Expanding Exports and the Structure of the Domestic Economy: A Monetary Analysis

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Abstract

This paper analyzes the dynamic adjustments of a small open economy faced with the certain prospect of a future export (resources) boom. It is shown how the adjustment occurs in three phases. First, the initial expectation generates an immediate (discrete) appreciation of the exchange rate. Secondly, prior to the export boom, the exchange rate continues to appreciate gradually, while a decumulation of bond holdings by domestic residents occurs. After the boom, the exchange rate gradually appreciates further, while the balance of trade moves into surplus and domestic residents begin to accumulate bond holdings. These adjustments are reflected in the movement of the relative price of traded to non-traded goods and the implications of this for the structural adjustment of domestic industry are discussed.
1. INTRODUCTION

The prospective resources boom in Australia is generating an extensive debate among both academic and government economists. Theoretical analyses of this issue began with Gregory (1976) who advanced the proposition that a boom in a new export sector (mining) will generate a reduction in the relative price of traded to non-traded goods, leading to a contraction in the traditional export sector (agriculture) and in the import-competing sector (manufacturing). Gregory's analysis was based on a simple partial equilibrium approach and since then several authors have been examining the robustness of these propositions. For example, Snape (1977) uses a general equilibrium model and shows that while an export boom will cause the relative price of traded goods to fall, not all of the other conclusions drawn by Gregory need hold. More recently, Long (1981) stresses how assumptions regarding relative factor intensities and the degree of factor mobility are important considerations in establishing the validity or otherwise of these propositions.1

These analyses focus exclusively on the real aspects of the boom and can therefore be viewed as representing long-run equilibrium adjustments. They abstract from capital flows, as well as the monetary and exchange rate effects, which are much more critical during the transitional adjustments to such a structural change. These aspects are addressed in the present paper.2

Specifically, we shall develop a macroeconomic model which draws upon the recent asset market approach to exchange rate determination. As its name suggests, this approach emphasizes the role of financial markets, and in particular exchange rate expectations, in the determination of the exchange rate. We shall demonstrate how through this mechanism the anticipation of an export boom at some time in the future generates immediate effects on the exchange rate and capital flows, giving rise to an immediate speculative capital boom. Particular attention is devoted to the dynamic time path of the economy generated by the expectation of an export boom and its transition to the new equilibrium. We should emphasize that while our interest in this problem has been motivated by the current debate
surrounding Australia's impending resources boom, the analysis is of much more general significance. The problem of structural adjustments facing Britain following the discovery of North Sea oil is precisely analogous to the current Australian resources boom. And further examples abound.

The paper proceeds as follows. Section 2 outlines the basic model. Key elements of this include capital flows and exchange rate expectations, which we assume to satisfy perfect myopic foresight. Because the dynamic behaviour of this system depends upon its steady-state properties, these are analyzed first, in Section 3. An analytical expression for the dynamic time path of exchange rates and the accumulation of bonds is given in Section 4. Section 5 analyzes the effects of an export boom and focuses on two cases. The first is where the boom occurs immediately and is therefore unanticipated. The second is where it is expected to occur at some date in the future, so that by the time it actually takes place it has been fully anticipated. Section 6 discusses the implications of the export boom for domestic industry. The following section introduces some alternative exchange market, monetary, and fiscal policies aimed at offsetting certain aspects of the boom, while the main conclusions are summarized in Section 8.

2. THE FRAMEWORK

We assume that the ratio of import prices to export prices remain fixed, so that import goods and export goods may be aggregated into a single traded commodity. We consider a small open economy which produces and consumes this composite good, together with a non-traded commodity. The only domestic factor of production is labour which is fully employed. Two financial assets are held in the portfolios of the domestic private sector; domestic money and a single traded bond denominated in foreign currency. This bond may be issued either by the domestic government, or by foreigners. The assumption that the domestic government denominates its bond in foreign currency is made
3.

purely for simplicity and is of no consequence. If, instead, it chooses to issue its bond in domestic currency, then provided that the two assets are perfect substitutes on an uncovered basis, our analysis is unchanged. Finally, we shall assume that the domestic monetary authority abstains from intervention in the foreign exchange market, so that the exchange rate is perfectly flexible. The relationships comprising the model consist of

\[ N\left(\frac{E}{P}, W\right) + G_N = 0 \quad , \quad N_1 > 0, \; N_2 > 0 \] (1a)

\[ C = p^\delta E^{1-\delta} \] (1b)

\[ \frac{M}{C} = L(r, W) \quad , \quad L_1 < 0, \; 0 < L_2 < 1 \] (1c)

\[ W = \frac{M + EB}{C} \] (1d)

\[ r = r^* + \varepsilon \] (1e)

\[ \varepsilon = \dot{E}/E \] (1f)

\[ \dot{M} + \dot{AE} = PC_N + r^*AE - T \] (1g)

\[ X - I + r^*(B-A) + \dot{A} - \dot{B} = 0 \] (1h)

where

- \( E \) = current exchange rate, expressed in units of the domestic currency per unit of foreign currency,
- \( P \) = price of domestic output, expressed in terms of domestic currency,
- \( C \) = domestic cost of living, expressed in terms of domestic currency,
- \( M \) = total domestic money supply, measured in domestic currency,
- \( B \) = nominal stock of traded bonds (denominated in foreign currency) held by domestic private residents,
- \( A \) = nominal stock of traded bonds (denominated in foreign currency) issued by domestic government and held by other than the domestic central bank,
- \( W \) = real private domestic wealth,
4.

\( r = \) opportunity cost of holding money,
\( r^* = \) foreign nominal rate of interest, taken to be exogenous,
\( \varepsilon = \) expected rate of exchange depreciation,
\( G_N = \) real domestic government expenditure on the non-traded good,
\( T = \) nominal tax receipts of domestic government,
\( X = \) real volume of domestic exports,
\( I = \) real volume of imports by domestic economy.

This model is fairly characteristic of modern monetary models analyzing exchange rate determination; see e.g. Boyer (1978), Branson (1979), Dornbusch and Fischer (1980), Turnovsky (1981). It consists of a series of short-run equilibrium relationships, which are embedded in a dynamically evolving system. Equation (1a) describes equilibrium in the non-traded goods market. Private excess demand \( N \), depends positively upon both the relative price of the traded good and real private wealth. The relative price is denoted by \( E/P \) and assumes that by choice of units the nominal price of the traded good abroad is unity. For simplicity, we assume that the demands for both the non-traded and traded good are independent of real income. Therefore, the changes in real income generated by the resources boom all go into savings, which is residually determined. While this assumption is obviously restrictive, it turns out to do little injustice to the analysis. Income effects basically do little but muddy the waters and in the Appendix we briefly sketch what happens when they are allowed to affect these demand functions as well.

The domestic cost of living is defined in (1b) as being a geometrically weighted average of the price of the non-traded and the domestic price of the traded good. While this form is chosen mainly for convenience, it does have some theoretical merit. It is the "true" cost-of-living index if the domestic residents' utility function, defined with non-traded and traded goods as arguments, is Cobb-Douglas.
5.

