Journal of International Economic
Integration 7(1), Spring 1992, 58—79

# The Terms of Trade, Investment, and the Current Account*

**Robert G. Murphy**
*Boston College*

***Abstract***

*This paper develops an optimizing model of a small open economy to study the adjustment of investment, saving, and the current account to a deterioration in the terms of trade. The analysis highlights the role of the real exchange rate as a channel through which changes in the terms of trade are transmitted to the rest of the economy. The results indicate that the response of investment and the current account to a permanent change in the terms of trade depends importantly on the relative strengths of income and substitution effects in determining household demand for non-traded goods. Furthermore, the paper finds that a temporary deterioration in the terms of trade is always associated with a current account deficit and capital accumulation in the long run, although the current account and investment may rise or fall in the short run.*

## I. Introduction

Sharp swings in the external terms of trade for many developing countries over the past two decades have generated renewed interest in studying how changes in the terms of trade affect small open economies. A central focus of this renewed interest has been the adjustment of the current account balance and, more specifi-

* An earlier version of this paper was completed while I was a visiting scholar at the Federal Reserve Bank of Boston. I wish to thank Mike Gavin and participants in seminars at Boston College and Columbia University for helpful comments on earlier drafts of this paper.

cally, the adjustment of domestic saving to a deterioration in the terms of trade. Papers by Obstfeld [1982, 1983], Svensson and Razin [1983], and Bean [1986] all use intertemporal optimizing frameworks to analyze how saving responds to a deterioration in the terms of trade. These papers have helped clarify the circumstances under which a deterioration will lower saving and worsen the current account, as originally predicted by the work of Harberger [1950] and Laursen and Metzler [1950]. In particular, the modern intertemporal approach has highlighted the important distinction between temporary and permanent changes in the terms of trade for assessing the validity of the Harberger-Laursen-Metzler prediction.

To fully understand the adjustment of the current account, however, requires the analysis of the investment decisions of firms in addition to the saving decisions of households. Recent papers by Persson and Svensson [1985], Matsuyama [1988], and Sen and Turnovsky [1989] have employed optimizing models that include investment in order to study the adjustment of the current account to exogenous changes in the terms of trade[1]. A general conclusion of these papers is that the response of investment and the current account to changes in the terms of trade depend crucially on the structure of production and the specification of the investment process.

The present paper continues this line of research by developing an intertemporal optimizing model of a small open economy to consider how investment, saving and the current account respond to a deterioration in the terms of trade. The model presented here differs from those developed by Persson and Svensson [1985] and Matsuyama [1988] and is similar to the model developed by Sen and Turnovsky [1989] in employing an infinite horizon, representative agent framework rather than the overlapping generations paradigm. As in Sen and Turnovsky [1989], we use the adjustment-cost framework of Hayashi [1982] to characterize the investment

1. Bovenberg [1988] and Brock [1988] also use optimizing neo-classical models to study capital accumulation and real exchange rate dynamics in an open economy setting. Their papers, however, analyze the effects of changes in fiscal policies, whereas the present paper highlights the response of the investment and the real exchange rate to shifts in the terms of trade. An alternative strand of the literature employs the Keynesian sticky-price assumption and investigates the optimal response of investment to changes in the terms of trade (Gavin [1992] and Nielsen [1992]). This literature differs from the fully optimizing model presented in this paper by integrating non-optimizing behavior of households and/or ad-hoc price adjustment with optimizing decisions of firms.

process. Their model, however, emphasizes the role of labor-leisure choice as the central mechanism through which an economy with one production sector adjusts to changes in the terms of trade, while our model focuses instead on the important role of non-traded goods as the key channel through which a two-sector economy adjusts.

The role of non-traded goods in adjusting to changes in the terms of trade has been investigated recently by Gavin [1990], who incorporates Mussa's [1978] mechanism of factor reallocation into an infinite horizon model of consumption and saving. The analysis presented here differs from Gavin's by allowing for aggregate capital accumulation while leaving aside issues concerning the sectoral reallocation of factor supplies. In Gavin's paper the dynamics are driven by the adjustment of the price of non-traded goods as fixed supplies of factors are reallocated across production sectors, whereas in our analysis the dynamics are determined by the adjustment of the price of non-traded goods as the aggregate capital stock itself changes over time. Accordingly, our analysis provides consideration of the response of investment as well as saving to a change in the terms of trade.

The paper is organized as follows. Section II develops the basic model and provides a graphical solution. Section III presents the results of how the economy responds to a deterioration in the terms of trade. Both a permanent change and a temporary change are analyzed. The paper concludes in section IV with a brief summary of findings and suggestions for further research.

## II. The Model[2]

We assume a small open economy producing an export good and a non-traded good. The export good is produced solely for export, while the non-traded good is both consumed domestically and used as an input in the production of capital goods. An importable good is also consumed, but not produced domestically. Since the economy is small relative to the rest of the world, residents take the relative price of the imported good in terms of the export good as given. Unlimited borrowing and lending, subject to the usual intertemporal budget constraint, is availa-

2. A variant of this paper's model is used in Murphy [1989] to investigate the effects of changes in fiscal policy on the real exchange rate and the price of equity for a small open economy.

ble to residents of the economy. Residents are assumed to exhibit perfect foresight in forming their expectations about the future.

