THE MONETARY APPROACH TO THE BALANCE OF PAYMENTS: STOCK-FLOW DYNAMICS, STICKY WAGES AND SPECULATIVE ATTACKS

KEITH FRANCIS WOOD

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ABSTRACT

The essence of the monetary approach to the balance of payments is identified with the stock-flow dynamics that arise from phases of private sector stock adjustment towards a desired long run relationship between assets and expenditures. This stock adjustment behaviour provides the link between monetary and expenditure based analyses of the open economy and demonstrates the consistency of the monetary approach with a model built around a Keynsian (aggregate demand-aggregate supply) structure. The model's dynamics follow from a wealth effect on expenditure and sticky wages, and drive the economy towards an equilibrium with a permanent balance of payments deficit following certain structural changes. A flexible wage version of the model is used to provide an analysis of balance of payments crises within a monetary approach framework. The ongoing reserve loss inevitably collapses the fixed rate regime, precipitated by a speculative attack on reserves. The attack must link the stock-flow dynamics of the fixed regime with the current account-portfolio balance dynamics of the post-collapse regime at a given level of wealth. These dynamics prohibit an analytical solution for the level of wealth that satisfies this condition, and therefore for the time at which the collapse occurs. Simulating both flexible and sticky wage versions of the model provides a solution for the critical level of wealth that links the regimes, and thus for the collapse time.

INTRODUCTION

The aim of this thesis is to examine the links between the monetary approach to the balance of payments, economic structure and speculative attacks.

It emphasises that the monetary approach to the balance of payments is primarily concerned with private sector stock adjustment and does not imply commitment to a specific characterisation of a structural model, nor does it require explicit analysis of the money market. These points are demonstrated by undertaking a monetary analysis of a Keynsian model that fully complies with the monetary approach in the short run, the process of dynamic adjustment and in the long run.

This model is then used to extend Krugman's (1979) analysis of balance of payments crises which inevitably cause the collapse of a fixed exchange rate regime in a speculative attack. The collapse can result from either an exogenously imposed policy of credit expansion, or, when the government's budget deficit is endogenous, from changes in economic structure. It is demonstrated that the stock adjustment process of the monetary approach both prevents a self-righting balance of payments mechanism in these circumstances but also precludes an analytical solution for the time at which the inevitable collapse will occur. Finally the thesis demonstrates how simulation techniques can be used to solve for the timing of collapse within a monetary approach model.

1. The Monetary Approach, Economic Structure and Stock-Flow Dynamics

It is important to establish what is, and what is not, essential to the monetary approach to the balance of payments. It is not necessary that a monetary approach entail either a particular model structure (i.e.: that associated with monetarism) or the "fundamental equation" which expresses the balance of payments via the balance sheet identity. It is also rather misleading to suggest that the monetary approach proposes the balance of payments to be "an essentially monetary phenomenon" as Frenkel and Johnson (1976) declare in their opening sentence.

What is essential to the monetary approach is the the way it relates the balance of payments to the issues of private sector stock adjustment and expenditure decisions. In an open economy in which money is the only asset and acts as a medium of exchange and store of value, the decision by the private sector to spend less than the flow of income it receives is the corollary of the decision to accumulate money. In an open economy, a balance of payments surplus provides one source of accumulation. However, indefinite accumulation or decumulation cannot be a feature of a stock-flow equilibrium. The essential insight of the monetary approach to the balance of payments is to insist that the disequilibrium represented by private sector net acquisition of assets must be recognised an an adjustment phase to stock equilibrium, entailing intrinsic stock-flow dynamics. Johnson (1976) writes:

> Deficits and surpluses represent phases of stock adjustment in the money market and not equilibrium flows and should not be treated in an analytical framework that treats them as an equilibrium phenomenon.
> Johnson, p.153.

It is true that some Keynsian accounts of the open economy (notably the Mundell-Fleming model), by concentrating on the determination of trade flows as derived from goods market equilibrium, ignored these intrinsic dynamics. However, it is also true that the "fundamental equation" of the monetary approach is based only on a flow equilibrium, albeit in the money rather than goods market. Thus it too has no more intrinsic validity than an expenditure based approach without the recognition that the flow demand for money (i.e.: net acquisition of assets by the private sector) is similarly derived from stock adjustment. Furthermore this "fundamental equation" is neither necessary nor sufficient to determine the balance of payments, as noted by Montiel (1985):

> The "fundamental equation" of the monetary approach expresses the balance of payments as the difference between the demand for money, which is a function of a few key macroeconomic variables, and the flow supply of credit, which is under the control of the authorities. Because the derivation of this equation relies only on a balance sheet identity and the assumption of flow equilibrium in the money market, this equation does not in itself constitute a model of the balance of payments ... it is not necessary for a well specified, internally consistent

model of an open economy to contain the "fundamental equation" of the monetary approach.
Montiel, p.179.

Whether choosing to adopt a monetary or expenditure focus, a structural model must be appended to determine the "key macroeconomic variables" that explain goods or monetary flows. No analytical error is involved in highlighting either goods or monetary flows; the error arises only if either approach is divorced from the issue of stock equilibrium.

Thus the monetary approach to the balance of payments is an essentially dynamic concept, and from the earliest analytical models in the monetary approach tradition developed at the I.M.F. (Polak (1957), Prais (1961)) the driving force behind these dynamics has been associated with the stock adjustment behaviour of the private sector. This stock adjustment behaviour posits that when the desired stock of money exceeds the actual stock, private sector expenditure will fall short of income, with net savings being devoted to the accumulation of money, thereby gradually reducing the stock disequilibrium. This behaviour, which has become known as the "hoarding function", is central to the monetary approach to the balance of payments. It may be captured either by an expenditure approach, working through goods market equilibrium, and incorporating a wealth effect on expenditure, or through an approach that works through flow monetary equilibrium and relates the flow demand for money to excess stock demand. Hence the hoarding function, by integrating the monetary sector with the process of income determination, provides the means of relating the monetary approach to the balance of payments with any specification of economic structure. In chapter two of the thesis this point is illustrated by undertaking a monetary analysis of a Keynsian open economy model, which is shown to be fully consistent with a monetary focused approach in the short run, the dynamic adjustment process and the long run. The emphasis is on how the hoarding function provides a precise link between the different approaches; its role having been implicit in other syntheses.

The hoarding function further draws attention to another crucial aspect of the monetary approach: that it is private sector deficits and surpluses, rather than balance of payments deficits and surpluses, that represent phases of stock adjustment. It is the behaviour of the private sector, and not the balance of payments, that exhibits a self-righting mechanism. During adjustment, assets acquired by the private sector can represent claims on government as well as foreigners. The private sector can sustain a stock equilibrium in which the rate of domestic credit expansion from a public sector deficit offsets the rate of reserve loss from an overseas sector deficit. When the government's deficit is endogenously determined, with tax revenue linked to the level of economic activity, certain structural changes mean the intrinsic dynamics of the monetary approach necessarily drive the economy to a stock-flow equilibrium with a balance of payments deficit. This relationship between private sector stock-flow dynamics, endogenous budget deficits and economic structure features heavily throughout chapters two, three and four of the thesis.

When a fixed exchange rate system involves the gradual decline of reserves, a balance of payments crisis develops. At some point in time, before the gradual depletion of reserves would have exhausted them, remaining reserves are eliminated in a speculative attack, forcing a switch to a floating exchange rate system.

2. The Monetary Approach and Speculative Attacks

Henderson and Salant (1978) demonstrated that when a reserve stock of goods is used to stabilise the price of that good, that stock is vulnerable to a speculative attack. Krugman (1979) applied this to the case where a government uses its stock of foreign exchange to peg the price of foreign exchange (i.e: the exchange rate). A balance of payments deficit creates demand for foreign exchange; when the government exhausts its reserve stock, this demand for foreign exchange will cause its price to start rising. Under rational expectations the anticipation of this creates an incentive to acquire foreign exchange before the governments stock is exhausted by launching a speculative attack. In order that arbitrary windfall profits be avoided, the attack must cause no change in the price of foreign exchange at the time it is launched.

Krugman's model deployed the simplest monetary approach structure, with exogenous output and continuous purchasing power parity - the balance of payments deficit is determined solely by the excess of absorption over income, or of the actual over the desired stock of wealth. In chapter three the model is extended in a novel way by incorporating a role for relative prices in substitution between domestic and foreign goods, and in the determination of output via the labour market. The analysis is further extended by introducing an endogenous budget deficit to examine the balance of payments crises that emerge as a consequence of structural changes as well as from a policy of exogenously imposed credit expansion.

The speculative attack condition of no exchange rate jump is used to link the process of regime collapse with the post attack floating regime; however, the analysis does not incorporate a solution for the time at which the fixed rate regime must collapse. This issue was first addressed by Flood and Garber (1984). Their method of solution is as follows:

> The central problem in finding the collapse time lies in connecting the fixed rate regime to the post-collapse floating regime. As our strategy we first determine the floating exchange rate conditional on a collapse at an arbitrary time z, referring to it as the "shadow floating exchange rate". Next we investigate the transition from fixed rates to the post-collapse flexible-rate system. ... Since agents foresee the collapse, predictable exchange-rate jumps at time z are precluded. ... We use this condition to determine the timing of the attack and the extent of government reserve holdings at the time of attack.
> Flood and Garber, p.3.

However, the usefulness of the "shadow floating exchange rate" concept in Flood and Garber's method derives from a crucial simplification in their model - the absence of a stock adjustment process (their model is thus effectively a flexible price version of the Dornbusch (1976) model). At all points in time equilibrium between the desired stock demand for money and the stock of money available to be held is maintained. Given the exogenous conditions that determine the desired stock of real balances the actual stock must be constantly preserved at this level. A policy of credit expansion does not alter the desired stock of real balances; the actual stock is kept constant by an equal and offsetting rate of reserve loss and depreciation under fixed and floating rates respectively. Whenever the floating regime starts the economy instantaneously jumps from one steady state to another. The opportunity cost of holding money instantaneously rises by steady state depreciation, and the desired stock of money falls by this amount adjusted for the elasticity of demand for money with respect to depreciation. This provides the level of reserves that must be attacked to reduce the money supply by an equal amount and thus preserve monetary equilibrium without requiring a jump in the exchange rate. (This steady state switch property is also exploited to determine collapse times in models of balance of payments crises within a general equilibrium intertemporal optimisation framework, instigated by Calvo (1987)). Thus the corollary of reserves hitting this critical level is that the shadow floating exchange rate hits the fixed parity. The Flood and Garber model is thus able to focus exclusively on asset market equilibrium, and the time path for the shadow floating exchange rate is entirely determined by the (exogenous) time path for domestic credit.

However, a model which excludes analysis of stock-flow interactions does not fall within the monetary approach tradition - but when monetary approach dynamics are introduced, the shadow floating exchange rate is no longer an analytically tractable tool for determining the timing of a speculative attack. This is because in a monetary approach model, as wealth gradually adjusts to its stock equilibrium level, the dynamics of the exchange rate are driven by the endogenous development of the current account over time as well as by the requirements of asset market equilibrium at all points in time. A non zero current account thus represents a process of two forms of adjustment. Firstly, from the hoarding function, the private sector adjusts its stock of wealth to its long run desired level through the current account. Secondly, from portfolio theory, capital flows (which, absent government intervention, must offset the current account) represent the stock re-allocation of portfolios to their desired long run composition. The exchange rate must reflect not only the contemporary portfolio composition but also the expected time path of net foreign asset holdings (as determined by the current account). Rodriguez (1980) writes:

> Introducing the time dimension, and therefore stock and flow markets, raises the possibility that some prices may be determined exclusively by one set of market equilibrium conditions (stock) which are independent from the rest of the system. Under

rational expectations, however, expectations about future asset prices are crucial elements in the market clearing process and are bound to depend on expected future developments in flow markets; the total independence of stock and flow markets is therefore not generally possible. To put it in simpler terms, a full equilibrium, portfolio balance model of exchange rate determination under rational expectations will yield an equilibrium exchange rate determined jointly by stock equilibrium and expected developments in flow markets.
Rodriguez, p.1151.

Thus, in a monetary approach analysis, linking the fixed and floating regimes by the condition of no exchange rate jump, and thereby determining the time of collapse, is a matter of much greater complexity. The shadow floating exchange rate is contingent not only on how the entire model structure determines the portfolio balance-current account interaction following a collapse at some time z, but also on the initial post-collapse values for domestic and foreign asset stocks entailed by attacking remaining reserves at time z. These values, inherited from the fixed regime, themselves depend on how the model structure and stock-flow dynamics determine the gradual decline of reserves and evolution of wealth in the fixed regime. The exact point in time at which the dynamics of the fixed regime implies that attacking the remaining stock of reserves satisfies the adjustment dynamics of the floating regime without requiring a jump in the exchange rate is discovered by an iterative procedure used in the simulation of monetary approach models conducted in chapter four.

3. Outline of the Thesis

This section presents a brief summary of the contents and results of the thesis. A more detailed explanation of the relationship between this study and the existing literature is provided in the introduction to individual chapters.

Chapter one presents an overview of the analytical literature on the monetary approach to the balance of payments under fixed and floating exchange rates, and also of a Flood and Garber style model of a speculative attack. It divides into three sections. The first reviews the operation of the monetary approach under fixed rates, the framework in which the theory was originally developed, concentrating on the stock-flow dynamics imposed by private sector stock adjustment. The central role of the hoarding function as a link between monetary and real sectors, as featured in the earliest analytical models of monetary approach dynamics (as developed at the I.M.F. and by Robert Mundell) is stressed. The section concludes by demonstrating that this stock adjustment behaviour also reconciles the Keynsian and monetary approach expressions for short run balance of payments outcomes. The second section examines this stock adjustment behaviour under floating exchange rates and in the presence of rational expectations . It emphasises that a monetary approach model must include the dynamics imposed by current account imbalances which reflect private sector stock adjustment. Thus the models reviewed are those in the portfolio balance-current account tradition developed by Kouri (1976). The third section presents the

Flood and Garber method for determining the timing of a speculative attack. It highlights the difference in the operation of their model pre and post-collapse from the monetary approach models in order to demonstrate why the tractability of the Flood and Garber method breaks down in the presence of the monetary approach.

Chapter two develops a monetary analysis of a Keynsian open economy model. It demonstrates that adopting the monetary approach to the balance of payments does not commit one to a specific characterisation of the economy by providing a synthesis of an expenditure and a monetary based approach in the spirit of Montiel (1985,1986). It particularly emphasises the hoarding function as a link for equilibria derived from goods and from monetary flows.

The country is assumed to be completely specialised in the production of exportables and consumes both its own product and a foreign produced good. The private sector can accumulate money, the only asset, from either a balance of payments surplus or an (endogenous) budget deficit. On the supply side the nominal wage is pre-determined by contract, and employment is demand determined according to the producer real wage. Wages gradually adjust to clear any excess demand/supply for labour. In the long run the labour market can clear at various levels of employment since the supply of labour responds to the consumer real wage. Any shock that alters the domestic price level relative to the consumer price index, that is any shock that causes a sustainable change in the real exchange rate, will lead to a permanent change in employment and output.

The chapter divides into three sections. The first section presents the short run results, as derived both from an orthodox Keynsian aggregate demand-aggregate supply framework and from a monetary approach based around the "fundamental equation". The second section examines the dynamics and stability of the model. The state variables are wealth and wages; the wealth dynamics may be derived from net private sector acquisition implied by equilibrium goods and expenditure flows, or directly from the desired flow demand for money. The third section solves for the steady state results. These results exhibit the propositions associated with "global monetarism" vis-a-vis the long run neutrality of devaluation or step increase in domestic credit. However, permanent real changes do emerge from three structural shocks - a rise in the level of government expenditure on home goods, a shift reduction in the demand for exports, and a shift reduction in the supply of labour. These structural factors ultimately determine the rate of credit expansion and therefore, with zero private sector accumulation, of reserve loss. On the goods focused approach, the balance of payments deficit is ascribed to the budget deficit "crowding out" net exports at an overvalued real exchange rate. The overvaluation is associated with "excessive" employment and output, but since labour market equilibrium and private sector balance prevail, the external deficit exerts no deflationary pressures. On the monetary approach argument, attainment of the desired money stock eliminates further flow demand for money. The incipient excess flow supply of money from credit expansion is removed by an equivalent rate of reserve loss from the balance of payments deficit.

Chapter three presents an analysis of a speculative attack within a monetary approach model. Krugman's graphical method of linking the pre and post collapse regimes is adopted. We extend Krugman's analysis by studying the collapse of the model used in chapter two, where that model is modified with the introduction of a foreign asset (foreign currency) and by assuming that the wage instantaneously clears the labour market.

The first half of chapter three deals with an exogenous budget deficit. The model is studied under fixed and floating exchange rates. Faced with the two real shocks of chapter two (a reduction in export demand and in labour supply), the economy evolves to the same real equilibrium under either exchange rate regime, and there is no long run alteration in portfolio composition. The fixed regime, which exhibits a self-righting balance of payments mechanism, will survive given that initial reserves are sufficiently large to cover the temporary deficit.

However, when subject to a policy of credit expansion the fixed regime, à la Khan and Lizondo (1987), evolves to an equilibrium with higher wealth (and therefore an appreciated real exchange rate and higher output) and a permanent balance of payments deficit. The floating regime, à la Calvo and Rodriguez (1977), returns to the initial real equilibrium (with current account balance) but with portfolio composition shifted towards foreign currency. The fixed regime must collapse, and a speculative attack links the two regimes via a stock transfer of domestic for foreign currency between the private sector and the government such that the exchange rate does not jump when the floating regime commences. There is thus no change in total real wealth on transition (so the real exchange rate remains overvalued) and the post-collapse regime inherits the external deficit, gradually eliminated as wealth returns to its initial level. The post-collapse dynamics reflect the "acceleration hypothesis" of the monetary approach under floating rates - current account deficits are associated with a depreciating exchange rate (relative to trend). The section on the speculative attack concludes by drawing the distinction between attacks in monetary approach models of stock adjustment and attacks in intertemporal optimisation models (which include solutions for the time of attack). It is pointed out again that it is the stock adjustment dynamics of the monetary approach which prohibit a tractable analytical solution for the timing of a speculative attack.

The second half of the chapter further extends the speculative attack literature by re-introducing the endogenous budget deficit of chapter two. The three structural shocks analysed in chapter two are examined (i.e.: fiscal expansion along with reductions in export demand and labour supply). The steady state of the fixed regime involves the same stock of wealth as in chapter two and thus associated real exchange rate and output levels that lead to a permanent balance of payments deficit. Under floating exchange rates wealth must fall further since the current account must balance in the steady state. The presence of depreciation in the floating regime's steady state also requires a shift in portfolio composition towards foreign assets (if the degree of currency substitution is sufficiently high the exchange rate initially jumps to such an extent that the adjustment process involves a current account surplus and accumulation of foreign currency under permanently floating rates).

The collapse of the fixed regime is again inevitable and precipitated by a speculative attack. The attack again involves an initial "overshoot" in the portfolio switch towards foreign currency since the level of wealth at the time of transition implies the floating regime inherits an external deficit, and therefore involves subsequent reductions in foreign currency holdings.

Chapter four completes our analysis of speculative attacks by simulating the models to determine the time at which the fixed regime will collapse. The case of the three structural shocks (fiscal expansion, reduction in export demand and labour supply) are examined in the context of both the sticky wage model of chapter two and the flexible wage version in (the second half of) chapter three.

The search procedure adopted is to commence the post-collapse regime at some time z with those domestic and foreign currency stocks that would result from terminating the fixed regime in a speculative attack at time z. These stocks are derived from the levels to which domestic and foreign currency (accumulated in fixed proportion whilst the exchange rate remains pegged) have evolved by time z adjusted by the transfer of reserves remaining at time z from domestic to foreign currency. The time at which commencing the floating regime with these initial stocks preserves portfolio equilibrium with no required jump in the exchange rate is the time at which the attack occurs.

The simulations are run for two values of the parameter δ, which measures the responsiveness of net exports to the real exchange rate (the choices are $\delta=2.5$ and $\delta=0.01$ - so in the latter case the Marshall-Lerner condition is only just met). Thus twelve cases of collapse are examined in all (three shocks delivered to two models, run on two parameter sets).

All results comply with the qualitative aspects of adjustment suggested by the theoretical analysis (and the steady state results are cross checked against the analytical expressions). In particular the smooth linking of all state and endogenous variables at the moment of attack and the acceleration hypothesis description of post-collapse dynamics are confirmed.

The principal results for the collapse times are as follows. Firstly the fixed regime always collapses earliest when hit by the fiscal shock (even when reserves are more rapidly depleted following the export shock, as is the case when $\delta=0.01$). Secondly the relative collapse times are significantly altered by the choice for δ - when $\delta=0.01$ collapse is delayed for the fiscal and wage shocks but occurs considerably earlier for the export shock. Finally the presence of sticky wages is found to delay collapse for the fiscal and wage shocks and to precipitate collapse in the case of the export shock. In interpreting these results we draw on the analytical considerations outlined in earlier chapters. In particular the synthesis of the monetary and expenditure based approaches to the balance of payments made in chapter two is found useful in this respect, and we thus return to our early concerns of linking the monetary approach to the balance of payments to economic structure.

4. Summary

The principal contributions of this thesis to the literature are perceived to be as follows. Firstly the demonstration that private sector stock adjustment behaviour is not only the essential element of the monetary approach to the balance of payments but the link between Keynsian and monetary approaches to the open economy. Secondly an extension of the literature on collapsing exchange rate regimes within a monetary approach model, and in particular an extension to the case of an endogenous budget deficit with an analysis of collapse induced by a change in economic structure. Finally we demonstrate that the adjustment dynamics that are the essence of the monetary approach also preclude an analytically tractable solution for the timing of a regime collapse, and develop a method that uses simulation to derive the collapse time in a monetary approach model.

CHAPTER ONE

THE MONETARY APPROACH UNDER FIXED AND FLOATING EXCHANGE RATES AND SPECULATIVE ATTACKS

INTRODUCTION

This chapter reviews the analytical literature on the monetary approach to the balance of payments, under fixed and floating exchange rates, and presents the Flood and Garber (1984) solution for the timing of a speculative attack.

The chapter divides into three sections. The first section sets out the fundamental stock-flow dynamics under fixed rates, the framework in which the monetary approach originated. The accounting framework that links private, overseas and public sectors is set out, and we then go on to consider their inter-relationships. First the essence of the monetary approach, the stock-flow dynamics imposed by the process of private sector stock adjustment to a desired long run relationship between assets, income and expenditure, is taken up. The hoarding function is introduced. This provides a simple analysis of the private sector's behaviour during phases of stock disequilibrium. It featured in the first analytical models developed in the monetary approach tradition at the I.M.F. (Polak (1957), Prais (1961)) and continues to provide the heart of all monetary approach models. In the next section the role of relative prices is introduced in an examination of the relation between private sector stock adjustment, alternative adjustment mechanisms in the home goods market, and the balance of payments. This draws on the analysis of Mundell (1968). In section 1.1.4. the public sector is introduced. We emphasise the point made by Parkin (1974) and Currie (1976) - since the stock-flow dynamics derive from private sector stock adjustment, the monetary approach is fully consistent with chronic balance of payments deficits which are matched by budget deficits. The monetary approach entails no intrinsic self-righting mechanism for the balance of payments. The section on fixed rates is concluded by focusing on the balance of payments in the short run. Both Keynsian and monetary approaches are examined. Two points are emphasised - firstly that it is the structure of the model, rather than the "fundamental equation" of the monetary approach per se, that determines the balance of payments, as stressed in Rhomberg and Heller (1977) and Montiel (1985). Secondly, although the analysis is short run in nature, the two approaches are connected by the stock adjustment behaviour of the private sector, as captured by the hoarding function.

The second main section of the chapter deals with models of the monetary approach operating under floating exchange rates in the presence of rational expectations, as developed by Kouri (1976). These models combine the asset market determination of the exchange rate at a point in time with the implications of the current account as a source of exchange rate behaviour over time. The current account dynamics correspond to the stock adjustment behaviour of the private sector in moving towards its desired stock of overall wealth, whilst the desired composition of wealth in agents' portfolios determines the exchange rate. Rational expectations reconcile continuous portfolio balance and current account adjustment - since the stocks of assets are pre-determined, and the time path of the exchange rate is determined by the adjustment to stock-flow equilibrium, there is (given the assumption of convergence) a unique level for the exchange rate that will enable portfolio balance to hold continuously during this adjustment. Thus the exchange rate does not play a role analogous to that of reserves under fixed rates. Reserve flows equilibrate the flow money market, with the flow demand for money derived directly from private sector stock adjustment behaviour; under floating rates the "flow demand equations" for individual assets in the portfolio are unspecified - the stock adjustment process relates to overall wealth.

Finally section 1.3. considers the literature on the timing of collapsing exchange rate regimes. This literature works by using the speculative condition of no exchange rate jumps to link fixed and floating rate models. However it is argued that the model used, which is based on Flood and Garber (1984), lies outside the monetary approach literature by excluding stock adjustment dynamics. By relating the Flood and Garber method to the previous analysis of monetary approach models, we explain why it loses tractability once these stock adjustment processes, that lie at the heart of the monetary approach, are re-introduced.

1.1. THE BALANCE OF PAYMENTS UNDER FIXED EXCHANGE RATES: SECTORAL EQUILIBRIA AND ADJUSTMENT

1.1.1. The Accounting Relationships

As is the case for closed economy modelling, where models are often built by functional specification of the components of national income, accounting relationships can play an important heuristic role in motivating open economy theory. For the open economy, particular interest focuses on relating the flows of the national income accounts to changes in stock holdings of the various sectors, with a surplus in any sector yielding net acquisition of financial assets by that sector.

Thus, from the familiar identity Y = C + I + G + X - M, adding and subtracting taxation T, and noting the definition of private sector saving as S = Y - T - C, we are able to re-express the relationship in terms of the "budgets" of the overseas, private and public sectors. Representing the net acquisition of financial assets by these sectors as $NAFA_o$, $NAFA_p$ and $NAFA_g$ respectively, we have:[1]

$$B = (X - M) = (S - I) + (T - G) \qquad (1.1)$$
$$NAFA_o = NAFA_p + NAFA_g$$

In this thesis, investment receives no independent analysis, and the label C henceforth stands for overall private sector expenditure, so that any positive saving, $S > 0$, yields net private sector accumulation. Thus we re-specify (1.1) as:

$$B = (X - M) = (Y^d - C) + (T - G) \qquad (1.1a)$$

$$NAFA_o = NAFA_p + NAFA_g$$

where saving is replaced with $S = Y^d - C$, with Y^d being disposable income, $Y^d = Y - T$.

For the present, we assume the only financial asset that any sector can accumulate is money.(2) The sources of money, denoted H, in the open economy are foreign reserves, R, and domestic credit, D:(3)

$$H = R + D \qquad (1.2)$$

Thus when the overseas sector is in surplus ($X > M$) reserves are accumulated $\dot{R} > 0$; a private sector surplus ($Y^d > C$) yields accumulation of private sector money balances $\dot{H} > 0$; a budget surplus for the public sector ($T > G$) yields $\dot{D} < 0$. Thus, combining these considerations with the national income relationships, we have:

$$B = (X - M) = (Y^d - C) + (T - G) \qquad (1.3)$$

$$\text{Current Account} = \text{Priv. Saving} + \text{Govt. Surplus}$$

$$NAFA_o = NAFA_p + NAFA_g$$

$$\dot{R} = \dot{H} - \dot{D}$$

In the next three sections, 1.1.2. to 1.1.4., we concentrate on the modelling of these three sectors and the interactions between the budget constraints and general macroeconomic behaviour.

1.1.2. The Private Sector

The private sector's behaviour provides the corner-stone to monetary analyses of the balance of payments, since it drives the process of adjustment to stock-flow equilibrium. In the present section, we provide an analysis of this behaviour within what might be considered a "pure" monetary approach to the balance of payments model. However, the analysis of private sector asset-expenditure decisions posited here is the basis for all the stock-flow models presented in this thesis.

A "pure" monetary approach to the balance of payments combines this stock-flow interaction with a simple monetarist macroeconomic model, of a type utilised by many contributors to the Frenkel and Johnson (1976) volume which did much to revive interest in the monetary approach. This macroeconomic model posits a world of perfectly competitive markets with prices instantaneously eliminating excess demand in flow markets. These instantaneous adjustments preclude quantity adjustments in goods and factor markets, so output is fixed at its full employment level, and since all markets are perfectly competitive arbitrage behaviour means all agents face perfectly elastic demand curves, so that each good fetches the same price wherever it is produced and sold (i.e.: Purchasing Power Parity):

$$Y = Y \qquad (1.4)$$

$$P_i = EP^f{}_i \qquad (1.5)$$

As noted in Bruce and Purvis (1985), i indexes all goods, so that the presence of continuous PPP effectively yields a one good world (thus we drop the goods index i henceforth - note also that the exogenous foreign price level is henceforth fixed at unity).

Hahn (1977), reviewing the Frenkel and Johnson volume, highlights the simplicity with which one can proceed from this specification of the real sector to the monetary approach result of a one to one correspondence between excess demand (supply) of money and balance of payments surpluses (deficits). This follows from the budget constraints of all agents which requires:

$$ED_g + ED_m - B = 0 \qquad (1.6)$$

where ED_g, ED_m are excess demands for goods and money respectively, and $B = X - M$ is the balance of payments. Since it has been assumed that instantaneous market clearing maintains $ED_g = 0$, the monetary approach conclusion ($B = ED_m$) follows directly.

However, as Hahn acknowledges, the essence of the monetary approach is its highlighting of the joint nature of agents' asset-expenditure decision, which (as we shall see) can be combined with various macroeconomic specifications. Thus we proceed to outline the nature of this choice.

Following the spirit of the monetary approach, it is assumed that the demand for assets accords with the quantity theory. Thus the desired stock of real balances is:

$$H^*/P = kY \qquad (1.7)$$

It remains to link this asset modelling with expenditures, and here we invoke what Dornbusch (1973) has dubbed the "hoarding function". This function, which relates monetary (stock) disequilibria to expenditures (flows) lies at the heart (albeit frequently implicit) of all monetary approaches to balance of payments modelling, as acknowledged in the following quote from Krueger (1983):

> One way or another, all neo-classical models of the payments mechanism for current account posit expenditure functions of a form such that expenditures increase or decrease relative to income as desired cash balances fall short of or exceed actual money holdings.
> Krueger, p.41.

In particular, it is interesting to note that this relationship was central to all the early analyses of open economies with a monetary sector made by the I.M.F., some years before the Frenkel and Johnson volume,[4] and has continued to play a central role in I.M.F. analysis - see Polak (1957), Prais (1960), Keller (1980), Montiel

(1985, 1986). Thus the expenditure function is specified as:

$$C = Y + \theta(H^{s}/P - H^{*}/P) \qquad (1.8)$$

$$= \beta Y + \theta H/P \qquad (1.8a)$$

where the relationship $\beta=1-\theta k$ provides the link between the hoarding function and an orthodox "Keynsian" consumption function with a real balance effect. The hoarding function derivation of (1.8a) emphasises that the real balance effect on consumption in this model is a direct consequence of stock disequilibrium - by using excess wealth to raise their level of consumption agents are reducing assets towards their desired stock.