Domestic money market equilibrium is specified by (1c) and is standard. The demand for money varies inversely with the opportunity cost of holding money, defined by (1e), and positively with domestic private wealth, the latter variable being defined in (1d).

The expected rate of exchange depreciation $e$ is assumed to satisfy perfect myopic foresight. Formally, this condition, described by (1f) requires the instantaneous expected rate of exchange depreciation to equal the actual rate of exchange depreciation. This condition shall be required to hold at all points where the exchange rate is moving continuously. It shall not be required to hold at points where the system is subject to a previously unforseen shock (such as the announcement of a resources boom), when, as we shall see below, the exchange rate $E$ is required to undergo a discrete jump, so that $E/E$ becomes infinite. Since, by their very nature such shocks are unanticipated events, this interpretation of perfect myopic foresight seems appropriate.

The final two equations describe the dynamic adjustments in the economy. Equation (1g) describes the government budget constraint. We shall assume that the government restricts its expenditure to the non-traded good. The budget deficit, which comprises government expenditure on this good, plus interest payments on domestic government interest-bearing debt less tax receipts, must be financed either by printing money or by issuing interest-bearing debt. The condition that with a perfectly flexible exchange rate the balance of payments is in equilibrium is specified by (1h). It asserts that the balance of trade plus net interest earnings, which together make up the balance of payments on current account, plus the net rate of capital inflow (the balance on capital account) must sum to zero, so that the stock of foreign reserves held by the domestic central bank remains fixed.

The dynamic evolution of the economy depends upon the assumptions made about government fiscal and monetary policy. We shall make assumptions
which as far as possible preserve simplicity. First, we shall treat $G_N$ as an exogenously set policy parameter. Secondly, we shall assume that taxes are specified by

$$T = P G_N + r^* E B$$

i.e. total taxes are set to cover government expenditure while interest earnings on domestic residents' bond holdings are assumed to be taxed away. This last assumption is invoked purely for convenience and could easily be relaxed, without changing the analysis significantly. Thirdly, we shall assume $M = 0$, so that the money supply is fixed at $\bar{M}$. Thus to the extent that the tax receipts do not cover expenditure, the government deficit is bond-financed. With these chosen assumptions, the dynamic equations (1g), (1h) become

$$\dot{A} = r^*(A - B) \quad (1g')$$

$$\dot{B} = X - I \quad (1h')$$

To complete the model, we must specify imports and exports. The former is described by

$$I = I(E/P, W) \quad I_1 < 0, I_2 > 0 \quad (3a)$$

which is of the same form as $N(.)$, except that the relative price effect is reversed. Given that the domestic economy is small, exports are determined by the supply function

$$X = X_0 + X(E/P) \quad X' > 0 \quad (3b)$$

This consists of two components. The emergence of the new booming export sector is parameterized by an increase $dX_0$ in the exogenous component. The second, the price responsive component, represents the traditional export sector, which in the case of Australia can be treated as agriculture.

This description of the export boom in terms of the shift parameter $dX_0$ is identical to the approach originally adopted by Gregory
(1976) and is of course a gross simplification of the process. It means that the resource boom is an exogenous phenomenon, like "manna from heaven". It is easy to relate the shift parameter $dX_0$ to an outward shift in the underlying production possibility curve as in Snape (1977) or to an underlying parameter describing technological progress which in turn leads to an (exogenous) outward shift in the production function of the booming industry; see Long (1981).

We may combine equations (1) - (3) to reduce the dimensionality of the model. To do this it is convenient to define the relative price

$$\sigma \equiv \frac{E}{P}$$

enabling us to describe the economy by

$$N(\sigma, W) + G_N = 0 \quad (4a)$$
$$\frac{\dot{N}}{E} = L(r, W) \quad (4b)$$
$$W = (\frac{\dot{N}}{E} + B)\sigma^\delta \quad (4c)$$
$$\dot{E} = E(r - r^*) \quad (4d)$$
$$\dot{B} = X_0 + X(\sigma) - I(\sigma, W) \quad (4e)$$

The evolution of the system is now clear. Except at points where the exchange rate $E$ undergoes discrete jumps, $E$ is continuous. Equations (4a) - (4c) thus determine instantaneous equilibrium solutions for the three variables $\sigma$, $W$, $r$, in terms of $E$ and $B$. Substituting these solutions into (4d) and (4e), the dynamic adjustment of the system is determined. Note that the evolution of $A$ is irrelevant. With perfect capital mobility, the domestic government can issue bonds indefinitely, which the rest of the world is willing to absorb.

3. **STEADY STATE EQUILIBRIUM**

Steady state equilibrium is attained when $\dot{E} = \dot{B} = 0$. Denoting the steady state by bars, we have
\begin{align}
N(\tilde{\sigma}, \tilde{W}) + G_N &= 0 \quad (5a) \\
\frac{\tilde{M}}{\tilde{E}} \delta &= L(r^*, \tilde{W}) \quad (5b) \\
\tilde{W} &= \left( \frac{\tilde{M}}{\tilde{E}} + \tilde{B} \right) \delta \quad (5c) \\
X_o + X(\tilde{\sigma}) - I(\tilde{\sigma}, \tilde{W}) &= 0 \quad (5d)
\end{align}

which determine the equilibrium values of \( \tilde{\sigma}, \tilde{W}, \tilde{E} \) and \( \tilde{B} \). The long-run domestic interest rate is just the world rate \( r^* \). It is apparent from an inspection of (5) that the long-run equilibrium has a simple recursive structure. The real variables \( \tilde{\sigma}, \tilde{W} \), are determined simultaneously by the non-traded goods market equilibrium condition, \( 5a \), together with the zero balance of trade condition \( 5e \). Given \( \tilde{W}, \tilde{\sigma} \), money market equilibrium determines the real quantity of money \( \tilde{M}/\tilde{E} \) and hence the long-run equilibrium exchange rate. The real stock of bonds \( \tilde{B} \) is then derived from the definition of wealth, \( 5c \).

Table 1 summarizes the long-run effects of various exogenous changes. To simplify these expressions, we assume that units are chosen so that at the initial equilibrium \( \tilde{E} = \tilde{\sigma} = 1 \). In column 1 we present the issue of prime concern, namely the effects of an export boom, as parameterized by an increase in the exogenous component of exports, \( X_o \). Columns 2 and 3 describe the effects of policy instruments, which may be used to offset the effects of an increase in \( X_o \). Column 2 describes the effects of an exogenous expansion in the money supply. The third column gives the effects of a fiscal expansion, taking the form of an increase in government expenditure on non-traded goods.