### A. Production and Investment

Exports and non-traded goods are produced using the services of labor and installed capital with constant-returns-to-scale technologies. We assume that the export sector is capital intensive relative to the non-traded sector, and that factor intensity reversals and specialization in production never occur.[3] Labor is supplied inelastically in amount $L$ and the capital stock is fixed at each point in time but changes over time as a result of investment. Both labor and capital are assumed to be mobile across production sectors. Under the assumptions of perfect competition, profit maximization, and factor market clearing, the following supply functions for non-traded goods and exports can be derived:

$$y^N = y^N(P, K), \quad y_1^N > 0, \ y_2^N < 0 \tag{1}$$

$$y^X = y^X(P, K), \quad y_1^X < 0, \ y_2^X > 0 \tag{2}$$

where $P$ is the relative price of the non-traded good in terms of the export good (which will be referred to as the inverse of the real exchange rate), $K$ is the economy-wide capital stock, and subscripts denote partial derivatives of the respective functions. To ease the notational burden, the fixed supply of labor and time subscripts are suppressed here and throughout the paper.

The assumption that all factors of production are mobile across production sectors implies that the returns to factors are only functions of the relative price of the non-traded good. As a result, the rental rate of installed capital can be expressed as:

$$r^k = r^k(P), \quad r^k{}_1 < 0, \tag{3}$$

3. This assumption about factor intensities is sufficient to guarantee that the steady-state equilibrium of the model is a saddlepoint. Earlier work on capital accumulation in the open economy has employed nonoptimizing models in which global stability required the traded goods sector to be relatively capital intensive (see, Dornbusch [1980] and Obstfeld and Stockman [1985] for details).

where an increase in the relative price of the non-traded good will reduce the rental rate on capital since the non-traded sector is labor intensive.

Investment is carried out by firms in the capital supply industry and follows the adjustment cost specification of Hayashi [1982]. Firms in the production sectors are assumed to rent capital services from firms in the capital supply industry. To increase the capital stock by $J$ units, firms in the capital supply industry must initially purchase $J$ units of non-traded output. This non-traded output is then irreversibly transformed into capital at an installation cost that uses additional non-traded output. Assuming that this installation cost is an increasing function of the amount of capital formation relative to the existing capital stock, total investment expenditure can be expressed as:

$$PI = PJ[1+h(J/K)],\ h(0)=0,\ h'(0)=0,\ h'>0,\ h''>0, \tag{4}$$

where the function $h(\ )$ determines the cost of installation.

The representative firm in the capital supply industry is assumed to choose investment so as to maximize its market value, which is defined as the present discounted value of its dividend stream:

$$V(t)=\int_t^\infty D(s)\exp^{-r(s-t)}ds. \tag{5}$$

Dividends are equal to the difference between the firm's after-tax revenue from rentals of capital less its expenditures on investment:

$$D=r^kK-PI. \tag{6}$$

The firm maximizes equation (5) subject to the following accumulation constraint for the capital stock:

$$\dot{K}=J-\delta K, \tag{7}$$

where $\delta$ is the constant rate at which the capital stock depreciates. First order conditions for this problem yield the following set of relationships:

$$q=P[1+h(J/K)+[J/K]h'(J/K)] \tag{8}$$

$$\dot{q}=q[\delta+r]-r^{k}-P[J/K]^{2}h'(J/K). \tag{9}$$

Equation (8) sets the marginal value of installed capital equal to its marginal cost and implicitly defines the rate of capital formation ($J/K$) as an increasing function of the marginal value of capital relative to its installation cost:[4]

$$J/K=x(q/P) \qquad x'>0. \tag{10}$$

Equation (9) describes the evolution of the marginal value of installed capital over time.

As discussed in Hayashi [1982] and Summers [1981], the assumptions that output is produced with a constant-returns-to-scale technologies and that installation costs are homogeneous of degree one in $K$ and $J$ imply that the marginal value of installed capital for this economy will be equal to the average value of installed capital. In other words, the market value of an equity claim on a unit of installed capital will equal the marginal value of an additional unit of installed capital ($q$). Accordingly, the variable $q$ represents the market price of equity measured in terms of the export good.

By using equation (10) to substitute for the rate of capital formation in equations (4), (7), and (9), we obtain relationships describing the demand for investment goods, the dynamics of the capital stock, and the dynamics of the price of equity as functions of $q$, $P$, and $K$:

$$I=[1+h(x(q/P))]x(q/P)K=I(q/P,\ K) \tag{11}$$

$$\dot{K}=K[x(q/P)-\delta]=\theta(q/P,\ K) \tag{12}$$

$$\dot{q}=[r+\delta]q-r^{k}(P)-P[x(q/P)]^{2}h'(x(q/P))=\phi(q,\ P) \tag{13}$$

where the partial derivatives of the functions are given as:

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4. At the steady-state equilibrium, the rate of gross capital formation equals the rate of depreciation ($x=\delta$) so that the capital stock is constant. Since we consider adjustment in the neighborhood of the steady-state equilibrium, the rate of gross investment will always be positive, implying that $q$ is always greater than zero.

$$I_1=[q/P]Kx'>0 \qquad \theta_2=[x-\delta]=\ ?$$

$$I_2=[1+h]x>0 \qquad \phi_1=[r+\delta-x]=\ ?$$

$$\theta_1=Kx'>0 \qquad \phi_2=-r^{k'}+xh>0.$$

The two derivatives with uncertain signs ($\theta_2$ and $\phi_1$) will be determinate at the steady-state equilibrium for the model where the rate of capital accumulation equals the rate of depreciation. For a given path of the relative price of the non-traded good, these equations determine how investment, the capital stock, and the price of equity evolve through time.

