts as "shock absorber" and occurs if $\sigma < (1-\mu_m)$. In this case, an (overly) sufficient condition for the indirect effect to be positive (and hence opposite in sign to the direct effect) is for nontradables and importables to be gross substitutes. 1/ It is easy to verify that for certain parameter configurations (particularly if β_n is large relative to β_m), the direction in which the trade balance moves may be determined by the (positive) indirect effect rather than by the (negative) direct effect. In the example just cited, the trade balance would--in a model without nontraded goods--move into deficit (acting as a "shock absorber") whereas in a model with nontraded goods, it would move into surplus as a result of a temporary current terms of trade deterioration.

Before summarizing our results in proposition 5, it is relevant to note that we have concentrated in the previous analysis on temporary current rather than anticipated future shocks to the terms of trade. The underlying symmetry between equations (32) and (33) suggests that a separate analysis of anticipated future shocks is not required. We can note briefly, however, that in the case of an anticipated future terms of trade deterioration the direct effect on today's trade balance will be positive if $\sigma < (1-\mu_m)$. This is the case in which the current account acts as a "shock absorber" moving into surplus in anticipation of a future real income loss. However, if $\sigma > (1-\mu_m)$, then the direct effect will worsen the trade balance as a result of an anticipated future terms of trade deterioration. The intuition here is that the expected rise in p_{m1} lowers the real rate of interest which raises real spending today, C_0; this effect dominates the negative real wealth effect which by itself tends to lower real spending and hence improve the trade balance. The direct effect is therefore negative if the real wealth effect is weak relative to the intertemporal substitution effect, i.e., if $\sigma > (1-\mu_m)$, and conversely.

The sign of the indirect effect of a rise in p_{m1} depends on the response of the time path of the real exchange rate, p_{n0}/p_{n1}. The parameters which influence this time path are the temporal and intertemporal elasticities of substitution. If $\sigma_{nm} > \sigma$, then a rise in p_{m1} lowers the price ratio, p_{n0}/p_{n1}, which in turn lowers the consumption based rate of interest. Real spending, C_0, therefore rises and the

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1/ The weaker condition, $\sigma_{nm} > (1-\mu_m)$ is sufficient.

indirect effect contributes to a worsening of the trade balance. On the other hand, if $\sigma_{nm} < \sigma$, a rise in p_{m1} raises the price ratio, p_{n0}/p_{n1}, which in turn raises the real rate of interest. Real spending, C_0, falls and the indirect effect contributes to an improvement of the trade balance.

Finally, we can see that, for certain parameter configurations, the direct and indirect effects of an anticipated future terms of trade change will be opposite in sign (and the latter may even dominate the former). Since, a priori these configurations are no less likely than alternative ones, it follows that the real exchange rate is potentially an important transmission mechanism of (anticipated future) terms of trade shocks to the current account.

The foregoing analysis leads us to proposition 5.

Proposition 5: Temporary terms of trade disturbances will in general have different effects in models with or without nontraded goods. The fundamental reason underlying these differences is that the time path of the real exchange rate (which is a key determinant of the real rate of interest and hence of real spending and the trade balance) is an endogenous variable which responds to disturbances in the terms of trade. Specifically, we showed that if σ_{nm}, the temporal elasticity of substitution between nontradables and importables, exceeds σ, the intertemporal elasticity of substitution, then a current deterioration in the terms of trade accelerates the rate of change of the real exchange rate while an anticipated future deterioration in the terms of trade decelerates the rate of change of the real exchange rate over time. The response of the time path of the real exchange rate in the opposite case, when $\sigma > \sigma_{nm}$, is opposite to the one just indicated, namely decelerating in the case of a current shock and accelerating in response to a future shock. We showed that for certain parameter configurations (specifically if the share of home goods in total spending is large relative to the share of importables), a temporary terms of trade shock will lead to a deterioration in the trade balance when the response of the real exchange rate is taken into account even if, holding constant the real exchange rate, the trade balance improves, and conversely.

Finally, it is relevant to note that the imposition of a temporary tariff (from an initial equilibrium with zero distortions and assuming lump-sum redistribution of the tariff revenue) will have the same effects on the trade balance as a temporary terms of trade shock evaluated at the autarky equilibrium. Using equations (32) and (33), this implies that the imposition of a temporary tariff always improves the trade balance while the anticipation of the imposition of a tariff in the future always worsens it, holding constant the time path of the real exchange rate. However, if the temporary tariff is accompanied by a sufficiently lower intertemporal real exchange rate ratio or if the anticipated future tariff is accompanied by a sufficiently higher one, the first policy may cause a worsened period zero trade balance while the second causes an improved period zero trade balance.