Turning to a more specific consideration of the results, we see from \( 5e \) that an increase in \( X_o \) must lead either to a fall in the relative price \( \tilde{\sigma} \), or a rise in real wealth \( \tilde{W} \), or both, in order for the appropriate offsetting fall in net exports, required to maintain balance of trade equilibrium, to take place. In fact, both \( \tilde{\sigma} \) and \( \tilde{W} \) must adjust as
indicated, for otherwise the non-traded goods market would be thrown into disequilibrium. This fall in \( \sigma \) causes the exports of the traditional export section \( (X(\sigma)) \) to fall. At the same time, the fall in \( \sigma \), together with the rise in wealth, leads to an increase in imports, and therefore to a contraction in the domestic import-competing sector. Moreover, assuming that the output of the non-traded goods sector varies inversely with \( \sigma \), this industry will be stimulated by the fall in the relative price \( \sigma \), generated by the export boom. The real effects of the export boom, suggested by Gregory, therefore hold in the steady state of the present analysis, although they depend critically upon the role of wealth effects, particularly in the excess demand function for non-traded goods. If \( N \) is independent of wealth, then \( \sigma \), the key relative price in determining the resource allocation in the domestic economy, depends solely upon \( G_N \) and is independent of \( X_0 \).

The rise in \( W \) means that the real stock of money (in terms of domestic cost of living units), \( M\delta /E \) is increased, although not by as much as the increase in real wealth. Consequently, there is an increase in the real stock of bonds held by domestic residents, those being accumulated during the transitional balance of trade surpluses stemming from the export boom. With \( \sigma \) falling, the real money stock \( M/E \) increases further, and since \( M \) is fixed, this means that \( E \) must fall. The export boom therefore leads to a long-run appreciation of the domestic exchange rate.

The effect of the expansion in exports on the price of domestic output is given by

\[
\frac{d\bar{P}}{dX_0} = \frac{N_2\bar{M}(1-\delta) - N_1L_2}{\bar{M}\Delta}
\]

where the initial choice of units \( \bar{E} = \sigma = 1 \), should be recalled. Thus whether the fall in the relative price \( \sigma \) occurs primarily through the appreciation of the exchange rate or through an increase in the price of
domestic output depends upon a variety of factors. In particular, \( \bar{P} \) may rise or fall, depending upon the magnitudes of the relative wealth effects in the money demand and in the non-traded goods demand functions.

In order to offset any undesired effects the export boom may impose on the rest of the economy, the domestic government may introduce some appropriate compensating policy. It is clear from the structure of the equilibrium, and also from column 2 of Table 1, that any monetary policy can in the long run affect only the monetary variables and will be totally incapable of offsetting any long-run real resource effects stemming from the export boom. Thus, for example, a monetary expansion of

\[
\frac{dM}{\Delta} = \frac{[N_1L_2 + N_2\delta\bar{M}]}{dX_o}
\]

will exactly offset the appreciation of the exchange rate resulting from the resources boom, thus leaving \( \bar{E} \) unchanged.

Real long-run effects can be achieved by some sort of fiscal policy. A decrease in government expenditure on the non-traded good \( G_N \) will raise \( \bar{G}, \bar{W} \). This offsets the decline in output of the traditional export sector, generated by the new export boom. But imports increase further and so the decline in the import-competing industry is exacerbated. Furthermore, the increase in \( \bar{G} \) will reduce activity in the non-traded good sector. The appropriate policy for \( G_N \) depends upon what the government's policy objectives are with respect to structural adjustment within the economy. Also, other real policies involving tariff adjustments will presumably be required to help attain all such objectives, but these are not considered in the paper.

4. TRANSITIONAL DYNAMICS

To investigate the dynamic adjustment of the economy in response to any exogenous disturbance inevitably involves a certain amount of technical detail. In this section, we merely outline the procedure adopted, with the formal details being given in Appendix B.
We begin, by assuming that the system is initially in the steady state equilibrium defined by (5) and linearize equations (4) about that point. To do this, we first express the deviations in $c$, $w$, and $r$ in terms of the deviations in $E$ and $B$ and then substitute these quantities into the linearized versions of the two differential equations. This leads to linearized differential equations in $E$ and $B$ of the form

$$\begin{pmatrix} \dot{E} \\ \dot{B} \end{pmatrix} = \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix} \begin{pmatrix} E - \bar{E} \\ B - \bar{B} \end{pmatrix} + \begin{pmatrix} b_{11} & 0 \\ b_{21} & 1 \end{pmatrix} \begin{pmatrix} dG_N \\ dX_0 \end{pmatrix}$$

(6)

where the elements $a_{11} > 0$, $a_{12} > 0$, $a_{21} > 0$, $a_{22} < 0$, $b_{11} < 0$, $b_{21} < 0$ are defined in the Appendix and $dG_N$ represents an exogenous increase in $G_N$.

The qualitative nature of the solution, and therefore the dynamic response of the economy, depends upon the characteristic roots of this system. As noted in the Appendix, the two roots, $\lambda_1$, $\lambda_2$, say, are real with $\lambda_1 < 0$, $\lambda_2 > 0$. The system therefore exhibits saddle-point instability.\(^{11}\)

The general solution to the system is obtained by integrating (6). We do this under the specific assumption that at an initial time $t = 0$, say, it becomes known with certainty that some exogenous disturbance is to take place at time $T$, the effect of which is to shift the steady state from its initial values $\bar{E}$, $\bar{E}$ to $\bar{E} = \bar{E} + dE$, $\bar{B} = \bar{B} + dB$, respectively. We assume that the information comes about through the form of an announcement although it may presumably be obtained in other ways. We shall refer to time $t = 0$ as the "announcement date." In general $T > 0$, in which case the change is fully anticipated by the time it occurs. But we may also have $T = 0$, in which case it is unanticipated at the time it takes place. The disturbance we shall focus our attention on is the export boom, although this may be accompanied by some policy change.

The fact that one of the roots is unstable means that if the system is constrained to evolve continuously from its initial state, it will eventually diverge. The rational expectations approach to eliminating this instability is to allow the system to undergo an appropriate endogenous jump, which will enable it to remain on a stable adjustment path (the stable arm of the saddle point).
This jump occurs most naturally at the announcement date, when new information impinges on the economy. Some formal justification for this procedure may be given by appealing to transversality conditions for appropriate optimizing models which, provided the underlying utility function satisfies suitable restrictions, impose stability on the system.\textsuperscript{12}

We assume that the accumulation of bonds evolves continuously from its initial steady-state equilibrium stock $\bar{B}$. The required jump in the system at the announcement date is therefore undertaken by the exchange rate. At all other points, both $E$ and $B$ follow continuous adjustment paths.

The formal solution of the time paths of $E(t)$ and $B(t)$ is obtained by imposing a combination of initial and terminal conditions and is given by equations (A.16) and (A.17) in the Appendix. These form the basis for the analysis of the disturbances in $\chi_0$ and the policy responses. In general, the transitional adjustment consists of three phases. The first is at the announcement date $t = 0$, when the exchange rate undergoes an initial discrete jump. Setting $t = 0$ in the solution (A.16a), the magnitude of this jump is given by

$$dE(0) = \frac{(\lambda_1-a_{11})dE - a_{12} dB}{\lambda_2 e^{\frac{\lambda_2}{T}}} \tag{7}$$

The precise jump depends upon the ultimate changes in the steady state levels of $E$ and $B$, which in turn depend upon the particular disturbance imposed on the system. It is clear from (7), as intuition would suggest, that the magnitude of the initial jump $dE(0)$ varies inversely with $T$, the time between the initial announcement date and the time when the disturbance actually takes effect.