### *B. Consumption*

The infinitely lived representative household chooses consumption of the non-traded good and the imported good so as to maximize the discounted sum of instantaneous utility:

$$U=\int_t^{\infty} u(c^N(s), c^M(s))\exp^{-\gamma(s-t)}ds, \tag{14}$$

where $\gamma$ is the constant rate of time preference. Equation (14) is maximized subject to an accumulation constraint that sets the change in household bond holdings equal to the excess of income over consumption expenditure:

$$\dot{B}=rB+[D+wL]/P^*-[P/P^*]c^N-c^M, \tag{15}$$

where income consists of interest earnings on bond holdings ($rB$), dividend payments on equity holdings ($D$), and labor income ($wL$).[5] Bonds are denominated in terms of the imported good since we assume that external borrowing and lending

5. The household also receives income in the form of capital gains on equity. Since the number of equity shares is assumed constant and is normalized to unity for convenience, the capital gain exactly equals the increase in the value of equity holdings. As a result, identical capital gain terms would appear on both sides of the accumulation equation for household wealth and would cancel each other, yielding equation (15).

are measured in units of the imported good. This is the case for many developing countries where the currency of invoice for imports and the currency of denomination for external debt is typically the U.S. dollar.

The first-order conditions for the household's problem can be solved to yield the following demand functions for consumption goods:

$$c^N = c^N(P/P^*,\ \lambda), \qquad c_1^N < 0,\ c_2^N < 0, \tag{16}$$

$$c^M = c^M(P/P^*,\ \lambda), \qquad c_1^M = ?,\ c_2^M < 0, \tag{17}$$

where $\lambda$ is the shadow value of wealth. The derivative of the demand function for the imported good with respect to its relative price is in general ambiguous in sign, reflecting opposing intratemporal and intertemporal substitution effects.[6] An additional necessary condition for the household's problem is the Euler relationship describing the evolution of $\lambda$:

$$\dot{\lambda} = \lambda[\gamma - r], \tag{18}$$

where $\gamma$ is the rate of time preference and $r$ is the world interest rate at which households can freely borrow and lend. Note that with a constant world interest rate and a constant rate of time preference, the condition $\gamma = r$ is necessary to ensure the existence of a steady state with a non-zero but finite level of consumption. This condition requires that the shadow value of wealth adjust instantly to its optimal steady-state level following changes in the terms of trade.

### *C. Equilibrium*

Equilibrium in the economy occurs when the market for the non-traded good

6. For a given shadow value of wealth ($\lambda$) the effect of an increase in the current period relative price of home goods on the demand for importables is, in general, ambiguous. The effect depends on the sign of the cross-partial derivative of the instantaneous utility function, $u_{12}$. This ambiguity reflects the conflicting effects of intertemporal substitution and intratemporal substitution on the demand for importables. As increase in the price of home goods induces substitution in the current period toward importables, but it also raises the consumer price index relative to the future and induces a reduction in overall consumption.

clears. This condition must hold at each point in time and determines the equilibrium path for the relative price of the non-traded good:

$$y^N(P,\ K) = I(q/P,\ K) + c^N(P/P^*,\ \lambda). \tag{19}$$

Solving for the relative price of the non-traded good yields:

$$P = \vartheta(q,\ K,\ \lambda,\ P^*),\ \ \vartheta_1 > 0,\ \ \vartheta_2 > 0,\ \ \vartheta_3 < 0,\ \ \vartheta_4 > 0, \tag{20}$$

where the signs of the partial derivatives follow from equations (1), (11), and (16).

### D. Solution of the Model

By using equation (20) to substitute for the relative price of the non-traded good in equations (12) and (13), we obtain two relationships describing the evolution of the price of equity and the capital stock as functions of $q$, $K$, $\lambda$ and $P^*$:

$$\dot{q} = H(q,\ K,\ \lambda,\ P^*) \tag{21}$$

$$\dot{K} = F(q,\ K,\ \lambda,\ P^*) \tag{22}$$

To solve the model, these equations are linearized around the point where $\dot{q} = 0$ and $\dot{K} = 0$ to obtain:

$$\begin{bmatrix} \dot{q} \\ \dot{K} \end{bmatrix} = \begin{bmatrix} H_1 & H_2 \\ F_1 & F_2 \end{bmatrix} \begin{bmatrix} q - \bar{q} \\ K - \bar{K} \end{bmatrix} \tag{23}$$

where the derivatives, evaluated at their steady-state values, are given as:

$$H_1 = \phi_1 + \phi_2\vartheta_1 > 0 \qquad F_1 = \theta_1[\bar{P} - \bar{q}\vartheta_1]/\bar{P}^2 > 0$$

$$H_2 = \phi_2\vartheta_2 > 0 \qquad F_2 = [\theta_2 - \theta_1\bar{q}\vartheta_2]/\bar{P}^2 < 0$$

and a *bar* over a variable denotes steady-state values. In deriving equation (23), we have made use of the fact that the shadow value of wealth is constant at its optimal steady-state value for a given relative price of imports.