Figure 5 illustrates some of these results. On the horizontal axis, we plot real income and spending in period zero and on the vertical axis we plot the corresponding period one variables. The initial real income and spending points are denoted I_0 and S_0, respectively. We assume, in Figure 5, that the initial trade balance is zero so that I_0, S_0 occur at the same point. The solid line in Figure 5 represents the lifetime budget constraint and its slope is (minus) one plus the real rate of interest.

Consider now a temporary current deterioration in the terms of trade. This shifts the real income point from I_0 to I_1. At a constant real discount factor, the real spending point shifts from S_0 to S_1. The period zero trade balance unambiguously turns negative, with the magnitude of the deficit being equal to the horizontal distance between I_1 and S_1.

However, in general the real rate of interest will not remain unchanged. First, the current deterioration in the terms of trade tends to raise the real rate of interest, holding constant the path of the real exchange rate. This change is captured by a clockwise pivot of the budget line through point I_1, where the new slope equals (minus) $R'_{c0} > R_{c0}$. Real spending moves to a point such as S_2, along a new Engel curve (not drawn) corresponding to the higher real interest rate. The movement from the pair (I_0, S_0) to the pair (I_1, S_2) corresponds to the direct effect in equation (32). Accordingly, we assume that the direct effect on the trade balance is negative.

Consider now the indirect effect and suppose that the temporary terms of trade deterioration results in a steeper time profile of the real exchange rate. This effect raises the real rate of interest and results in a further clockwise pivot of the budget line through point I_1. The slope of the new budget line is equal to (minus) $R''_{c0} > R'_{co}$ and spending moves to a point such as S_3, at the intersection of a new Engel curve (not drawn) and the budget line. At S_3, there is a trade surplus corresponding to the horizontal distance between I_1 and S_3. Thus, while the direct effect (which corresponds to the movement from (I_0, S_0) to (I_1, S_2)) lowers the trade balance, the total effect (from (I_0, S_0) to (I_1, S_3)) yields a trade surplus. The fundamental reason underlying these different results is the endogenous movement in the time profile of the real exchange rate.

Clearly, the diagrammatic apparatus can be used to generate a wide variety of interesting results. Specifically, we can use the analysis to show that the imposition of a temporary tariff, which necessarily improves the trade balance holding constant the time path of the real exchange rate, may actually worsen the trade balance if the time profile of the real exchange rate becomes sufficiently flatter. We can also use the apparatus to analyze the effects of anticipated future and permanent shocks to th world terms of trade (or analogous movements in the domestic terms of trade arising from tariff changes).

V. Conclusions and Extensions

In this section, I summarize the main results of this paper and suggest possible extensions.

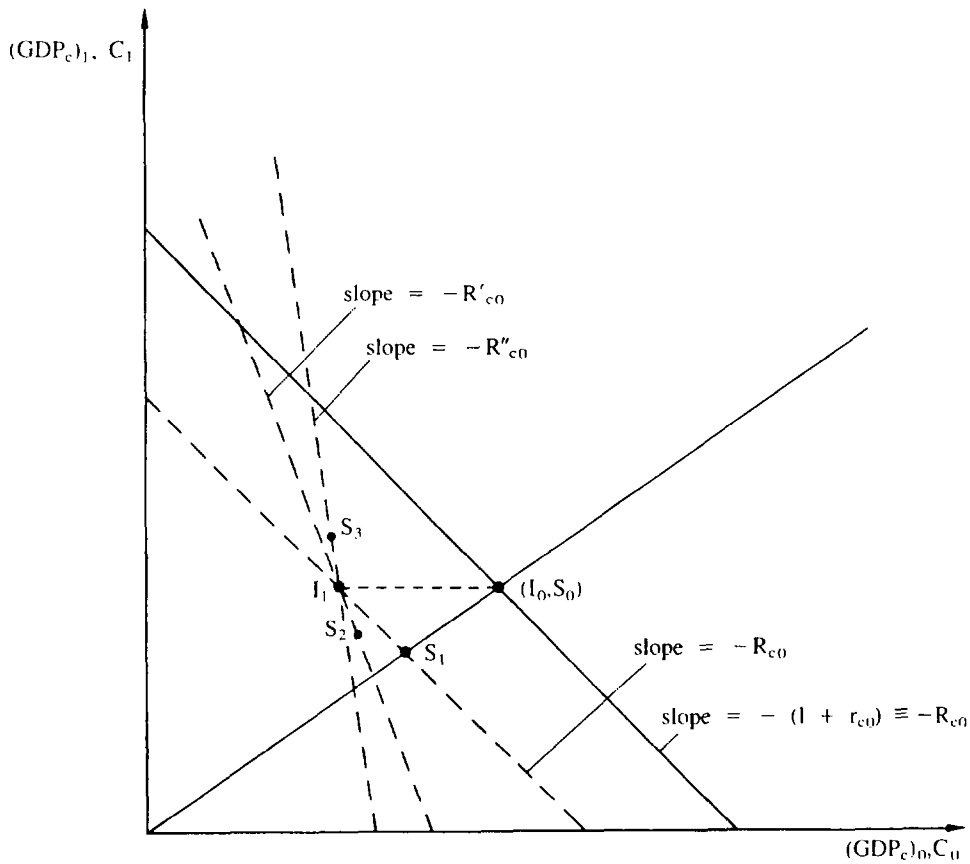
This paper uses an intertemporal optimizing model of a small country in which agents consume three goods which are imperfect substitutes in demand, in order to determine to what extent the introduction of a nontradables sector alters the relationship between changes in the terms of trade and the balance of trade. An answer to this question requires an understanding of how the two temporal relative prices--the terms of trade and the real exchange rate--are linked. We, thus, analyzed the effect of various terms of trade shocks on the real exchange rate. These real exchange rate changes represent a separate and distinct channel via which terms of trade changes affect a country's trade balance.