The initial jump in $E$ generates instantaneous changes in the endogenous variables $\sigma$, $W$, and $r$, which may be determined from (A.11). As a consequence of these, $E(t)$ and $B(t)$ follow the paths defined by the differential equations (A.16). These describe the second phase of the adjustment which begins immediately
following the announcement and ends at time \( T \), when the change actually occurs. These equations define a locus between \( E(t) \) and \( B(t) \) having the properties

\[
\frac{dE(t)}{dB(t)} > 0 \quad \frac{d^2E(t)}{dB^2(t)} < 0 \quad (8)
\]

and which are important when we illustrate the adjustment paths in Figures 1, 3, and 4 below. The locus defined by (A.16) is unstable, so that if \( E \) and \( B \) were to follow it indefinitely, the system would ultimately diverge.

However, at time \( T \), \( E(t) \), \( B(t) \) reach the locus defined by (A.17). Eliminating \( e^{-\lambda_1 t} \) from these two equations, gives rise to the linear relationship

\[
E(t) - \bar{E} = \frac{a_{12}}{\lambda_1 - a_{11}} (B(t) - \bar{B}) \quad (9)
\]

which defines the equation of the stable arm of the saddle point passing through the new steady state \((\bar{E}, \bar{B})\). This line has a negative slope. After time \( T \), when the change has now taken place the system follows the stable path continuously toward the new steady state. This is the third phase in the transitional adjustment. In the case that \( T = 0 \), so that the change takes place immediately and is therefore unanticipated, the system jumps straight onto the stable arm (9); the second phase of the adjustment therefore degenerates.

5. AN EXPORT BOOM

We shall analyze the two cases of an unanticipated and a pre-announced boom in turn.

A. An Unanticipated Export Boom

We begin with the case where the export boom takes place at time \( t = 0 \) and is therefore unanticipated. From Table 1 and the definitions of \( a_{11}', a_{12}' \), the changes in the steady-state levels of \( E \) and \( B \) are given by
\[ \frac{dE}{dx_o} = \frac{L_1 Da_{12}}{M_\Delta}; \quad \frac{dB}{dx_o} = -\frac{L_1 Da_{11}}{M_\Delta} \]

implying

\[ \frac{dE}{dB} = -\frac{a_{12}}{a_{11}} < \frac{a_{12}}{\lambda_1 - a_{11}} < 0. \]

The transitional behaviour of the exchange rate and the stock of bonds is illustrated in Figure 1.A. Initially the system is assumed to be in steady state at the origin say, which lies on the stable arm of the saddle point \( X_1 X_1' \). Because of (10) an increase in \( X_o \) leads to a downward shift in this locus to \( X_2 X_2' \). Since \( dE/dx_o < 0, \ dB/dx_o > 0 \), the new steady state is at \( Q \), which lies to the south east of \( 0 \).

In order for the system to remain stable, \( E \) and \( B \) must always lie on the stable arm. Thus any disturbance in \( X_o \), which leads to a shift in \( X_1 X_1' \), must give rise to an instantaneous jump in the system which enables it to move instantaneously from the stable arm appropriate to the original equilibrium to one which will ensure convergent adjustment to the new equilibrium. With \( B \) constrained to adjust continuously, the jump is brought about by a jump in the exchange rate.

In this case, with the boom being unanticipated, the exchange rate will immediately appreciate by the discrete amount represented by the jump from \( 0 \) to \( C \). Thereafter, the exchange rate continues to appreciate continuously as the economy proceeds along the new stable arm \( X_2 X_2' \) towards the new equilibrium at \( Q \). The magnitude of the initial jump, obtained by substituting (10) into (7) and setting \( T = 0 \) is

\[ dE(0) = \left[ \frac{\lambda_1}{\lambda_1 - a_{11}} \right] dE < dE \]

and is a fraction of the ultimate response.

The following intuitive explanation of the adjustment can be given. At time 0, when the previously unanticipated export boom occurs, the exchange rate immediately appreciates. As a consequence of this, the relative price
σ = E/P immediately falls, while real wealth immediately rises. The fall in the relative price leads to an immediate contraction of the price elastic (traditional) export sector, while the fall in σ, together with the rise in wealth increases imports, at the expense of the import-competing sector. In the first instance, these adjustments only partially offset the direct increase in exports resulting from the export boom itself, so that following the fall in E, the balance of trade remains in surplus. Corresponding to the trade account surplus is a deficit on the capital account with a resulting accumulation of bonds by domestic residents. At the same time, the balance of trade surplus continues to exert pressure for a further appreciation of the exchange rate. This is compounded by the fact that the initial revaluation of the exchange rate causes the domestic interest rate to fall below the world rate r*; see (A.11c). In order for interest rate parity to be maintained, the domestic exchange rate must continue to appreciate. As domestic residents continue to accumulate bonds and the exchange rate continues to appreciate, these pressures for further adjustment diminish and eventually the new equilibrium is approached.

B. An Anticipated Export Boom

We now turn to the case, probably most relevant to the current Australian debate, where at time 0 it is first "announced" that an export boom will occur at time T. The change in the steady state is identical to that of the previous case; the only difference is in the transitional dynamics, which is as illustrated in Figure 1.B.

At the announcement date t = 0, the exchange rate appreciates from 0 to A. It then begins to move along the unstable locus AC, until it reaches the stable arm of the saddle-point at C, which it does at time T, when the export boom actually takes place. Thereafter it follows the stable locus towards the new steady state equilibrium Q.

Intuitively, we have the following. At time 0, when the export boom is first announced, the exchange rate immediately undergoes a revaluation of an amount
which as noted earlier, is less than in \((11)\). Since the export boom has yet to occur, the fall in \(\sigma\) and the rise in \(W\), which we have seen to be immediate consequences of this revaluation, create a balance of trade deficit. In order to maintain balance of payments equilibrium, domestic residents must reduce their holdings of the traded bond. In effect there is a net capital inflow. We may refer to this as the speculative capital boom and which like Corden's (1981) domestic investment boom precedes the export boom. At the same time, the initial fall in the domestic interest rate, following the initial revaluation, puts pressure on the exchange rate to continue its appreciation in order for interest rate parity to hold. At time \(T\), when the export boom actually takes effect, exports suddenly increase and the balance of trade moves into surplus. In order for balance of payments equilibrium to prevail, domestic residents now begin a net accumulation of bonds, which continues until the new equilibrium \(Q\) is attained.