The determinant of the transition matrix for the system of differential equations given by equation (23) is equal to $[H_1F_2 - H_2F_1]$, which is negative thereby ensuring that the equilibrium where $\dot{q}=0$ and $\dot{K}=0$ is a saddlepoint. For a constant price of the imported good, the solution for $q$ and $K$ along the stable trajectory is given in general form as:

$$[q-\bar{q}]=[\omega_1/\omega_2]\exp^{\mu t}[K_0-\bar{K}] \tag{24}$$

$$[K-\bar{K}]=\exp^{\mu t}[K_0-\bar{K}], \tag{25}$$

where $[K_0-\bar{K}]$ is the deviation of the initial value of $K$ from its steadystate level, $\mu$ is the stable (negative) eigenvalue of the transition matrix, and the $\omega_i$ are the elements of the eigenvector associated with $\mu$. By using equations (24) and (25), the relationship between $q$ and $K$ along the stable adjustment path can be expressed as:

$$[q-\bar{q}]=[\omega_1/\omega_2]\ [K-\bar{K}], \tag{26}$$

where $[\omega_1/\omega_2] = -H_2/[H_1-\mu] < 0$. As a result, the price of equity and the capital stock will move in opposite directions along the stable adjustment path.

To determine how the relative price of the non-traded good evolves over time, we first linearize equation (20) around the steady state and then substitute for $[q-\bar{q}]$ using equation (26) to obtain:

$$[P-\bar{P}]=\{\vartheta_1[\omega_1/\omega_2]+\vartheta_2\}[K-\bar{K}]. \tag{27}$$

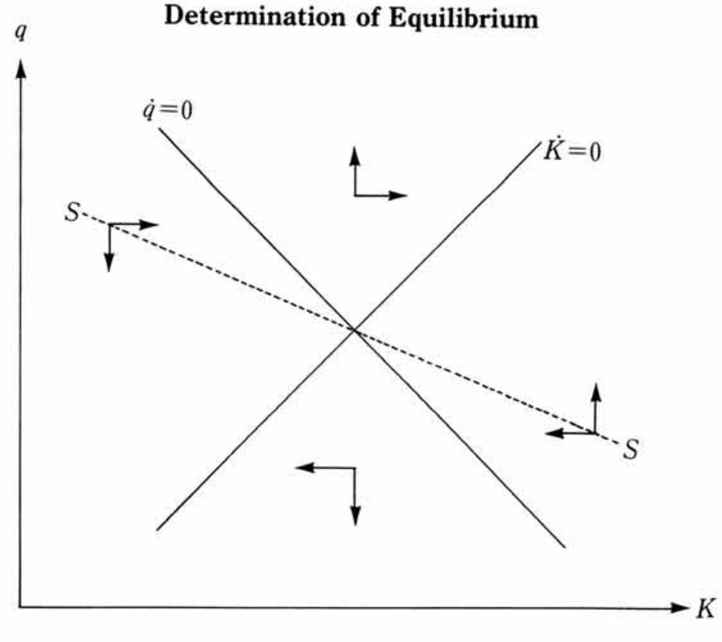
By using the definition of $[\omega_1/\omega_2]$, the term in brackets can be rewritten as:

$$\vartheta_2\{[r-\mu]/[r+\phi_2\vartheta_1-\mu]\}>0 \tag{28}$$

This term is always positive since $\vartheta_1$, $\vartheta_2$, $\phi_1$, $\phi_2$, and $r$ are positive while $\mu$ is negative, implying that the relative price of the non-traded good and the capital stock will move in the same direction along the stable adjustment path. Hence, the model predicts real appreciation accompanying capital accumulation as the economy adjusts toward long-run equilibrium.

A graphical solution of the model is presented in Diagram 1 where the steady-state values of $q$ and $K$ are given by the intersection of the $\dot{q}=0$ schedule with the $\dot{K}=0$ schedule. The $\dot{q}=0$ schedule is downward sloping because an increase in $K$ (accounting for effects on the relative price of the non-traded good) lowers the return to capital (and thus dividends), thereby requiring a fall in the price of equity so that the yield on equity with zero expected capital gains equals the world real interest rate. The $\dot{K}=0$ schedule is upward sloping because an increase in $K$ induces a rise in the price of the non-traded good (through effects on the non-traded goods market), which raises the cost of investment and requires an increase in $q$ to keep investment from falling. As shown in Diagram 1, the stable adjustment path ($SS$), described by equation (26), is downward sloping and follows from the pattern of adjustment for points off of the $\dot{q}=0$ and $\dot{K}=0$ schedules.