Finally, by noting the accounting relationships(6) for the balance sheet $\dot{H} = \dot{R} = PB$, and goods flows $Y = C + B$, we derive a simple dynamic equation for accumulation from private sector savings:

$$B = S = Y - C = \theta(kY - H/P) \qquad (1.9)$$

$$\dot{H} = \dot{R} = PB = \theta(kPY - H) \qquad (1.10)$$

Thus the system is clearly stable as $\theta > 0$ - from any inherited wealth stock H_0, the economy converges back to H^{*} at the rate θ as saved income is used to clear the excess stock demand for money. The time path for wealth is:

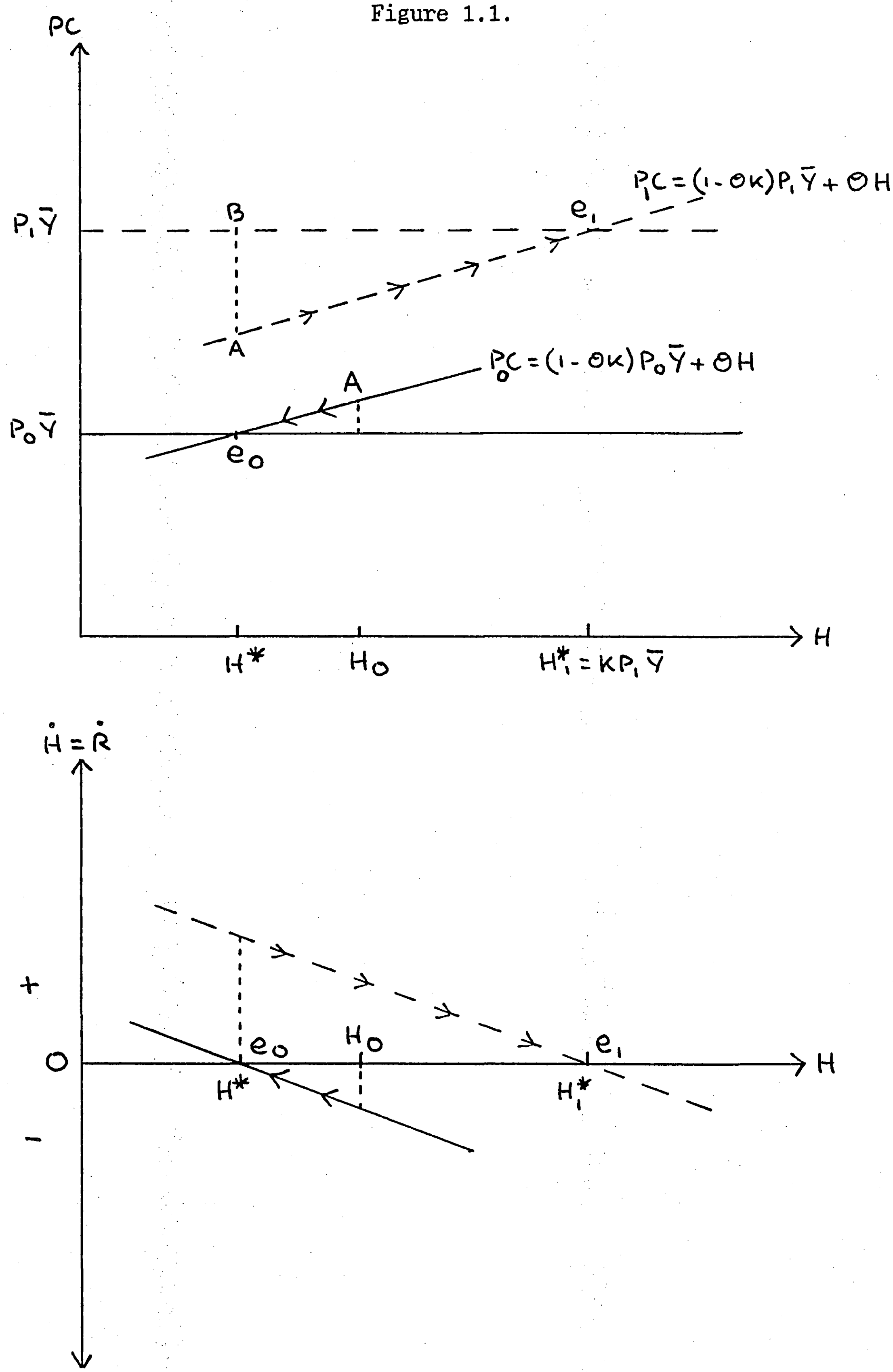
$$H_t = H_0 + (H_t - H^{*})\exp^{-\theta t} \qquad (1.11)$$

Suppose from initial equilibrium e_0 a monetary expansion raises the stock of wealth from H^* to H_0, then the convergence of the system back to equilibrium is illustrated in figure 1.1.

In the top half the expenditure function (1.8) is shown - it has slope θ, the proportion of excess money stocks diverted into demand for goods. The excess of absorption over income at point A measures the balance of payments deficit shown in the bottom half. However, the higher real balances at H_0 (recall the price level is fixed by (1.5)) only temporarily raise expenditures above their equilibrium level as the excess supply of money is gradually eliminated via the balance of payments deficit until the original equilibrium is restored.

Figure 1.1. also shows how the same stock-flow interaction process determines the response of the balance of payments to a devaluation. From the initial equilibrium at point e_0, a devaluation, via purchasing power parity, requires an instantaneous and equal increase in domestic prices from P_0 to P_1 - causing the various schedules to shift up as illustrated. The devaluation thus deflates real balances, given the pre-determined initial stock of nominal wealth H^*, producing an excess demand for money. This implies a reduction in expenditure which produces an excess of income over absorption, measured by BA which constitutes the initial balance of payments surplus. However, the surplus is only temporary, as agents use the excess of income over absorption to accumulate wealth to H^*_1 (the new desired level) by running a balance of payments surplus.

Figure 1.1.



PC
$P_1 \bar{Y}$
B
e_1
$P_1C = (1-\Theta K)P_1\bar{Y} + \Theta H$
A
$P_0C = (1-\Theta K)P_0\bar{Y} + \Theta H$
A
$P_0\bar{Y}$
e_0
H
H^*
H_0
$H_1^* = KP_1\bar{Y}$
$\dot{H} = \dot{R}$
+
0
-
e_0
H_0
e_1
H
H^*
H_1^*

The accumulated wealth, via the real balance effect, raises expenditures until the income absorption discrepancy, and hence the balance of payments surplus, is eliminated. Hence a devaluation only produces a temporary improvement in the balance of payments.

The above describes the operation of the monetary approach in its most classical form. However, a number of points warrant emphasis. Firstly, it is unnecessary that the analysis be "essentially monetary". The evolution of the balance of payments can be equally well described by specifying a consumption function with a real balance effect, and utilising the accounting relationships of national income flows. The monetary focus (working via excess money stocks and the financial balance sheet) may appear preferable to the extent that it places a clearer emphasis on the issue of stock adjustment. Secondly the structure of the above model offers the monetary focus additional primacy since analysis of the balance of payments can be conducted in exclusively monetary terms due to the simplicity with which the real sector is specified. Conversely, as one specifies more elaborate goods and factor market structures, it becomes necessary to account for the spill-over effects of stock disequilibrium on flows, and the expenditure approach becomes increasingly attractive. Finally the above stock-flow dynamics are intrinsic to the private sector rather than the balance of payments per se. It is only when the public sector is excluded that a private sector surplus necessarily entails a balance of payments surplus, and adjustment to desired asset stocks by the private sector necessarily entails a self-righting balance of payments mechanism.

1.1.3. The Overseas Sector

In the previous section, no independent analysis of the determination of trade flows was offered. As the model presented assumed continuous purchasing power parity (the "as if" one good world) there was no role for relative prices in determining the flows of exports and imports. Here we introduce goods that are differentiated in demand to allow a part for their relative price in the adjustment process.

The choice of goods disaggregation we adopt in this thesis is that for what Branson (1983a) terms the "semi-small" country - the domestic economy is completely specialised in the production of exportables, and consumes both the home produced good and importables which are available in the world market in perfectly elastic supply. This is the disaggregation sometimes referred to as the "Mundell-Fleming" specification, and has been frequently used in Keynsian demand determined and aggregate demand/aggregate supply models.

If we denote the domestic currency price of the foreign produced good by P^f; the domestic currency price of foreign currency (the exchange rate) by E; and the domestic currency price of the home good P, then the relative price of the imported good faced by domestic consumers and producers is:

$$\sigma = EP^f/P \qquad (1.12)$$

which is often referred to as the "real exchange rate". (In the present goods disaggregation the "terms of trade" - the price of exportables over importables - is simply the inverse of σ).[6]

A real depreciation, a rise in σ, induces domestic consumers to substitute out of imports and into the home good, whilst exports become more competitive abroad. These substitution effects will improve the trade balance if they are sufficient to outweigh the revaluation of the pre-existing export and import flows (since a given quantity of imports becomes more expensive) caused by depreciation - this is the Marshall-Lerner condition. Formally, the trade balance in terms of domestic output is defined by $B = X - \sigma M$, thus, starting from initial trade balance, a real depreciation yields a trade surplus iff:

$$dB/d\sigma = \delta = dX/d\sigma - M - \sigma dM/d\sigma \qquad (1.13)$$

$$= M(e_x+e_m-1) > 0$$

where e_x and e_m are the (absolute values of) elasticities of demand for exports and imports with respect to the real exchange rate respectively.

Historically some controversy arose from comparing the above considerations in determining the balance of payments as opposed to the approach of the previous section - the "elasticities" versus "income-absorption" approaches. However, as noted by Michaely (1960), the incorporation of a real balance effect (as present in the previous section) provides a resolution of the two approaches. (This point is pursued in a short run context in section 1.1.5.). Thus we incorporate these relative price effects into the stock-flow model presented earlier in the following macroeconomic model:

$$H^*/P = kY \qquad (1.7)$$

$$C = Y + \theta(H^S/P - H^*/P) \qquad (1.8)$$

$$M = m(C, \sigma) \qquad m_1 > 0,\ m_2 < 0 \qquad (1.14)$$

$$X = x(z, \sigma) \qquad x_1 < 0,\ x_2 > 0 \qquad (1.15)$$

Thus imports constitute some proportion of overall expenditure, with that proportion falling with any depreciation; whilst there is a downward sloping demand for exports subject to a negative shift factor, z.

As before, we abstract from the public sector, so that the dynamics of private sector accumulation are associated one for one with the balance of payments. However, here the assumption of instantaneous clearing of goods markets is abandoned, and instead gradual price or quantity adjustments to excess demand for domestic goods, which is equal to (C + B - Y), are posited:

$$\dot{H} = P(X - \sigma M) \qquad (1.16)$$

$$\dot{P} = \alpha(C + B - Y),\ \alpha > 0 \qquad (1.17a)$$

$$\dot{Y} = \beta(C + B - Y),\ \beta > 0 \qquad (1.17b)$$

Thus a second order dynamic system is obtained, constituted by (1.16) and (1.17a) or (1.16) and (1.17b),[7] illustrating what Mundell (1961) terms the "price-specie flow mechanism of Hume" and the "income-specie flow mechanism of Keynes".

These systems link the stock-flow aspects considered earlier to a more explicit consideration of the goods market. As noted in Mundell (1968), in such a model:[8]

> Three conditions must be met before the system can be said to be in equilibrium. Firstly, the supply of money must be equal to the demand for money; second, the balance of payments must be in equilibrium; and third, the demand for domestic output must equal the supply of domestic output. If the first condition were not met there would be a tendency for spending to exceed or fall short of income; if the second condition were not met the money supply would be increasing or decreasing; and if the third were not met the domestic price level would be rising or falling.[9]
> Mundell, p.114.

The two systems in figures 1.2.(a) and 1.2.(b). Consider the price-specie flow mechanism in figure 1.2.(a). The HH locus indicates monetary (stock) equilibrium, where the supply of money equals demand as specified by the quantity theory in (1.7) (the slope of this locus is 1/kY) so that points of stock-flow equilibrium are situated along HH. The external balance locus $\dot{H} = 0$ has slope $\theta m_1/(\theta m_1 - \delta)$ (where δ is defined in (1.13)). Given P, a rise in H

Figure 1.2.(a)

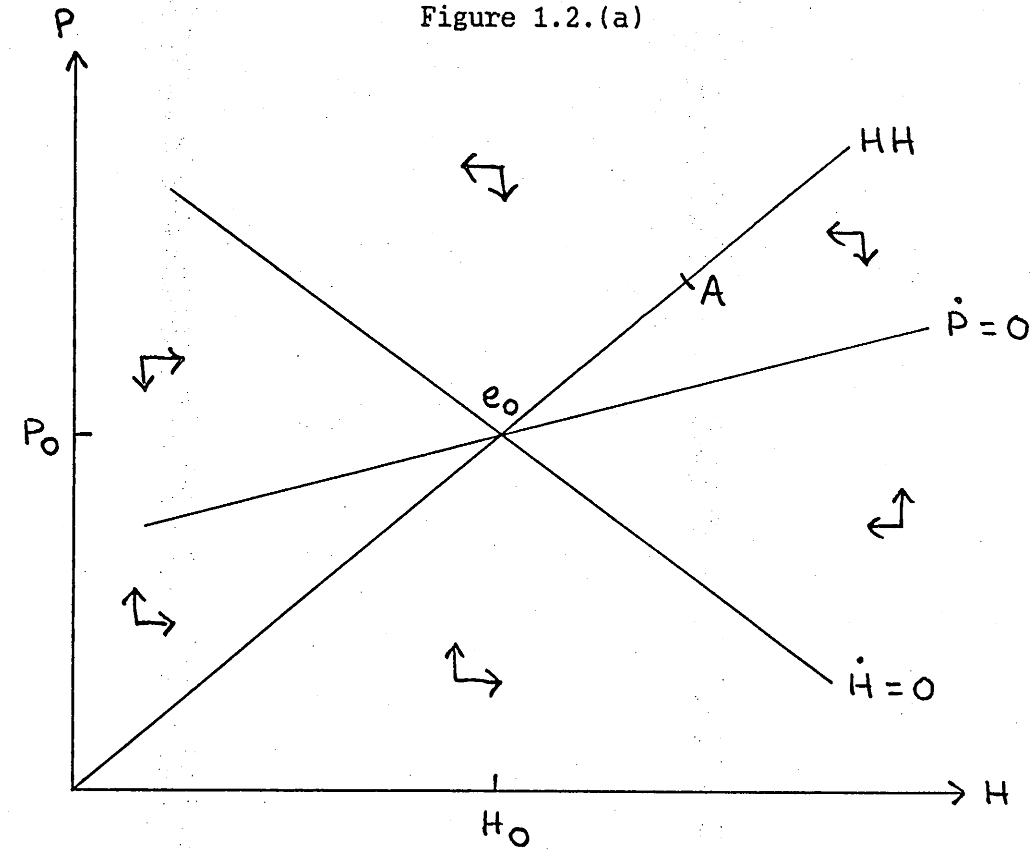
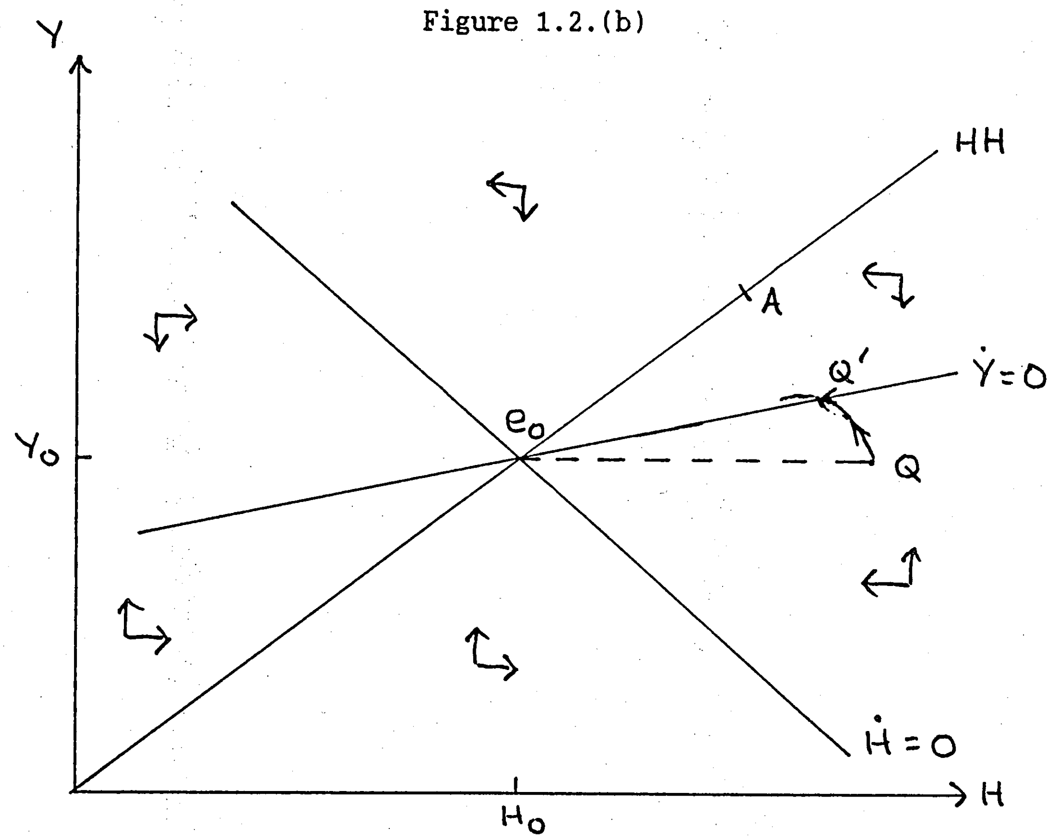


Figure 1.2.(b)



clearly worsens the balance of payments via a real balance effect which raises imports; an equivalent rise in P would eliminate this effect. However, as drawn, a fall in P is required due to the substitution effect in favour of domestic goods as they become more competitive (this is sometimes referred to as the "Marshall-Lerner plus" assumption - in this case the assumption that $\delta > \theta m_1$).

The internal balance locus $\dot{P} = 0$ is clearly positively sloped (with gradient $\theta(1-m_1)/(\theta(1-m_1)+\delta)$) - given P, higher levels of H produce excess demand for goods via a real balance effect, requiring a rise in P to eliminate this excess demand by offsetting the real balance effect and inducing substitution away from domestic goods. Furthermore, the internal balance locus must be flatter than the monetary equilibrium locus HH. To see this, consider a move from initial equilibrium e_0 to point A, which preserves monetary equilibrium, and therefore equality of income and absorption, C = Y. There are thus no real balance effects to consider at point A (according to the nature of the hoarding function); however, the move from e_0 to A involves real appreciation, which, given $\delta > 0$, produces a balance of payments deficit. Hence, at point A, there must be excess supply of goods, that is $(C + B - Y) < 0$, since at point A we have C = Y and $B < 0$, implying a falling price level. An increase in wealth is required to boost demand and obtain the $\dot{P} = 0$ locus. This argument also shows why, if the Marshall-Lerner condition does not hold, the stability of the price-specie adjustment mechanism breaks down, as emphasised in Milani (1989). (In this case the $\dot{P} = 0$ locus must be steeper, and the, positively sloped, $\dot{H} = 0$ locus flatter than HH, implying instability in regions of excess demand/supply and external surplus/deficit).

The statics of this model are readily seen as points on the stock-flow equilibrium HH locus. A devaluation (negative export shock) shifts $\dot{P} = 0$ and $\dot{H} = 0$ up (down) from original equilibrium at e_0, initially creating excess demand for goods and a balance of payments surplus (excess supply and deficit), causing a process of rising (falling) levels of H and P.[10]

In figure 1.2.(b) the case of quantity adjustment to excess demand for domestic goods is shown. The system is assuredly stable (stability being independent of δ). Higher levels of both income and wealth raise imports, so $\dot{H} = 0$ must be negatively sloped (the slope is $-\theta/(1-\theta k)$).[11] As for internal balance, given the leakages of imports and savings, a rise in income is not matched by an equal rise in expenditure on domestic goods, requiring a higher level of wealth to eliminate excess supply (thus $\dot{Y} = 0$ has the positive slope $\theta(1-m_1)/(m_1+\theta k(1-m_1))$. The $\dot{Y} = 0$ locus must also be flatter than HH by the argument outlined earlier - again by comparing points such as e_0 and A.

This model shows that even in an apparently "Keynsian" world with wages and prices fixed, and analysis conducted in income-expenditure terms, there is a self righting balance of payments adjustment mechanism, so long as one incorporates a real balance effect on expenditures. In particular, consider a "Hume style" experiment of an increase in the money supply, taking the economy to a point like Q. At point Q there is an excess supply of money, some of which is diverted to expenditures so there is also an excess demand for goods and a balance of payments deficit. The deficit stimulates decumulation, reducing expenditures until internal balance obtains at a point such as Q'. However, at Q', the excess supply of money has not been eliminated and is offset by a balance of payments deficit (the classic monetary approach relationship), so adjustment continues, as wealth will still be falling according to the stock-adjustment rule.(12)

1.1.4. The Public Sector

It has been seen in the previous sections that whether specifying a Keynsian or a Monetarist style model, stock-flow dynamics produced a self-righting balance of payments adjustment mechanism. However, this is only a special case for stock-flow equilibrium in an open economy. The driving force behind these dynamics is the private sectors adjustment towards its desired asset stock, accumulation ceasing once this is attained - thus the condition of stock-flow equilibrium is simply that savings be zero, so that private sector wealth is constant.

From the accounting relationships the condition that private sector savings be zero is the condition that the public sector deficit (surplus) be equal to the balance of payments deficit (surplus):

$$(G - T) + (X - M) = 0 \qquad (1.18)$$

$$(G - T) = \dot{D} = (X - M) = \dot{R} \gtrless 0$$

Thus any rate of change in reserves is consistent with a given stock of money if it is offset by an equal rate of change in domestic credit. Thus although the stock-flow dynamics determine the equilibrium level of the money stock, they impose no conditions on its composition.(13)

The condition (1.18), which is simply a general statement of a monetary approach stock-flow equilibrium, is often associated with the fiscal approach to the balance of payments.(14) Nevertheless it is an entirely general result for any type of model specification, since we have seen that the stock adjustment behaviour of the private sector can be incorporated in a variety of macroeconomic specifications. The point that private sector balance is compatible with any (offsetting) non-zero public and overseas sector balances tended to be overlooked by early proponents of the monetary approach since their models often assumed output fixed at a given full employment level and, by abstracting from explicit consideration of expenditure functions, ignored the effect of fiscal policy on the home goods market. However, in a more general macroeconomic model, allowing for variable output, the fiscal approach relationship becomes more relevant since tax revenue is often linked to the level of economic activity, a point emphasised by Currie (1976) in his review of the Frenkel and Johnson volume:

> ... in the long run the relationship between the money stock and domestic credit must be regarded as endogenous, primarily determined by real factors. This reflects the fact that a government budget deficit matched by a balance of payments deficit need not distort private sector portfolio equilibrium, merely requiring a run down in government held international reserves. ... A rigorous insistence on the analysis of full stock-flow equilibrium must result in a recognition that domestic credit is an endogenous variable and largely determined (in relation to the money supply), in the long run, by real factors.
> Currie, p.521.

The consequences of the endogeneity of the composition, as well as the level, of the money stock in a fixed exchange open economy are considered at length in later chapters.(15)

1.1.5. Monetary and Expenditure Based Approaches to the Balance of Payments in The Short Run:

One of the most frequently quoted passages in the literature on the balance of payments is the following extract from the Frenkel and Johnson introductory essay to the 1976 volume on the monetary approach:

> ... the monetary approach should in principle give an answer no different from that provided by a correct analysis in terms of the other accounts.
> Frenkel and Johnson, p.22.

The point has been addressed in various syntheses of Keynsian and monetary approaches (Frenkel et al (1980), McCallum and Vines (1981), Montiel (1985)). Here we approach the issue slightly differently by determining the balance of payments separately in terms of the trade and monetary accounts (à la Khan et al (1986) and Khan and Montiel (1989))[16] and then showing that the hoarding function ensures the similarity of the two methods.

From the accounting relationships reviewed in section 1.1.1., we know that the balance of payments can be equivalently expressed in terms of trade or monetary flows. An expenditure approach seeks to explain the trade flows of exports and imports as in (1.19); whilst a monetary approach examines flows of money demand and supply to obtain an outcome for the reserve flows required to equilibrate the money market, as expressed in (1.20)-(1.22):[17]

$$B = X - M \qquad (1.19)$$

$$DH^s = DR + DD \qquad (1.20)$$

$$DH^s = DH^d = DH \qquad (1.21)$$

$$DR = DH - DD \qquad (1.22)$$

Since the two relationships express the same thing, it is clear the results obtained for the balance of payments should be invariant to the choice of approach.

However, the alternative expressions for the balance of payments in (1.19) and (1.22) emphasise that there is indeed a prima facie need to demonstrate that the outcome for the balance of payments is independent of the particular account through which one chooses to express it, as acknowledged by Frenkel et al (1980).

By positing conventional determinants for the demand for money, exports and imports, apparent contradictions arise. Consider, ceteris paribus, the effect of a rise in income - the demand for money rises in (1.22), implying a balance of payments surplus; imports rise in (1.19), implying a deficit. Similarly consider, ceteris paribus, the effect of a rise in price - again the demand for money rises, whilst exports fall and imports rise. Furthermore, moving away from this partial equilibrium framework to a casual consideration of macroeconomic effects seems equally troublesome. A positive expenditure shock would conventionally raise both price and income, again producing apparently different balance of payments outcomes - a deficit by the Keynsian expression (1.19); a surplus via the "fundamental equation" of the monetary approach (1.22).

A resolution of these problems requires that the alternative balance of payments expressions be carefully related to a given macroeconomic structure. Thus we build a short run macroeconomic model based on a simplified and modified version of the model presented in McCallum and Vines (1981). The short run balance of payments outcomes in response to devaluation and fiscal expansion, as derived from expenditure and monetary approaches, are examined. We see that the merging of monetary and real sectors suggested by the hoarding function provides the required resolution.

Thus consider how the flows of exports and imports are determined in (1.19) in the following simple Keynsian model, with prices and wages fixed and expenditure flows specified as:[18]

$$C = \beta(Y - T) + \theta H \qquad (1.23)$$

$$T = tY \qquad (1.24)$$

$$G = G \qquad (1.25)$$

$$X = \delta(E - P) \qquad (1.26)$$

$$M = \Gamma C \qquad (1.27)$$

Output is demand determined according to $Y = C + G + X - M$, and the consequent flows of exports and imports determine the balance of payments through (1.19):

$$dY = \{ \delta dE + dG \} / Q \qquad (1.28)$$

$$dB = \{ \delta(1-\beta(1-t))dE - \beta\Gamma(1-t)dG \} / Q \qquad (1.29)$$

where $Q = (1-\beta(1-\Gamma)(1-t)) > 0$.

Such a model may be used as a paradigm case for demonstrating the "dual target-dual instrument" message of Keynsian demand management in the open economy. In order to preserve both internal and external balance, a unique combination for the "expenditure changing" (G) and "expenditure switching" (E) instruments of government policy is required.

From a position of internal balance, denoted $Y = Y^*$ (where Y^* is a target output level), a fiscal expansion (a rise in G) directly raises demand for home goods. Thus, in order to remove excess demand, a revaluation (a fall in E) is required to switch consumption away from home goods. The maintenance of internal balance requires that G and E be adjusted according to the negative relationship $(dE/dG)_{Y=Y*} = -1/\delta$.

However, the policy instruments must be adjusted in a positive relationship in order to preserve external balance (according to $(dE/dG)_{B=0} = \beta\Gamma(1-t)/\delta(1-\beta(1-t)))$. From a position of balance a rise in G induces higher imports and an external deficit; a devaluation (rise in E) is thus required to switch expenditure in favour of home goods. The intersection of the two schedules in E, G space determines the unique combination of instruments which achieves the two targets.(19)

We now turn from this Keynsian analysis to derive the balance of payments via the "fundamental equation" of the monetary approach, (1.22).

In adopting a monetary approach, we concentrate equilibrium in the money market, (1.21), rather than the goods market. It is thus necessary to specify explicitly the flow demand for money. We again assume that the flow demand, (1.31), rises as the actual stock of money H falls short of the desired stock H^*, specified in (1.30):

$$H^* = k(Y - T) \qquad (1.30)$$

$$DH^d = \pi(H^* - H) \qquad (1.31)$$

Recalling the accounting relationships of section 1.1.1., we know that the net accumulation of financial assets by the private sector, represented in this single asset model by the flow of money DH, must be equal to private sector savings and can derive from the public and overseas sectors:

$$DH = S = (G - T) + (X - M) \qquad (1.32)$$

Thus we combine the monetary sector of (1.30)-(1.31) with the previous specifications for G, T, X and M as defined in (1.24)-(1.27).[20] We substitute (1.30) into (1.31) and set the flow demand for money equal to flow supply in (1.21), and then substitute (1.24)-(1.27) into (1.32). This produces a two equation reduced form in savings DH, and output Y:

$$\begin{bmatrix} 1 & -\pi k(1-t) \\ (1-\Gamma) & \Gamma(1-t)+t \end{bmatrix} \begin{bmatrix} DH \\ Y \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ \delta & 1 \end{bmatrix} \begin{bmatrix} E \\ G \end{bmatrix} \qquad (1.33)$$

The system may be solved for the jointly endogenous variables DH and Y in terms of the exogenous variables E and G. In (1.34) below we express the solutions in matrix form:[21]

$$\begin{bmatrix} dDH \\ dY \end{bmatrix} = \frac{1}{\Sigma} \begin{bmatrix} \delta\pi k(1-t) & \pi k(1-t) \\ \delta & 1 \end{bmatrix} \begin{bmatrix} dE \\ dH \end{bmatrix} \qquad (1.34)$$

where the determinant is $\Sigma = (\Gamma(1-t)+t+\pi k(1-t)(1-\Gamma)) > 0$.

Finally, the "fundamental equation" of the monetary approach, the balance sheet identity (1.22), provides the reserve flows that are required to ensure monetary equilibrium is preserved in the face of either shock. The results are again expressed in the form of (1.34) above:

$$dDR = \Sigma^{-1} \begin{bmatrix} \delta(\pi k(1-t)+t) & -(1-\pi k)\Gamma(1-t) \end{bmatrix} \begin{bmatrix} dE \\ dG \end{bmatrix} \qquad (1.35)$$

Just as the Keynsian approach provided a paradigm case for considering management of the balance of payments in the short run, the above monetary approach constitutes what Khan, Montiel and Hacque (1986) identify as the "basic monetary model" pioneered by Polak and Robichek for use in I.M.F. "financial programming" exercises.[22] In this framework, the exchange rate remains an "expenditure switching" instrument; government expenditure is perhaps best regarded as a "savings inducing" (rather than "expenditure changing") instrument.