Specifically (and schematically), the effect of temporary shocks to the terms of trade were found to depend critically on two factors: First, the relative magnitude of temporal and intertemporal elasticities of substitution and second, the relative magnitude of the intertemporal elasticity of substitution and the ratio of imports to consumption of importables. The first factor determines the effect of the terms of trade change on the time profile of the real exchange rate (which is a key determinant of the real rate of interest and hence real spending and the trade balance) while the second determines the effect of the terms of trade change on the trade balance, holding constant the real exchange rate. We showed that for certain parameter configurations, the predictions of models which incorporate nontraded goods may differ from those which do not. The real exchange rate is potentially an important transmission mechanism of terms of trade shocks to the current account.

The analysis of permanent shocks revealed that (a) the initial trade balance position and (b) the relative magnitudes of the temporal elasticity of substitution and the ratio of imports to consumption of importables are the key factors which determine the behavior of the trade balance. This is in constrast to the previous analysis which showed that the initial borrowing position of the country was the main factor determining the behavior of the current account as a result of a permanent terms of trade shock.

Figure 5

The Harberger–Laursen–Metzler Effect with Non-Traded Goods: The Effect of a Temporary Current Deterioration in the Terms of Trade on the Trade Balance



The extensions to this paper are numerous. I will mention only two of them here, the criterion for selection being that they represent work in progress. The first is to analyze the role that capital mobility plays in determining the comovement between the terms of trade and the real exchange rate. In this paper, agents were assumed to have perfect access to the world capital market; other possibilities, including restricted access to the capital markets or--in the limit--no access so that, in each period, the current account must balance, would be worthy of examination.

A second possible extension would involve relaxing the small country assumption in order to understand, within the context of a two-country general equilibrium optimizing model of the world economy, how various shocks to demand (e.g., fiscal policy) or supply (e.g., endowment shocks) affect the comovement among world real interest rates, real exchange rates at home and abroad, and the terms of trade.

The Basic Model

In this appendix, I provide some guideposts to the main derivations contained in the body of the paper.

On numerous occasions in the text, use is made of the relationship between gross elasticities and Hicks-Allen elasticities of substitution. The Allen elasticity of substitution between goods i and j, $\sigma_{ij} = \sigma_{ji}$, equals $\bar{\eta}_{ij}/\beta_j$, where $\bar{\eta}_{ij}$ is the compensated elasticity of demand of good i with respect to a change in price p_j. Using this definition, the Slutsky decomposition of a total elasticity into its corresponding substitution and income effect components, and the homogeneity property of demand function gives a relationship between gross elasticities and an expenditure share weighted average of the elasticities of substitution and total spending (or wealth) elasticities. Under the homotheticity assumption, the elasticities of demand with respect to spending as well as of spending with respect to lifetime wealth are both unity. The following relationships used in the paper are now readily derivable. These are:

(A-1) $$\eta_{c_0\alpha} = \gamma(\sigma-1)$$

(A-2) $$\eta_{c_1\alpha} = -\left[(1-\gamma)\sigma + \gamma\right]$$

(A-3) $$\eta_{n_t p_{nt}} = -\beta_{mt}\sigma_{nm} - \beta_{xt}\sigma_{nx} - \beta_{nt}$$

(A-4) $$\eta_{n_t p_{mt}} = \beta_{mt}(\sigma_{nm}-1)$$

where σ, the intertemporal elasticity of substitution, is defined as

(A-5) $$\sigma = \frac{\partial \log(C_1/C_0)}{\partial \log[(\partial U/\partial C_0)/(\partial U/\partial C_1)]}$$

Note that since $\sigma > 0$ and $0 < \gamma < 1$, $\eta_{c_1\alpha}$ is negative. However, whether $\eta_{c_0\alpha} \gtrless 0$ depends on the intertemporal elasticity of substitution. If $\sigma > 1$, then a rise in the "price" of C_1, α_{c1}, raises demand for C_0. In this case, real spending in the two periods are gross substitutes and conversely. Note also that since $-[\beta_{mt}\sigma_{nm}+\beta_{xt}\sigma_{nx}]$ is a compensated effect, it is nonpositive by the negative semidefiniteness of the Slutsky substitution matrix.

The derivation of equations (7), (8), (9), (29), and (30) follows from differentiation of the trade balance equations ((5) and (6)) and the budget constraint (3) and (4). Use is made also of the relationships (A-1) and (A-2).

Many of the subsequent expressions in the paper follow from a solution to the system of market clearing conditions (10) and (11). For convenience, we rewrite these equilibrium conditions

$$\text{(A-6)} \qquad c_{n0}(p_{n0}, p_{m0}, P_0 C_0(\alpha_{c1}, W_{c0})) = \bar{Y}_{n0},$$

$$\text{(A-7)} \qquad c_{n1}(p_{n1}, p_{m1}, P_1 C_1(\alpha_{c1}, W_{c0})) = \bar{Y}_{n1}.$$

Totally differentiating, we have

$$\text{(A-8)} \qquad (\eta_{n_0 p_{n0}} + \beta_{n0})\hat{p}_{n0} + (\eta_{n_0 p_{m0}} + \beta_{m0})\hat{p}_{m0} + \eta_{c_0 \alpha}\hat{\alpha}_{c1} + \hat{W}_{c0} = 0,$$

$$\text{(A-9)} \qquad (\eta_{n_1 p_{n1}} + \beta_{n1})\hat{p}_{n1} + (\eta_{n_1 p_{m1}} + \beta_{m1})\hat{p}_{m1} + \eta_{c_1 \alpha}\hat{\alpha}_{c1} + \hat{W}_{c0} = 0.$$

where use has been made of the fact that the elasticity of the price index P_t with respect to a change in one of the temporal relative prices (p_{nt} or p_{mt}) is simply the corresponding expenditure share (β_{nt} or β_{mt}). We assume throughout that there are no supply shocks (endowments are constant) and that the world discount factor, α_{x1}, is given. In this case, the discount factor relevant for domestic consumption, α_{c1}, evolves according to

$$\text{(A-10)} \qquad \hat{\alpha}_{c1} = \beta_{n1}\hat{p}_{n1} + \beta_{m1}\hat{p}_{m1} - \beta_{n0}\hat{p}_{n0} - \beta_{m0}\hat{p}_{m0}.$$

Recalling that real wealth is given by

$$\text{(A-11)} \qquad W_{c0} = \{\bar{Y}_{x0} + p_{m0}\bar{Y}_{m0} + p_{n0}\bar{Y}_{n0} + \alpha_{x1}[\bar{Y}_{x1} + p_{m1}\bar{Y}_{m1} + p_{n1}\bar{Y}_{n1}] - (1+r_{x,-1})B_{-1}\}/P_0$$

we can totally differentiate (A-11) to obtain

$$\text{(A-12)} \qquad \hat{W}_{c0} = [(1-\gamma)\mu_{m0}-1]\beta_{m0}\hat{p}_{m0} - \gamma\beta_{n0}\hat{p}_{n0} + \gamma\mu_{m1}\beta_{m1}\hat{p}_{m1} + \gamma\beta_{n1}\hat{p}_{n1}.$$