**Diagram 1**
**Determination of Equilibrium**




### *E. Adjustment of the Current Account Balance Along a Stable Saddlepath*

To determine the response of the current account along the stable adjustment path, we first express the current account as the excess of domestic income over domestic spending:

$$
\begin{aligned}
P^* \dot{b} = {} & rP^* b + Py^N(P, K) + y^X(P, K) - PI(q/P, K) \\
& - Pc^N(P/P^*, \lambda) - P^* c^M(P/P^*, \lambda)
\end{aligned} \tag{29}
$$

where we are measuring the current account balance in terms of the export good. By linearizing this equation around the steady-state values of the variables and noting that $P^*$ and $\lambda$ are constant along the stable adjustment path, we obtain:

$$
\begin{aligned}
P^* \dot{b} = {} & rP^*[b - \bar{b}] + \{[q/P]I_1 - Pc_1^N - P^* c_1^M\}[P - \bar{P}] \\
& + \{Py_2^N + y_2^X - PI_2\}[K - \bar{K}] - I_1[q - \bar{q}]
\end{aligned} \tag{30}
$$

where all expressions are evaluated at steady-state values of the variables. In deriving equation (30), the market clearing condition for the nontraded good (equation 19) has been used to eliminate certain terms and the envelope condition for production has been used to set $[Py_1^N + y_1^X] = 0$.

By using equations (26) and (27) to substitute for $[q - \bar{q}]$ and $[P - \bar{P}]$, equation (30) can be rewritten as:

$$
\begin{aligned}
P^* \dot{b} = {} & rP^*[b - \bar{b}] + [\sigma\{[q/P]I_1 - [Pc_1^N + P^* c_1^M\} + Py_2^N + y_2^X \\
& - PI_2 - \varphi I_1][K - \bar{K}]
\end{aligned} \tag{31}
$$

where $\sigma = \{\vartheta_1[\omega_1/\omega_2] + \vartheta_2\} > 0$ and $\varphi = [\omega_1/\omega_2] < 0$. The second term in equation (31) captures the total effect on the trade account resulting from an increase in the capital stock. The sign of this term is positive in the neighborhood of the steady-state equilibrium.[7]

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7. To see this, first note that the adjustment of consumption spending $[Pc_1^N + P^* c_1^M]$ will be negative under the assumption (which is maintained here) that both consumption goods are normal goods. Next, note that the direct effect of a change in $K$ on output net of investment can be reexpressed as $Py_2^N + y_2^X - PI_2 = r^k - P[1 + h(\delta)]\delta$, where we have used the definitions of derivatives given above evaluated at their steady-state values. From equations (8) and (9), though, $r^k$ is equal to $P\{[1 + h(\delta)]\delta + r[1 + h(\delta) + \delta h'(\delta)]\}$ at the steady-state equilibrium. Accordingly, since $r[1 + h(\delta) + \delta h'(\delta)]$ is strictly positive, $r^k$ must exceed $P[1 + h(\delta)]\delta$. This implies that the sign of $[Py_2^N + y_2^X - PI_2]$ is positive. Finally, as discussed earlier, $I_1 > 0$, $\sigma > 0$, and $\varphi < 0$. This ensures that the total effect on the trade account resulting from an increase in the capital stock will be positive.

To obtain the relationship between $K$ and $b$ along the stable path, first substitute for $[K\text{-}\bar{K}]$ in equation (31) using equation (25) and integrate to yield the following expression:

$$P^*[b-\bar{b}]=\Omega[K_0-\bar{K}]\exp^{[\mu t]}+\{P^*[b_0-\bar{b}]-\Omega[K_0-\bar{K}]\exp^{[rt]} \quad (32)$$

where $\Omega=[\sigma\{[q/P]I_1-[Pc_1^N+P^*c_1^M]\}+Py_2^N+y_2^X-PI_2-\varphi I_1]/[\mu-r]<0$ and, as before, and $[K_o\text{-}\bar{K}]$ and $[b_o\text{-}\bar{b}]$ denote deviations of the initial values of the capital stock and bonds from their steady state levels. The assumption that the transversality condition holds (i. e., $\lim_{t\to\infty} \lambda b\exp^{[-rt]}=0$) so that household can not borrow forever to repay past debts, ensures that the second term in equation (3) is equal to zero.[8] As a result, equation (32) can be rewritten as:

$$\begin{aligned} P^*[b-\bar{b}] &= \Omega[K-\bar{K}]\exp^{[rt]} \\ &= \dot{\Omega}[K-\bar{K}] \end{aligned} \quad (33)$$

indicating a negative relationship between $K$ and $b$ along the stable adjustment path. When $K$ is less than its steady-state value along the adjustment path, $b$ must be greater than its steady-state value. Consequently, capital accumulation (decumulation) will be accompanied by a current account deficit (surplus) along the adjustment path.[9]

## III. Adjustment to Changes in the Terms of Trade

This section considers how the relative price of non-traded goods, the market price of equity, the stock of capital, and the stock of foreign bonds adjust in response to a deterioration in the terms of trade. Both permanent and temporary changes in the terms of trade are considered.

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8. To see this, multiply equation (32) by $\lambda exp^{[-rt]}$ and take limits as $t\to\infty$. The term remaining $(P^*[b_o\text{-}b] - \Omega[K_o\text{-}\bar{K}])$ must therefore always equal zero.
9. Note that adjustment of the current account along the stable path is driven by *both* an intertemporal substitution effect on consumption expenditure and the adjustment of output net of investment expenditure. As a result, the present analysis complements that of Gavin [1990] which highlights only the intertemporal substitution effect in a model without investment activity.

### *A. A Permanent Deterioration in the Terms of Trade*

An unanticipated permanent deterioration in the terms of trade (rise in $P^*$) will initially generate a substitution effect within consumption toward the non-traded good and away from the imported good that is opposed by the reduction in real income implied by a deterioration in the terms of trade. Since this is a permanent change in $P^*$, there will be no initial intertemporal substitution effect on consumption. The initial effect on the relative price of the non-traded good thus depends on whether the consumption demand for the non-traded good initially rises, falls, or remains unchanged.