It can be seen from (1.34) and (1.35) that the same conclusions hold for the effects of the two policy instruments on internal and external balance.

Internal balance, or the response of output, is now determined along with the requirement of monetary equilibrium. A rise in G and E both raise the flow supply of money to the private sector via (1.32) -

fiscal expansion creates a public sector deficit, and devaluation creates an overseas sector surplus - just as both instruments raised the flow demand for domestic goods in the Keynsian analysis. Thus, in order to prevent an incipient excess flow supply of money, monetary equilibrium, (1.21), requires a rise in the flow demand for money, which, by (1.31), is associated with a rise in output.

However, given the monetary flows relationship DR = DH - DD, the two instruments have opposite effects on external balance. Devaluation raises the flow demand for money (DH > 0) and, through higher tax revenue, reduces the flow of domestic credit (DD < 0) - thus the other component of the flow supply of money, reserves, must rise to meet the incipient excess flow demand. The fiscal expansion, despite raising the flow demand for money, also brings a substantial increase in the flow of domestic credit so that an incipient excess flow supply is created, requiring a negative flow of reserves.

Finally, note that the qualitative similarity of these results for determining the short run balance of payments can be shown to be identical outcomes if (and only if) one invokes the parameter relationships $\theta = \pi$, and $\beta = (1-\pi k)$(23) - i.e.: if one explicitly links the real balance effect in a Keynsian expenditure function with the excess stock supply of money. This provides the relationship between monetary and expenditure flows suggested by the hoarding function. Setting $\theta = \pi$ ensures that that part of an excess money stock diverted towards consumption is equal to the desired reduction in the flow demand for money which also results from an excess stock. The relationship $\beta = (1-\pi k)$ equates the propensity to save from disposable income (which is $(1-\beta)$) with the propensity to hoard - since all savings must be held as money.

The above analysis shows that it is possible to link a thoroughly Keynsian approach that concentrates solely on goods market equilibrium with the analysis of the monetary approach based around the "fundamental equation". It has been seen that that link is provided by what is truly fundamental to the monetary approach - the stock adjustment behaviour of the private sector.

The analysis has also emphasised that the apparent simplicity with which the balance of payments can be analysed via the "fundamental equation" of the monetary approach is illusory - the balance of payments cannot be determined without reference to the economic structure. This point is emphasised by Montiel:

> An explanation of how the variables that affect the demand for money are themselves determined is required - that is, implementation of the monetary approach to the balance of payments requires that a structural general equilibrium model of the economy be appended. Without such a model, the "approach" is underdetermined as a theory. The important operational consequence is that it is the underlying structural model, not the "approach" per se, that determines how the balance of payments and other endogenous macroeconomic variables will respond to stabilisation policy and to exogenous shocks.
> Montiel, p.180.

In chapter two we return to the themes of this section within a more complex macroeconomic structure involving explicit consideration of the labour market, and thus allowing for the endogeneity of the price level in the short run. Once again we show the similarity of the expenditure and monetary based expressions for the balance of payments when the two approaches are linked by the hoarding function (we also show the compatibility of the two approaches in the dynamic and long run contexts). The analysis proves particularly useful in examining the simulation results of chapter four, where relating the evolution of the balance of payments to economic structure is a critical element in explaining the collapse of fixed rate regimes.

1.2. THE MONETARY APPROACH UNDER FLOATING EXCHANGE RATES

In this section we examine a floating exchange rate model that incorporates the stock-flow dynamics that we have seen to be essential to the monetary approach to the balance of payments.

These stock-flow dynamics are preserved in terms of overall wealth, but under a floating exchange rate regime the composition of wealth also plays a key role in the dynamics of the economy. Thus the single asset assumption that has been made to date is now dropped, and foreign assets (in the form of foreign currency) are introduced.

The presence of foreign denominated assets is important when the exchange rate is allowed to float since the expectation of a depreciating (appreciating) exchange rate raises (reduces) the desirability of holding stocks in the form of foreign assets. Thus the introduction of foreign assets requires analysis of the capital account of the balance of payments.(24)

It is important to note that the literature on capital flows under floating exchange rates falls into two main strands. It is common to each approach to emphasise the role of rational expectations in affecting the desirability of holding wealth denominated in domestic and foreign currency and the role of the exchange rate as an asset price (i.e.: the relative price of monies) which is thereby primarily determined by the requirements of asset market equilibrium. Thus each approach emphasises the asset market determination of exchange rates, and it is the exchange rate itself that instantaneously jumps to ensure asset stocks are willingly held. However, the two approaches differ in other respects.

One approach (as found in Dornbusch (1976), Gray and Turnovsky (1979), Buiter and Miller (1981), and Mussa (1982)) concentrates on applying exchange rate expectations to versions of the Mundell-Fleming model. This approach generally assumes perfect capital mobility (i.e.: instantaneous portfolio adjustment between foreign and domestic assets that are perfect substitutes) so that differential returns on foreign and domestic assets only arise if precisely offset by exchange rate expectations. However, the more important point vis-a-vis the monetary approach is that the Mundell-Fleming model abstracts from the wealth effects of external imbalance and stock-flow adjustments. Hence, under a fixed exchange rate regime, these models would yield a fully and instantaneously endogenous money supply and ignore the implications of a stock of wealth that deviates from its desired level, in marked contrast to the monetary approach as described in section 1.1.

The second strand of the literature (e.g. : Kouri (1976), Calvo and Rodriguez (1977), Dornbusch and Fischer (1980), and Branson and Buiter (1983)) tends to differ in its modelling of capital mobility and wealth effects. Capital mobility is viewed as instantaneous portfolio adjustments between imperfectly substitutable assets - thus differential returns do not lead to chronic capital flows, but to a readjustment of portfolio composition. This approach also associates current account imbalance with the deviation of wealth from its stock-flow equilibrium level, and takes cognisance of the implications of the current account, along with portfolio composition, for exchange rate dynamics. Hence it is this strand of the literature which we explore as being analogous with the stock-flow dynamics that the monetary approach to the balance of payments applies to fixed exchange rates.

As mentioned above, the introduction of foreign currency requires the introduction of the capital account of the balance of payments, and thus an alteration of the accounting framework that was outlined in section 1.1.1. It is assumed here that foreign residents do not hold domestic currency, so that the capital account is simply changes in domestic residents' holdings of foreign currency. Hence a net capital inflow (outflow), or a surplus (deficit) on the capital account is constituted by a net reduction (increase) in domestic residents' purchases of foreign currency - i.e.: $\dot{F} < 0$ $(\dot{F} > 0)$. Balance of payments accounting states that the sum of the change in government reserves plus the current account plus the capital account must be zero - however, when the government ceases to buy or sell foreign exchange in a freely floating regime, the balance of payments relationship reduces to the condition that a capital account surplus (deficit) must offset a current account deficit (surplus), so:

$$\dot{F} = B \qquad (1.36)$$

This relationship ensures that the foreign exchange market stays in equilibrium over time - any excess demand for foreign exchange arising from a current account deficit (net purchases of goods) is met by a capital account surplus ("net sales" of foreign currency).

However, (1.36) is an accounting identity, and should not be regarded as an ex ante equilibrium condition for the exchange rate (the price of foreign exchange), since portfolio balance models determine the exchange rate in asset rather than flow markets. Thus portfolio balance is instantaneously achieved through changes in the valuation of existing asset stocks (i.e.: changes in the exchange rate) according to arbitrage behaviour which leaves market demand equations in terms of changes in desired asset holdings undefined.

These points were emphasised by Kouri (1976), in an early analysis of the monetary approach to the balance of payments under floating exchange rates:

> The point of departure in the literature on the foreign exchange market is usually the ex post balance of payments identity. The problem inherent in this approach is that, in general, this accounting identity has no meaning as an ex ante equilibrium condition. The reason is that when using the assumption of a continuous portfolio equilibrium, the "flow demand equations" for individual assets cannot be defined. Kouri, p.153.

Hence, whereas under fixed exchange rates the monetary approach to the balance of payments can focus on the "fundamental equation" that relates the flow of assets via the balance of payments to the desired flow of assets derived from the deviation of the stock of assets from their desired level, this is not so under floating exchange rates. Although the stock adjustment behaviour of the private sector remains in terms of adjusting the overall level of wealth to its long run desired level through the current account, these stock-flow dynamics do not define the system alone. In a flexible exchange rate regime, this stock-flow process must be combined with an explanation of how the exchange rate is determined by the requirement that a desired allocation of wealth between domestic and foreign assets is maintained during adjustment.

If portfolio equilibrium is to be maintained at all points in time, the nominal exchange rate must adjust to ensure that the predetermined stocks of assets in agents' portfolios are willingly held. Thus analysis of portfolio equilibrium requires a behavioural function specifying the determination of the desired allocation between domestic and foreign denominated assets. The nature of portfolio choice between domestic and foreign currencies under floating exchange rates is described as follows by Calvo and Rodriguez (1977):

> If we let an asterisk denote the proportional rate of change in a variable (i.e.: $X^* = (1/X)(dX/dt)$), the real rate of return on domestic currency holdings is given by $-P^*$, where P is the domestic price level (however defined) while the real rate of return on foreign currency holdings is E^*-P^*. The difference between the rates of return of domestic and foreign currency is, therefore, the rate of depreciation of the domestic currency, E^*.
> Calvo and Rodriguez, p.619.

Calvo and Rodriguez thus specified their portfolio balance function as $E^* = L(M/EF)$, $L' < 0$ (where EF is the domestic currency value of the stock of foreign currency). Here, we work with a log-linear specification (where lower case letters denote logs, and a proportional rate of change is given by $\dot{x} = (dx/dt)$). Thus the portfolio balance function may be specified as:[25]

$$m - e - f = \Phi - \pi^{-1}\dot{e} \qquad (1.37)$$

$$\dot{e} = \pi(\Phi - (m - e - f)) \qquad (1.37a)$$

where $\dot{e}$ represents the actual and expected rate of depreciation by rational expectations. This formulation of portfolio balance determines the desired composition of wealth as follows: since Φ represents the desired ratio of domestic to foreign currency in the portfolio when there is no depreciation ($\dot{e} = 0$), agents will only willingly hold a ratio in excess of this (i.e.: $(m - e - f) > \Phi$) if they expect to be compensated for holding the higher proportion of domestic assets due to the anticipated appreciation of their value ($\dot{e} < 0$).

Solving (1.37) yields:

$$e_t = e_{t+T}\exp^{-\pi t} + \pi\int_0^T (m_{t+x} - \Phi - f_{t+x})\exp^{-\pi x}dx \qquad (1.38)$$

This provides a continuum of exchange rate paths, and thus requires the imposition of the transversality condition (the condition that $e_{t+T}\exp^{-\pi t} \to 0$ as $T \to \infty$). This eliminates the first term in (1.38) and thereby defines a unique and stable solution:

$$e_t = \pi\int_0^T (m_{t+x} - \Phi - f_{t+x})\exp^{-\pi x}dx \qquad (1.38a)$$

Thus the exchange rate is determined by the expected future time paths for domestic and foreign currency.

This rational expectations solution raises two important points.

Firstly, rational expectations provide a reconciliation of the asset market determination of the exchange rate at all points in time according to the portfolio balance relation (1.37) with the balance of payments flows identity (1.36). Since the equilibrium level of the exchange rate depends on the (correctly) anticipated future time path for foreign currency, the planned change in the stock of foreign currency will equal the realised ex post change in (1.36). Note also that the solution for the exchange rate in (1.38a) implies the balance of payments flow account (which defines the change in the stock of foreign currency) defines a second order differential equation in the exchange rate.

The second point is that the assumption of continuous portfolio equilibrium does not divorce stock and flow sectors (in contradiction to the spirit of the monetary approach) when agents form expectations rationally. Niehans (1977) suggested that a floating exchange rate version of the monetary approach to the balance of payments should involve individual stock adjustment equations for domestic and foreign assets, rather than assuming portfolio balance is instantaneously achieved, and that without such individual stock adjustment equations, trade flows would have no role in determining the exchange rate.[(26)] As noted above, when continuous portfolio equilibrium is assumed, the flow demand equations for individual assets are undefined - however, the stock adjustment process remains in portfolio balance-current account models in terms of the adjustment of overall wealth to its stock-flow equilibrium level. This adjustment determines the evolution of the current account, and thereby the time path for foreign assets. Thus, from (1.38a), the exchange rate cannot be determined in asset markets alone, even with continuous portfolio equilibrium, since knowledge of present and future trade flows is required for the rational expectations solution. Rodriguez (1980), responding to Niehans, writes:

> In a "rational" economy we need not resort to the assumption of portfolio disequilibrium in order to find a contemporary connection between the exchange rate and the level of the trade account ... a full equilibrium, portfolio balance model of exchange rate determination under rational expectations will yield an equilibrium exchange rate jointly determined by stock equilibrium and expected developments in flow markets.
> Rodriguez, p.1151.

Thus, assuming the stock of domestic currency to be exogenous (there is no government deficit), consider an economy faced with persistent structural factors that produce a current account deficit, and thereby expected reductions in foreign currency over time. By (1.38a) the expectation of a persistent deficit means the current exchange rate will be over-valued (over-appreciated) relative to its "fundamental" level - the level that will balance the current account and leave foreign currency holdings constant. This overvaluation is a consequence of the expected persistence of the structural factors combined with the slow response of the endogenous determinants of the current account to the position of stock-flow disequilibrium. This slow response derives from gradual monetary approach adjustments towards desired stock levels.

It remains to combine these floating exchange rate dynamics arising from the portfolio balance-current account interaction with a macroeconomic model based around the hoarding function that we have seen to be central to the stock adjustment process of the monetary approach.

Here we build models analogous to the price and income specie-flow models as described under fixed rates in section 1.1.3. However, as noted above, the portfolio balance-current account process implies a second order differential system.[27] Thus, instead of postulating sluggish price or quantity adjustment as found in section 1.1.3., we now assume either price or quantity instantly clears excess demand for goods. Thus, with this exception, we write a log-linear version of the models presented in section 1.1.3. to examine their behaviour under flexible exchange rates:

$$a^{*} = ky \qquad (1.39)$$

$$c = \beta y + \theta a \qquad (1.40)$$

$$b = \delta\sigma - \Gamma c - z \qquad (1.41)$$

$$\dot{e} = \pi(\,\Phi - (m - e - f)\,) \qquad (1.37a)$$

$$\dot{f} = db \qquad (1.36a)$$

where, following previous notation, $\sigma = (e - p)$ is the real exchange rate and Γ the propensity to import. A wealth effect in expenditure remains the key to analysis of stock-flow interaction, but wealth must now include both assets in deriving the hoarding function relationship. Thus, real wealth, a, (in terms of traded goods) is defined as $a = (m - e + f)$ and $\beta = 1 - \theta k$ as before. (Henderson and Rogoff (1982) explicitly note that the incorporation of wealth in expenditure by Calvo and Rodriguez (1977) and Dornbusch and Fischer (1980) yields a savings function in which agents save to reduce the gap between target and actual real wealth).

The models produce a second order dynamic system in e and f, as described by (1.37a) and (1.36a). For both models, the transition matrix has a negative determinant, a sufficient condition to produce one stable and one unstable root.[28] Thus the transversality condition is imposed so that the free variable (the exchange rate) jumps to a value that obtains the unique convergent equilibrium path by eliminating the unstable root. In figure 1.3.(a) the resulting saddle path stability is illustrated.

For either model, the $\dot{e} = 0$ locus has a slope of -1. The reason for this is clear on examination of (1.37a). Along $\dot{e} = 0$, the ratio of domestic to foreign currency, $(m - e - f)$, must remain constant, and a rise in the value of foreign currency from a unit rise in f can be offset one for one by appreciating the value of domestic currency with a unit fall in e. Consider a point such as Q to the right of $\dot{e} = 0$: at such a point, the proportion of foreign currency in agents' portfolios has increased, and agents only willingly hold the additional stock of foreign currency in their portfolios if they expect its value to appreciate over time - i.e.: $\dot{e} > 0$, as the arrows of motion indicate. In order to restore a position of zero depreciation, the ratio of domestic to foreign currency must be restored to its initial value of Φ.

The current account balance locus $\dot{f} = 0$ is upward sloping. In the flexible price case, $\dot{f} = 0$ has a slope of unity. This is because, given exogenous values, there is a unique real equilibrium in this model and a continuous relationship between the real exchange rate and real wealth - a rise in real wealth must be met by a instant real appreciation to clear excess demand for goods. However, higher levels of real wealth and the real exchange rate clearly worsen the current account via real balance and substitution effects. Hence a unit rise in f requires a unit rise in the exchange rate to maintain real wealth, $a = m - e + f$, constant along $\dot{f} = 0$. In the output clearing model the slope of $\dot{f} = 0$, though still positive, must be flatter. For in this model, with the domestic goods price fixed, the real exchange rate moves one for one with the nominal exchange rate. Hence if a unit rise in f were accompanied by a unit rise in the exchange rate, real wealth would be unaltered but the real depreciation would produce a current account surplus. Hence a less than proportionate rise in e is required to maintain current account balance, so that higher real wealth offsets a higher real exchange rate. In either model, f will be falling to the right of $\dot{f} = 0$, as the higher wealth creates a current account deficit.

Figure 1.3.(a)

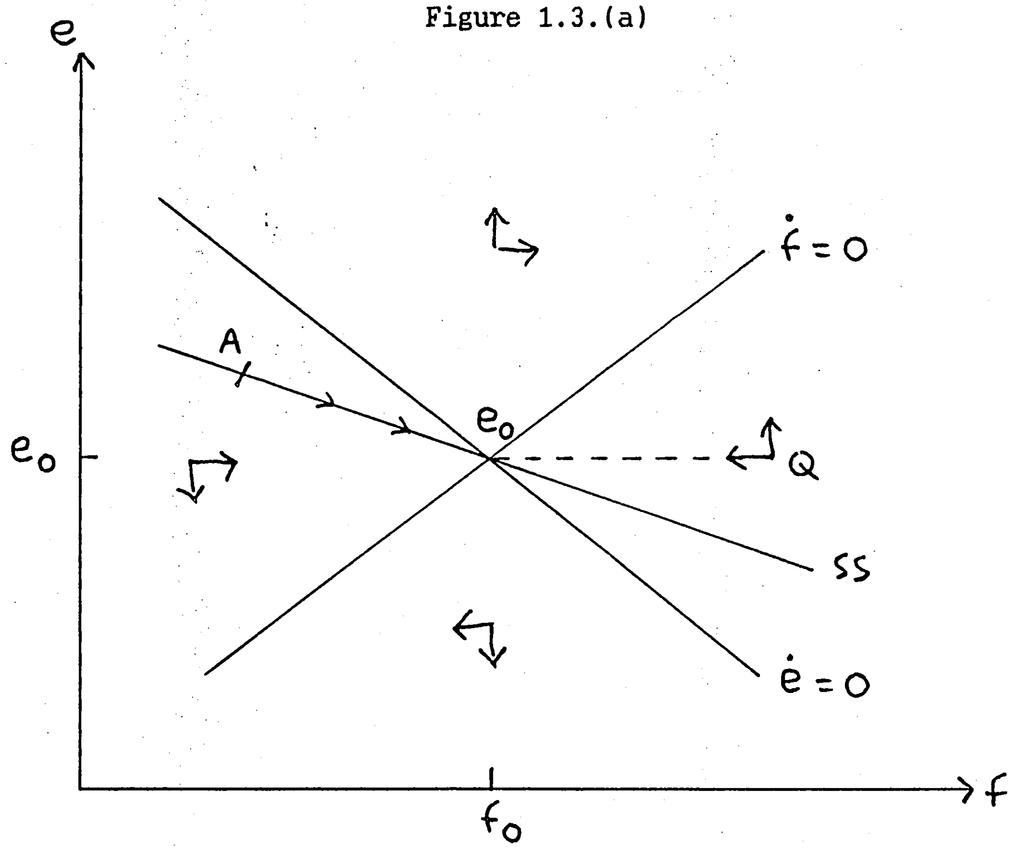
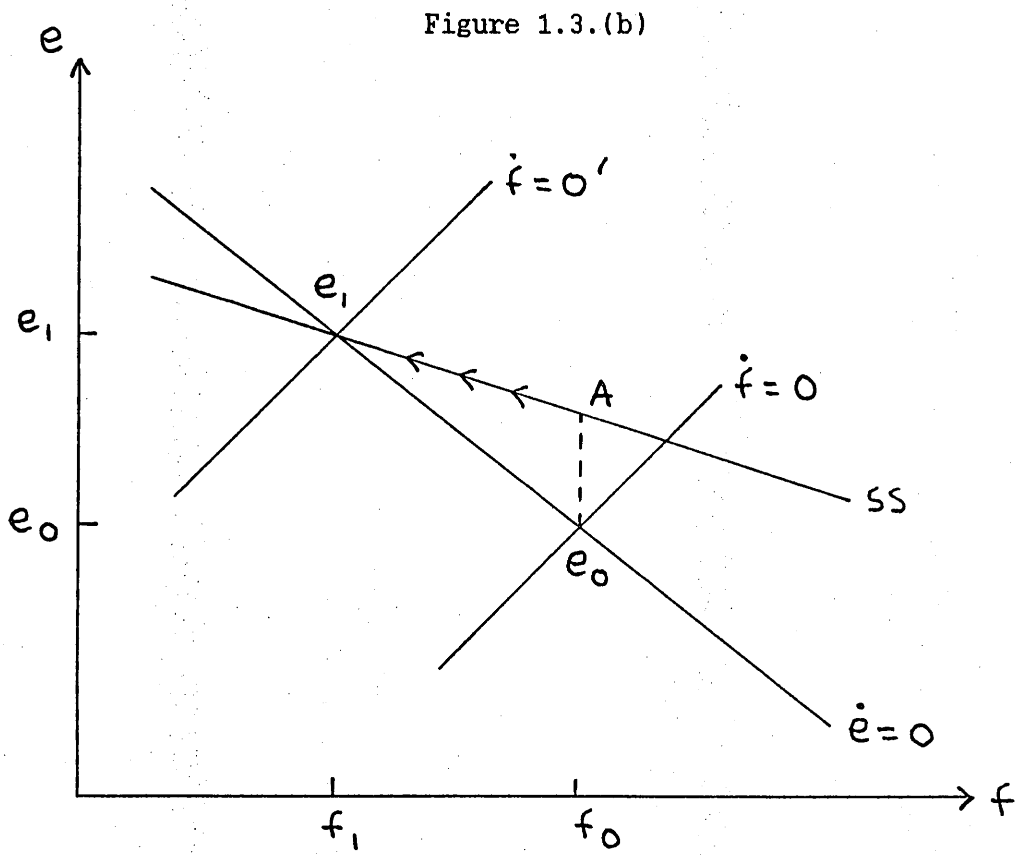


Figure 1.3.(b)



The saddle path is negatively sloped, and flatter than $\dot{e} = 0$. The negative slope means a current account surplus must be associated with an appreciating exchange rate. This accords with the "stylised fact" of exchange rate behaviour dubbed the "acceleration hypothesis" by Kouri (1983):

> Domestic currency appreciates whenever the current account is in surplus and depreciates whenever it is in deficit.
> Kouri, p.

Thus consider point A in figure 1.3.(a). There is a current account surplus, $\dot{f} > 0$, and the exchange rate is appreciating, $\dot{e} < 0$; and wealth is rising $(\dot{a} = \dot{m} - \dot{e} + \dot{f} = (\dot{f} - \dot{e}) > 0)$. The adjustment process from A to e_0 gradually eliminates the current account surplus.

In the fixed output case this is achieved since the rising level of wealth is accompanied by an appreciating real exchange rate (which removes excess demand for domestic goods). The rising level of wealth also has a real balance effect - hence the endogenous determinants of the current account gradually remove the surplus until equilibrium is established at e_0 where wealth has obtained its desired long run level. In the flexible output case, a further element reducing the current account surplus during adjustment is due to imports rising along with real income.

Portfolio balance is maintained in this adjustment process as follows: the appreciating exchange rate is anticipated, so that agents will wish to hold a greater proportion of domestic currency in their portfolios during adjustment than they do in the steady state. As the saddle path is flatter than $\dot{e} = 0$ this is indeed the case, since points to the left of $\dot{e} = 0$ imply $(m - e - f) > \Phi$.

Figure 1.3.(b) illustrates the effect of an unanticipated permanent structural deterioration in the current account, brought about by a shift reduction in the demand for exports - $dz > 0$.[29] The current account balance locus shifts to the left at a lower level of wealth; the $\dot{e} = 0$ locus is unchanged (since there is no steady state depreciation, no permanent change in portfolio composition is desired). However, with the stock of foreign currency predetermined, wealth cannot immediately fall to the lower level that is held in the final equilibrium e_1, and the only way that wealth can be reduced, and portfolio composition remain unaltered in the steady state, is via an adjustment process (point A to e_1) involving a current account deficit and overvalued exchange rate. (Note that in the steady state the nominal stock of foreign currency has fallen and the given nominal stock of domestic currency depreciated in value). The exchange rate initially jumps from e_0 to A so that portfolio equilibrium is instantaneously preserved - the jump re-allocates the portfolio in favour of foreign currency due to the anticipated depreciation involved during adjustment from A to e_1.

1.3. A MODEL OF A SPECULATIVE ATTACK

In this section we present an analysis of a speculative attack on a fixed exchange rate regime when the government pursues a policy of unsustainable monetary expansion, and solve for the time at which such an attack occurs. The analysis of a speculative attack on a stock of goods held for purposes of price stabilisation was first developed by Salant and Henderson (1978), and first applied to attacks on government reserves of foreign exchange by Krugman (1979). Krugman illustrated the inevitability and nature of a speculative attack within a monetary approach model, but did not solve for the timing of collapse for reasons which will become apparent.

The first presentation of an analytical solution for the precise timing of the collapse of a fixed exchange rate regime was developed by Flood and Garber (1984), using a more simplified macroeconomic model than that deployed by Krugman. This model consists of fixed output, continuous purchasing power parity, and, most crucially, the assumption of continuous monetary (stock) equilibrium, so that stock-flow dynamics and the nature of the private sector's asset-expenditure decisions during stock adjustment phases are set aside.(30)

Thus the Flood and Garber model is built in the Mundell-Fleming tradition (albeit with fixed output and flexible prices), since it involves an instantaneously endogenous money stock under fixed exchange rates. Under flexible exchange rates the model follows the asset market theory of exchange rate determination but again abstracts from stock-flow adjustment by ignoring current account dynamics (so it is effectively a flexible price version of the Dornbusch (1976) model).

By the arguments presented earlier in this chapter, the Flood and Garber model is thus incompatible with the monetary approach to the balance of payments. However, we shall see that the abstraction from stock adjustment issues is a necessary simplification for obtaining an analytical solution for the timing of an attack.

The key to finding the timing for the collapse of an unsustainable fixed rate regime lies in connecting this regime with the post collapse freely floating regime. Thus we first consider the behaviour of this simple model, subject to a policy of monetary expansion, under fixed and floating regimes. The model (using a log-linear form and discrete time) is:

$$m_t = r_t + d_t \qquad (1.42)$$

$$p_t = e_t + p^f_t \qquad (1.43)$$

$$m_t - p_t = \alpha y_t - \pi i_t \qquad (1.44)$$

$$i_t = i^f_t + x_t \qquad (1.45)$$

$$x_t = E_t e_{t+1} - e_t \qquad (1.46)$$

The equations specify the money stock, consisting of reserves and domestic credit, purchasing power parity, the demand for money and uncovered interest parity (reflecting the assumption of perfect capital mobility) respectively.

Substituting (1.43), (1.45) and (1.46) into (1.44), and equating money demand to money supply (1.42) enables the model to be reduced to a single equation expressing monetary equilibrium:

$$r_t + d_t = \Phi + e_t - \pi x_t \qquad (1.47)$$

where $\Phi = (p^f_t + \alpha y_t - \pi i^f_t)$. Output, the foreign price level and the foreign interest rate are all exogenous variables, and henceforth we set $\Phi = 0$.

With the assumption that other exogenous variables remain constant, the behaviour of the endogenous variable that adjusts to maintain monetary equilibrium (reserves or the exchange rate) is entirely determined by the governments policy for domestic credit. Here, we assume that at $t = 0$ the government announces and introduces a policy of domestic credit expansion at the permanent growth rate μ:

$$d_t = d_{t-1} + \mu \quad , t = 1,2,.... \qquad (1.48)$$

Under fixed exchange rates (so $e_t = \overline{e}$), there is no expected depreciation ($x_t = 0$), so the equation for monetary equilibrium is simply:

$$r_t = \overline{e} - d_t = \overline{e} - d_0 - \mu t \qquad (1.49)$$

Hence any expansion of domestic credit is instantly lost through reserves, and the monetary policy rule (1.48) leads to reserves being lost at the rate μ from the time of implementation. By contrast, in a monetary approach model, this is a property that only holds true when private sector stock adjustment is complete.

Under flexible exchange rates reserves are exogenous, and the exchange rate (or, equivalently, the price level) is now determined by monetary equilibrium. thus (1.47) now yields:

$$e_t = d_t/(1+\pi) + \beta E_t e_{t+1} \qquad (1.50)$$

where $0 < \beta = \pi/(1+\pi) < 1$. Rolling this equation forward, and using the law of iterated expectations and the rational expectations assumption gives:

$$e_t = (1+\pi)^{-1} \Sigma_{i=0}^{n} \beta^i E_t d_{t+i} + \beta^{n+1} E_t e_{t+n+1} \qquad (1.51)$$

Equation (1.51) contains two endogenous variables (e_t and $E_t e_{t+n+1}$). Thus, in order to obtain a unique solution, we impose the transversality condition, supposing $\beta^{n+1} \to 0$ as $n \to \infty$, which rules out explosive paths for the exchange rate. Equation (1.51) can then be solved and reduced to:

$$e_t = d_t + \pi\mu = d_0 + \mu t + \pi\mu \qquad (1.51a)$$

Thus any expansion of domestic credit is instantly deflated by the exchange rate, and the monetary policy rule (1.48) leads to a rate of depreciation equal to μ from its inception. Once again this is a property that only emerges in the steady state for a monetary approach model; during adjustment the equilibrium exchange rate depends on the time path for foreign currency (as endogenously determined by the current account) as well as that for domestic credit. (Thus (1.51) and (1.51a) should be contrasted with (1.38) and (1.38a) of section 1.2.).

Equation (1.51a) provides the time path for what Flood and Garber call the "shadow floating exchange rate" that evolves from the onset of monetary expansion during a fixed rate regime. As explained below, when the shadow floating rate reaches the level of parity, a speculative attack is triggered.

We now turn to the issue of analysing the collapse of a fixed rate regime running an expansionary credit policy such as that in (1.48). The first point to note is that, from (1.49), so long as there is some lower bound on the reserves the government is prepared to use to support the exchange rate, the fixed rate regime cannot survive forever - a finite reserve stock will be exhausted in finite time. It is assumed here that the government will abandon intervention to support the exchange rate when reserves reach zero. It is also a critical assumption of the speculative attack literature that this policy is known to the private sector, hence agents foresee the collapse of the fixed regime.