6. IMPlications of Export Boom for Structural Adjustments in Domestic Industry

The dynamic adjustments in \(E\) and \(B\), following the announcement of and the eventual export boom are mirrored, through equations (A.11a), (A.11b), in corresponding movements in \(\sigma\) and \(W\). These in turn have implications for the structural adjustments which occur in domestic industry. To discuss these it suffices to focus solely on the relative price \(\sigma\). This is because the output of the export good and non-traded good are assumed to depend only on \(\sigma\). Also, while imports depend upon both \(\sigma\) and \(W\), the latter can be eliminated through the equilibrium in the non-traded goods market. Thus taking differentials of (4a) (holding \(G_N\) constant) we have

\[
N_1d\sigma + N_2dW = 0
\]
\[ dI = I_1 d\sigma + I_2 dW = \left[ I_1 - \frac{N_1 I_2}{N_1} \right] d\sigma. \]  

(12)

Since the coefficient of \( d\sigma \) in (12) is negative, it is clear that the volume of imports varies inversely with \( \sigma \), while the size of the import-competing sector varies directly with \( \sigma \).

These structural adjustments occur in three phases:

(i) Those resulting from an initial discrete jump in \( \sigma \), which stems from the initial discrete change in the exchange rate and which occurs at the announcement date \( t = 0 \);

(ii) continuous adjustments which occur after the initial jump but prior to the boom itself;

(iii) further continuous adjustment, which occur after the boom has taken place.

Typical adjustment paths for \( \sigma \) are illustrated in Figure 2. At the announcement date \( t = 0 \), the initial appreciation of the exchange rate causes the relative price to fall from its initial equilibrium level at A to say C. This leads to a discrete decline in the output of the "traditional" export sector, together with an increase in the output of the non-traded goods sector. At the same time, the fall in the relative price stimulates imports, resulting in a corresponding decline in the domestic import-competing industry.

During the second phase, the relative price \( \sigma \) may follow a variety of paths. As discussed in Section 5, the balance of trade deficit created by the fall in \( \sigma \) immediately generates a decumulation of bond holdings by domestic residents. This means that their real wealth starts to decline, generating a reduction in the demand for non-traded goods. Thus in order for the non-traded goods market to remain in equilibrium, the relative price \( \sigma \) must begin to rise. On the other hand, the reduction in the domestic interest rate below the world rate, following the initial appreciation of the exchange rate, puts pressure on the exchange rate to appreciate further in order for interest rate parity to be
maintained. This generates an offsetting tendency for real wealth to begin to increase, so that for the similar reason to that just given, the relative price \( \sigma \) must begin to fall. Which of these two effects dominates is not clear and it is quite possible for \( \sigma \) to either begin rising after the initial fall, or to continue falling.

At time \( T \), when the export boom takes place, \( \sigma \) will reach a point such as D to D', depending upon the trajectory followed in the pre-boom phase. While this point may be either above or below C, it is below the original equilibrium level, indicated by A. Thereafter, \( \sigma \) falls monotonically, towards its new equilibrium level, as E and B converge along the stable arm.

Thus while the traditional export sector and the domestic import-competing industry suffer both short-run and long-run declines from the export boom, they may nevertheless experience some temporary expansionary tendencies during the period prior to the export boom. From a practical point of view, the most difficult period of adjustment confronting these industries occurs at the initial announcement date when the discrete jump in the relative price takes place. Almost everywhere else changes in these industries occur continuously and can therefore be easily forseen. The only exception is at D or D' where, although \( \sigma \) still moves continuously, it is non-differentiable, so that a discrete jump in the rate of change of adjustment takes place.

7. SOME POLICY RESPONSES

The analysis of Sections 5 and 6 describes the effects of the export boom under the assumption that government policy remains passive. In this section we briefly consider how the dynamic adjustment path responds to policy actions undertaken by the government, directed at offsetting certain effects of the export boom.
A. Expansionary Monetary Policy

Suppose that the domestic monetary authority wishes to maintain the exchange rate at its initial steady-state level in the new steady state equilibrium, after the resources boom has occurred. This can be achieved by introducing a monetary expansion, thereby offsetting the revaluation which would otherwise occur. Whether this is done at the time the export boom is first announced, or at the time it actually takes place does not affect the final equilibrium outcome, only the transitional dynamics.

From the comparative static properties summarized in Table I it is clear that in order to hold $\bar{E}$ constant in the long-run, $\bar{M}$ must be increased by an amount

$$dM = \left(\frac{N_1L_2 + \delta N_2M}{\Delta} \right)dx.$$  

(13)

Turning to Figure 2, the export boom shifts the stable arm $X_1X_1'$ down to $X_2X_2'$ as before. The monetary expansion specified by (13) shifts the locus from $X_2X_2'$ to $X_3X_3'$, so that the steady-state equilibrium moves from 0 to P, with the equilibrium exchange rate, restored to its initial level.

The transitional dynamics in Figure 3 is illustrated for the case where the monetary authority announces at time 0 a monetary expansion to take place at time T, coincident with the export boom. Setting $d\bar{E} = 0$ in (7), we can see that the depreciation in the exchange rate due to the anticipation of the future monetary expansion more than offsets the appreciation due to the expected export boom. Specifically, we have

$$dE(o) = \frac{-a_{12}dB}{\lambda_2^T} > 0.$$ 

$$\frac{\lambda_1-a_{11}}{(\lambda_1-a_{11})e^2} > 0$$
so the net effect is a depreciation, given by OA. This creates a balance of trade surplus, leading to the accumulation of foreign bonds by domestic residents. At the same time, the depreciation causes the domestic interest rate to rise above the world rate and this in turn requires the exchange rate to depreciate continuously for interest rate parity to hold. This generates a movement along the locus AC until time T, when the point C is reached. Thereafter, the monetary expansion, together with the resources boom take effect, and the economy converges towards the new equilibrium P. In short, following an initial depreciation, the exchange rate continues to depreciate continuously until the time of the boom, when it begins to appreciate back to its original level.

B. Contraction in Government Expenditure on Non-Traded Goods

Let us now assume that the policy makers wish to maintain the relative price σ at its initial steady-state level, following the export boom. This may be achieved by decreasing $G_N$ by an amount

$$dG_N = \frac{N_2}{I_2} dX_o. \tag{1}$$

From Table I and noting (14), the net effect on $E$, $B$, is given by

$$\frac{dE}{dX_o} = \frac{-L_2}{M I_2} < 0 ; \quad \frac{dB}{dX_o} = \frac{1 - L_2}{I_2} > 0$$

so that

$$\frac{dE}{dB} = \frac{-L_2}{M (1-L_2)} < 0.$$

Hence the equilibrium exchange rate appreciates, while the stock of bonds increases.