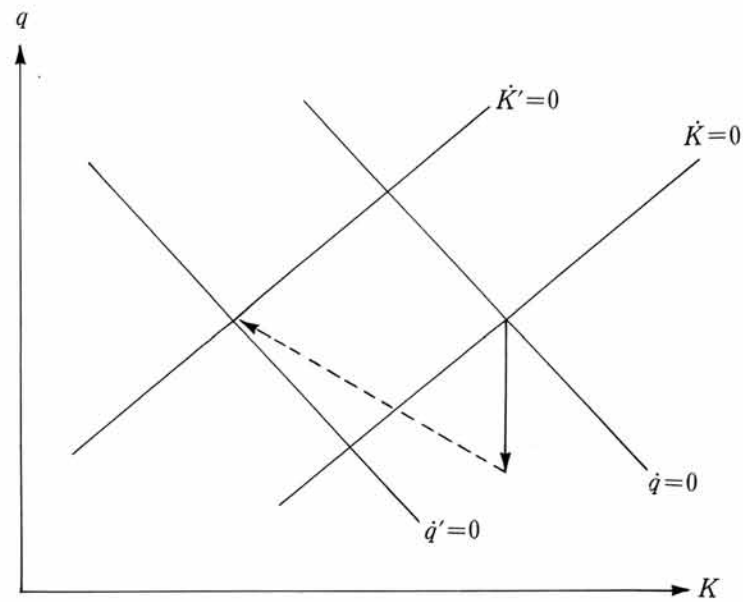
To determine the dynamics of adjustment, consider how the $\dot{q}=0$ and $\dot{K}=0$ schedules shift following a change in the relative price of imported goods. From equations (21) and (22), the horizontal shifts in these schedules are equal and given by:

$$\begin{aligned} dK/dP^* \mid_{q=q^*} &= -\vartheta_4/\vartheta_2 - [\vartheta_3/\vartheta_2]\, d\lambda/dP^* \\ &= \{-c_1^N P/P^{*2} + c_2^N [d\lambda/dP^*]\}/[y_2^N - I_2^N] \end{aligned} \tag{34}$$

where the derivative expressions are as previously described. Since the denominator of the expression is always negative (given the assumption that non-traded goods are labor intensive), the sign of $dK/dP^*|_{q=q^*}$ will depend on the term in curly brackets. This term, however, is the change in consumption demand for non-traded goods following a change in the terms of trade, accounting for the immediate adjustment of the shadow value of wealth ($\lambda$) to its new steady-state level (see equation (16)). This term is ambiguous in sign since it captures the opposing income and substitution effects of a deterioration in the terms of trade. When the substitution (income) effect dominates, this term is positive (negative). As a result, the $\dot{q}=0$ and the $\dot{K}=0$ schedules will shift to the left (right) when the substitution effect dominates (falls short of) the income effect. For the case where the two effects exactly offset each other, these schedules do not shift.

Diagram 2 illustrates the adjustment path for the economy following a permanent increase in $P^*$ for the case where the substitution effect of the deterioration in the terms of trade dominates the income effect so that the $\dot{q}=0$ and $\dot{K}=0$ schedules shift to the left. Since the capital stock is predetermined at each point in time, the immediate effect is a drop in the price of equity sufficient to place the economy on the stable path. The reason for this is that the deterioration in the terms of trade leads to an initial rise in the price of the non-traded good in order to maintain equilibrium in the market for non-tradeables. The rise in the price of the labor-intensive non-traded good, though, lowers the return to capital (via equation (3)) and thus the return to holding equity. As a consequence, the demand for equities falls, thereby resulting in an immediate drop in the market value of equity ($q$) in order to restore equilibrium in the equity market.

**Diagram 2**
**A Permanent Deterioration in the Terms of Trade: Substitution Effect Dominates Income Effect**




As noted earlier, the assumed specification of adjustment costs in the model imply that the average and marginal values of installed capital as equivalent. Accordingly, a fall in the price of equity also represents a fall in the marginal value of installed capital. Since the price of the non-traded good has risen and the marginal value of installed capital has fallen, the ratio $q/P$ clearly falls and the rate of investment spending by firms in the capital supply industry drops below the depreciation rate. The lower rate of investment then drives the dynamics as the capital stock declines and the price of equity rises along the stable path.

As shown by equation (27), the price of the non-traded good will decline toward its original level as the capital stock falls along the stable adjustment path. The price of the non-traded good must equal its original level in the new steady state because the production side of the model implies that the return to installed capital is determined exclusively by the price of the non-traded good and the steady-state return on installed capital is independent of the terms of trade. Accordingly, the new steady state is characterized by a lower capital stock and a reestablishment of the initial values of the prices of equity and non-traded goods.

The effect on the current account can be determined by using equation (33), which shows that the stock of foreign bonds will rise as the stock of capital declines along the stable path. Accordingly, the current account must move into surplus so as to generate a rising stock of bonds along the stable adjustment path.