The next crucial aspect in determining the time of attack is to note that predictable exchange rate jumps at the time the fixed regime collapses are ruled out by speculative behaviour. Suppose agents anticipated a collapse at time z followed by an instantaneous depreciation: $e_{z+} > \bar{e}$ (where e_{z+} indicates the value of the exchange rate in the moment after collapse). This implies that speculators attacking reserves at time z will profit by $(e_{z+} - \bar{e})r_{z-}$, so that any individual speculator has an incentive to pre-empt competitors by buying out all the reserves just prior to this moment. Thus the anticipation of depreciation following an attack at any time z will precipitate an attack at an earlier date.

If agents were to anticipate both a collapse at time z and an instantaneous appreciation $(e_{z+} < \bar{e})$, then any agent attacking reserves at time z would incur a capital loss: $(e_{z+} - \bar{e})r_{z-} < 0$. Hence there is no incentive to attack reserves at time z and the fixed rate regime would survive.

Thus, in order that predictable capital gains or losses be avoided, it must be the case that the if the fixed regime is expected to collapse by an attack launched at time T, $e_{T+} = \bar{e}$ - i.e.: there is no jump in the exchange rate.

This condition enables the timing of the attack to be determined by linking the two regimes, as expressed in (1.49) and (1.51a). Substituting for e_T from (1.51a) in (1.49) solves for the level that reserves will have reached at time T. Since this level of reserves satisfies the speculative attack condition, it is the level that must be attacked at time T to ensure the exchange rate does not jump. We denote this critical reserve level as r^*_T:

$$r^*_T = \pi\mu \qquad (1.52)$$

Since we know that during the fixed regime reserves are steadily depleted at the rate μ from their initial level r_0, $r^*_T = r_0 - \mu T$. Substituting this into (1.52) solves for the time of attack as:

$$T = r_0/\mu - \pi \qquad (1.53)$$

Thus the fixed rate regime collapses earlier the smaller the initial stock of government reserves, the greater the rate of credit expansion, and the greater the elasticity of demand for money with respect to expected depreciation.

Some further consideration of these results for the timing of a speculative attack helps reveal why these simple analytical techniques for solving the attack date become intractable in a more complex monetary approach style economic model.

The explanation of the entire process lies in considering how monetary equilibrium (which is not differentiated in this model from a full stock-flow equilibrium) is constantly maintained during both the fixed and floating regimes and at the moment of collapse.

Throughout the process the actual and desired stock of real balances, which we denote by $h^*_t = m_t - p_t$, remain equal. Thus the stock-flow dynamics imposed by the deviation of the actual stock of wealth from its desired level are avoided.

If we denote the initial stock as h_0, then:

$$h^*_t = h_0 , \qquad t = 0, 1, 2, \ldots ,T. \qquad (1.54)$$
$$h^*_t = h_0 - \pi x_t = h_0 - \pi\mu , \quad t = T+, T+1, T+2, \ldots$$

During the fixed regime there is no depreciation, and, with price and output fixed, desired real balances remain at their initial level m_0; once the credit expansion begins the nominal money supply is kept at this level as $Dr_t = -Dd_t$ (where D is the change operator). Under floating exchange rates the credit expansion raises the cost of holding real balances which instantaneously rises by the rate of inflation μ, and desired real balances fall by $\pi\mu$. Desired real balances are again constant, and the real money supply is kept at a constant level since $De_t = Dd_t$. At the moment of collapse there is an instantaneous rise in expected depreciation from zero to μ, and thus an instantaneous decline in desired real balances by $\pi\mu$. Hence the real money supply must also fall by $\pi\mu$ at this moment. However, this fall in the real money supply cannot occur by a depreciation as explained above; instead the money supply falls by a once and for all loss of reserves of amount $\pi\mu$ in a speculative attack, which precisely offsets the decline in desired real balances.

The Flood and Garber model has been the basis of a number of further contributions to the literature on balance of payments crises and the timing of the collapse of a fixed rate regime (Connolly and Taylor (1984), Obstfeld (1986), Grilli (1986), Dornbusch (1987), Buiter (1989)).[31] Similarly the simple model structure adopted by Flood and Garber has been a feature of all empirical applications to date (Blanco and Garber (1986), Grilli (1990), Goldberg (1991)).[32]

However, it is common to all these contributions that they obtain a solution for the timing of attack by abstracting from the stock-flow dynamics that lie at the heart of the monetary approach to the balance of payments.[33]

When the stock adjustment process of the monetary approach is introduced the condition of no exchange rate jump, though remaining a requirement of a speculative attack, ceases to provide the basis for a tractable solution for the timing at which the attack will occur. In the absence of stock-flow dynamics, the stock demand for money determines the time path for both reserves and the exchange rate; in the monetary approach the "fundamental equation" (a flow relationship) is insufficient to determine the time path of reserves (as seen in section 1.1.5.), and asset market equilibrium is insufficient to determine the exchange rate (as seen in section 1.2.).

It would be possible to solve for the reserve and exchange rate time paths in a monetary approach model, but the fundamental problem in linking the two regimes is that the stock of wealth is a dynamic state variable. Thus the stock (and composition) of wealth with which the floating regime commences post-collapse will be determined by the adjustment dynamics of the fixed regime. The initial value for the exchange rate is determined by the requirement that there be stable convergence of the floating regime given these initial stocks of nominal assets. The collapse will occur at that time when these requirements are consistent with no jump in the exchange rate (note that this implies an unchanged level of real wealth, so the floating regime inherits the external deficit and the exchange rate is initially overvalued, implying depreciation in excess of steady state rates).(34) In chapter four we search for the collapse time by simulating a monetary approach model and carrying over the nominal asset stocks entailed by attacking the fixed regime at some time z to the floating regime - when the exchange rate is not required to jump, the correct collapse time is found.

MATHEMATICAL APPENDIX

Notation: The dynamic equations are written as: $\dot{\underline{x}} = \underline{A}\underline{x} + \underline{B}\underline{y}$ where $\underline{x}$ is the vector of state variables, $\underline{y}$ is the vector of exogenous variables, $\underline{A}$ is the transition matrix, and $\underline{B}$ is the forcing matrix.

1.(a) The Price Specie-Flow Model of Section 1.1.3.

$$\dot{\underline{x}} = \underline{A}\underline{x} + \underline{B}\underline{y}, \text{ where } \underline{x} = \begin{bmatrix} P & H \end{bmatrix}^T, \ \underline{y} = \begin{bmatrix} E & Z \end{bmatrix}^T,$$

$$\underline{A} = \begin{bmatrix} -\alpha(\Phi+\theta(1-m_1) & \alpha\theta(1-m_1) \\ \theta m_1-\Phi & -\theta m_1 \end{bmatrix}, \ \underline{B} = \begin{bmatrix} \alpha\Phi & \alpha x_1 \\ \Phi & x_1 \end{bmatrix}$$

Stability: stability is assured if $\Phi > 0$, where $\Phi = M(e_x+e_m-1)$ as described in (1.13) of the text.

Then $Tr(A) = -\{\alpha(\Phi+\theta(1-m_1))+\theta m_1\} < 0$, $|\underline{A}| = \alpha\theta\Phi > 0$

Statics: $\underline{x} = -\underline{A}^{-1}\underline{B}\underline{y}$ gives: $dP/dE=dH/dE = 1$; $dP/dZ=dH/dZ = x_1/\Phi < 0$

1.(b) The Income Specie-Flow Model of Section 1.1.3.

$$\dot{\underline{x}} = \underline{A}\underline{x} + \underline{B}\underline{y}, \text{ where } \underline{x} = \begin{bmatrix} Y & H \end{bmatrix}^T, \ \underline{y} = \begin{bmatrix} E & Z \end{bmatrix}^T,$$

$$\underline{A} = \begin{bmatrix} -\beta(m_1+\theta k(1-m_1) & \beta\theta(1-m_1) \\ -m_1(1-\theta k) & -\theta m_1 \end{bmatrix}, \ \underline{B} = \begin{bmatrix} \beta\Phi & \beta x_1 \\ \Phi & x_1 \end{bmatrix}$$

Stability: $Tr(A) = -\{\beta(m_1+\theta k(1-m_1))+\theta m_1\} < 0$, $|\underline{A}| = \beta\theta m_1 > 0$ so the system is stable.

Statics: $\underline{x} = -\underline{A}^{-1}\underline{B}\underline{y}$ gives: $dY/dE = \Phi/m_1 > 0$, $dH/dE = k\Phi/m_1 > 0$;
$dY/dZ = x_1/m_1 < 0$, $dH/dZ = kx_1/m_1 < 0$

2. The Portfolio Balance-Current Account Models of Section 1.2

2.(a) The Flexible Price Model

Prices are fully flexible and eliminate any excess demand for domestic goods (c + b - y) where c and b are given in (1.40) and (1.41) of the text. Thus, as in Calvo and Rodriguez (1977), there must be a continous negative relationship between the real excahnge rate and real wealth (subject to the shift factor z):

$\sigma = -\tau\theta a - \tau\beta z$, where $\tau = (1-\Gamma)/\delta$

Thus the instantaneous current account is:

$b = -\theta a - (1-\beta)z$, where $(1-\beta)z$ represents the reduction in savings

Dynamics:

$$\dot{\underline{x}} = \underline{A}\underline{x} + \underline{B}\underline{y}, \text{ where } \underline{x} = \begin{bmatrix} e & f \end{bmatrix}^T, \ \underline{y} = \begin{bmatrix} m & z \end{bmatrix}^T,$$

$$\underline{A} = \begin{bmatrix} \pi & \pi \\ \theta & -\theta \end{bmatrix}, \ \underline{B} = \begin{bmatrix} -\pi & 0 \\ -\theta & -(1-\beta) \end{bmatrix}$$

Stability: $|\ \underline{A}\ | = -2\pi\theta < 0$, thus the system has saddle path stability, with the unstable root eliminated by the jump in e.

Statics: $de/dm = 1$, $df/dm = 0$: since prices are flexible, a step increase in the money supply is instantly deflated, and the system jumps straight to equilibrium (à la Dornbusch and Fischer (1980)).

$de/dz = -df/dz = (1-\beta)/2\theta$, which implies total real wealth falls by $da/dz = -(1-\beta)/\theta = -k$, but portfolio composition is unaltered.

2.(b) The Flexible Output Model

Output clears the goods market so:

$y = \Omega\theta(1-\Gamma)a + \Omega\delta e - \Omega z$, where $\Omega = (1-\beta(1-\Gamma))^{-1}$, the Keynsian multiplier.

The current account is:

$b = \Omega\mu e - \Omega\theta\Gamma m - \Omega\theta\Gamma f - \Omega(1-\beta)z$, where $\mu = (\delta(1-\beta)+\theta\Gamma)$

Dynamics:

$$\mathring{\underline{x}} = \underline{A}\underline{x} + \underline{B}\underline{y}, \text{ where } \underline{x} = \begin{bmatrix} e & f \end{bmatrix}^T, \ \underline{y} = \begin{bmatrix} m & z \end{bmatrix}^T,$$

$$\underline{A} = \begin{bmatrix} \pi & \pi \\ \mu\Omega & -\theta\Gamma\Omega \end{bmatrix}, \ \underline{B} = \begin{bmatrix} -\pi & 0 \\ -\theta\Gamma\Omega & -(1-\beta)\Omega \end{bmatrix}$$

Stability: $|\underline{A}| = -\pi\Omega\Sigma < 0$, where $\Sigma = (\delta(1-\beta)+2\theta\Gamma)$, so the system has saddle path stability.

Statics: $de/dm = 2\theta\Gamma/\Sigma$, $df/dm = (1-\beta)\delta/\Sigma$, so that total wealth rises $da/dm = 2(1-\beta)\delta/\Sigma$, but portfolio composition is unaltered, since $dm/dm - de/dm - df/dm = 0$.

$de/dz = -df/dz = (1-\beta)/\Sigma$, so that total wealth falls, but portfolio composition is again unaltered.

NOTES:

(1) In these accounting relationships, the national income symbol Y represents G.D.P. rather than G.N.P., as net factor payments are not considered.

(2) In abstracting from bonds, IS-LM style transmission mechanisms are omitted; our focus is on the overall relationship between stocks and flows which is the essence of the fixed exchange rate monetary approach literature. Foreign denominated assets are introduced in our analysis of the monetary approach under floating exchange rates.

(3) We abstract from the banking system and money multipliers, so that H represents high powered money.

(4) Rodriguez was the only contributor to explicitly set out a hoarding function relationship linking monetary and income-expenditure approaches.

(5) For the present the public sector is excluded.

(6) The most popular alternative goods disaggregation is that between traded and non-traded goods. For the "small" or "dependent" economy this disaggregation assumes the domestic economy's supply of exports cannot effect the world market clearing price for traded goods, thus $P_t = EP^f{}_t$: the terms of trade are exogenous. The endogenous relative price (the real exchange rate) is that between traded and non-traded goods : P_t/P_n - a real depreciation reduces domestic consumption of traded goods (imports) and raises domestic production (exports) of traded goods. For the larger economy, the terms of trade P_x/P_m become endogenous, and the traded good is further differentiated into importables and exportables, yielding two endogenous relative prices : $EP^f{}_x/P_n$ and $EP^f{}_m/P_n$ which effect both production and consumption decisions.

(7) A fuller mathematical description is found in the appendix.

(8) Mundell (1968) was also one of the first to explicitly invoke the hoarding function, noting it's use by Prais (1961), and deeming it "a novelty that deserves wider application".

(9) Alternatively, with (1.17b), we have the level of output rising or falling as the demand for domestic output exceeds or falls short of supply.

(10) Adjustment may be cyclical, but is certainly stable (see appendix). Note that during adjustment a point of external balance ($\dot{H} = 0$) can be reached that would not entail stock-flow equilibrium (in contrast to the model of section 1.1.2.) due to offsetting excess demands in the goods and money markets.

(11) Recall that from the asset-expenditure relationship posited by the hoarding function (see (1.8a)) $\theta k < 1$ is assured by a non-negative marginal propensity to consume.

(12) The statics results for devaluation and export shocks work much as before, except that nominal income adjustment is via quantity rather than price. Note, however, that the Marshall-Lerner condition is required to avoid a contractionary devaluation.

(13) Note that any shock, even if only leading to a temporary balance of payments disequilibrium, as with those examined in the previous sections, must change the composition of the money stock.

(14) McCallum and Vines (1981) and Dixon (1982) both argue that the fiscal and monetary approaches are essentially similar in their emphasis on asset-expenditure decisions.

(15) In later chapters, the budget deficit is incorporated in an aggregate demand-supply framework, in a manner suggested by Mayer (1984), with all financing via credit creation. This emphasises how the economic structure determines the composition of the money stock and is a key aspect of our analysis of speculative attacks.

(16) Khan et al merge the I.M.F. approach via the "fundamental equation" with output determined by investment as in the World Bank approach. In chapter two the "fundamental equation" is merged with a model that determines the supply side with labour, rather than capital, as the variable factor of production.

(17) D is the change operator, so DR is the flow of reserves in the short run.

(18) Goods disaggregation is again of the Mundell-Fleming variety - the relative price effect is subsumed in the export function, as in McCallum and Vines. Government expenditure is on the home good.

(19) This is the "Swan diagram" analysis. However, note that in the long run external balance would be automatically achieved (as in section 1.1.3.), provided there is no budget deficit.

(20) Note that imports in (1.27) are proportion Γ of consumption. In this monetary approach consumption is derived from the accounting relationship $C = Y - T - S = (1-t)Y - DH$.

(21) This form for presenting results is found in Buiter and Miller (1981). It is used extensively in chapters two and three.

(22) In these early I.M.F. analyses nominal income is determined along with external balance; price adjustments are introduced in chapter two.

(23) In particular note that this implies $Q = \Sigma$, where Q and Σ are defined in (1.28) and (1.34) respectively.

(24) In chapters three and four foreign assets, and thus the capital account, are also introduced in a fixed rate regime. However, we see that their presence does not alter stock-flow dynamics whilst the exchange rate remains pegged since there is no motivation for currency substitution.

(25) This log-linear specification of portfolio balance is found in Rodriguez (1980).

(26) Thus Niehans postulates $\dot{f} = \alpha(f - f^*)$ and $\dot{m} = \beta(m - m^*)$, where f^*, m^* are the desired stocks of domestic and foreign currency.

(27) Branson (1983b) and Kouri (1983) provide partial equilibrium accounts of capital-current account interactions, which require second order models.

(28) A fuller mathematical description is in the appendix.

(29) For the flexible price case, it is assumed that dz represents a permanent loss of output.

(30) Krugman also assumes constant output and PPP, but deploys a hoarding function by including a wealth effect on consumption. Thus, under fixed exchange rates, his model is like that presented in section 1.1.2. with first order dynamics; and under flexible exchange rates has the portfolio balance/current account dynamics of the second order models presented in section 1.2.

(31) Grilli considers buying and selling attacks, Obstfeld considers bubbles, and Buiter extends analysis to the two country case. However, all models abstract from monetary approach dynamics.

(32) These empirical works build a series for the shadow floating exchange rate as described in equation (1.51a), having estimated the parameters of the money demand equation (1.44) and the money supply rule (1.48). The series obtained should show a discrete jump at the time of a balance of payments crisis.

However, over and above the avoidance of stock-flow issues, these empirical works are somewhat limited within their own framework.

From (1.51) of the text the shadow floating exchange rate is determined by the expected future time path for domestic credit:

$$e_t = (1+\pi)^{-1} \Sigma_{j=0}^{\infty} \beta^j E_t d_{t+j},$$

where $\beta = \pi/(1+\pi)$, and we have imposed the transversality condition. The empirical studies estimate π and an AR(1) process for credit:

$$d_t = \alpha_1 d_{t-1} + u_t$$

The AR(1) process implies:

$$E_t d_{t+j} = \alpha_1{}^j d_t, \text{ so that } \Sigma_{j=0}^{\infty} \beta^j E_t d_{t+j} = d_t/(1-\alpha_1\beta)$$

Thus the shadow floating exchange rate is $e_t = d_t/(1+\pi(1-\alpha_1))$.

However, suppose one found an AR(2) process for credit:

$$d_t = \alpha_1 d_{t-1} + \alpha_2 d_{t-2} + u_t$$

This process implies:

$$E_t d_{t+j} = \left[\Sigma_{i=0}^{\lceil j/2 \rceil} {}^{(j-i)}C_i \alpha_1{}^{j-2i} \alpha_2{}^i \right] d_t + \left[\Sigma_{i=0}^{\lceil (j-1)/2 \rceil} {}^{(j-(i+1))}C_i \alpha_1{}^{j-(2i+1)} \alpha_2{}^{i+1} \right] d_{t-1}$$

where $\lceil x \rceil$ denotes integer values for x, and C is the combinations operator: ${}^nC_r = n!/(n-r)!r!$

Thus, for instance: $E_t d_{t+7} = \{\alpha_1{}^7 + 6\alpha_1{}^5\alpha_2 + 10\alpha_1{}^3\alpha_2{}^2 + 4\alpha_1\alpha_2{}^3\}d_t + \{\alpha_1{}^6\alpha_2 + 5\alpha_1{}^4\alpha_2{}^2 + 6\alpha_1{}^2\alpha_2{}^3 + \alpha_2{}^4\}d_{t-1}$

Hence $E_t d_{t+j}$ is no longer a geometric progression and no solution can be found for the shadow floating exchange rate.

(33) It is also commonly assumed that domestic credit is exogenous

(34) Thus it follows that in a monetary approach model one cannot derive the quantity of reserves that must be attacked from the rate of depreciation, x_t, that emerges immediately post-collapse. In the Flood and Garber model $x_t = \mu$ at all times; in a monetary approach model a current account deficit is associated with $x_t > \mu$ via the acceleration hypothesis. Once again, the precise value for x_t will depend on all the values of the model that determine the evolution of wealth in the fixed and floating regimes.

CHAPTER TWO

THE MONETARY APPROACH, STICKY WAGES AND ENDOGENOUS BUDGET DEFICITS

INTRODUCTION

The model presented in this chapter demonstrates the consistency of the monetary approach to the balance of payments with a model of Keynsian economic structure in the short and the long run. This is done by introducing explicit modelling of the labour market in combination with the stock-flow dynamics of the monetary approach considered in chapter one. Nominal wages are pre-determined, so the dynamics of labour market adjustment are added to the stock adjustment process for wealth.

The model thus builds on the synthesis of approaches suggested by Frenkel et al (1980) and McCallum and Vines (1981) by following the dynamic processes implied by the short run outcomes of a Keynsian model through the dynamics of adjustment to their long run equilibrium in the manner of the contributions by Montiel (1985,1986).[1] Like Montiel, we find the propositions of "global monetarism" (that devaluation has no real effects, and a step increase in domestic credit produces an equal decline in reserves) emerging as long run properties of our model. Nevertheless we also follow Montiel in emphasising that it is the structure of the model, rather than the "fundamental equation" of the approach per se, that determines the balance of payments, and the model also exhibits permanent real changes.

These real changes are linked to a second concern of this chapter, which lies in examining the issue raised by Currie (1976) of the consequences of domestic credit being an endogenous variable whose rate of expansion is in the long run determined by structural factors. The budget deficit is linked in a simple way to our aggregate demand-aggregate supply framework, in a manner suggested by Mayer (1984).

The compatibility of chronic payments deficits with the monetary approach has been stressed by Parkin (1974), and (in more Keynsian style models) by Calmfors (1979), Soderstrom and Viotti (1979), Nyberg and Viotti (1979), as well as more recently by Khan and Lizondo (1987).(2)

Here the evolution of payments deficits is examined as a prelude to the analysis of speculative attacks which is conducted in chapter three and the simulations used to obtain the time of the fixed regime's collapse in chapter four.(3) The results presented there emphasise our present themes: although the "fundamental equation" of the monetary approach per se cannot assess the state of external balance, when it is linked to a macroeconomic framework, and the equivalence of monetary and Keynsian approaches is acknowledged, both these approaches offer advantageous perspectives on the evolution of the balance of payments.

2.1. The Short Run

The model combines the principal features of monetary approach adjustment under fixed exchange rates reviewed in chapter one with explicit modelling of the labour market. The short run of the model can be analysed within an orthodox aggregate demand-aggregate supply framework such as presented in De Grauwe (1983) and Cook and Kirkpatrick (1990), with the balance of payments determined by the state of home goods and labour markets.

On the demand side agents make their asset expenditure decisions and choose their desired allocation of expenditure between the domestic and foreign produced good according to their relative price, the real exchange rate. On the supply side, with the nominal wage predetermined by contract, employment is demand determined according to marginal productivity conditions. The dynamics are then imposed by private sector accumulation (of money, the only asset) deriving from the state of overseas and public sector balances which emerge from the short run equilibrium. The short run also determines the extent of excess demand/supply of labour which determines the dynamics of wage adjustment.

Policy shocks of a step increase in domestic credit, devaluation and fiscal expansion are analysed. There are also two real shocks, from the demand and supply side - a structural deterioration in the balance of payments from a shift reduction in the demand for exports, and a shift reduction in the labour supply function.

2.1.1. The Model

Equations (2.1) to (2.10) present the model which determines short run equilibrium:[4]

Definitions:

$$\sigma = e - p \qquad (2.1)$$

$$p_c = (1-\Gamma)p + \Gamma e \qquad (2.2)$$

$$y^{dis} = (1-t)y \qquad (2.3)$$

$$y^d = c + g + b \qquad (2.4)$$

Demand:

$$h^* = ky^{dis} \qquad (2.5)$$

$$c = y^{dis} - \theta(h^*-h) \qquad (2.6)$$

$$= \beta y^{dis} + \theta h \quad , \beta=1-\theta k$$

$$b = \delta\sigma - \Gamma c - z \qquad (2.7)$$

Supply:

$$y^s = an \qquad (2.8)$$

$$n^d = -b(w-p) \qquad (2.9)$$

$$n^s = c(w-p_c) - w^t \qquad (2.10)$$

The definitions declare the real exchange rate, σ (where p is the price of the domestically produced good), the consumer price index,

p_c[5] (where Γ is the proportion of consumers' expenditures allocated to the imported good), real disposable income, y^{dis} (where t is the proportional income tax rate), and aggregate demand for the domestically produced good, y^d (note that it is assumed all government expenditures are allocated to the domestic good).

On the demand side, equation (2.5) states the familiar quantity theory determination of the stock of desired real balances, h^*. This is used, via the hoarding function, to derive the real balance effect on expenditure in (2.6). The balance of payments, b, is assumed to improve with a real depreciation (a rise in σ) which switches demand towards the home good (thus the Marshall-Lerner conditions are assumed to hold - $\delta > 0$). The balance of payments deteriorates with a rise in expenditure (according to the proportion Γ allocated to imports) and also with the exogenous reduction in the demand for exports, z.

The supply side determines output from the labour market via the production function (2.8).[6] As we shall see, a critical aspect of supply side determination of output in the open economy is the distinction between the producer and consumer real wage. The demand for labour, n^d, is, via marginal productivity conditions, a negative function of the producer's real wage, (w - p), where p is the price of the home produced good; whilst labour supply, n^s, is a positive function of the consumer real wage ($w - p_c$) and subject to the shift factor, w^t.[7]

2.1.2. Aggregate Demand, Aggregate Supply and Short Run Equilibrium

Short run equilibrium determines the two jointly endogenous variables p and y at the intersection of aggregate demand and supply. Aggregate demand is derived by substituting (2.6) and (2.7) into (2.4):

$$\delta p = -qy + \theta(1-\Gamma)h + \delta e + g - z \qquad (2.11)$$

where $0 < q = (1-\beta(1-\Gamma)(1-t)) < 1$.

Thus the aggregate demand curve, which is illustrated in figure 2.1.(a), has slope $dp/dy_{(yd)} = -q/\delta < 0$. Given p, a rise in output (say from point A to B) raises income and expenditure - however, spending on home goods rises by less than the increase in output due to the "leakages" of savings, imports and tax payments from the circular flow. The resulting incipient excess supply of home goods at point B is eliminated by a fall in the price of home goods, raising exports and reducing imports, to produce an expenditure switch in favour of home goods (represented by the movement from point B to point C). Thus the demand curve is flatter the greater the propensity to spend on home goods, $(\beta(1-\Gamma)(1-t))$, which creates less incipient excess supply for a given increase in output, and the higher the responsiveness of exports and imports to relative prices (so that a smaller real depreciation is required to eliminate a given excess supply).

It is also possible to illustrate a balanced trade locus bb in p, y space which is:

$$\delta p = -\beta\Gamma(1-t)y - \theta\Gamma h + \delta e - z \qquad (2.12)$$

with slope $dp/dy_{(bb)} = -\beta\Gamma(1-t)/\delta < 0$

A rise in income will raise import spending and worsen external balance, requiring a real depreciation - a fall in p - to restore balance. Thus points above and to the right of bb correspond to a balance of payments deficit. The bb locus is flatter than aggregate demand. This is because as one moves down and along the aggregate demand curve (from A to C) a growing trade surplus is required to remove the incipient excess supply of domestic goods and thus sustain the higher levels of output.(8)

With nominal wages pre-determined by contract in the short run, employment is determined by firms' demand according to the producer real wage. Thus aggregate supply is:

$$\alpha p = y + \alpha w \qquad (2.13)$$

where $\alpha = ab > 0$.

The supply curve is positively sloped and has a gradient equal to $dp/dy_{(ys)} = 1/\alpha > 0$. A rise in p reduces the producer real wage, raising demand for labour and thus employment and output.

By using the definitions of the real exchange rate and consumer price index in (2.1) and (2.2) it is worth noting a simple re-arrangement of the supply function (2.13) used in Sachs (1980):

$$y^{s} = -\alpha \left((w - p_{C}) + \Gamma\sigma \right) \qquad (2.13a)$$

Thus, although employment is demand determined in the present model, (2.13a) provides a simple illustration of the importance of the relative price of domestic and foreign goods in determining output when workers' preferences are taken into account.[9] Equation (2.13a) states that, given workers' decisions about the income-leisure trade-off (so that a given consumer real wage brings forth a given supply of labour), a real appreciation produces greater aggregate supply.[10] Thus the model accords with the analyses of Branson and Rotemburg (1980), Marston (1982) and Bruce and Purvis (1985) which show that, once one departs from the one good world implied by continuous purchasing power parity, any demand side shock causing a sustainable real appreciation (depreciation) permits output to rise (fall) permanently from its initial level.[11] By raising the price of domestic output relative to the consumer price index, real appreciation reduces the costs that firms must incur to hire a given amount of labour.