Whether the stable arm of the saddle-point XX' shifts up or down depends upon whether

$$\frac{dE}{dB} = \frac{-L_2}{M (1-L_2)} \leq \frac{a_{12}}{\lambda_1 - a_{11}}.$$
and either case is possible. For example, if $L_2$, the wealth coefficient in the demand for money is small, the XX curve shifts up, while if for example $L_2 = \bar{M}/(\bar{M} + \bar{B})$ (i.e. the wealth elasticity in the demand for money is unity), the movement will be downward. The two cases are illustrated in Figures 4.A and 4.B respectively. The dynamics is drawn on the assumption that at time $0$ the fiscal authorities announce that they will engage in a contraction in $G_N$ to take effect at time $T$, coincident with the export boom. The explanation is similar to that given in other cases and is not discussed further.

8. CONCLUSION

In this paper we have traced through the adjustments in the exchange rate and asset accumulation of a small open economy faced with the certain prospect of an export (resources) boom at some specified time in the future. It is shown how the adjustment occurs in three phases. First, the initial expectation of such a boom generates an immediate appreciation of the exchange rate. Secondly, prior to the export boom the exchange rate will continue to appreciate gradually. Domestic residents will decumulate their holdings of bonds in response to the balance of trade deficit generated by the fall in the relative price of traded to non-traded goods resulting from the appreciation of the currency. After the boom takes place, the exchange rate will continue to appreciate, while the balance of trade moves into surplus and domestic residents begin to accumulate bond holdings.

These adjustments in the exchange rate and domestic bond holdings are reflected in movements of the relative price of traded to non-traded goods and the implications of this for the structural adjustments of domestic industry have been discussed. We have seen how in the short run and in the long run the fall in this relative price will generate the kinds of responses suggested by Gregory. However, during the pre-boom transitional phase it is possible for these adjustments to be temporarily reversed.
We have considered how monetary, and fiscal policies may be adopted by the government to influence both the steady-state and the transitional adjustment path of the economy to the export boom. Monetary policy cannot of course generate any real long-run responses; for these some kind of fiscal intervention is required.¹⁵

Like any formal analysis, this one is limited in scope and to conclude two important restrictions should be noted. First, the model is based on the assumption of full employment. Secondly, while we have focused on the flows of financial capital induced by exchange rate movements resulting from the impending export boom, we have abstracted entirely from physical capital flows, which are surely important, particularly in the case of a resources boom. To integrate these aspects into the present framework would seem to be an important next step.
FIG. 1.A Unanticipated Export Boom

FIG. 1.B Announced Export Boom
FIG. 2 Time Path for $\sigma$

Initial $\sigma = 1$

Steady state

Final steady state
FIG. 5 Monetary Expansion to Maintain Exchange Rate
downward shift due to export boom

upward shift due to fiscal contraction

FIG 4.A Decrease in $G_N$ to Maintain $\bar{\sigma}$ Constant: Net Downward Shift in XX' Curve

downward shift due to export boom

upward shift due to fiscal contraction

FIG 4.B Decrease in $G_N$ to Maintain $\bar{\sigma}$ Constant: Net Upward Shift in XX' Curve
### TABLE I

<table>
<thead>
<tr>
<th>On</th>
<th>( \frac{-N_2}{\Delta} &lt; 0 )</th>
<th>( \frac{-I_2}{\Delta} &lt; 0 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \sigma )</td>
<td>( \frac{N_1}{\Delta} &gt; 0 )</td>
<td>( \frac{-X'\text{-}I_1}{\Delta} &lt; 0 )</td>
</tr>
<tr>
<td>( \delta )</td>
<td>( \frac{-N_1 l_2 + \delta N_2 \bar{M}}{\bar{M} \Delta} &lt; 0 )</td>
<td>( \frac{L_2(X'\text{-}I_1) - \delta \bar{M} I_2}{\bar{M} \Delta} \geq 0 )</td>
</tr>
<tr>
<td>E</td>
<td>( \frac{-N_1 (1\text{-}L_2) + \delta N_2 B}{\Delta} &gt; 0 )</td>
<td>( \frac{\delta \bar{B} l_2 - (X'\text{-}I_1) (1\text{-}L_2) \Delta}{\bar{M} \Delta} \geq 0 )</td>
</tr>
<tr>
<td>X(\sigma)</td>
<td>( \frac{-X'N_2}{\Delta} &lt; 0 )</td>
<td>( \frac{-X'I_2}{\Delta} &lt; 0 )</td>
</tr>
<tr>
<td>I</td>
<td>( \frac{N_1 I_2-I_1 N_2}{\Delta} &gt; 0 )</td>
<td>( \frac{-X'I_2}{\Delta} &lt; 0 )</td>
</tr>
</tbody>
</table>

\( \Delta \equiv N_1 I_2 + (X'\text{-}I_1) N_2 > 0 \)

**N.B.** 1. All effects are evaluated at the initial steady state \( \bar{E} = \bar{\sigma} = 1 \).

2. Note in elasticity terms \( \frac{dE/E}{d\bar{M}/\bar{M}} = 1 \).
APPENDIX

A. Incorporation of Income Effects into Commodity Demand Functions

In this Appendix, we briefly indicate what happens when the commodity demand functions are augmented to allow for income effects.

Suppose that the domestic output of the non-traded and traded goods, indexed by N and T respectively, are given by the production functions:

\[ Y_N = F_N(L_N) \]  \hspace{1cm}  (A.1a)

\[ Y_T = F_T(L_T) \]  \hspace{1cm}  (A.1b)

where \( Y_i \) = production of good \( i \) (\( i = N, T \))

\( L_i \) = labour employed in the production of good \( i \) (\( i = N, T \)).

The assumption of full employed is described by

\[ L_N + L_T = \bar{L} \]  \hspace{1cm}  (A.2)

where \( \bar{L} \) is the fixed endowment of labour.

Optimal production is described by the efficiency condition

\[ PF_N'(L_N) = EF_T'(L_T) \]  \hspace{1cm}  (A.3)

where \( P \) and \( E \) are as defined in the text. Solving (A.2) and (A.3), we obtain

\[ L_N = L_N(\sigma), \quad L_T = L_T(\sigma) \]  \hspace{1cm}  (A.4)

Nominal factor income, \( Y \), is

\[ Y = PF_N(L_N) + EF_T(L_T) \]  \hspace{1cm}  (A.5)

while real income, \( y \), expressed in terms of domestic cost of living units (comparable to wealth) is
where $X_0$ is introduced to parameterize the exogenous component of export production.

The change in real income resulting from a shift in the production function for the traded good (taking the form of the export boom) is

$$dy = (\delta - 1) \sigma^{\delta - 2} F_N \, d\sigma + \delta \sigma^{\delta - 1} F_T \, d\sigma + \sigma \delta dX_0$$
$$+ \sigma^{\delta - 1} F'_N \, dL_N + \sigma^{\delta - 1} F'_T \, dL_T$$

Using the efficiency condition (A.5), the full employment condition (A.2), and adopting the initial choice of units ($\sigma = 1$), we obtain

$$dy = (\delta Y - F_2) \, d\sigma + dX_0$$  \hspace{1cm} (A.8)

It is seen that the income effect generated by the export boom consists of the direct effect, $dX_0$, together with an induced relative price effect. The magnitude of the latter depends upon the share of non-traded goods in domestic production, as compared to $\delta$, the corresponding ratio in domestic consumption. If these are approximately equal, then $dy = dX_0$. Otherwise, the income effect induced by the change in $\sigma$ and contained in (A.8) can also be incorporated in, and assumed to be dominated by, the substitution effect from the change in $\sigma$, discussed in the text.