Substituting (A-1), (A-2), (A-3), (A-4), (A-10), and (A-12) into (A-7) and (A-8), we obtain the system

$$\text{(A.13)} \quad \begin{bmatrix} -\beta_{m0}\sigma_{nm}-\beta_{x0}\sigma_{nx}-\beta_{n0}\gamma\sigma & \gamma\beta_{n1}\sigma \\ \beta_{n0}(1-\gamma)\sigma & -\beta_{m1}\sigma_{nm}-\beta_{x1}\sigma_{nx}-\beta_{n1}(1-\gamma)\sigma \end{bmatrix} \begin{bmatrix} \hat{p}_{n0} \\ \hat{p}_{n1} \end{bmatrix}$$

$$= \begin{bmatrix} -\beta_{m0}[\sigma_{nm}-\{1-\gamma)(1-\mu_{m0})+\gamma\sigma\}] & -\beta_{m1}\gamma(\sigma-(1-\mu_{m1})) \\ -\beta_{m0}(1-\gamma)(\sigma-(1-\mu_{m0})) & -\beta_{m1}[(\sigma_{nm}-\sigma)+\gamma(\sigma-(1-\mu_{m1}))] \end{bmatrix} \begin{bmatrix} \hat{p}_{m0} \\ \hat{p}_{m1} \end{bmatrix}.$$

This system underlies the derivation of the slopes of the N_0N_0 and N_1N_1 schedules as well as their shifts in response to various terms of trade changes.

Using (A-13), we can solve for $\hat{p}_{n0}$ and $\hat{p}_{n1}$ in terms of $\hat{p}_{m0}$ and $\hat{p}_{m1}$. The solutions are

$$\begin{aligned} \text{(A.14)} \quad \hat{p}_{n0} = {} & \Delta^{-1}\{\beta_{m0}[\sigma_{nm}-((1-\gamma)(1-\mu_{m0}) + \gamma\sigma)][\beta_{m1}\sigma_{nm} + \beta_{x1}\sigma_{nx}+\beta_{n1}(1-\gamma)\sigma] \\ & + \beta_{m0}(1-\gamma)(\sigma-(1-\mu_{m0}))\gamma\beta_{n1}\sigma\}\hat{p}_{m0} + \Delta^{-1}\{\gamma\beta_{m1}[\sigma-(1-\mu_{m1})][\beta_{m1}\sigma_{nm}+\beta_{nm}+\beta_{x1}\sigma_{nx} \\ & + \beta_{n1}(1-\gamma)\sigma] + \beta_{m1}[(\sigma_{nm}-\sigma) + \gamma(\sigma-(1-\mu_{m1}))\gamma\beta_{n1}\sigma\}\hat{p}_{m1} \end{aligned}$$

(A.15) $\hat{p}_{n1} = \Delta^{-1}\{\beta_{m0}(1-\gamma)[\sigma-(1-\mu_{m0})][\beta_{m0}\sigma_{nm} + \beta_{x0}\sigma_{nx} + \beta_{n0}\gamma\sigma]$

$+ \beta_{m0}(1-\gamma)\beta_{n0}\sigma[\sigma_{nm}-((1-\gamma)(1-\mu_{m0}) + \gamma\sigma)]\}\hat{p}_{m0}$

$+ \Delta^{-1}\{\beta_{m1}[(\sigma_{nm}-\sigma) + \gamma(\sigma-(1-\mu_{m1}))][\beta_{m0}\sigma_{nm} + \beta_{x0}\sigma_{nx} + \beta_{n0}\gamma\sigma]$

$+ \beta_{m1}(1-\gamma)\beta_{n0}\gamma\sigma[\sigma-(1-\mu_{m1})]\}\hat{p}_{m1}$

where $\Delta = [\beta_{m0}\sigma_{nm}+\beta_{x0}\sigma_{nx}][\beta_{m1}\sigma_{nm}+\beta_{x1}\sigma_{nx}+\beta_{n1}(1-\gamma)\sigma]+\beta_{n0}\gamma\sigma[\beta_{m1}\sigma_{nm}+\beta_{x1}\sigma_{nx}] \geq 0$

Equations (19) and (22) correspond to the coefficients of $\hat{p}_{m0}$ and $\hat{p}_{m1}$ in (A-14). To determine the effects of permanent shocks, set $\hat{p}_{m0} = \hat{p}_{m1} = \hat{p}_m$ in (A-14). Equation (A-15) is used to determine the effect of terms of trade changes on the relative price of home goods in period one.

Substitution of the relevant terms in equations (A-14) and (A-15) into equations (26), (27) and (28) underlies the main derivations in Section IV of the paper.

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