Figure 2.1.(b) demonstrates the short run system, illustrating the three schedules discussed above. The supply schedule is invariant to exogenous shocks in the short run (shifting only with wages, a pre-determined state variable). A rise in the money supply increases

Figure 2.1.(a)

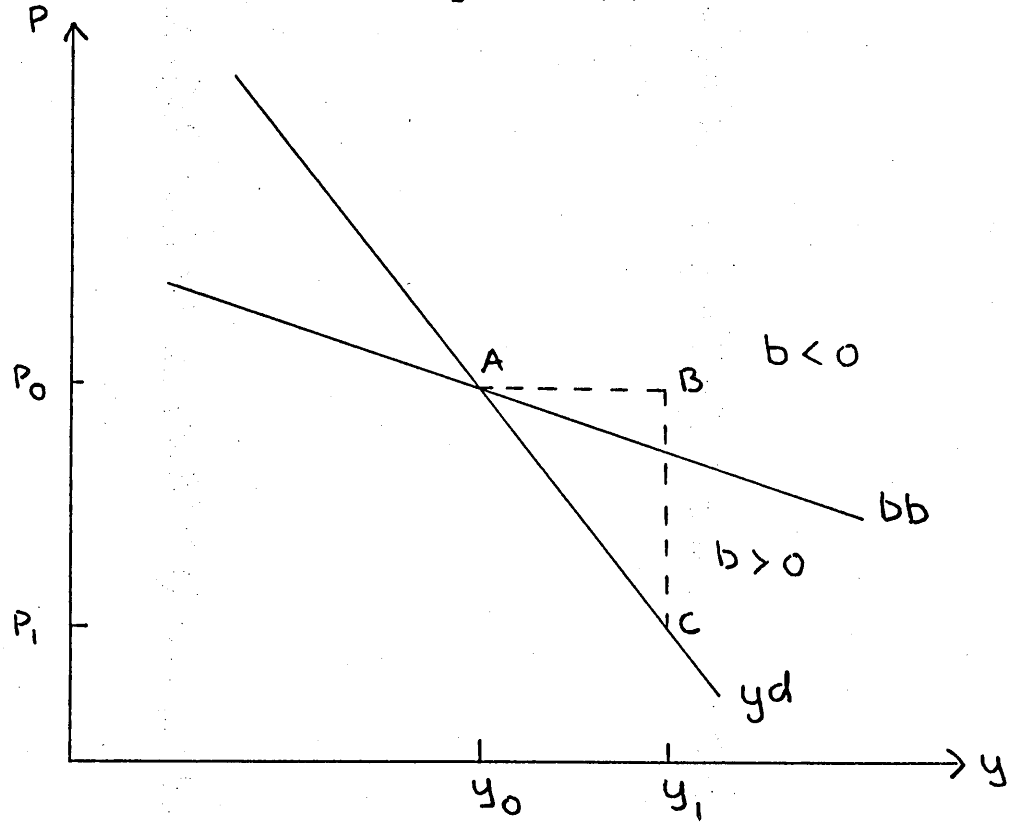
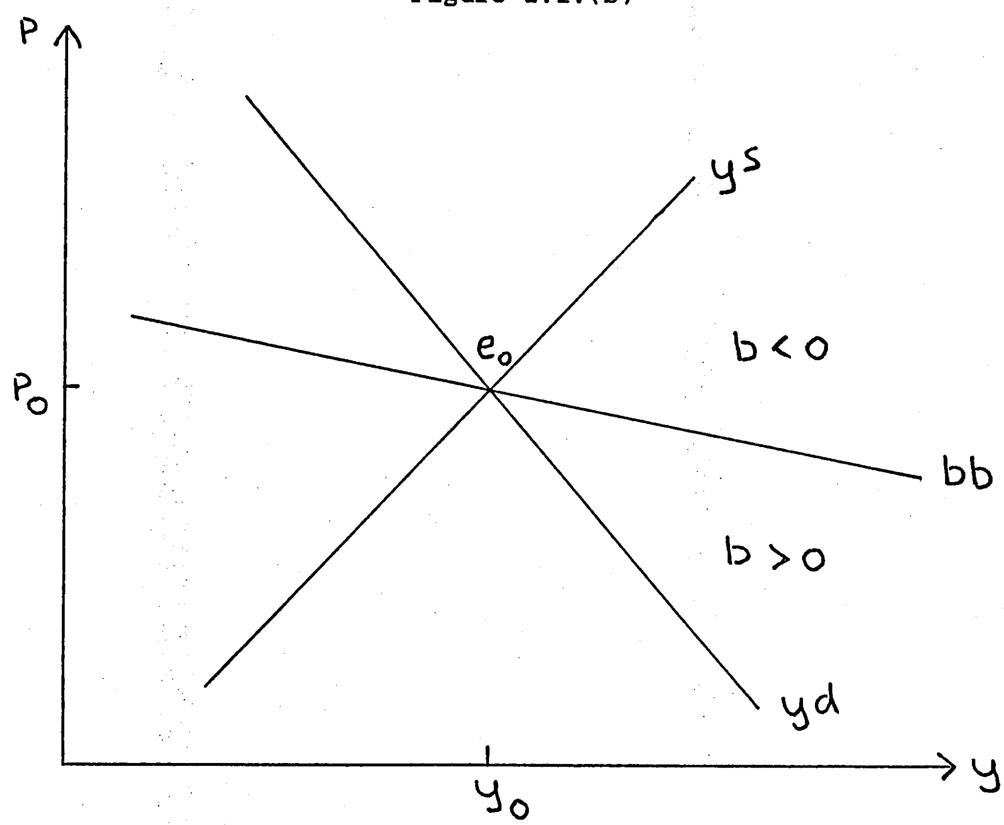


Figure 2.1.(b)



spending on domestic goods and imports, shifting the demand curve out, and the bb locus to the left . Fiscal expansion also shifts the demand curve out, but leaves bb unchanged as government expenditure is allocated to the home good. A devaluation shifts the demand and balance of payments loci up by the same amount since at a given level of output a devaluation induces excess demand for home goods, requiring an offsetting rise in p to eliminate any relative price change and thus any improvement in external balance. Similarly, at a given level of output, a fall in the demand for exports shifts the demand and bb curves down by the same amount. The extent of real depreciation required to restore the initial level of exports (i.e.: the extent of the downward shift) is less the greater the responsiveness of demand to relative prices (i.e. : the higher the value of the parameter δ).

Equilibrium is determined at the intersection of supply and demand, thus equations (2.11) and (2.13) provide reduced from equations for p and y as functions of the pre-determined and exogenous variables:

$$\begin{bmatrix} \delta & q \\ \alpha & -1 \end{bmatrix} \begin{bmatrix} p \\ y \end{bmatrix} = \begin{bmatrix} 0 & \theta(1-\Gamma) & \delta & 1 & -1 \\ 1 & 0 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} w \\ h \\ e \\ g \\ z \end{bmatrix} \qquad (2.14)$$

The solutions for price and output from this system then determine the balance of payments. The results are listed in Table 2.1.[12]

TABLE 2.1.

Short Run Outcomes for Price, Income and the Balance of Payments

	dd	de	dg	dz
dp	$\theta(1-\Gamma)\Omega > 0$	$\delta\Omega > 0$	$\Omega > 0$	$-\Omega < 0$
dy	$\alpha\theta(1-\Gamma)\Omega > 0$	$\alpha\delta\Omega > 0$	$\alpha\Omega > 0$	$-\alpha\Omega < 0$
db	$-\theta(\delta+\alpha\Gamma)\Omega < 0$	$\alpha\delta s\Omega > 0$	$-(\delta+\alpha\beta\Gamma(1-t))\Omega < 0$	$-\alpha s\Omega < 0$

where:

$\Omega = (\alpha q+\delta)^{-1} > 0.$

$q = 0 < (1-\beta(1-t)(1-\Gamma)) < 1$, one minus the propensity to spend on home goods,

$s = 0 < (1-\beta(1-t)) < 1$, the propensity to save.

A rise in wages will, at a given price level, shift the supply curve to the left since a higher producer real wage reduces employment and output. Thus equilibrium is established by moving up along the demand curve, with higher price and lower output, and (since the demand curve is steeper than bb) a balance of payments deficit.

A rise in wealth will shift the demand curve to the right, and bb to the left. Equilibrium is established by moving up along the supply curve, with higher price and output, whilst the balance of payments moves into deficit.

A devaluation also shifts the demand curve out, with expansionary effects on price and output (given $\delta > 0$). However, the devaluation will produce a balance of payments surplus by creating an expenditure switch towards home goods. The extent of the surplus will depend on the degree to which the rise in domestic price reduces the relative price effects of devaluation.[13]

The fiscal expansion and export shocks have precisely opposite effects on price and output, since the former represents an exogenous increase in demand for home goods (thus raising their price and quantity), whereas the latter is an exogenous fall in demand. The balance of payments moves into deficit following fiscal expansion due to the rise in price and output. A deficit also results from the export shock, since the fall in price and output are insufficient to offset the initial negative impact (this again follows from the relative slopes of the demand and bb curves).

2.1.3. The Monetary Approach to The Short Run Balance of Payments

As was seen in Section 1.1.5., for a given macroeconomic framework, it should be possible to derive similar balance of payments outcomes whether working through the expenditure approach presented above, or a more explicitly monetary approach. The latter approach works through the familiar balance sheet identity (2.15), and the condition of flow money market equilibrium (2.16) to produce the "fundamental equation" of the monetary approach (2.17):

$$\dot{h}^s = \dot{r} + \dot{d} \qquad (2.15)$$

$$\dot{h}^s = \dot{h}^d \qquad (2.16)$$

$$\dot{r} = \dot{h}^d - \dot{d} \qquad (2.17)$$

The expression for the balance of payments in (2.17) is based on a flow relationship, as is the Keynsian expression (2.7), and therefore similarly requires a macroeconomic framework to explain the levels of price and output that will help determine these flows.

The first stage in this process is to relate these flows to the stock adjustment of the private sector. The flow demand for money (the only asset) derives from the desire to accumulate (decumulate) money when there is stock disequilibrium due to the actual money stock falling short of (exceeding) the desired stock:

$$h^* = ky^{dis} \qquad (2.5)$$

$$\dot{h}^d = s = \pi(h^* - h) \qquad (2.18)$$

In (2.18) we note the necessary equality of the flow demand for money and private sector savings, since all saved income must be held as money. Since the monetary approach focuses on monetary rather than expenditure flows, the flow definition of savings, which is $s = y^{dis} - c$, is used to define expenditure flows:

$$c = y^{dis} - \dot{h}^{d} \qquad (2.19)$$

Thus, by concentrating on the flow demand for money, rather than an expenditure function with a real balance effect, we use this specification of the monetary sector in combination with the macroeconomic framework specified above to solve for price, output, and the flow of money. This is done by using the "fundamental equation" (2.17), the stock adjustment equation (2.18), and the supply side defined in (2.8)-(2.10).

Hence, from (2.17) we equate the private sector surplus, $\dot{h}$, to the overseas sector surplus as specified by (2.7) (where imports are proportion Γ of expenditures as defined in (2.19)), and the public sector deficit, which is $\dot{d} = g - ty$. Next, the desired stock of money (2.5) is substituted in the stock adjustment equation (2.18). Finally equation (2.13) continues to provide the reduced from for the supply side determination of output by the labour market. This yields three equations in price, output and monetary flows:

$$\begin{bmatrix} \delta & (1-\Gamma) & \Phi_a \\ 0 & 1 & -\Phi_b \\ -\alpha & 0 & 1 \end{bmatrix} \begin{bmatrix} p \\ \dot{h} \\ y \end{bmatrix} = \begin{bmatrix} 0 & 0 & \delta & 1 & -1 \\ 0 & -\pi & 0 & 0 & 0 \\ -\alpha & 0 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} w \\ h \\ e \\ g \\ z \end{bmatrix} \qquad (2.20)$$

where $\Phi_a = \Gamma + (1-\Gamma)t$, and $\Phi_b = \pi k(1-t)$.

The solution to the system (2.20) is expressed in matrix tabulation form in (2.21) below. (The elements of the right hand side matrix correspond to the response of the endogenous to exogenous variables, e.g.: $dp/dw = \Omega_m \alpha \Phi_c$ etc.)

$$\begin{bmatrix} dp \\ d\dot{h} \\ dy \end{bmatrix} = \Omega_m \begin{bmatrix} \alpha\Phi_c & \pi(1-\Gamma) & \delta & 1 & -1 \\ -\alpha\delta\Phi_c & -\pi(\delta+\alpha\Phi_a) & \alpha\delta\Phi_b & \alpha\Phi_b & -\alpha\Phi_b \\ -\alpha\delta & \alpha\pi(1-\Gamma) & \alpha\delta & \alpha & -\alpha \end{bmatrix} \begin{bmatrix} dw \\ dh \\ de \\ dg \\ dz \end{bmatrix} \qquad (2.21)$$

where $\Phi_c = \Phi_a + (1-\Gamma)\Phi_b$, and $\Omega_m = (\delta+\alpha\Phi_c)^{-1} > 0$.

Since the flow demand for money equals the flow supply the reserve flows from the balance of payments are the excess of the flow demand for money over the flow supply of domestic credit: $\dot{r} = \dot{h} - \dot{d}$. Thus the external balance outcomes are:

$$d\dot{r} = \begin{bmatrix} a_{11} & a_{12} & a_{13} & a_{14} & a_{15} \end{bmatrix} \begin{bmatrix} dw & dh & de & dg & dz \end{bmatrix}^T \qquad (2.22)$$

$$a_{11} = -\Omega_m\alpha\delta(1-t)(\Gamma+\pi k(1-\Gamma)) < 0$$

$$a_{12} = -\Omega_m\pi(\delta+\alpha\Gamma) < 0$$

$$a_{13} = \Omega_m\alpha\delta(1-t)(\Gamma+\pi k(1-t)) > 0$$

$$a_{14} = -\Omega_m(\delta+\alpha\Gamma(1-t)(1-\pi k)) < 0$$

$$a_{15} = -\Omega_m\alpha(\pi(1-t)+t) < 0$$

A comparison of the results in (2.21) and (2.22) with those derived from the expenditure approach in the previous section reveals the compatibility of the two approaches since similar outcomes are obtained.(14) However, in explaining these results we concentrate on the determination of the flow demand and supply for money.

A rise in wages reduces output, which reduces the desired stock of money, and thus induces private sector dis-saving. The fall in output also brings a positive flow of domestic credit by lowering tax revenues. Hence there must be an external deficit and a negative reserve flow to eliminate the incipient excess supply of money, and this is brought about by the rise in the relative price of the domestic good.

A rise in wealth itself leads directly to an excess stock of money, which, by the stock adjustment rule, again produces private sector dis-saving. Part of the excess wealth is diverted into higher expenditure, thus raising price and output. Higher price and output raise tax revenue and also produce a negative reserve flow to match the flow supply of money with the flow demand.

A devaluation directly improves external balance and thereby produces incipient excess supply of money. The excess supply is met by a rise in price and (through a lower producer real wage) a rise in output which both mitigate the extent of the payments surplus and also raise the demand for money.

The money market is brought into flow equilibrium in the same manner following a fiscal expansion - the difference being that the initial incipient excess supply of money arises from domestic credit - the rise in price and output increase the demand for money and reduce the excess flow supply by the consequent balance of payments deficit.

Finally the reduction in demand for exports, by instigating a balance of payments deficit, induces incipient excess demand for money - the fall in price and output correct this by reducing flow demand , mitigating the initial impact on external balance, and inducing credit expansion.

2.2. Dynamics and Stability

We now return to the model as expressed in Keynsian expenditure terms to examine the effects of allowing for the endogeneity of the dynamic state variables wealth and wages on the aggregate demand-aggregate supply framework. These state variables were taken as pre-determined in the previous section, which solved for short run equilibrium of price and output. These solution values generate non-zero values for the rates of change at which the stock of wealth and wages are evolving in a particular short run equilibrium. These rates of change can thus be written as a function of price and output, which, in turn, are subsequently determined by the evolving levels of the state variables. Thus the system continues to evolve through short run equilibria, even with the exogenous variables unchanged. This yields a pair of dynamic equations whose full stock-flow equilibrium is studied in section 2.3. Here we concentrate on the stability of dynamic adjustment following the introduction of equations in $\dot{h}$ and $\dot{w}$ to the model.

2.2.1. The Dynamic Loci

The dynamics derive from private sector accumulation and wage adjustment. The stock of wealth consists of reserves and domestic credit, thus their time derivatives provide the rate of private sector accumulation from external surpluses (2.23a) and public sector deficits (2.23b):[15]

$$\dot{r} = db \qquad (2.23a)$$

$$\dot{d} = dg - tdy \qquad (2.23b)$$

$$\dot{h} = db + dg - tdy \qquad (2.24)$$

Wages sluggishly adjust towards their market clearing level, denoted by w^* in (2.25) below, so that if w^* exceeds (falls short of) the pre-determined contract wage, wages will be rising (falling) to gradually clear the excess demand (supply) of labour:

$$\dot{w} = \pi(dw^* - dw) , \pi > 0 \qquad (2.25)$$

where $dw^* = \mu_a dp + \mu_b de + \mu_c dw^t$, from setting $dn^d = dn^s$, and:

$\mu_a = (b+(1-\Gamma))/(b+c)$

$\mu_b = 1-\mu_a = \Gamma c/(b+c)$

$\mu_c = 1/(b+c)$,

with b and c being the parameters of the labour demand and supply functions, (2.9) and (2.10).

These equations come into operation once the short run equilibrium establishes outcomes for dp and dy. The subsequent response of $\dot{h}$ and $\dot{w}$ is determined by taking the total differentials of the dynamic equations (2.24) and (2.25) and substituting the short run results for dp, dy and db obtained earlier.

In considering the loci and stability, we examine how the dynamic equations respond to changes in the state variables themselves:

$$\begin{bmatrix} \dot{h} \\ \dot{w} \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \cdot \begin{bmatrix} h \\ w \end{bmatrix} \qquad (2.26)$$

where the adjustment coefficients of the transition matrix $\underline{A}$ are:

$$a_{11} = -\theta\Omega(\delta+\alpha(\Gamma+(1-\Gamma)t)) < 0$$

$$a_{12} = -\alpha\delta\Omega(1-\beta)(1-t) < 0$$

$$a_{21} = \pi\mu_a\theta\Omega(1-\Gamma) > 0$$

$$a_{22} = -\pi\Omega(\alpha q(1-\mu_a)+\delta) < 0$$

In figure 2.2. the dynamic loci are plotted in h, w space. The zero accumulation locus $\dot{h} = 0$ has the slope:

$$dh/dw_{(\dot{h}=0)} = -\alpha\delta(1-\beta)(1-t)/\theta(\delta+\alpha(\Gamma+(1-\Gamma)t) < 0$$

Given the nature of the hoarding function, a rise in the level of wealth (from e_0 to A) implies, ceteris paribus, an excess stock of wealth, inducing private sector decumulation ($\dot{h} < 0$) at point A. This dis-saving can be prevented, and the $\dot{h} = 0$ locus re-attained, by a fall in wages (the movement from point A to B). This negative relationship may be viewed from two perspectives.

The most direct explanation is to recall the positive relationship between the desired stock of real wealth and real income (equation (2.5)). Thus the higher level of wealth at point A will be willingly held if a rise in income is brought about. A fall in wages will achieve this, ceteris paribus, by reducing the producer real wage, and thereby raising employment and output.

Alternatively a (somewhat more involved) explanation may be offered from the Keynsian aggregate demand-aggregate supply framework. Consider, from the point of balance e_0, a fall in wages. This would shift the aggregate supply curve to the right in figure 2.1.(b). The increase in output, at the given price level, implies a situation of incipient excess supply of domestic goods, since leakages of savings, imports and tax payments mean the demand for domestic goods rises less than output. In order that the domestic goods market clears the price level must fall sufficiently to eliminate this excess supply by inducing substitution towards domestic goods. The extent of this price fall must be more than that required to offset leakages of higher tax payments and imports alone (which, by (2.24), would tend to produce decumulation), since savings have also risen. Thus a fall in the wage must have a positive overall effect on private sector accumulation. In order to restore a position of zero accumulation a rise in wealth (which raises tax payments, imports and reduces exports, due to the effects of higher price, output, and real balances) is called for. Thus $\dot{h} = 0$ is downward sloping.

The zero wage adjustment locus has slope:

$$dh/dw_{(\dot{w}=0)} = (\delta+\alpha q(1-\mu_a))/\theta\mu_a(1-\Gamma) > 0$$

From a point on the $\dot{w} = 0$ (labour market equilibrium) locus, a rise in the wage will create excess supply of labour. This excess supply can be removed by a rise in wealth. The reason is that a rise in wealth will raise the domestic price level by more than the consumer price index (given the fixed price of imports). This means that the producer real wage will fall by more than the consumer real wage, thus correcting the excess supply of labour.

The stability of the system requires a negative trace and positive determinant, both of which are satisfied:

$$Tr(\underline{A}) = a_{11} + a_{22} < 0$$

$$Det(\underline{A}) = \pi\theta\Omega\Sigma > 0$$

where $\Sigma = (\delta+\alpha(1-\mu_a)(\Gamma+(1-\Gamma)t)) > 0$

Thus suppose again that the economy is at point A in figure 2.2. (a point that would be reached following an increase in the money supply). The rise in real balances from equilibrium point e_0 induces dis-saving by the stock adjustment behaviour. The rise in real balances also implies a higher price level, so that the producer real wage has fallen by more than the consumer real wage. Hence wages will be rising at point A in response to excess demand for labour. The process of falling wealth and rising wages has offsetting effects on accumulation (since falling wealth reduces the actual stock of wealth, whilst rising wages reduce the desired stock), but both effects raise the producer real wage, and therefore reduce excess demand for labour. Thus labour market equilibrium will be attained before zero accumulation is accomplished (a point such as Q). Adjustment continues from point Q due to falling wealth, but, as the arrows of motion show, adjustment must be stable (albeit possibly cyclical), and the economy will eventually return to e_0.

Figure 2.2.

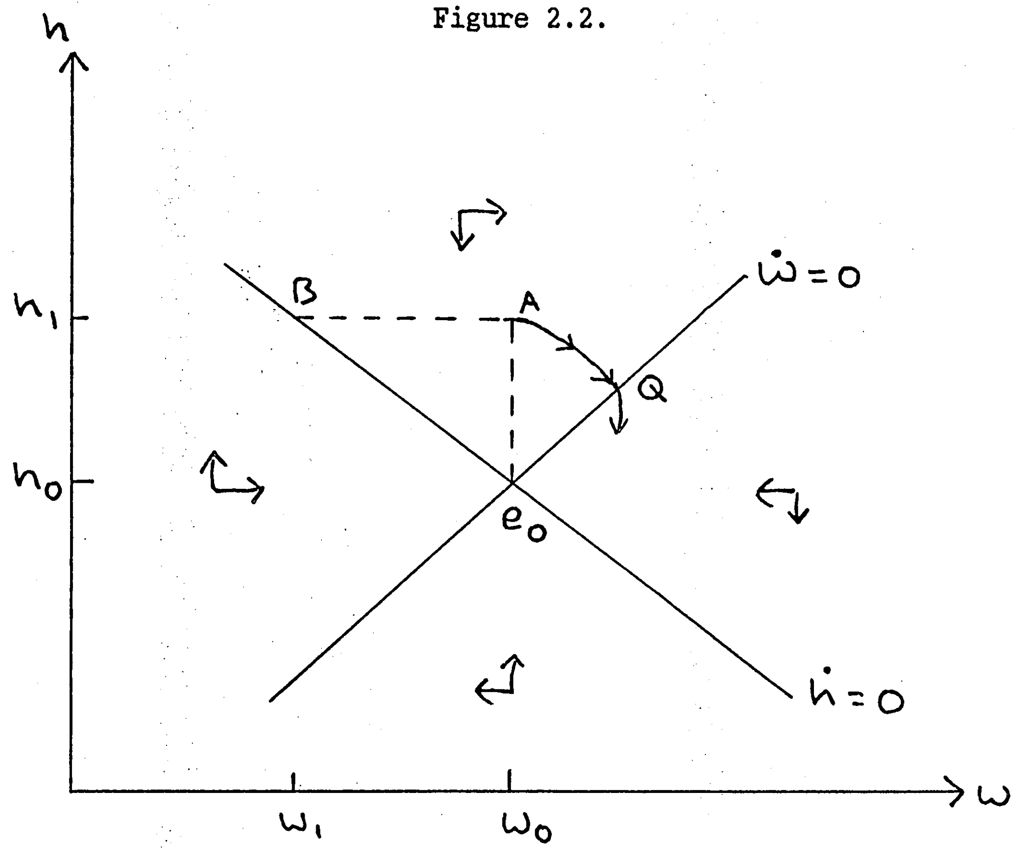
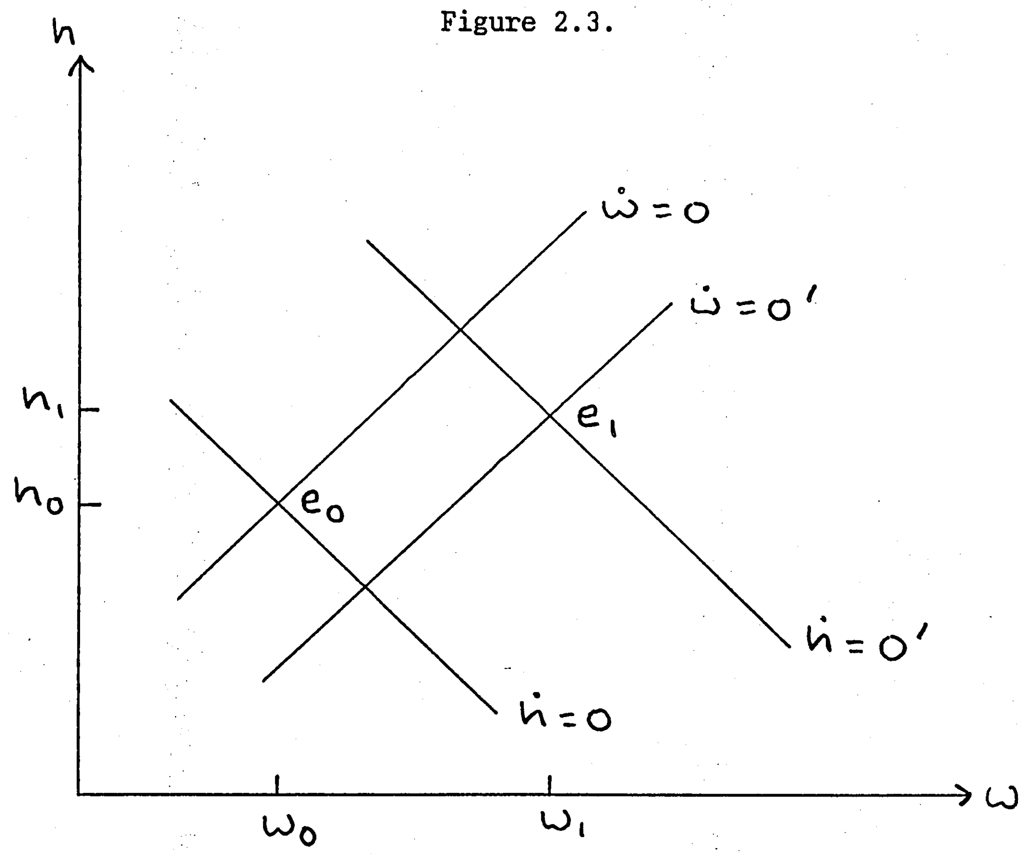


Figure 2.3.



2.3. Long Run Statics

As the system is stable, it will finally converge to a short run equilibrium yielding values of p and y that are consistent with no further change in either of the state variables - i.e.: $\dot{h} = \dot{w} = 0$. In the absence of further shocks, this constitutes the economy's long run equilibrium. This long run thus provides solutions for the state variables h and w, and thereby for the jointly endogenous variables p and y, in response to any exogenous shock.

The effects of the shocks on short run equilibrium has been examined in section 2.1.2. - the outcomes for p and y yield the non-zero values for the rates of change in the state variables as follows:

$$\begin{bmatrix} \dot{h} \\ \dot{w} \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \begin{bmatrix} h \\ w \end{bmatrix} + \begin{bmatrix} b_{11} & b_{12} & b_{13} & b_{14} & b_{15} \\ b_{21} & b_{22} & b_{23} & b_{24} & b_{25} \end{bmatrix} \begin{bmatrix} dd \\ de \\ dg \\ dz_t \\ dw \end{bmatrix} \qquad (2.27)$$

where the elements of transition matrix $\underline{A}$ are given in (2.26) and:

$b_{11} = -\theta\Omega(\delta+\alpha(\Gamma+(1-\Gamma)t) < 0$

$b_{12} = \alpha\delta\Omega(1-\beta)(1-t) > 0$

$b_{13} = \alpha\Omega(1-\beta)(1-t) > 0$

$b_{14} = -\alpha\Omega(1-\beta)(1-t) < 0$

$b_{15} = 0$

$b_{21} = \pi\mu_a\theta\Omega(1-\Gamma) > 0$

$b_{22} = \pi\Omega(\alpha q(1-\mu_a)+\delta) > 0$

$b_{23} = \pi\mu_a\Omega > 0$

$b_{24} = -\pi\mu_a\Omega < 0$

$b_{25} = \pi\mu_c > 0$

The long run solution of (2.27) is $\underline{x} = -\underline{A}^{-1}\underline{B}\underline{y}$, where $\underline{x}$ is the vector of state variables (h and w), and $\underline{y}$ the vector of exogenous variables. The solutions for h and w determine the long run values for p and y and thereby also determine the state of external balance in the long run. The results are listed in Table 2.2. Note that, although we have chosen to specify the model via the expenditure approach, the results in Table 2.2. all comply with the long run stock-flow relationship between desired real wealth and real income, $h^* = ky^{dis}$, on making the substitution $\beta=(1-\theta k)$.

The model yields the classical results of the monetary approach to the balance of payments for the effects of an increase in domestic credit and devaluation. Following a step increase in credit, the stock of reserves must fall by an offsetting amount, leaving real wealth (and thus, through the quantity theory relationship, real income) unchanged. As the real exchange rate must also remain unchanged, the nominal values for p and w must return to their original levels. Thus a long run nominal-real dichotomy obtains. A devaluation similarly has no real effects in the long run, with the initial real depreciation being eroded as workers restore their real wage in a process that ends with a rise in nominal wages and the price level equal to the extent of devaluation.(16)

However, a fiscal expansion does produce real effects in the long run, as it represents a shift in demand in favour of domestic goods. Figure 2.3. illustrates the effects on the dynamic loci. The $\dot{w} = 0$ locus shifts down. The reason for this is that, at the initial wage

TABLE 2.2.

LONG RUN OUTCOMES

A step increase in the money supply has no long run effects:

$dh/dd = dw/dd = dp/dd = dy/dd = db/dd = 0.$

Devaluation has no real effects; nominal values rise proportionately:

$dh/de = dy/de = db/de = 0; \; dw/de = dp/de = 1.$

	dg	dz	dw^t
dh	$\alpha\phi(1-\mu_a)/\theta\Sigma > 0$	$-\alpha\phi(1-\mu_a)/\theta\Sigma < 0$	$-\alpha\phi\delta\mu_c/\theta\Sigma < 0$
dw	$\mu_a/\Sigma > 0$	$-\mu_a/\Sigma < 0$	$\mu_c(\delta+\alpha\tau)/\Sigma > 0$
dp	$1/\Sigma > 0$	$-1/\Sigma < 0$	$\alpha\mu_c\tau/\Sigma > 0$
dy	$\alpha(1-\mu_a)/\Sigma > 0$	$-\alpha(1-\mu_a)/\Sigma < 0$	$-\alpha\delta\mu_c/\Sigma < 0$
db	$-(\delta+\alpha\Gamma(1-t)(1-\mu_a))/\Sigma < 0$	$-\alpha(1-\mu_a)t/\Sigma < 0$	$-\alpha\delta t\mu_c/\Sigma < 0$

where:

$$\Sigma = (\delta+\alpha(1-\mu_a)\tau) > 0,$$

$$\tau = (\Gamma+(1-\Gamma)t) > 0,$$

$$\phi = (1-\beta)(1-t) > 0$$

w_0, preservation of labour market equilibrium requires no change in the domestic price level (and therefore no change in producer and consumer real wages), which requires a fall in wealth that offsets the excess demand for domestic goods caused by fiscal expansion. The $\dot{h} = 0$ locus shifts up because fiscal expansion raises output and thus the desired stock of wealth.(17) The new steady state at point e_1 involves higher levels of real wealth and nominal wages (see Table 2.2.). These results for the state variables imply the relative rise in the price of the home good is sustained in the long run, and this real appreciation means labour market equilibrium is established with a lower producer real wage and higher consumer real wage, so that employment and output are permanently higher.(18) The rise in wealth, income and price all raise imports, whilst the real appreciation also "crowds out" exports by making them less competitive, hence the equilibrium at e_1 involves a balance of payments deficit. However, the consequent reserve loss does not exert any self-righting pressure on the balance of payments, since it is offset by the budget deficit, maintaining the higher level of wealth which the private sector desires to hold. On the monetary approach argument, since the desired level of wealth is attained at point e_1, and private sector stock adjustment complete, the "fundamental equation" requires an external deficit to match the budget deficit caused by fiscal expansion.