Thus the model (4a) - (4e), modified to allow for income effects becomes

$$N[\sigma, \, W, \, \psi(\sigma, X_0)] + G_N = 0$$  \hspace{1cm} (A.9a)

$$\frac{M}{E} \sigma^5 = L(r, \, W)$$  \hspace{1cm} (A.9b)

$$W = \left( \frac{M}{E} + B \right) \sigma^5$$  \hspace{1cm} (A.9c)

$$E = E(r - r^*)$$  \hspace{1cm} (A.9d)
\[ \dot{B} = X_o + X(\sigma) - I(\sigma, W, \psi(\sigma, X_o)) \]  

(A.9e)

The only difference is that the change in \(X_o\) now impinges directly on \(N(.)\) and \(I(.)\). Otherwise the structure of the system remains unchanged. The steady-state effects summarized in the first column of Table 1 are in some instances subject to a few minor indeterminacies. However, if these do not dominate, the qualitative effects will be essentially as before.

Given that, the analysis of the transitional dynamics proceeds virtually unchanged and indeed the formal solution is still given by equations (A.16a) and (A.16b).

B. Formal Analysis of Transitional Dynamics

We begin by linearizing equations (4a)-(4c) about the initial steady state yielding

\[
\begin{bmatrix}
N_1 & N_2 & 0 \\
-\delta \tilde{M} & L_2 & L_1 \\
-\delta (\tilde{M} + \tilde{B}) & 1 & 0
\end{bmatrix}
\begin{bmatrix}
\sigma - \tilde{\sigma} \\
W - \tilde{W} \\
r - r^*
\end{bmatrix}
= 
\begin{bmatrix}
-dG_N \\
-\bar{M}(E - \bar{E}) \\
(B - \tilde{B}) - \bar{M}(E - \bar{E})
\end{bmatrix}
\]

(A.10)

where \(dG_N\) represents an exogenous disturbance in \(G_N\) and the elements of the matrix and vector appearing in (A.10) have been evaluated at the initial steady state values of \(E = \bar{E} = 1\).

The solutions for \(\sigma - \tilde{\sigma}, W - \tilde{W}, r - r^*\), to be inserted into the linearized differential equations are

\[
\sigma - \tilde{\sigma} = \frac{1}{(-L_1^1)} \left\{ N_2 L_1 \left[ (B - \tilde{B}) - \bar{M}(E - \bar{E}) \right] + L_1 dG_N \right\}
\]

(A.11a)

\[
W - \tilde{W} = \frac{1}{(-L_1^1)} \left\{ -N_1 L_1 \left[ (B - \tilde{B}) - \bar{M}(E - \bar{E}) \right] + \delta (\tilde{M} + \tilde{B}) dG_N \right\}
\]

(A.11b)

\[
r - r^* = \frac{1}{(-L_1^1)} \left\{ N_1 L_2 + \delta N_2 \tilde{M} (B - \tilde{B}) + [(1 - L_2) N_1 + \delta N_2 \tilde{B}] \bar{M}(E - \bar{E}) \right. \\
+ \left[ \delta \bar{M}(1 - L_2) - \delta \bar{B} L_2 \right] dG_N \}
\]

(A.11c)

where \(D = N_1 + \delta N_2 (\tilde{M} + \tilde{B}) > 0\).
Substituting these expressions, the linearized differential equations become

\[
\begin{bmatrix}
\dot{E} \\
\dot{B}
\end{bmatrix} =
\begin{bmatrix}
a_{11} & a_{12} \\
a_{21} & a_{22}
\end{bmatrix}
\begin{bmatrix}
E - \bar{E} \\
B - \bar{B}
\end{bmatrix} +
\begin{bmatrix}
b_{11} & 0 \\
b_{21} & 1
\end{bmatrix}
\begin{bmatrix}
dG_N \\
dX_0
\end{bmatrix}
\]

(A.12)

where

\[
a_{11} = \frac{\tilde{M}((1-L_2)N_1 + \delta N_2 \tilde{B})}{(-L_1)D} > 0 \quad a_{12} = \frac{N_1 L_2 + \delta N_2 \tilde{M}}{(-L_1)D} > 0
\]

\[
a_{21} = \frac{-L_1 \tilde{M}[I_2 N_1 + (X' - I_1)N_2]}{(-L_1)D} \quad a_{22} = \frac{L_1 [N_2(X' - I_1) + I_2 N_2]}{(-L_1)D} < 0
\]

\[
b_{11} = \frac{\delta ([\tilde{M}(1-L_2) - \tilde{B}L_2])}{(-L_1)D} \quad b_{21} = \frac{(X' - I_1)L_1 - I_2 \delta (\tilde{M} + \tilde{B})}{(-L_1)D} < 0.
\]

The qualitative nature of the solution depends upon the roots of the characteristic equation of (A.12), namely

\[
\lambda^2 - (a_{11} + a_{22})\lambda + a_{11}a_{22} - a_{12}a_{21} = 0.
\]

By direct examination, we can verify that the two roots to this equation \(\lambda_1, \lambda_2\), are real with \(\lambda_1 < 0, \lambda_2 > 0\) say, so that the solution is a saddle point.

Integrating (A.12), the solution is of the form

\[
E(t) = \bar{E} + C_1 e^{\lambda_1 t} + C_2 e^{\lambda_2 t}
\]

(A.13a)

\[
B(t) = \bar{B} + C_1 \left[\frac{\lambda_1 - a_{11}}{a_{12}}\right] e^{\lambda_1 t} + C_2 \left[\frac{\lambda_2 - a_{11}}{a_{12}}\right] e^{\lambda_2 t}, \quad 0 \leq t \leq T
\]

(A.13b)

\[
E(t) = \bar{E} + A_1 e^{\lambda_1 t} + A_2 e^{\lambda_2 t}
\]

(A.14a)

\[
B(t) = \bar{B} + A_1 \left[\frac{\lambda_1 - a_{11}}{a_{12}}\right] e^{\lambda_1 t} + A_2 \left[\frac{\lambda_2 - a_{11}}{a_{12}}\right] e^{\lambda_2 t}, \quad t > T
\]

(A.14b)

where \(A_1, A_2, C_1, C_2\) are arbitrary constants to be determined by a combination of initial conditions, terminal conditions, and continuity.
First, we shall impose the requirement that the system remain stable as \( t \to \infty \). Since \( \lambda_2 > 0 \), for this to be so, we require \( A_2 = 0 \). Secondly, we assume that the accumulation of bonds evolves continuously from the initial stock \( \bar{b} \). Setting \( t = 0 \) in (A.13b) we obtain

\[
C_1(\lambda_1-a_{11}) + C_2(\lambda_2-a_{11}) = 0 \quad (A.15a)
\]