The alternative case where the income effect dominates the substitution effect following a deterioration in the terms of trade is straightforward to analyze. In this case, the price of the non-traded good initially declines, inducing a rising capital stock and a current account deficit along the adjustment path.[10]

### *B. A Temporary Deterioration in the Terms of Trade*

A temporary deterioration in the terms of trade will generate three types of effects influencing the consumption demand for the non-traded good, and thus determining the shifts in the $\dot{q}=0$ and the $\dot{K}=0$ schedules. As with a permanent deterioration, there will be a negative effect on the demand for the nontraded good due to the reduction in real income and a positive effect arising from the tendency to shift consumption away from expensive imports and toward the cheaper non-traded good. For a temporary change, however, there will also be a third effect that operates through the desire to households to speculate on the reestablishment in the future of the original level of the terms of trade.

---

10. If the imported good were employed in the investment process, then the possibility that investment declines and the current account improves is strengthened since the cost of investment would rise directly. This is the case explored by Warner [1991] in analyzing the drop in investment for the Mexican economy during the 1980s. Warner finds that the deterioration in the terms of trade during the early 1980s raised the relative price of investment good for the Mexican economy and resulted in the subsequent decline in investment.

This last effect reflects the willingness of households to substitute consumption between the present and the future. Since households borrow and lend in terms of the imported good, a temporary terms of trade deterioration represents a decline in the consumption-based real interest rate which induces a shift in consumption away from the future and toward the present. The extent to which households take advantage of borrowing today and repaying in the future will ultimately depend on the elasticity of substitution between current and future consumption.

The income effect of a temporary deterioration in the terms of trade will cause the shadow value of wealth (λ) to jump immediately to its new higher steady-state level, reflecting the net reduction in the economy's resources. This implies from equation (34) that the final position of the $\dot{q}=0$ and $\dot{K}=0$ schedules after the terms of trade return to their initial level will be given by:

$$
\begin{aligned}
dK/dP^* \mid_{q=q^*} &= [\vartheta_3/\vartheta_2]\, d\lambda/dP^* \\
&= \{c_2^N [d\lambda/dP^*]\}/[y_2^N - I_2^N]
\end{aligned}
\tag{35}
$$

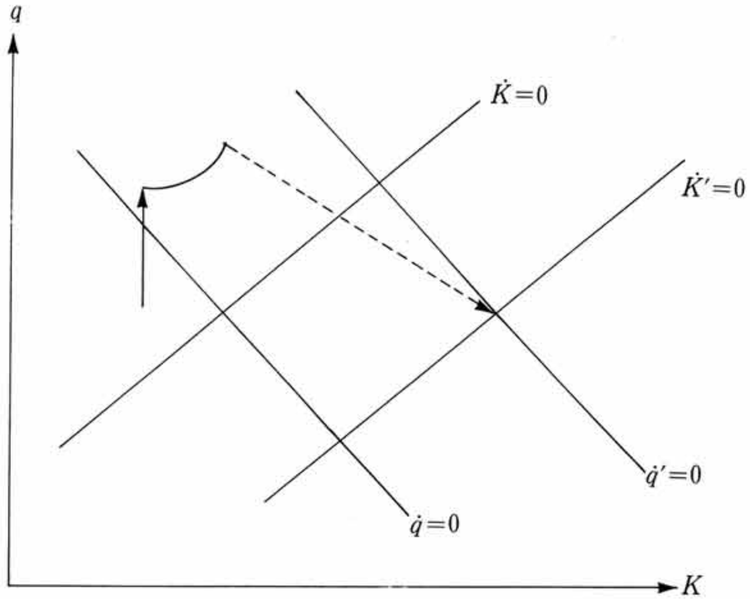
where $d\lambda/dP^*$ is the change in the shadow value of wealth following the deterioration in the terms of trade. Since $d\lambda/dP^*$ is positive (the shadow value of wealth rises following a deterioration in the terms of trade), equation (35) indicates that the final position of the $\dot{q}=0$ and $\dot{K}=0$ schedules will be to the right of the original steady-state. Hence, in the new steady-state equilibrium the capital stock will have increased relative to its initial level.

The dynamics of adjustment to the new steady-state equilibrium depend critically on whether or not the initial positive substitution effects on the demand for non-traded goods resulting from the deterioration in the terms of trade are sufficient to offset the negative income effect. Diagram 3 illustrates the two possibilities.

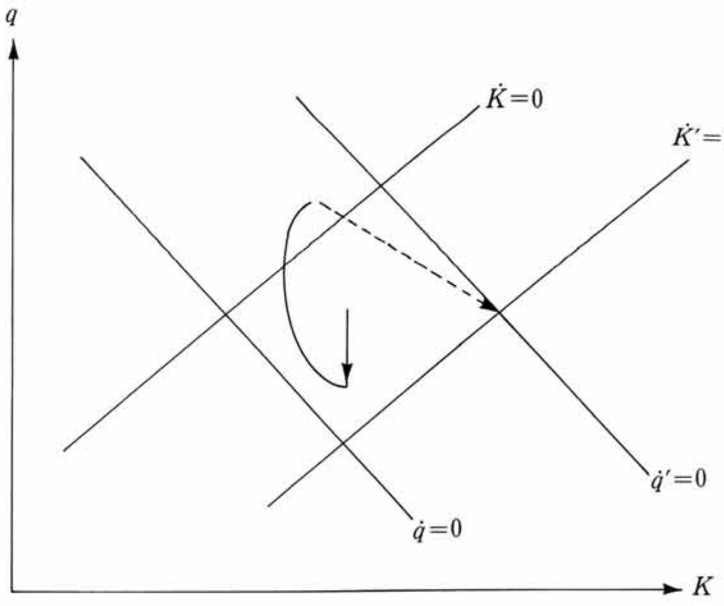
In the top panel of Diagram 3, the income effect dominates the substitution effects so that the price of non-traded goods initially falls. According to equation (34), the $\dot{q}=0$ and $\dot{K}=0$ schedules will shift to the right but by less than their final steady-state positions. As illustrated, the price of equity will rise, inducing capital accumulation along the adjustment trajectory. The price of equity rises during the period prior to the improvement in the terms of trade, and declines to its steady-state value after the terms of trade improve.