In terms of the state variables wealth and wages, and therefore also in terms of the jointly endogenous p and y, the long run effects of a shift reduction in the demand for exports are the opposite of a fiscal expansion.[19] The structural shift in demand away from home goods leads to a permanent reduction in the relative price of domestic output. The real depreciation causes the producer real wage to rise, and the consumer real wage to fall across steady states, so that output falls in line with wealth. However, although the fall in wealth, price and income helps reduce imports and re-gain some lost exports, there is a permanent balance of payments deficit in the long run. The reason is that the fall in income, by lowering tax revenue, induces domestic credit expansion so that the monetary approach process of wealth decumulation ceases before wealth falls sufficiently to eliminate the deficit. Hence, in the steady state, the budget deficit is still "crowding out" net exports, and the real exchange rate is permanently mis-aligned (overvalued) relative to the levl required for external balance.

It should be noted that, despite the symmetry in terms of wealth, wages, price and output in response to the fiscal and export shocks, the extent and evolution of the balance of payments deficit differs. Following the short run outcomes (that differ according to the domestic/external source of the shocks), the movement to the long run position is likely to entail exacerbation of the external deficit in the case of fiscal expansion due to the processes of accumulation and further real appreciation; whilst the opposite process is likely to mitigate the deficit in the case of the export shock[20] This relationship between the symmetric evolution of macroeconomic (demand-supply) equilibria and the differing evolution of the balance of payments is taken up again in chapter four.

The wage shock clearly leads to a loss of income and wealth and a rise in price over steady states. In terms of the dynamic loci, the higher wage claims will shift $\dot{w} = 0$ to the right - a given level of real wealth holds the price level constant, so that a higher level of nominal wages ensures that workers achieve their objective of a greater return for a given quantity of labour that they supply. The new steady state thus involves moving down and along the $\dot{h} = 0$ locus to an equilibrium with higher wages and lower wealth. For this supply side shock, the real appreciation does not raise employment and output (as it does for demand side shocks), since the producer real wage rises across steady states (by $\mu_c\delta/\Sigma$). The fall in output again determines the long run rate of domestic credit expansion, and, with the stock of wealth at its desired level, stock-flow equilibrium is again established with a permanent balance of payments deficit.

In summary this chapter has seen the compatibility of the monetary approach to the balance of payments with an orthodox aggregate demand-aggregate supply model structure and with permanent balance of payments deficits. The next two chapters preserve the same basic model structure and follow up cases of permanent deficits with the inevitable collapse of the fixed regime.

NOTES:

(1) The present model differs from Montiel in its goods disaggregation (complete specialisation), in the incorporation of an endogenous labour supply and budget deficit, and in its explicit linking of the asset-expenditure interaction which demonstrates the full compatibility of trade and monetary flow expressions for the balance of payments, taken up in section 2.1.3.

(2) All these papers differ in various aspects of model specification from that presented here. A principal difference is that they all assume an exogenous labour supply, so that permanent payments deficits only arise from policy changes (except in Soderstrom and Viotti, where wages are taken to be exogenous).

(3) In chapter three the present model is amended by the assumption of wage flexibility; chapter four simulates the same model presented here to incorporate the timing of collapse and post-attack regime.

(4) The model is written in log-linear form.

(5) In the definitions for the real exchange rate and consumer price index, the foreign price level is assumed fixed and its log set to zero, so $\bar{e}$ is the price of the foreign good to domestic residents.

(6) We abstract from changes in the capital stock.

(7) The labour supply curve shifts horizontally to the left with w^t.

(8) In the case of purchasing power parity ($\delta \rightarrow \infty$), the aggregate demand and trade balance schedules are horizontal.

(9) That is to say when the labour market clears, as it must in the long run.

(10) Note that a terms of trade improvement is the same as a real appreciation, since the terms of trade are simply $-\sigma$.

(11) For a supply side shock (implying a given consumer real wage produces less employment and output) there is a negative long run relation between the real exchange rate and output.

(12) The short run is not affected by the dw^t shock as employment is demand determined in the short run, so that shifts in the supply of labour have no impact on aggregate supply.

(13) Devaluation has no short run real effects if there is a vertical supply &/or a horizontal demand curve ($\alpha \to 0$ and $\delta \to \infty$ respectively).

(14) As was seen in section 1.1.5., precise similarity follows from explicit recognition of the hoarding function stock-flow relationships: $\pi = \theta$, and $\beta = (1-\theta k)$. This implies $\Omega_e = -\Omega_m$, where Ω_e and Ω_m are the determinants of the L.H.S. matrices in (2.14) and (2.20) respectively.

(15) If the parameter relationships of footnote (14) are observed, the rate of private sector accumulation could equivalently be taken directly from the results for dh in (2.21).

(16) The loci $\dot{h} = 0$ and $\dot{w} = 0$ both shift to the right by the extent of the devaluation, so the new steady state involves the initial level of wealth, whilst nominal wages rise one for one with devaluation.

(17) The $\dot{h} = 0$ locus shifts up by $\alpha(1-\beta)(1-t)/\theta(\delta+\alpha(\Gamma+(1-\Gamma)t))$, or equivalently by $\alpha k/(\delta+\alpha(\Gamma+(1-\Gamma)t))$ (see footnote (14)). The $\dot{w} = 0$ locus shifts up by $1/\theta(1-\Gamma)$.

(18) The producer real wage falls by μ_b/Σ; the consumer real wage rises by $\Gamma b/\Sigma$, where b is the elasticity of demand for labour.

(19) In terms of figure 2.3. the loci shift, by equal amounts, in the opposite directions - thus if initial equilibrium were e_1, the economy would evolve to e_0 following the export shock.

(20) This observation must be qualified, since the change in output between short and long run equilibria is ambiguous. Thus, taking the case of fiscal expansion, although the accumulation process ensures that wealth and price have both risen in the long run (compared to the short run), tending to worsen the balance of payments, output may have fallen compared to its short run level as wage pressures push up aggregate supply.

CHAPTER THREE

THE MONETARY APPROACH, BUDGET DEFICITS AND SPECULATIVE ATTACKS

INTRODUCTION

In this chapter the issue of the chronic payments deficits that emerged as a stock-flow equilibrium in the model of chapter two are taken up and extended with an analysis of the collapse of a fixed rate regime in a speculative attack. The method used to analyse a speculative attack follows Krugman (1979), who presented a graphical demonstration that links the dynamics of a monetary approach model pre and post collapse by using the condition of no exchange rate jump. The analysis remains incomplete due to the absence of a solution for the timing of collapse (for reasons explained in chapter one, and which we return to below) - this issue is taken up in chapter four.

Krugman's article remains the only analysis of the collapse of a monetary approach model of a fixed regime.(1) His model assumed continuous purchasing power parity and fixed output (the fixed regime thus corresponds to the model of section 1.1.2. in chapter one; the floating regime is based on Kouri (1976)). We extend this by employing the structure of the model of chapter two in which domestic and foreign produced goods are differentiated in demand so that their relative price (the real exchange rate) has a direct effect on external balance. The real exchange rate also affects the supply side by driving a wedge between the producer and consumer real wage, as in chapter two. However, we simplify the modelling of the labour market from that in chapter two by assuming it is continuously cleared by instantaneous wage adjustment. With wages no longer a pre-determined state variable the dynamics of the fixed regime are thus reduced to first order. The reason for this assumption is that, in the floating regime that must emerge post-collapse, the analysis of portfolio balance raises the order of dynamics of the system over that required to analyse the model under fixed rates (as explained in section 1.2. of chapter one). The adjustment dynamics of the post-collapse floating regime are thus restricted to second order by the assumption of instantaneous labour market clearing.(2)

The analysis of the floating regime draws on the monetary approach literature on exchange rate determination (that is to say models that combine the asset market determination of exchange rates under rational expectations with stock adjustments via the current account). Dornbusch and Fischer (1980) and Branson and Buiter (1983) extended Kouri's analysis by employing the goods disaggregation used here, but their models abstracted from explicit consideration of the supply side (Dornbusch and Fischer took output as fixed; Branson and Buiter assumed either fixed price or fixed output).(3) The supply side structure of the present model becomes particularly important when we re-introduce the endogenous budget deficit (as modelled in chapter two) in the second half of the present chapter. This is because we are then able to introduce speculative attack analysis to examine the consequences of the rate of credit expansion (and therefore reserve loss) being ultimately determined by structural factors within a monetary approach model.

Despite producing chronic payments deficits and thus the conditions for an inevitable collapse à la Krugman, this aspect of the monetary approach has not been included into the balance of payments crisis literature. Indeed analysis of endogenous budget deficits has been largely absent from the portfolio balance-current account literature. As Kawai (1985) explains, this absence is largely due to the requirements of tractability.[(4)] Most contributions to the portfolio balance-current account literature have an asset menu consisting of domestic and foreign bonds as well as money. In this case the financing of a government deficit would add a third order of dynamics to the system. The government could choose to finance its deficit by printing money or issuing bonds, thereby altering the allocation between money and bonds in the portfolio, and influencing the level of interest rates. The level of interest rates and the stock of government bonds determine the interest payments on government debt, and thereby partly determine the level of the budget deficit itself. However, by adopting a currency substitution model à la Calvo and Rodriguez (1977), this problem is avoided since all deficit financing must be by credit creation, and domestic and foreign currency are the only assets in agents' portfolios. At any point in time, the level of total wealth and the stock of foreign currency are sufficient to determine the system. The level of wealth determines output and relative prices and thereby both current account and budget deficits; whilst the contemporary level of foreign currency holdings defines the composition of agents portfolios and therefore the equilibrium exchange rate consistent with portfolio balance and the expected future time paths of domestic and foreign currency.

We now turn to consider how the approach adopted in this chapter relates to the literature which is directly concerned with balance of payments crises, as it has developed since Krugman. This literature falls into three strands.

Firstly, as reviewed in section 1.3. of chapter one, a large number of contributions have followed Flood and Garber (1984) in deploying models which dissociate balance of payments deficits from private sector stock adjustment. However, we have argued that this approach is incompatible with the monetary approach in which stock adjustment dynamics are the essential element.

Secondly crises have been analysed within a full general equilibrium intertemporal optimisation framework (Calvo (1987), van Wijnbergen (1988)). This framework is again clearly different from the spirit of the monetary approach as pursued in this thesis (which concentrates on the links between phases of stock disequilibrium and Keynsian determination of flow (goods) markets). A speculative attack within the intertemporal optimisation models differs significantly from that in a monetary approach model since it involves a direct switch between steady states (further consideration of the comparisons are made in section 3.1.3.).

Finally Edwards (1988) and Edwards and Montiel (1989) have provided more recent analyses of balance of payments crises within a monetary approach model (the model structure is based on Khan and Montiel (1987)). However, these analyses differ in two respects from that presented here. Firstly the model differs in structure - adopting the small country assumption in the specification of goods disaggregation, assuming aggregate employment (and thus output) is fixed at a level determined by an exogenous supply of labour, and taking the budget deficit to be exogenous. Secondly, these analyses are concerned with the different issue of the effects of a corrective policy switch as a balance of payments crisis develops, so that the fixed regime never actually collapses.[(5)] this differs from the spirit of Krugman's analysis, in which the regime switch (the abandonment of fixed rates) is inevitable and determined by rational speculative behaviour.

The chapter divides into two halves. In the first half the budget deficit is taken as exogenous. The two real shocks (reductions in export demand and labour supply) now cause only temporary balance of payments deficits, eliminated by the classic specie-flow mechanism (in a floating regime, the corollary is that there is no long run change in desired portfolio composition). However, we also impose the shock of a permanent increase in the rate of credit expansion that must lead to the collapse of the fixed regime.[(6)] Agents alter the composition of their portfolios in two stages - firstly there is a discrete rise in foreign currency holdings in the attack; subsequently foreign currency holdings are gradually reduced as the current account deficit is gradually eliminated. This stock adjustment process is compatible with portfolio equilibrium via the acceleration hypothesis - the rate of depreciation that emerges immediately post-attack exceeds its steady state.

In the second half of the chapter the endogenous budget deficit of chapter two is re-introduced. We follow up the analysis of the three shocks that yield permanent balance of payments deficits with the collapse of the fixed regime, and dynamics of the post-attack floating system. The portfolio adjustments are again made at the moment of attack and during the floating regime's dynamics. During the fixed regime, the real exchange rate responds to changes in economic structure, but, in contrast to the case with no budget deficit, will remain permanently overvalued (as in chapter two) for as long as the fixed regime lasts since the endogenous deficit pushes the economy towards a stock-flow equilibrium at excessive levels of wealth. It is only under a floating regime that the stock of wealth must finally fall to a level compatible with external balance.

3.1. AN EXOGENOUS BUDGET DEFICIT

The model is studied under fixed and floating rates in turn, analysed in sections 3.1.1. and 3.1.2. respectively. When the budget deficit is exogenous, we see that reserves will be continuously depleted, and the collapse of the fixed regime inevitable, only if the government embarks on a policy of credit expansion. The collapse of the fixed regime in a speculative attack that results from this policy is studied in section 3.1.3.

3.1.1. The Fixed Regime

Equations (3.1) to (3.9) lay out the model. The basic structure is as outlined in chapter two, with the modifications noted below.

Definitions:

$$a = (m - e) + f \qquad (3.1)$$

$$\sigma = e - p \qquad (3.2)$$

Identities:

$$m = r + d \qquad (3.3)$$

$$y = c + b \qquad (3.4)$$

Demand:

$$c = \beta y + \theta a \qquad (3.5)$$

$$b = \delta\sigma - \Gamma c - z \qquad (3.6)$$

Supply:

$$y = an \qquad (3.7)$$

$$n^d = -b(w - p) \qquad (3.8)$$

$$n^s = c(w - (1-\Gamma)p - \Gamma e) - w^t \qquad (3.9)$$

The stock of wealth in (3.1) now consists of foreign currency holdings, f, as well as the domestic money stock, m. Real wealth, a, is defined in terms of the purchasing power of currency stocks over the imported good.(7). The real exchange rate σ remains the relative price of the imported to the domestic good, in the production of which the economy is completely specialised.

The accounting relationships (3.3) and (3.4) show the domestic money stock as the stock of reserves, r, and domestic credit, d; and national income (absent the public sector) as private sector consumption, c, and the trade balance, b.

Consumption in (3.5) includes a real balance effect, which, as before, may be seen as deriving from the hoarding function. (In the present chapter we utilise the expenditure flows approach and do not explicitly consider the monetary flows approach, having demonstrated the equivalence of the two in the previous chapter).[8]

The trade balance (3.6) is as in chapter two. It improves with a real depreciation, deteriorates as imports rise with consumption (Γ being the marginal propensity to import), and is subject to an exogenous reduction in the demand for exports, z.

Equations (3.7)-(3.9) model the supply side. Labour is again the only variable factor of production. The demand for labour falls with the producer real wage; the supply of labour rises with the consumer real wage, subject to an exogenous shifty reduction, w^t.

The Short Run

Labour is the variable factor of production that determines output on the supply side, as in chapter two. However, it is now assumed that the wage instantly clears the labour market, and this solves for the level of employment (which was demand determined at the contract wage in chapter two). This is substituted into the production function (3.7) to yield a supply curve relationship along which labour market equilibrium holds:

$$y = -s_1\sigma - s_2w^t \qquad (3.10)$$

where $s_1 = \Gamma abc/(b+c)$, $s_2 = ab/(b+c)$.

Thus, subject to the shift factor w^t, there will be a continuous negative relationship between the real exchange rate, and employment and output.(9) Private sector accumulation will lead to movements along this supply schedule, inducing continuing appreciation and rising levels of employment and output.

Substituting the components of aggregate demand (3.5) and (3.6) into the national income identity (3.4) yields an aggregate demand curve along which the domestic goods market clears:

$$qy = \delta\sigma + \theta(1-\Gamma)a - z \qquad (3.11)$$

where $q = (1-\beta(1-\Gamma))$.

The model may be solved in the short run for the two jointly endogenous variables σ and y. The aggregate supply schedule (3.10) provides one relationship between these variables; aggregate demand (3.11) provides the other. Thus solving (3.10) and (3.11) gives the short run response of the real exchange rate and output with respect to the pre-determined variable wealth and the exogenous variables z and w^t, such that goods and labour market equilibria are continuously maintained. The equations for the short run statics results are tabulated in matrix from in (3.12):

$$\begin{bmatrix} d\sigma \\ dy \end{bmatrix} = \Omega \begin{bmatrix} -\theta(1-\Gamma) & 1 & -s_2q \\ s_1\theta(1-\Gamma) & -s_1 & -s_2\delta \end{bmatrix} \begin{bmatrix} da \\ dz_t \\ dw^t \end{bmatrix} \qquad (3.12)$$

where $\Omega = (s_1q+\delta)^{-1} > 0$.

A rise in wealth creates excess demand for domestic goods, bringing about an increase in their price (a real appreciation, or fall in σ). The real appreciation establishes labour market equilibrium with a lower producer real wage and higher consumer real wage, raising employment and output. A fall in demand for exports ($dz > 0$) has the opposite effect. A shift reduction in the labour supply function ($dw^t > 0$) has an immediate effect in reducing employment and output. The reduction in output implies incipient excess demand for domestic goods, thus requiring a real appreciation to maintain goods market equilibrium.(10)

Figure 3.1.(a) illustrates the short run system. The labour market equilibrium locus NN has a negative slope ($(d\sigma/dy)_{NN} = -s_1$), since a real appreciation implies the domestic price level rises relative to the consumer price index, reducing the producer real wage by more than the consumer real wage, thus raising employment and output. The domestic goods market equilibrium locus DD has a positive slope ($(d\sigma/dy)_{DD} = (1-\beta(1-\Gamma))/\delta$). A rise in output raises income and spending, but spending on domestic goods rises by less due to "leakages" of saving and imports; hence a real depreciation is required to eliminate excess supply of domestic goods.

A balanced trade locus B=0, derived from (3.6), is also illustrated in figure 3.1.(a). This has a positive slope ($(d\sigma/dy)_{B=0} = \beta\Gamma/\delta$). A rise in output and income would induce higher imports, thus

Figure 3.1.(a).

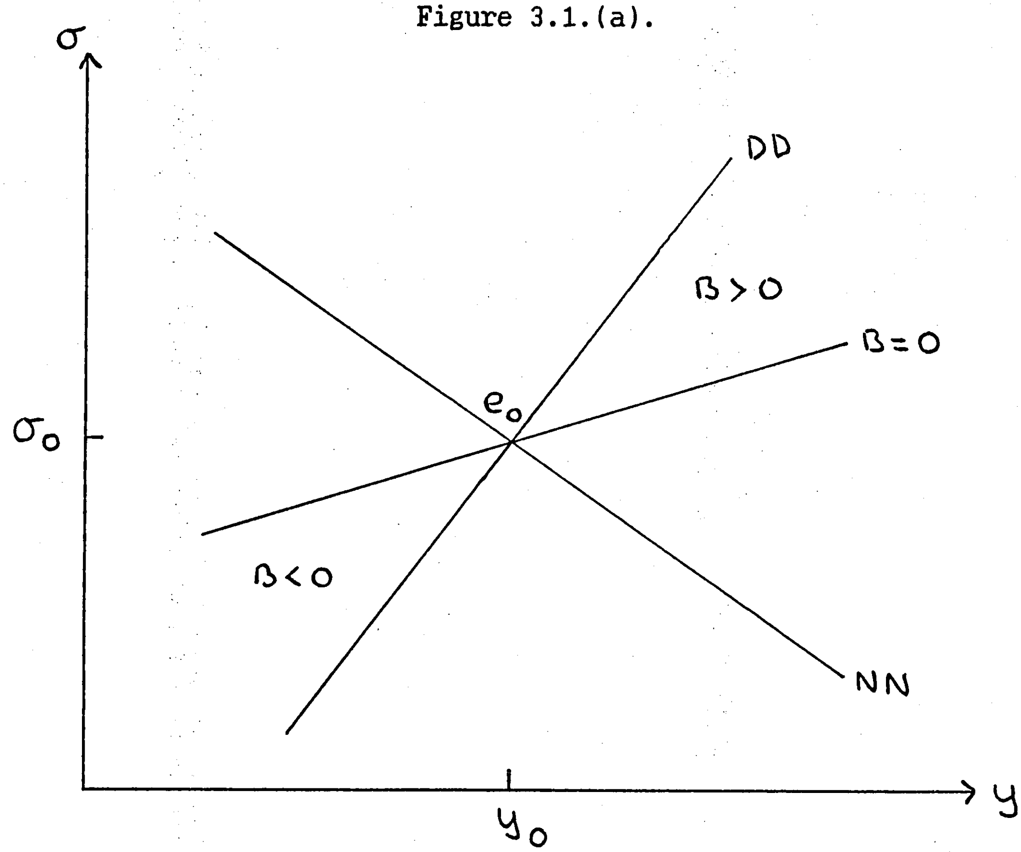
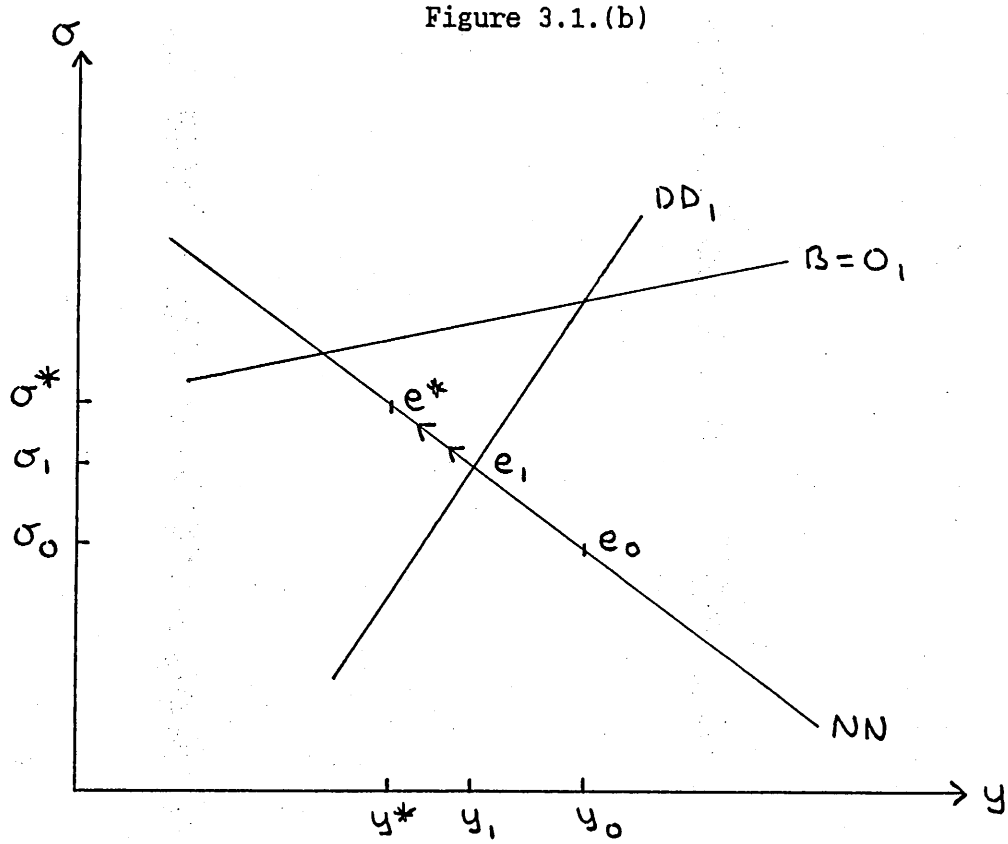


Figure 3.1.(b)



requiring real depreciation to switch demand towards domestic goods and restore external balance. The B=0 locus is flatter than the domestic goods equilibrium locus DD. This is because in order to sustain higher levels of output (moving up and along DD) without creating an excess supply of domestic goods (due to the higher levels of savings associated with higher income), a growing trade surplus (points above and to the left of B=0) is required.

Reference to figure 3.1.(a) shows the effects on trade balance of changes in the levels of the pre-determined and exogenous variables. A rise in wealth, via the real balance effect, raises demand for both domestic goods and imports, shifting DD to the right and B=0 to the left. Goods and labour market equilibria are established by moving down and along NN, with a consequent trade deficit.

The shift reduction in labour supply would shift NN to the left (with DD and B=0 unchanged). Equilibrium involves moving down and along DD. The reduction in output involves incipient excess demand for domestic goods, averted by the trade deficit arising from real appreciation.

The export shock is shown separately in figure 3.1.(b). From initial equilibrium e_0, the shock shifts DD and B=0 up by the same amount (to DD_1 and $B=0_1$ respectively). This is because the initial level of output would involve excess supply of domestic goods without a real depreciation sufficient to offset the trade deficit. Goods and labour market equilibria are at e_1, with the real depreciation reducing employment and output. The reduction in output implies incipient excess demand for domestic goods, once again requiring a trade deficit (which is again ensured by DD being steeper than B=0).

Thus joint labour and domestic goods market equilibria requires a trade deficit in all cases. The extent of the deficit is obtained by substituting the equilibrium outcomes for σ and y from (3.12) into (3.7), which yields the results:

$$db = -\Omega \begin{bmatrix} \theta(\delta+\Gamma s_1) & s_1(1-\beta) & s_2\delta(1-\beta) \end{bmatrix} \begin{bmatrix} da & dz & dw^t \end{bmatrix}^T \qquad (3.13)$$

<u>The Dynamics</u>

The model's state variable is wealth, and taking the time differential of (3.1) gives:

$$\dot{a} = \dot{m} - \dot{e} + \dot{f} = \dot{m} + \dot{f} \qquad (3.14)$$

since $\dot{e} = 0$.

Whilst the exchange rate is pegged, there is no incentive for the private sector to substitute between the two assets as their expected relative rate of return (i.e.: expected depreciation) is unaltered. Thus, following Krugman (1979), it is assumed that the two assets are accumulated in fixed proportions:

$$\dot{f} = \alpha\dot{a} \qquad (3.15)$$

$$\dot{m} = (1-\alpha)\dot{a} \qquad (3.16)$$

where α is the fraction of wealth initially held in foreign currency. From (3.3), we have:

$$\dot{m} = \dot{r} + \dot{d} \qquad (3.17)$$

Reserves are accumulated if the balance of payments surplus is in surplus from the current (or trade) account and the capital account combined:

$$\dot{r} = db - \dot{f} \qquad (3.18)$$

Thus the balance of payments flows equation (3.18) states that if the government wishes to maintain a given level of the exchange rate, it must be prepared to sell reserves ($\dot{r} < 0$) to meet any excess demand for foreign exchange in order to prevent depreciation. Excess demand for foreign exchange can arise from either a current account deficit ($db < 0$), as domestic residents require foreign exchange to acquire net imports, or a capital account deficit - i.e.: increases in private sector holdings of foreign currency, creating net capital outflows ($\dot{f} > 0$). Thus equation (3.18) governs the required evolution of the government's stock of foreign reserves to preserve equilibrium in the foreign exchange market at the pegged exchange rate.

Domestic credit is the other component of the domestic money stock, and this is assumed to evolve as:

$$\dot{d} = 0 \text{ or } \mu \qquad (3.19)$$

Thus the governments budget is either held in balance ($\dot{d} = 0$), or as at a given exogenous deficit such that a constant rate of domestic credit creation is required to finance the deficit ($\dot{d} = \mu > 0$).

Substituting (3.15)-(3.19) into (3.15), provides the dynamic equation for private sector accumulation:

$$\dot{a} = db + \dot{d} \qquad (3.20)$$

where db is given in terms of the state and exogenous variables by (3.13). Note that, as in Krugman (1979) and Khan and Lizondo (1987), capital flows have no effect on the overall rate of asset accumulation, since the government instantaneously supplies foreign exchange at a fixed price (whereas the private sector must run a current account surplus to obtain foreign currency under floating exchange rates).

Substituting the results from (3.13) into (3.20) gives a first order dynamic system in wealth, with exogenous variables z, w^t and μ:

$$\dot{a} = b_a a + \begin{bmatrix} b_z & b_w & 1 \end{bmatrix} \begin{bmatrix} z & w^t & \mu \end{bmatrix}^T \qquad (3.21)$$

where the subscripts to b represent the partial derivatives for the effects on the trade balance of a rise in the relevant variable as expressed in (3.13) - i.e. : $b_i = db/di$, $i = a; z, w^t$.

The system is clearly stable, since a rise in wealth creates a trade deficit, as discussed above: $b_a = -\Omega\theta(\delta+\Gamma s_1) < 0$.

The Long Run

In the long run accumulation ceases ($\mathring{a} = 0$) when a new stock-flow equilibrium is attained (note from (3.15) that capital flows cease along with overall accumulation). This solves (3.21) for the steady-state changes in wealth:

$$da = -b_a^{-1}\left[b_z \; b_w \; 1 \right]\left[z \; w^t \; \mu \right]^T \qquad (3.22)$$

where:

$da/dz = -b_z / b_a = -(1-\beta)s_1 / \theta(\delta+\Gamma s_1) < 0,$

$da/dw^t = -b_w / b_a = -(1-\beta)s_2\delta / \theta(\delta+\Gamma s_1) < 0,$

$da/d\mu = -1 / b_a = 1 / \theta(\delta+\Gamma s_1)\Omega > 0.$

For the real shocks wealth must fall sufficiently to eliminate the balance of payments deficit so the dynamic process of decumulation ceases. Following monetary expansion wealth must rise to create an equal rate of reserve loss from a growing payments deficit.

The process of adjustment that occurs following the real shocks may be understood by reference to figure 3.1.(b) (which illustrates the response to a loss of exports). Since the short run equilibrium e_1 is associated with a balance of payments deficit, the consequent decumulation involves the DD schedule moving up and to the left, as falling wealth implies falling levels of consumption. Goods market equilibrium is maintained by moving up along the supply schedule, with the gradual real depreciation raising the producer real wage by more than the consumer real wage, reducing employment and output. The process of decumulation also causes the external balance locus to shift down, and, with the real depreciation and income reduction eliminating the deficit, convergence eventually occurs at a point such as e^*, where wealth dynamics cease. From the point of short run equilibrium, a similar adjustment process of falling wealth and income and a depreciating real exchange rate eliminates the deficit in the case of the labour supply shock.(11)

Monetary expansion has the opposite effect on wealth and the evolution of the balance of payments. Since adjustment to desired stock levels is sluggish, the expansion initially creates positive accumulation and a balance of payments deficit gradually emerges as a consequence. This process will continue until the growing balance of payments deficit (from rising wealth and income, coupled with an appreciating real exchange rate) is sufficiently large to yield a rate of reserve loss that offsets the rate of credit expansion one for one, so that accumulation ceases. Thus a policy of credit expansion creates gradual and continual depletion of reserves.