Thirdly, at all time after \( t = 0 \), both \( E \) and \( B \) follow continuous adjustment paths. In particular, at time \( t = T \), when the change is implemented, the solutions for the two sets of equations (A.13) and (A.14) must be consistent. This requires

\[
-A_1 e^{\lambda_1 T} + C_1 e^{\lambda_1 T} + C_2 e^{\lambda_2 T} = d\bar{E} \quad (A.15b)
\]

\[
-A_1(\lambda_1-a_{11}) e^{\lambda_1 T} + C_1(\lambda_1-a_{11}) e^{\lambda_1 T} + C_2(\lambda_2-a_{11}) e^{\lambda_2 T} = a_{12} d\bar{E}. \quad (A.15c)
\]

Solving equations (A.15a)-(A.15c) for \( A_1, C_1, C_2 \) and substituting into (A.13), and (A.14), the general solutions for \( E(t) \) and \( B(t) \) are given by

0 \leq t \leq T

\[
E(t) = \bar{E} + \frac{(\lambda_2-a_{11})[(\lambda_1-a_{11})d\bar{E} - a_{12}d\bar{B}]e^{\lambda_1 t}}{(\lambda_2-\lambda_1)(\lambda_1-a_{11})e^{\lambda_1 T}} + \frac{[a_{12}d\bar{E} - (\lambda_1-a_{11})d\bar{E}]e^{\lambda_2 t}}{(\lambda_2-\lambda_1)e^{\lambda_2 T}} \quad (A.16a)
\]

\[
B(t) = \bar{B} + \frac{(\lambda_2-a_{11})[(\lambda_1-a_{11})d\bar{E} - a_{12}d\bar{B}][e^{\lambda_1 t} - e^{\lambda_2 T}]}{a_{21}(\lambda_2-\lambda_1)e^{\lambda_2 T}} \quad (A.16b)
\]

\[
t \geq T
\]

\[
E(t) = \bar{E} + \left\{ \frac{(\lambda_2-a_{11})(\lambda_2-a_{11})(e^{\lambda_1 T} - e^{\lambda_2 T})d\bar{E} + [(\lambda_1-a_{11})e^{\lambda_2 T} - (\lambda_2-a_{11})e^{\lambda_1 T}]a_{12}d\bar{B}}{(\lambda_2-\lambda_1)(\lambda_1-a_{11})e^{(\lambda_1+\lambda_2)T}} \right\} e^{\lambda_1 t} \quad (A.17a)
\]
\[ B(t) = \bar{B} + \left\{ \frac{ (\lambda_1-a_{11}) (\lambda_2-a_{22}) (e^{\lambda_1 T} - e^{\lambda_2 T}) \, \tilde{dE} + \left[ (\lambda_1-a_{11}) e^{\lambda_2 T} - (\lambda_2-a_{22}) e^{\lambda_1 T} \right] a_{12} \, \tilde{dB} }{ (\lambda_1+\lambda_2)^T } \right\} e^{\lambda_1 t} \]

(A.17b)

where \( \tilde{E} - \bar{E} = \tilde{dE}, \quad \tilde{B} - \bar{B} = \tilde{dB}. \)

These equations form the basis for the analysis of our subsequent disturbances in \( X_0 \) and the policy responses.
FOOTNOTES

* This paper was completed when I was at the Australian National University. I wish to thank Max Corden and two anonymous referees for their helpful comments on earlier drafts of this paper.

1. Additional references to this discussion are provided by Corden (1981).

2. A recent paper by Nguyen, Campbell and Carland (1982) uses simulation methods to analyze the monetary effects of a resource boom.

3. This is not to be confused with the domestic investment boom identified by Corden (1981). This refers to the inflow of capital associated with the rise in domestic investment which generates the increase in physical capital that later causes the export boom.

4. This composite commodity also includes the output of the domestic competing industry.

5. This relationship assumes that investors are risk neutral.

6. Note that we do not get into the issue of whether or not government bonds are net wealth.

7. This assumption can be justified on at least two grounds. First, being the continuous-time analogue to rational expectations, it embodies the efficiency of the foreign exchange market, which receives some empirical support; see e.g. Frenkel (1976), Levich (1978). Secondly, as Gray and Turnovsky (1979) have argued, if one assumes, as is typical the case in modelling continuous time systems, that: (i) the variable being forecast is differentiable; (ii) information is available instantaneously; (iii) individuals have some ability to store that information, at least for a finite period, then expectations over an infinitesimally short period and based on the efficient use of available information must satisfy perfect myopic foresight.

8. This specification of tax collection is chosen partly to eliminate the instability resulting from interest payments outstanding debt; see Turnovsky (1981). The analysis is virtually unchanged, although marginally more complicated if (2) is modified to $T = P_C$. Many analyses simply ignore interest payments as being negligibly small.

9. In Corden's analysis the rise in exports is not exogenous; rather it is the result of the increase in capital.

10. We shall hypothesize that the supply of non-traded good is specified by $N^S(a)$, with $N^S' < 0$.

11. Saddle point instability is of course a widely prevalent phenomenon in rational expectations models, such as this.
12. See e.g. Brock (1974, 1979). This result is obtained for a utility function that is separable in real money balances and consumption and the extent to which instability can be ruled out for more general utility functions is not known.

13. We can write $\bar{E} = \bar{E}(X_0, M_0)$, so that simultaneously changes in $X_0$ and $M_0$ introduced to maintain $d\bar{E} = 0$ must satisfy

$$d\bar{E} = 0 = \frac{\partial \bar{E}}{\partial X_0} dX_0 + \frac{\partial \bar{E}}{\partial M_0} dM_0.$$ 

Thus

$$dM_0 = - \frac{\partial \bar{E}}{\partial \bar{E}/\partial M_0} dX_0$$

with the partial derivatives being obtained from Table 1.

14. Taking the differentials of the domestic non-traded goods market equilibrium and the balance of trade equilibrium we have

$$N_1 d\bar{G} + N_2 d\bar{W} + dG_N = 0$$

$$dX_0 + (X' - I_1) d\bar{G} - I_2 d\bar{W} = 0.$$ 

Setting $d\bar{G} = 0$, immediately yields (14). Having obtained this equation, the overall effect on $\bar{E}$, is obtained by taking the differential

$$\frac{d\bar{E}}{dX_0} = \frac{\partial \bar{E}}{\partial X_0} + \frac{\partial \bar{E}}{\partial G_N} \frac{dG_N}{dX_0}$$

and analogously for $d\bar{E}/dX_0$, with the appropriate partial derivatives being obtained from Table 1.

15. An earlier version of this paper also analyzes the effects of alternative exchange rate policies.

16. Even though we have let $\bar{E} = \bar{a} = 1$, we prefer to write the deviations as $(E - \bar{E})$, $(\sigma - \bar{\sigma})$. 
REFERENCES