The bottom panel of Diagram 3 presents the case where the substitution effects dominate the income effect so that the price of the non-traded good initially

**Diagram 3**
**A Temporary Deterioration in the Terms of Trade**




**Panel A: Income Effect Dominates**




**Panel B: Substitution Effect Dominates**

rises. As shown, the $\dot{q}=0$ and $\dot{K}=0$ schedules will shift to the left of the initial steady state, and, obviously, to the left of the final steady state. The initial rise in the price of the labor intensive non-traded good reduces the return on equity, resulting in an initial jump downward in $q$ as asset holders attempt to shift their portfolios away from equities and toward bonds. As illustrated in Diagram 3, the drop in $q$ produces a phase of capital decumulation prior to the time at which the terms of trade improve. After the improvement, the price of equity declines as capital accumulates along the stable path.

The adjustment of the current account following a temporary deterioration in the terms of trade can be broken down into two distinct phases. During the first phase, which involves the period of time after the deterioration in the terms of trade but prior to the subsequent improvement, the adjustment of the current account will be determined by three factors. The first factor is the desire by households to smooth the loss of income due to the temporary deterioration in the terms of trade. This by itself will move the current account into deficit. The second factor is the desire of households to consume more when the price of consumption goods is low and expected to rise. During the period prior to the improvement in the terms of trade, households, whose borrowing is denominated in imported goods units, will anticipate a higher price of consumption following the improvement and will accordingly take advantage of the temporarily lower price by raising consumption.[11] This factor also tends to move the current account toward deficit. The third factor is the adjustment of the level of output net of investment, which depends on whether the capital stock is rising or falling. When the capital stock is rising, output net of investment will also be rising, so that this factor moves the current account toward deficit. As noted above the capital stock will initially rise in the case where the income effect dominates the substitution effects in determining the initial response of the demand for the non-traded good. On the other hand, when the substitution effects dominate the income effect, the capital stock will initially decline, inducing a declining level of output

11. If the economy's borrowing were denominated in terms of the export good instead of the import good, then the intertemporal substitution motive would oppose the consumption smoothing motive following a temporary deterioration in the terms of trade. For many non-oil developing countries, borrowing is typically denominated in the currency in which much of their imports are invoiced.

net of investment. In this case, the third factor opposes the first two factors, yielding an ambiguous total impact on the current account.

During the second phase of adjustment, which is the period of time following the reestablishment of the original terms of trade, the economy is once again on the stable saddlepath. Accordingly, the current account will be in surplus or deficit depending on whether the capital stock is falling or rising, as described by equation (33). From Diagram 3, it is clear that the capital stock will always be rising during the final phase of adjustment to a temporary deterioration in the terms of trade. As a result, the current account must be in deficit during the final phase of adjustment.

## IV. Summary

This paper has analyzed the important role of non-traded goods in determining macroeconomic adjustment for a small open economy experiencing a deterioration in its terms of trade. By using an intertemporal optimizing model of households and firms, we were able to distinguish between a temporary and a permanent deterioration in the terms of trade while characterizing the response of investment, the price of equity, the price of non-traded goods and the current account.

The results indicate that the adjustment of investment and ultimately the current account following a permanent deterioration in the terms of trade depends critically on the degree of intratemporal substitutability between imports and non-traded goods. In particular, when substitution effects dominate income effects, investment will decline and the current account will improve, whereas when income effects dominate, investment will rise and the current account will deteriorate. This finding complements the results of Gavin (1990) who also highlights the role of intratemporal substitution for determining current account adjustment in a model without investment.

For a temporary deterioration in the terms of trade, the initial response of the price of the non-traded good and thus investment likewise depends on whether or not substitution effects dominate income effects. Here, however, the adjustment of the current account is qualitatively the same in the long run regardless of which effects dominate in determining the initial shift in demand for the non-traded good. Furthermore, a temporary deterioration in the terms of trade always generates an increase in the steady-state capital stock. This occurs because of the need to expand the capital-intensive export sector and thus improve the trade account in order to service the increase in net external borrowing.

As with any analytical framework, this paper has emphasized certain aspects of adjustment in small open economies while ignoring additional important issues. For example, it would be useful to adapt this framework to analyze adjustment to changes in the terms of trade in the situation where the economy is unable to borrow freely on international markets. Alternatively, the model of this paper could be extended to a two-country setting in order to endogenize the terms of trade and focus on more fundamental disturbances such as productivity shocks or shifts in fiscal and commercial policies. Finally, the analysis could be easily extended to consider alternative specifications of the investment process.

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