3.1.2. The Floating Regime

We now consider the model outlined in section 3.1.1., when the government no longer intervenes in the foreign exchange market to peg the exchange rate - thus $\dot{r} = 0$ in (3.18). Hence the balance of payments flow equation becomes:

$$\dot{f} = db \qquad (3.23)$$

Thus any excess demand for foreign exchange arising from a current account deficit ($db < 0$) must be offset entirely by an equivalent capital account surplus (net inflows $\dot{f} < 0$) as the government no longer supplies its reserves of foreign exchange to the market.

However, as discussed in section 1.2. of chapter one, equation (3.23), as an ex post accounting identity, does not determine the exchange rate alone since, at any instant in time, the exchange rate must be at a level that ensures portfolio equilibrium. The two assets in agents' portfolios are domestic and foreign currency, and the difference in their expected rates of return is the expected rate of depreciation, equal to the actual rate of depreciation by the rational expectations assumption. The desired allocation of agents' portfolios between domestic and foreign currencies is thus a negative function of the expected rate of depreciation of domestic currency:

$$m - e - f = \Phi - \pi^{-1}\dot{e} \qquad (3.24)$$

Thus, if there is zero expected depreciation, the desired ratio of domestic to foreign currency is Φ. When there is positive expected depreciation agents desire to re-allocate their portfolios by reducing the proportion of domestic currency they hold. The parameter π measures the (inverse of) the elasticity of substitution between domestic and foreign currency with respect to expected depreciation. The lower the value of π, the "more elastic" is currency substitution, the more agents wish to substitute out of domestic currency in the presence of anticipated depreciation offering a greater relative return on foreign currency.

The portfolio balance equation (3.24) can be inverted to provide a dynamic equation for the exchange rate:

$$\mathring{e} = \pi(\Phi - (m - e - f)) \qquad (3.25)$$

This specification states that agents only willingly hold a proportion of foreign currency in excess of Φ in their portfolios if they expect to be compensated due to anticipated appreciation of their value (depreciation of the domestic exchange rate, $\dot{e} > 0$).

As we saw in section 1.2. of chapter one, the dynamics inherent in equations (3.23) and (3.24) above constitute the corner-stone of the portfolio balance-current account literature that models the monetary approach under floating exchange rates. However, in this literature a variety of combinations has been utilised in the choice of state variables. The simple necessity that (absent government intervention) the capital offset the current account has resulted in foreign assets invariably providing one state variable.

The asset market determination of exchange rates by portfolio balance suggests the (nominal) exchange rate as the other obvious choice for state variable. This choice also has the virtue of isolating the role of the fundamental jump variable in the system - as it is the nominal exchange rate that jumps to ensure any pre-determined stocks of assets are willingly held. This selection of state variables is used in partial equilibrium models (Branson (1983b), Kouri (1983)), and was used in Dornbusch and Fischer (1980). Here it is utilised to analyse the present model in the face of real (export and labour supply reduction) shocks.

However, for examining the reaction of the model to shocks involving steady states with ongoing depreciation of the exchange rate, this selection of state variables does not facilitate convenient graphical exposition; thus Calvo and Rodriguez (1977) use the real exchange rate along with foreign assets, whilst Kouri(1976) and Krugman (1979) nominated (domestic) real balances. In the present chapter, total real wealth is used along with foreign assets for the purpose of analysing such shocks.(12) Since nominal asset stocks are deflated by the exchange rate in the definition of real wealth, this now becomes the jump variable, as it falls discretely (given stocks of nominal assets) with a jump depreciation of the nominal exchange rate. This choice also aids comparison with the fixed exchange rate regime, in which real wealth is the state variable, as it is fundamental to the stock-flow analysis of the monetary approach. Thus, since wealth is a state variable under both regimes, analysis of the "linkage" of the two systems at the moment of a speculative attack is facilitated.

We now analyse the effects of shift reductions in the demand for exports and supply of labour, and of monetary expansion in our model operating in a floating regime. In section 3.1.1. we saw that only the monetary expansion involved an ongoing loss of reserves - here it is only monetary expansion that involves ongoing depreciation and a permanent change in portfolio composition.

The Floating System and Real Shocks

We now proceed by expressing the dynamics of (3.23) and (3.24) in terms of e and f. The inverted portfolio balance relation (3.25) is already in an appropriate form, as it expresses $\mathring{e}$ as a function of the state variables e and f, and of the parameter Φ and exogenous variable, m.

The current account equation (3.23) may also be expressed in such terms by reference to (3.13), which shows the trade balance as a function of real wealth and exogenous variables. Recall that real wealth comprises the stocks of domestic and foreign nominal assets (i.e.: the exogenous variable, m, and state variable, f), deflated by the exchange rate (the other state variable). Thus we may express the current account as a function of our present state variables according to:

$$\dot{f} = b_a(f - e) \qquad (3.26)$$

where $b_a = -\Omega\theta(\delta+\Gamma s_1) < 0$, from (3.13).

Equations (3.25) and (3.26) provide a second order system in e and f. Expressing this in matrix form, we have:

$$\begin{bmatrix} \dot{e} \\ \dot{f} \end{bmatrix} = \begin{bmatrix} \pi & \pi \\ -b_a & b_a \end{bmatrix} \begin{bmatrix} e \\ f \end{bmatrix} + \begin{bmatrix} 0 & 0 \\ b_z & b_w \end{bmatrix} \begin{bmatrix} z \\ w^t \end{bmatrix} \qquad (3.27)$$

The transition matrix $\underline{A}$ has a negative determinant, a sufficient condition for one positive and one negative characteristic root, so that the system exhibits saddle point stability:

$$| \underline{A} | = 2\pi b_a = -2\pi\Omega\theta(\delta+\Gamma s_1) < 0 \qquad (3.28)$$

Figure 3.2(a) depicts the system in e, f space. Note from (3.27) that the $\dot{f} = 0$ locus has a slope of unity, because along this locus the level of real wealth, $a = (m - e) + f$, must be constant. Constant wealth leaves the real exchange rate and real income unchanged, ceteris paribus, so that the current account stays in equilibrium. Points to the right and below $\dot{f} = 0$ involve higher levels of wealth, and thus current account deficits, so that $\dot{f} < 0$.

Figure 3.2.(a)

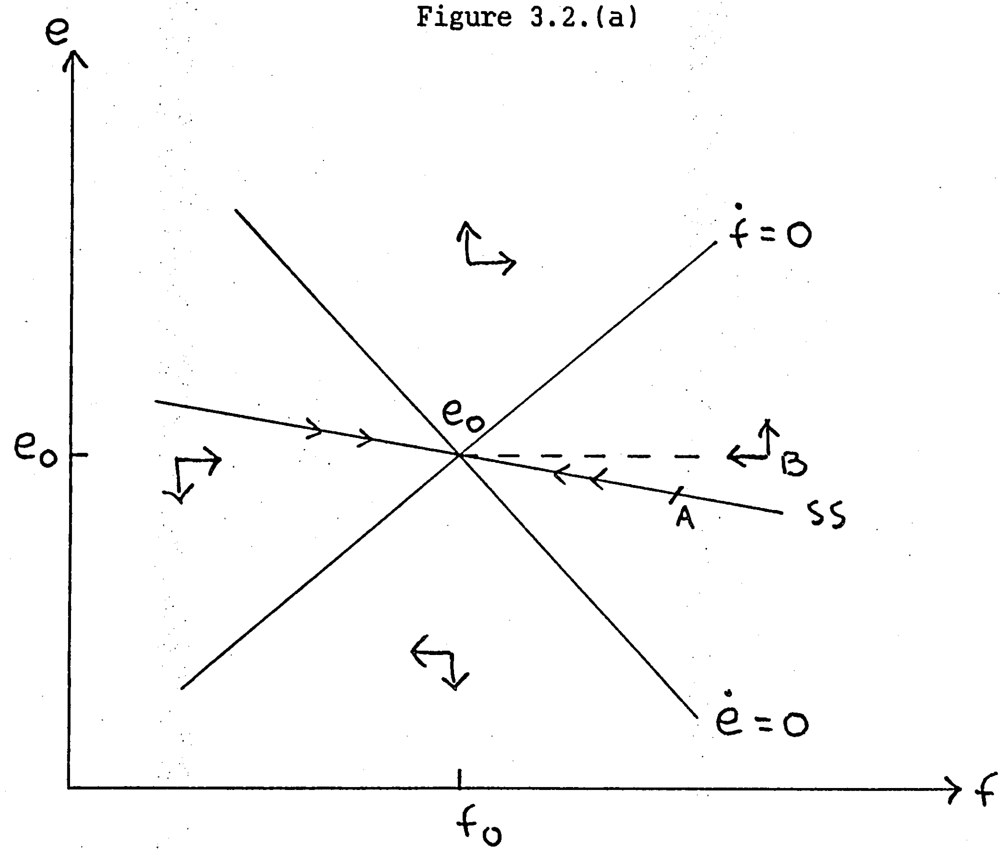
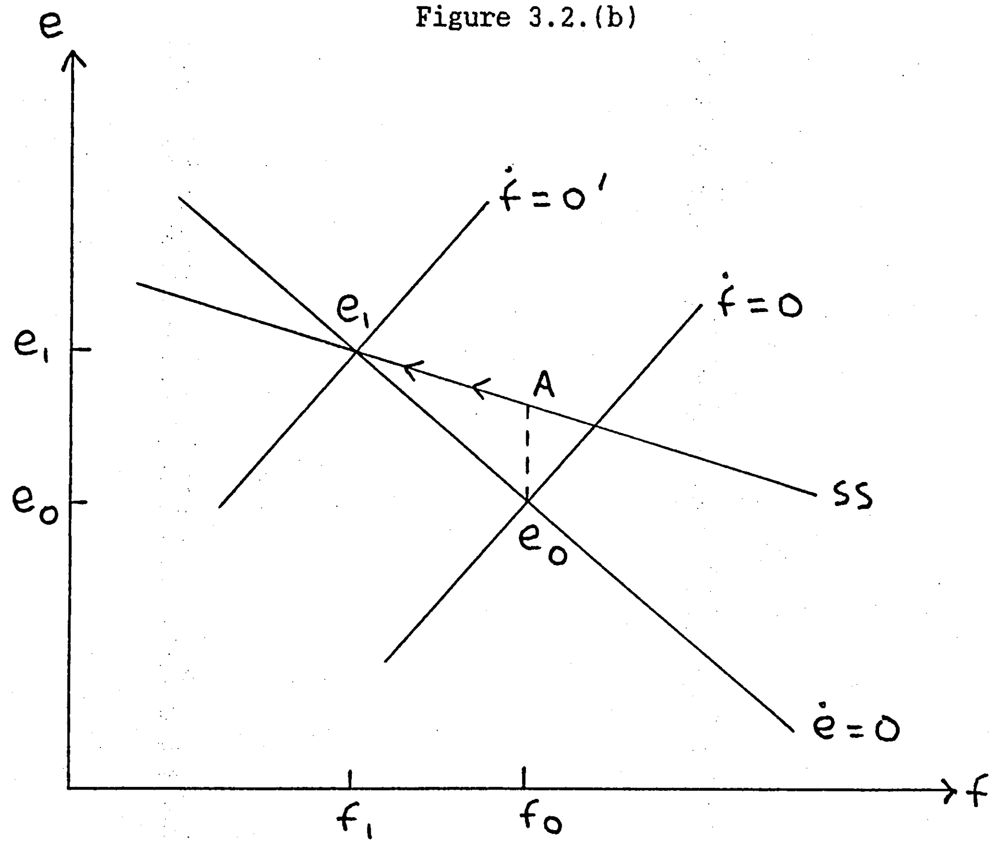


Figure 3.2.(b)



The slope of the $\dot{e} = 0$ locus is minus unity, because along this locus the ratio of domestic to foreign assets, (m - e - f), must remain constant. A rise in the value of foreign currency from a unit rise in f can be offset one for one by appreciating the value of domestic currency by a unit fall in e. Consider a point such as B to the right of $\dot{e} = 0$: this implies a lower domestic to foreign asset ratio. Agents only willingly hold the extra stock of foreign currency at point B in their portfolios if they expect its value to appreciate (i.e.: $\dot{e} > 0$), as the arrows of motion indicate.

From the arrows of motion in figure 3.2.(a), it can be seen that the saddle path is negatively sloped. Thus at points to the right and below the $\dot{f} = 0$ schedule (i.e.: points with current account deficits), such as point A in the diagram, are associated with depreciating exchange rates reflecting the "acceleration hypothesis".

Equation (3.27) may be solved for the long run when $\dot{e} = \dot{f} = 0$:

$$de/dz = -df/dz = b_z \;/\; 2b_a = (1-\beta)s_1 \;/\; 2\theta(\delta+\Gamma s_1) > 0$$

$$de/dw^t = -df/dw^t = b_w \;/\; 2b_a = (1-\beta)s_2\delta \;/\; 2\theta(\delta+\Gamma s_1) > 0$$

Thus it can be seen that the fall in wealth across steady states (which, with m constant, simply comprises the fall in f plus the rise in e) is equal to $-b_i/b_a$ ($i = z, w^t$), the amount that wealth fell by under the fixed regime (see(3.22)).(13) This reflects the fact that, ceteris paribus, external balance is associated with a unique level of real wealth, and, given no budget deficit, both fixed and floating systems require restoration of external balance for stock-flow equilibrium.

The process is illustrated in figure 3.2.(b) (which, qualitatively speaking, can apply to either shock). Following the shock, agents correctly foresee a process of external deficit and a depreciating exchange rate. The expectation of depreciation requires an immediate jump in the exchange rate from e_0 to A to preserve portfolio balance with the pre-determined stocks of nominal assets.

During the adjustment process from A to e_1, the current account deficit is gradually eliminated as wealth is falling (and thereby output is falling and the real exchange rate depreciating). Portfolio balance is maintained throughout adjustment as follows: the depreciating exchange rate means agents wish to hold a higher proportion of foreign currency in their portfolios than they do in the steady state (when depreciation is zero), and this is the case along the adjustment path (which lies to the right of $\dot{e} = 0$).

Note that in the steady state portfolio composition returns to its initial allocation, with the ratio of domestic to foreign currency returning to Φ. This result is due to the absence of a government deficit and thus the absence of inflation and depreciation in the steady state.

The Floating System and Monetary Expansion

In order to examine the case of monetary expansion (which leads to steady state depreciation) under floating exchange rates, the model is re-specified with wealth and foreign currency stocks as state variables.

For the current account equation, this simply yields:

$$\dot{f} = b_a a \qquad (3.29)$$

where b_a is given in (3.13). Since the level of wealth determines real variables, current account balance is associated with a unique level of wealth.

For the accumulation of total real wealth, we take the time differential of (3.1):

$$\dot{a} = \dot{m} - \dot{e} + \dot{f} \qquad (3.30)$$

The components of (3.30) are as follows. The level of the budget deficit determines $\dot{m} = \mu$, the rate of monetary expansion chosen by the government at time zero. The rate of change in foreign currency holdings is given by the current account equation (3.29) above. Finally, the rate of depreciation is obtained from the portfolio balance condition by substituting for e in terms of a and f in (3.25) to give:

$$\overset{\circ}{e} = \pi(\Phi - (a - 2f)) \qquad (3.31)$$

Substituting all these elements into (3.30) yields:

$$\dot{a} = \mu - \pi(\Phi - (a - 2f)) + b_a a \qquad (3.32)$$

Thus, with (3.29) and (3.32), the system may be expressed as:

$$\begin{bmatrix} \dot{a} \\ \dot{f} \end{bmatrix} = \begin{bmatrix} b_a+\pi & -2\pi \\ b_a & 0 \end{bmatrix} \begin{bmatrix} a \\ f \end{bmatrix} + \begin{bmatrix} \mu \\ 0 \end{bmatrix} \qquad (3.33)$$

The determinant remains $2\pi b_a < 0$, as given in (3.28), since we have re-expressed the same model. Thus the system is again saddle path stable, with wealth as the jump variable (since wealth falls discretely with a discrete depreciation).

The system is depicted in figure 3.3(a). The external balance locus $\dot{f} = 0$ is horizontal - fixed at that level of real wealth for which stock-flow equilibrium obtains and the current account is in balance. Any higher level of wealth would raise output and appreciate the real exchange rate and thus create a deficit: $\dot{f} < 0$.

The $\dot{a} = 0$ locus has slope:

$$(da/df)_{\dot{a}=0} = 2\pi/(\pi+b_a) \gtrless 0 \text{ as } \pi \gtrless |b_a| \qquad (3.34)$$

An understanding of the forces determining the slope of the $\dot{a} = 0$ locus can be obtained by isolating real and portfolio balance effects.

Suppose that from point e_0 (at which full equilibrium prevails), wealth is reduced from a_0 to a_1, so that we move from e_0 to point A. From the real side of the economy, the reduction in wealth sends the current account into surplus, so $\dot{f} > 0$ at point A.

From the perspective of portfolio balance, the movement form e_0 to A constitutes a decline in the ratio of domestic to foreign assets, since the stock of foreign currency has been held constant at f_0. Thus in order that portfolio balance be maintained at point A there must be positive depreciation, $\dot{e} > 0$. This is because agents only willingly accept a switch in portfolio composition towards foreign currency if foreign currency holdings attract a greater rate of return. Note that as the degree of currency substitution becomes "more elastic" with respect to expected depreciation - the lower the value of π in (3.24) - a smaller change in the rate of depreciation is associated with a given switch in portfolio composition. Thus, given the reduction in the domestic to foreign currency ration represented by the move to point A, the rate of depreciation required for portfolio balance is lower, the lower the value of π.

Positive rates of foreign currency accumulation and depreciation produce offsetting effects on the overall rate of accumulation, $\dot{a}$. Suppose that the elasticity of currency substitution is sufficiently

Figure 3.3.(a).

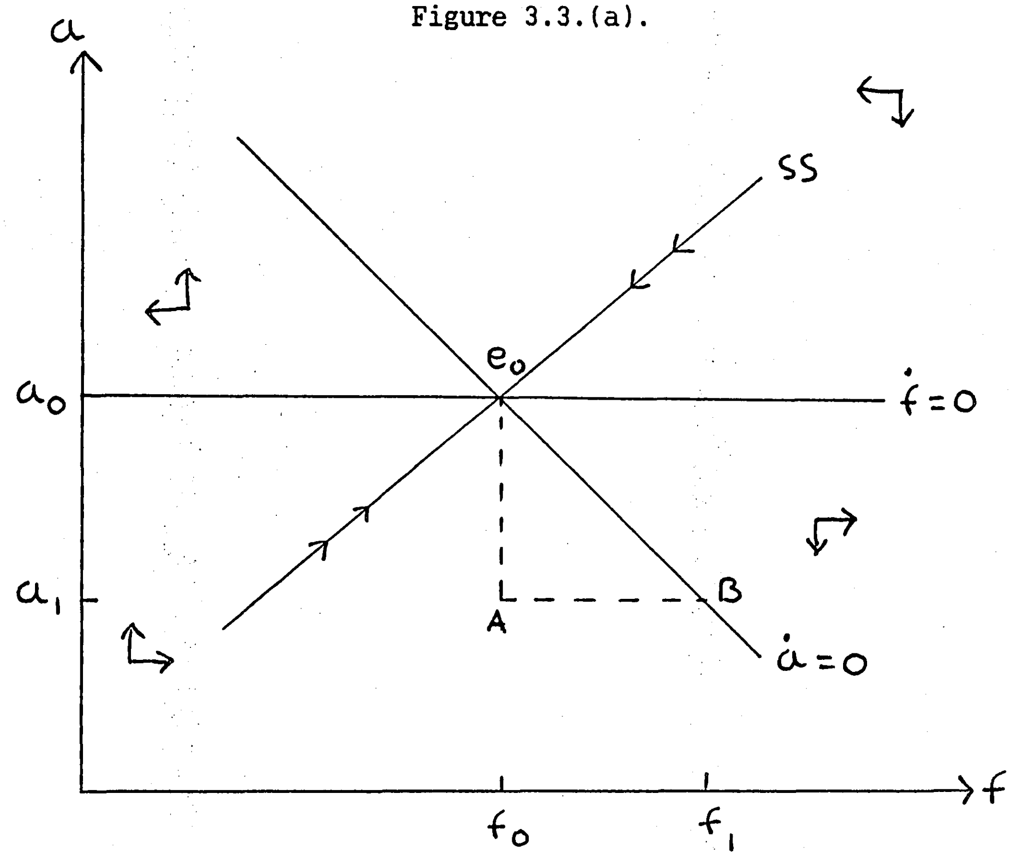
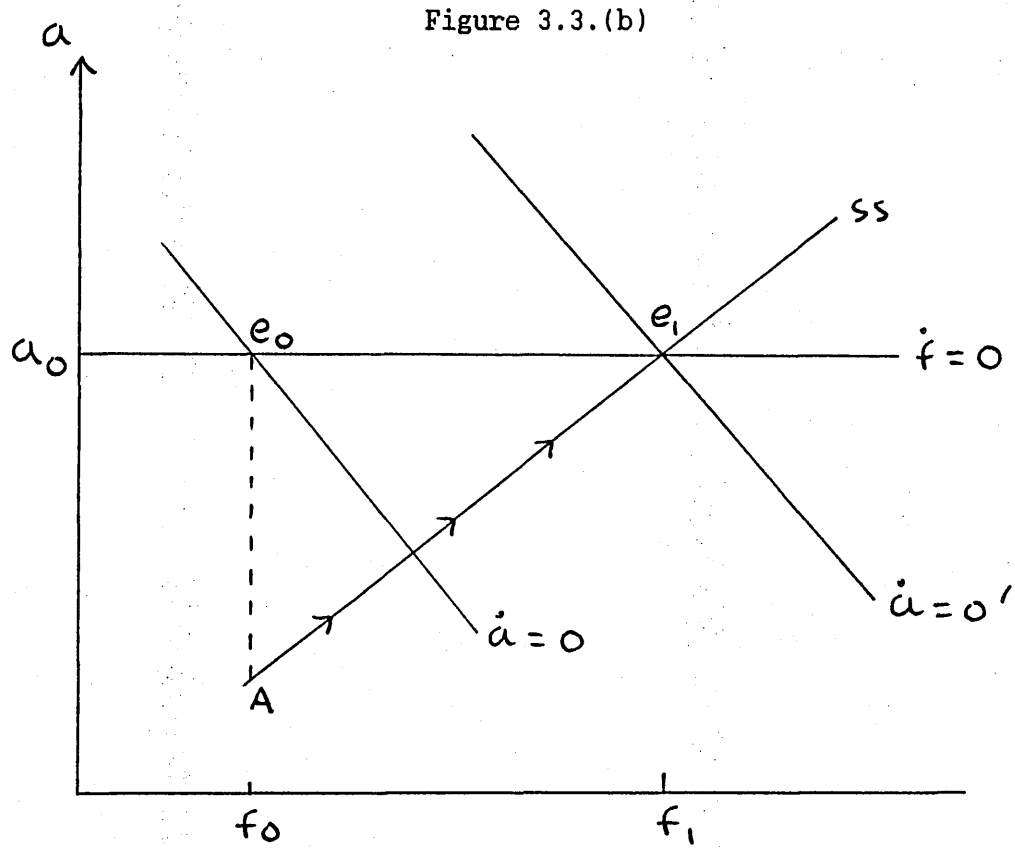


Figure 3.3.(b)



great to yield $\pi < |b_a|$ (this is the case shown in figure 3.3.(a)). From the above argument, the rate of depreciation at point A will be relatively low, so that $\mathring{a} = (\dot{f} - \dot{e}) > 0$: the positive effect on accumulation from the current account surplus exceeds the negative effect from portfolio balance at point A.

Thus we must ask how the $\dot{a} = 0$ locus can be re-attained form point A. Given the level of wealth a_1 (and therefore given the state of the current account), a higher rate of depreciation is required to produce $\mathring{a} = 0$. From the portfolio balance relationship, a higher rate of depreciation follows from a further reduction in the domestic to foreign currency ratio. This is achieved by raising the stock of foreign currency from f_0 to f_1 - moving from point A back to the $\mathring{a} = 0$ locus at point B.

Note that the saddle path is positively sloped irrespective of the slope of the $\mathring{a} = 0$ locus, since the fundamental dynamics of the portfolio balance-current account system accord with the acceleration hypothesis - when the current account is in deficit, the exchange rate will be depreciating (relative to steady state). Thus, with monetary expansion at the rate μ, when the current account is in deficit (so that $\dot{f} < 0$) we have $\dot{e} > \mu$. Hence when stocks of foreign currency are falling due to an external deficit, overall wealth will also be falling, $\dot{a} = (\mu - \dot{e} + \dot{f}) < 0$, producing the positive relationship between changes in overall wealth and changes in foreign currency holdings, that is exhibited by the saddle path.

In the long run the current account must balance, and all nominal variables rise at the same rate (so the rates of inflation and depreciation are set by μ; real wealth, relative prices and real output are unchanged). Thus we have $\mathring{f} = 0$ and $\mathring{e} = \mu$, so $\dot{a} = 0$. Solving (3.33) for long run multipliers shows real wealth will be unchanged, whilst the stock of foreign currency rises by $1/2\pi$ (implying an equal offsetting fall in the stock of real domestic currency).

The new steady state and dynamics are shown in figure 3.3(b), which illustrates the response to monetary expansion found in Calvo and Rodriguez (1977).[14] When the expansion occurs, the stock of foreign currency is pre-determined at f_0, but there is an instantaneous jump in the rate of expected depreciation, requiring a discrete depreciation (and thus reduction in wealth) to reduce the domestic to foreign currency ratio. As Calvo and Rodriguez note, the transition process involves net accumulation of foreign currency (a current account surplus) which contrasts with the usual result of foreign exchange losses (from a balance of payments deficit) during the transition under fixed parities (such as we considered in 3.1.1.). The reason is that, in the new steady state, the domestic to foreign currency ratio will have fallen from Φ to $(\Phi-\mu/\pi)$, and, given that total wealth must return to its initial level for current account balance, the desired portfolio reallocation can only be achieved by accumulation of foreign currency.

3.1.3. Speculative Attack

As we have seen, monetary expansion in the present model brings about a situation of gradual and ongoing reserve loss. Since the fundamental economic structure is unchanged by monetary expansion, external balance remains associated with the original level of wealth (assuming initial equilibrium). However, given the monetary approach process of gradual stock adjustment, the monetary expansion also leads to (positive) accumulation of wealth by the private sector during the fixed rate regime. The economy moves towards a stock flow equilibrium at a higher level of wealth, and rising wealth is associated with worsening external balance. Reserves are thus constantly depleted, and, however large the governments initial stock, must eventually be exhausted, preventing further government intervention in the foreign exchange market, and requiring a switch to a floating exchange rate regime. Thus the policy of monetary expansion produces conditions that inevitably lead to the eventual collapse of a fixed rate regime, and, in the presence of rational expectations, conditions which will precipitate a speculative attack.

It was seen in section 1.3. of chapter one that the explanation of speculative attacks in models without stock adjustments is best approached by considering how monetary equilibrium is maintained at all points in time. However, in such models the entire system can be described exclusively in monetary (stock) terms, since stock-flow dynamics are avoided.

In this monetary approach model, we must distinguish between monetary equilibrium, portfolio balance, and stock adjustment. As we have seen earlier in the thesis, monetary equilibrium in a monetary approach model is maintained only in flow terms under fixed rates. The credit expansion leads to excess monetary stocks, creating, via the hoarding function, a wealth effect raising expenditure, income and prices. This process maintains a flow monetary equilibrium since the flow demand for money rises with income, eliminating part of the excess flow supply, whilst a balance of payments deficit removes the rest through reserve loss. However, the concept of flow demands for assets is redundant in a monetary approach model under floating rates.

Thus, in concentrating on the event of a speculative attack in a monetary approach model, it is the concept of portfolio balance, and how this is continuously preserved, that is more revealing. It is portfolio balance that determines the composition of wealth, and this is what a speculative attack directly affects.

In the absence of any changes in the relative rates of return offered by the two assets, portfolio balance is kept by agents maintaining a constant distribution of their portfolio between foreign and foreign currencies during the fixed regime. However, should the fixed rate regime collapse, and a floating regime be instigated, then preservation of portfolio balance will require a discrete reallocation at the moment of collapse. This is because immediately following the collapse there is a discrete jump in expected depreciation (hitherto zero) which requires an immediate reduction in the ratio of domestic to foreign currency to maintain portfolio equilibrium. With the nominal stocks of domestic and foreign currency pre-determined this reallocation would be achieved by a discrete depreciation.

However, the requirements of a speculative attack are that since the collapse is foreseen it cannot cause a predictable jump in the exchange rate, because this implies unexploited arbitrage profits. Thus, if the speculative condition of no exchange rate jump is to be observed, and if portfolio balance is to hold at the moment of collapse, then agents must reallocate their portfolios by a discrete exchange of nominal asset stocks, rather than a discrete revaluation of existing stocks. This is what a speculative attack achieves.

Once the fixed rate regime has collapsed agents can only obtain foreign assets by running a current account surplus over time; however, at any point prior to the introduction of a floating regime, the government stands prepared to sell its stocks of foreign exchange, which provides the private sector with an alternative method of portfolio reallocation. When agents buy out some level of government reserves they alter the composition of their portfolios by exchanging their holdings of domestic currency in order to raise their holdings of foreign currency by that amount. Thus an attack produces the desired reduction in the domestic to foreign currency ratio, and, by attacking some critical level of reserves (which we denote r^*), portfolio balance can be maintained immediately before and after the attack, without requiring a jump in the exchange rate, as follows:

$$\text{Before} : m_- - \bar{e} - f_- = \Phi \qquad (3.35)$$
$$\text{After} : (m_- - r^*) - e_+ - (f_- + r^*) = \Phi - \dot{e}_+/\pi$$

where for a variable x, x_- denotes its value immediately prior to the attack, and x_+ the value immediately after the attack. The speculative attack condition of no exchange rate jump requires that r^* be chosen such that $e_+ = \bar{e}$. Note that the higher the instantaneous jump in expected depreciation, $\dot{e}_+$, the greater the quantity of reserves that must be attacked.

The above description explains how a speculative attack is able to meet the requirement of continuous portfolio balance. It remains to show how the attack links up the stock-flow dynamics of the two regimes. It is the stock-flow dynamics that will determine all the critical values in (3.35).

Figure 3.4.(a). demonstrates the process of accumulation and reserve loss that occurs as the economy evolves under the fixed rate regime. The initial level of wealth a_0 is uniquely associated with external balance in the absence of real shocks - nevertheless, the gradual stock-flow dynamics push the economy towards a stock-flow equilibrium at $\hat{a}$ (at this level of wealth $\dot{r} = -\mu$) once the credit expansion begins. In figure 3.4.(b). the fixed regime is represented by a movement along the expansion path of a ray from the origin

through the initial equilibrium e_0 such that a constant proportion of foreign assets in agents' portfolios is preserved.

Figure 3.4.(b) also shows the response of the economy to monetary expansion under permanently floating exchange rates, as considered in the previous section. The linking up of the two regimes in a manner that avoids an exchange rate jump is represented by a discrete movement from the expansion path of the fixed regime to the saddle path of the floating regime. The attack must occur at a given level of wealth, since the level of wealth immediately before and after the attack is:

$$\text{Before: } a^*_- = m_- - \bar{e} + f_- \qquad (3.36)$$

$$\text{After: } a^*_+ = (m_- - r^*) - e_+ + (f_- + r^*)$$

The transfer of r^* from domestic to foreign currency leaves total nominal wealth stocks unchanged, and since r^* is that critical reserve level that yields $e_+ = \bar{e}$, there is no discrete deflation of the nominal wealth stock. (Henceforth we simply put $a^*_- = a^*_+ = a^*$).

Thus the speculative attack leaves wealth at that level a^* to which it had evolved just prior to the collapse of the fixed regime, whilst there is a discrete rise in private sector holdings of foreign currency of amount r^*. This is the movement from A to B in figure 3.4.(b).(15)

Figure 3.4. (a)

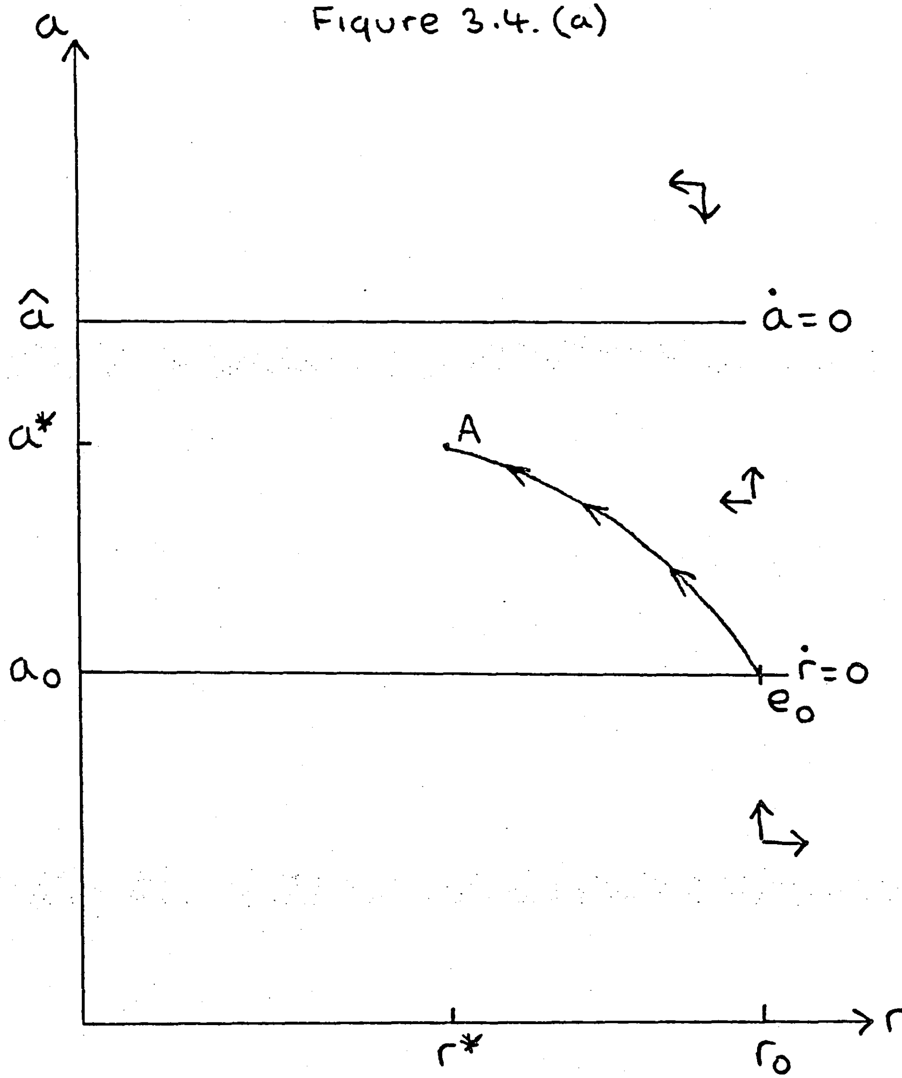
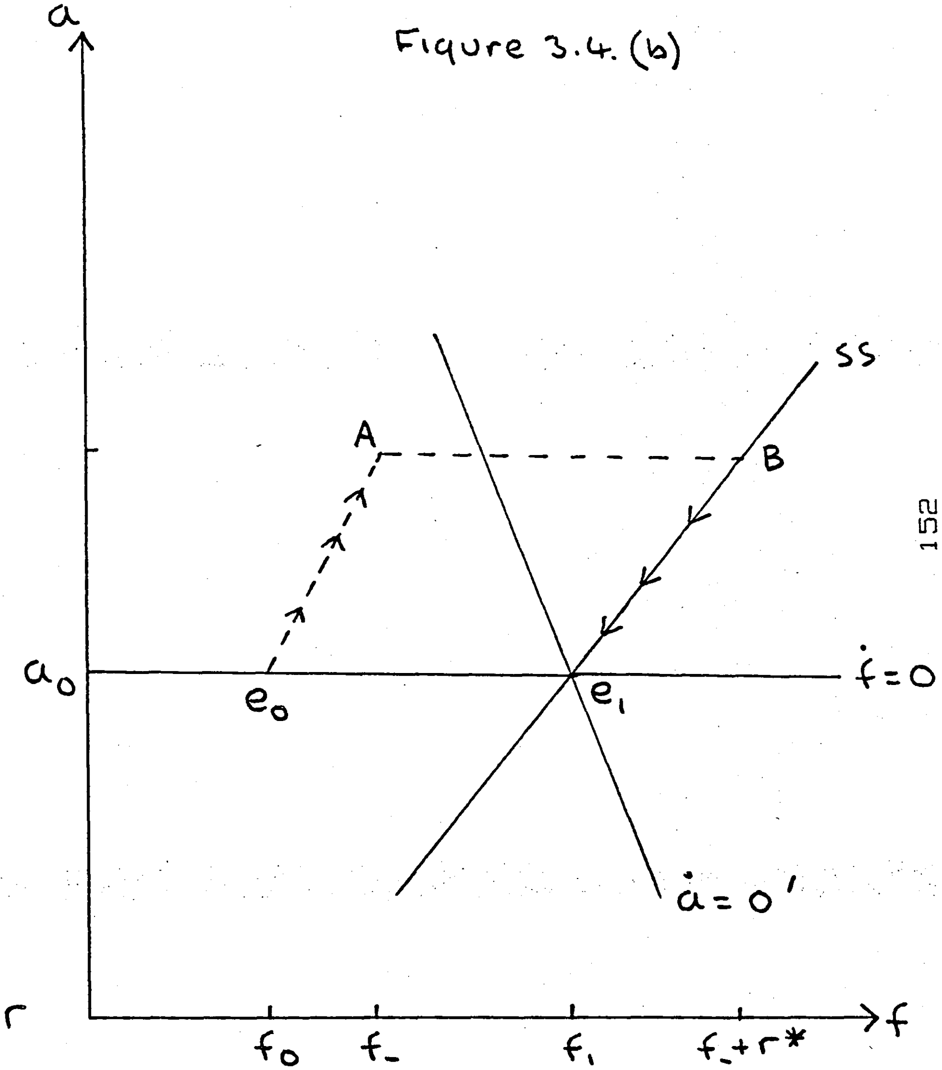


Figure 3.4. (b)



Thus, given that exchange rate jumps and divergent paths are to be avoided, the floating regime commences with the inherited stocks of wealth a^* and foreign currency $(f_- + r^*)$. Since the accumulation process under fixed rates establishes that $a^* > a_0$, the floating regime inherits an external deficit. The post-collapse adjustment path from B to e_1 involves wealth returning to a_0, and correspondingly, output falling and the (initially overvalued) real exchange rate depreciating back to their original levels. Hence the inherited deficit is gradually eliminated. The combination of this post-collapse current account process with portfolio balance again reflects the acceleration hypothesis - in this case that $\dot{e} > \mu$ along the adjustment path from B to e_1. The anticipation of this rate of depreciation means that agents wish to commence the floating regime with a portfolio composition shifted more towards foreign currency than will be the case when stock and portfolio adjustments are complete (and $\dot{e} = \mu$) at e_1. Hence agents are content to start the floating regime with $(f_- + r^*)$ given the time path of reduced foreign currency holdings from the current account deficit.

The foregoing analysis establishes the inevitability of a collapse and the nature of a speculative attack, along with the fixed and floating regimes which surround it. It is the adjustment dynamics surrounding the regime switch that prohibit an analytical solution for the timing of the attack. All the critical values involved in the attack (the values that determine how portfolio balance is instantaneously achieved) are functions of wealth, a sluggishly adjusting dynamic variable.

Recall that Flood and Garber style analyses solve for the collapse time by abstracting from stock adjustment dynamics. The analyses of crises within a general equilibrium intertemporal optimisation framework (Calvo (1987), van Wijnbergen (1988)) show that a speculative attack must involve a discrete switch between the steady states of fixed and floating regimes.[16] In these models, a justification for the existence of money must be found. Calvo adopts a "cash in advance" approach, so that the first order condition means the optimal planned consumption path (which is constant) will depend on the opportunity cost of holding money (return dominated by bonds) against consumption. This cost falls under fixed rates, so consumption rises to a higher level, and a deficit arises from the excess of absorption over income. After the crisis, the system locks itself into another steady state, the opportunity cost of holding money instantaneously rises by steady state depreciation, and consumption falls to the (constant) level of gross national product. There is a discrete one off fall in the demand for money, which determines the reserve quantity to be attacked. In van Wijnbergen, money directly enters the utility function, a first order condition is that the marginal rate of substitution between money and consumption be equal to the nominal interest rate (which instantaneously rises by steady sate inflation on collapse). Thus, a given value of consumption determines the equilibrium money stock, which again falls discretely on transition to floating, determining the quantity of reserves, which, if attacked, locks the system into a new steady state.

In the monetary approach model presented here, however, money represents a stock that is accumulated when the private sector is in an adjustment phase, rather than a good that is always held in desired quantity. Hence we cannot appeal to steady state results for desired stock holdings to determine the desired reduction in the money stock (through elimination of reserves) at the moment of transition. The instantaneous switch in portfolio composition depends on the stage of dynamic adjustment. Thus simulation methods are used in chapter four to find that level of wealth at which attacking remaining reserves will both preserve portfolio balance with no exchange rate jump, and satisfy the adjustment dynamics of both regimes.

3.2. AN ENDOGENOUS BUDGET DEFICIT

In this section the model of the economy used in section 3.1. is maintained, but the government's budget deficit is now rendered endogenous. Fiscal stance is modelled as in chapter two - tax revenue is endogenous via a proportional income tax, whilst government expenditure (again allocated to the domestic good) is exogenous. This means the policy of an exogenously imposed rate of credit expansion examined in section 3.1. is here replaced by the policy shock of a rise in government expenditure. The two real shocks (a fall in demand for exports and supply of labour) are maintained for analysis.

All three shocks inevitably lead to the collapse of the fixed regime, which evolves towards the same stock-flow equilibrium as chapter two (recall that the labour market cleared in the long run). Thus the fixed regime is described briefly in section 3.2.1. The floating regime is described in section 3.2.2., and the two regimes finally linked by a speculative attack in section 3.2.3.

3.2.1. The Fixed Regime

The model remains as specified in equations (3.1) to (3.9) except that government expenditure is included in the national income identity (3.4) and private sector consumption is a function of disposable income $y^{dis} = (1-t)y$ in (3.5). The equations are repeated for convenience (with (3.4) and (3.5) amended):

Definitions:

$$a = (m - e) + f \qquad (3.1)$$

$$\sigma = e - p \qquad (3.2)$$

Identities:

$$m = r + d \qquad (3.3)$$

$$y = c + b + g \qquad (3.4a)$$

Demand:

$$c = \beta(1-t) + \theta a \quad (3.5a)$$

$$b = \delta\sigma - \Gamma c - z \quad (3.6)$$

Supply:

$$y = an \quad (3.7)$$

$$n^d = -b(w - p) \quad (3.8)$$

$$n^s = c(w - (1-\Gamma)p - \Gamma e) - w^t \quad (3.9)$$

As before, a short run equilibrium jointly determines the endogenous variables σ and y by the conditions of labour and goods market clearing. The labour market equilibrium locus is given by (3.10) as before; substituting (3.5a) and (3.6) into (3.4a) gives the domestic goods market condition (3.11a):

$$y = -s_1\sigma - s_2w^t \quad (3.10)$$

where $s_1 = \Gamma abc/(b+c)$, $s_2 = ab/(b+c)$.

$$qy = \delta\sigma + \theta(1-\Gamma)a + g - z \quad (3.11a)$$

where $q = (1-\beta(1-t)(1-\Gamma))$.

The short run system (3.10) and (3.11a) solves for σ and y with respect to (pre-determined) wealth and the exogenous variables g, z and w^t. The results are:

$$\begin{bmatrix} d\sigma \\ dy \end{bmatrix} = \Omega \begin{bmatrix} -\theta(1-\Gamma) & -1 & 1 & -s_2q \\ s_1\theta(1-\Gamma) & s_1 & -s_1 & -s_2\delta \end{bmatrix} \begin{bmatrix} da \\ dg \\ dz \\ dw^t \end{bmatrix} \qquad (3.37)$$

where $\Omega = (s_1q+\delta)^{-1} > 0$.

The results are as derived in section 3.1.1. (with the only difference the incorporation of income tax effects in q). Note that the new shock, fiscal expansion, simply has the opposite effect on σ and y to a loss of exports, as the former represents an exogenous rise in the demand for the home goods; the loss in exports being an exogenous fall. The substantial difference between the two shocks arises from their differential effects on external and public sector balance (and thus on accumulation dynamics), which we now consider.

The external balance outcomes are again derived by substituting the short run results for $d\sigma$ and dy into (3.6):

$$db = \begin{bmatrix} b_a \; b_g \; b_z \; b_w \end{bmatrix} \begin{bmatrix} da \; dg \; dz \; dw^t \end{bmatrix}^T \qquad (3.38)$$

where $b_i = db/di$, $i = a; g, z, w^t$. These results are:

$b_a = -\Omega\theta(\delta+\Gamma s_1) \quad < 0$

$b_a = -\Omega(\delta+s_1 ß\Gamma(1-t)) < 0$

$b_g = -\Omega s_1(1-ß(1-t)) \quad < 0$

$b_w = -\Omega s_2\delta(1-ß(1-t)) < 0$

The effects of rises in wealth, loss of exports and reduction in labour supply are to create trade deficits as discussed before. The fiscal expansion clearly creates a trade deficit as a consequence of the real appreciation and rise in income in (3.37).

With an endogenous budget deficit the private sector will also accumulate assets from the public sector via budget deficits. Since tax revenue is endogenous, the short run solution for output also yields an instantaneous outcome for public sector balance, and thus for the rate of credit expansion:

$$\dot{d} = \left[d_a \; d_g \; d_z \; d_w \right] \left[da \; dg \; dz \; dw^t \right]^T \qquad (3.39)$$

$d_a = -\Omega\theta t s_1(1-\Gamma) \quad < 0$

$d_g = \Omega(\delta+s_1(q-t)) \quad > 0$

$d_z = \Omega t s_1 \quad > 0$

$d_w = \Omega t s_2 \delta \quad > 0$

A rise in wealth raises output, and thus tax revenue, yielding a public sector surplus - rises in z and w^t have the opposite effect. The fiscal expansion raises output, but the multiplier is insufficient to raise tax revenue to cover the extra government expenditure.

We now consider the dynamic effects of private sector accumulation form (3.38) and (3.39).

The Dynamics

As before, we take the time differential of (3.1), and maintain the assumption that the two assets are accumulated in fixed proportions whilst the exchange rate is pegged:

$$\dot{a} = \dot{m} - \dot{e} + \dot{f} = \dot{m} + \dot{f} \quad (3.40)$$

$$\dot{f} = \alpha\dot{a} \quad (3.41)$$

$$\dot{m} = (1-\alpha)\dot{a} \quad (3.42)$$

From (3.3), domestic assets are derived from balance of payments surpluses and budget deficits:

$$\dot{m} = \dot{r} + \dot{d} \quad (3.43)$$

$$\dot{r} = db - \dot{f} \quad (3.44)$$

$$\dot{d} = dg - tdy \quad (3.45)$$

with db and $\dot{d}$ taken from (3.38) and (3.39) respectively. Substituting (3.41) to (3.45) into (3.40) gives overall private sector accumulation:

$$\dot{a} = db + \dot{d} \quad (3.46)$$

Thus the system may again be expressed as first order with wealth as the state variable, since both overseas and public sector balance can be expressed as functions of wealth and the exogenous variables g, z and w^t. Substituting (3.38) and (3.39) in (3.46):

$$\dot{a} = a_a a + \begin{bmatrix} a_g & a_z & a_w \end{bmatrix} \begin{bmatrix} dg & dz & dw^t \end{bmatrix}^T \qquad (3.47)$$

where $a_i = (db/di + dd/di)$, $i = a; g, z, w^t$. These derivatives are:

$a_a = -\Omega\theta(\delta+s_1((1-\Gamma)t+\Gamma)) < 0$

$a_g = \Omega s_1(1-\beta)(1-t) > 0$

$a_z = -\Omega s_1(1-\beta)(1-t) < 0$

$a_w = -\Omega s_2\delta(1-\beta)(1-t) < 0$

Thus, although each exogenous shock produces deficits on both public and overseas sector balances (with offsetting effects on accumulation), the overall effects on accumulation accord with the hoarding function. A positive (negative) shock raises (reduces) the desired stock of wealth, inducing positive (negative) private sector savings. A rise in wealth itself creates an excess stock and leads to dis-saving, $a_a < 0$, so the system is stable.

The Long Run

Setting $\dot{a} = 0$ in (3.47) yields the following changes for wealth across steady states:

$da/dg = -a_g/a_a = s_1(1-\beta)(1-t) / \theta\Sigma > 0$

$da/dz = -a_z/a_a = -s_1(1-\beta)(1-t) / \theta\Sigma < 0$

$da/dw^t = -a_w/a_a = -s_2\delta(1-\beta)(1-t) / \theta\Sigma < 0$

$\Sigma = (\delta+s_1(\Gamma+(1-\Gamma)t) > 0$

Wealth rises for the fiscal shock, and falls for the export demand and labour supply shocks. These outcomes for the state variable again yield long run multipliers for the real exchange rate and output.(17) Finally all these results are substituted into the trade balance equation (3.6) to produce a steady state balance of payments deficit (recall that capital flows cease on setting $\dot{a} = 0$). The results are reported below in terms of the positive rate of reserve loss (denoted μ^r) that would obtain in the steady state:(18)

$$d\mu^r/dg = (\delta + s_1\Gamma(1-t)) \;/\; \Sigma > 0$$

$$d\mu^r/dz = ts_1 \;/\; \Sigma > 0$$

$$d\mu^r/dw^t = ts_2\delta \;/\; \Sigma > 0$$

From the position of short run equilibrium, the same adjustment process is encountered in the case of the export demand and labour supply shocks. The private sector is dis-saving, and the falling stock of wealth is associated with falling output and a depreciating real exchange rate. Thus this adjustment process involves an improving balance of payments position. However, the process also involves falling tax revenues and a rising budget deficit. Hence the process of decumulation tends to a stock-flow equilibrium where the rising rate of credit expansion offsets the falling rate of reserve expansion, leaving the stock of total wealth constant. Wealth (and output) will never fall sufficiently to remove the balance of payments deficit, and the real exchange rate will remain permanently overvalued for as long as the fixed regime lasts.

From the position of short run equilibrium that follows the rise in government expenditure, the adjustment process involves positive accumulation. The rising level of wealth brings about rising output and an appreciating real exchange rate, and thus a deteriorating balance of payments. The budget deficit, however, is improving as tax revenue rises. Hence the process of accumulation drives the economy towards a stock-flow equilibrium in which the rising rate of reserve loss offsets the falling rate of credit expansion.

Thus, in all cases, the approach to a stock-flow equilibrium involves gradual and continuing reserve loss, with the budget deficit "crowding out" net exports at an overvalued real exchange rate. There are no endogenous forces requiring elimination of the balance of payments deficit since private sector stock adjustment would be completed at an "excessive" level of wealth.

3.2.2. The Floating Regime

The steady states of the fixed regime involved credit expansion, with stock-flow equilibrium preserved via offsetting reserve loss leaving real wealth constant; in a floating system the equilibrium level of real wealth is maintained by steady state inflation offsetting the domestic credit expansion. Thus, in line with the discussion of section 3.1.2., we select total wealth and foreign assets as the state variables to describe the response of the floating regimes to the various shocks considered in section 3.2.1.

Dynamics and Stability

The accumulation of foreign currency is derived from the current account. At any point in time the stock of total real wealth remains sufficient to determine the real exchange rate, income, and thus the state of the current account. Thus we may again adjust the current account equation to suit the present model specification:

$$\mathring{f} = b_a a \qquad (3.48)$$

where $b_a = -\Omega\theta(\delta+\Gamma s_1) < 0$, as reported in (3.38).

Accumulation of total real wealth is:

$$\mathring{a} = \dot{m} - \mathring{e} + \mathring{f} \qquad (3.49)$$

Again we substitute in the components of (3.49). The accumulation of foreign currency is described in terms of the level of wealth by the current account equation (3.48). The rate of increase in domestic assets is now also endogenously determined by the stock of real wealth as domestic credit evolves according to:

$$\dot{m} = d_a a \qquad (3.50)$$

where $d_a = -\Omega\theta t s_1(1-\Gamma) < 0$, from (3.39).

The rate of depreciation is determined by portfolio balance according to the allocation of the portfolio between domestic and foreign currency stocks. As we saw earlier, portfolio composition may be expressed in terms of total wealth and its foreign component which yields depreciation as follows:

$$\dot{e} = \pi(\Phi - (a - 2f)) \qquad (3.51)$$

Substituting (3.48), (3.50) and (3.51) into (3.49), we have:

$$\dot{a} = a_a a - \pi(\Phi - (a - 2f)) \qquad (3.52)$$

where $a_a = (b_a + d_a) = -\Omega(\delta+s_1((1-\Gamma)t+\Gamma)) < 0$.

Equations (3.52) and (3.48) constitute a second order dynamic system in wealth and foreign currency:

$$\begin{bmatrix} \dot{a} \\ \dot{f} \end{bmatrix} = \begin{bmatrix} a_a+\pi & -2\pi \\ b_a & 0 \end{bmatrix} \begin{bmatrix} a \\ f \end{bmatrix} + \begin{bmatrix} a_g & a_z & a_w \\ b_g & b_z & b_w \end{bmatrix} \begin{bmatrix} g \\ z_t \\ w^t \end{bmatrix} \qquad (3.53)$$

where the elements of the forcing matrix b_i, a_i, $i = g, z, w^t$ are provided in (3.38) and (3.47) respectively.

The system exhibits saddle point stability, as the transition matrix $\underline{A}$ has determinant:

$$| \underline{A} | = 2\pi b_a = -2\pi\Omega\theta(\delta+\Gamma s_1) < 0$$

In a, f space, the $\dot{f} = 0$ locus remains horizontal for that unique combination of real variables which maintains external balance, whilst the $\dot{a} = 0$ locus has the slope:

$$(da/df)_{\dot{a}=0} = 2\pi/(\pi+a_a) \gtrless 0 \text{ as } \pi \gtrless |\, a_a \,| \qquad (3.54)$$

Thus the slope of $\dot{a} = 0$ depends on the degree of currency substitution, as was discussed when considering the case of monetary expansion in section 3.1.2.

Given the stock of foreign currency, a reduction in wealth will tend to produce positive accumulation via a current account surplus (which implies $\dot{f} > 0$) and by a budget deficit (so $\dot{m} > 0$). However, from the portfolio balance relation the implied reduction in the domestic to foreign currency ratio also causes depreciation. Thus the slope of the $\dot{a} = 0$ locus depends on the relative strengths of these offsetting effects. A large degree of currency substitution (a low value for π) means that small variations in depreciation are associated with given changes in portfolio composition. Thus, when π is sufficiently small, we will have $\dot{e} < (\dot{m} + \dot{f})$ following the reduction in wealth. In this case a further switch in portfolio composition towards foreign currency (a rise in f, given the level of a) is required to produce an offsetting rate of depreciation and the $\dot{a} = 0$ locus will be downward sloping.

The saddle path again has a positive slope, reflecting the acceleration hypothesis.

The Long Run

Equation (3.53) is solved for equilibrium ($\dot{a} = \dot{f} = 0$) to obtain steady state changes in total wealth and foreign currency holdings for each shock. We first consider the results for overall wealth, which are determined by the real structure of the economy, and then the results for foreign currency which depend on the influence the degree of currency substitution has on the transition process.

The results for wealth are:

$$da/dg = -b_g/b_a = -(\delta+s_1 \beta\Gamma(1-t)) \,/\, \theta\tau < 0,$$
$$da/dz = -b_z/b_a = -s_1(1-\beta(1-t)) \,/\, \theta\tau < 0,$$
$$da/dw^t = -b_w/b_a = -s_2\delta(1-\beta(1-t)) \,/\, \theta\tau < 0,$$

where $\tau = (\delta+s_1\Gamma) > 0$.

Thus total wealth falls across steady states for all shocks, and falls by more than is the case in the fixed regime.[19] This is due to the requirement that the current account must balance in the steady state.

The fiscal expansion represents a structural shift of demand in favour of home goods. This brings forth a rise in the relative price and home goods (a real appreciation) and a rise in their production.[20] These effects would tend to produce a current account deficit, hence the stock of wealth must fall for current account balance. The shift reduction in the demand for exports brings about a steady state fall in wealth that exceeds that under the fixed regime (correspondingly the real exchange rate depreciates and output falls further) so that the current account will balance. The shift reduction in the supply of labour also requires wealth to fall further than in the fixed regime, accompanied by a greater fall in output and real depreciation (although the real exchange rate is still appreciated relative to its original level due to the "cost push" nature of the shock).(21)

Before considering the results for foreign currency holdings, it is useful to note the steady state rate of depreciation (and inflation), which we denote by μ^e below. This is determined by the rate of credit expansion required to finance the budget deficit:

$$d\mu^e/dg = (\delta+s_1\Gamma(1-t)) / \tau > 0,$$
$$d\mu^e/dz = ts_1 / \tau > 0,$$
$$d\mu^e/dw^t = ts_2\delta / \tau > 0$$

The steady state changes in the stock of foreign currency are:

$$df/dg = (a_g b_a - b_g(a_a+\pi)) / 2\pi b_a$$
$$= (\delta(\theta-\pi)+s_1\Gamma(1-t)(\theta-\beta\pi)) / 2\pi\theta\tau \gtrless 0$$
$$df/dz = (a_z b_a - b_z(a_a+\pi)) / 2\pi b_a$$
$$= s_1(\theta t-\pi(1-\beta(1-t)) / 2\pi\theta\tau \gtrless 0$$
$$df/dw^t = (a_w b_a - b_w(a_a+\pi)) / 2\pi b_a$$
$$= s_2\delta(\theta t-\pi(1-\beta(1-t)) / 2\pi\theta\tau \lessgtr 0$$

Although total wealth must fall, the stock of foreign currency may rise or fall. The possibility that the stock of foreign currency can rise across steady states, implying current account surplus during adjustment, may at first seem surprising.[22] However, the result reflects the influence that the composition of portfolios has on dynamics under floating exchange rates. The results reported above show that steady state depreciation is a function of the real parameters that determine the required fall in overall wealth. The results for the long run change in foreign currency holdings are dependent on the degree of currency substitution π as well as real parameters. This is because, given the ultimate rate of depreciation, π determines the extent of the desired stock re-allocation of portfolios across steady states in response to the permanently higher depreciation. As we shall see, when portfolio composition is highly sensitive to depreciation (recall this "high elasticity case means a small value for π), the stock of foreign currency will rise, and the initial jump in the exchange rate will be greater.

Consider the case where domestic and foreign currencies become near perfect substitutes. Thus portfolio composition becomes highly sensitive to their relative rate of return.

Figure 3.5.(a) illustrates the response to a fiscal expansion.[23] The $\dot{f} = 0$ locus shifts down, since a lower level of wealth is required for current account balance. The $\dot{a} = 0$ locus, which, by (3.54), is downward sloping (since $\pi < |a_a|$) shifts to the right by

Figure 3.5.(a).

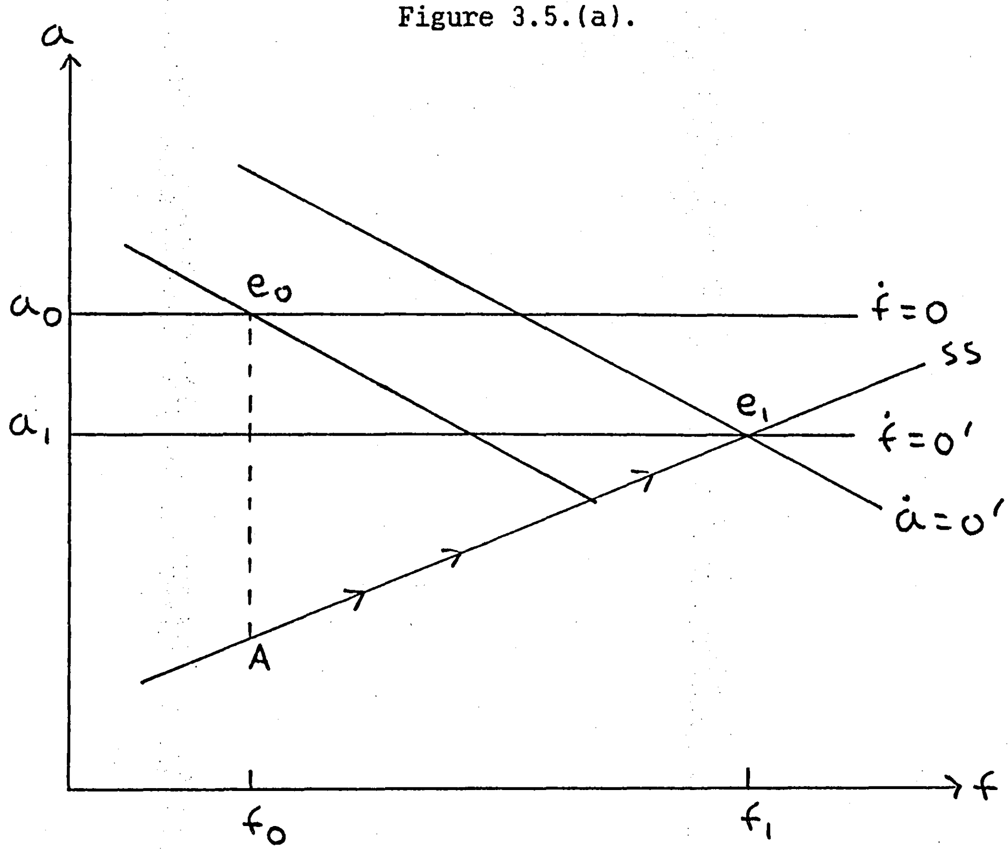
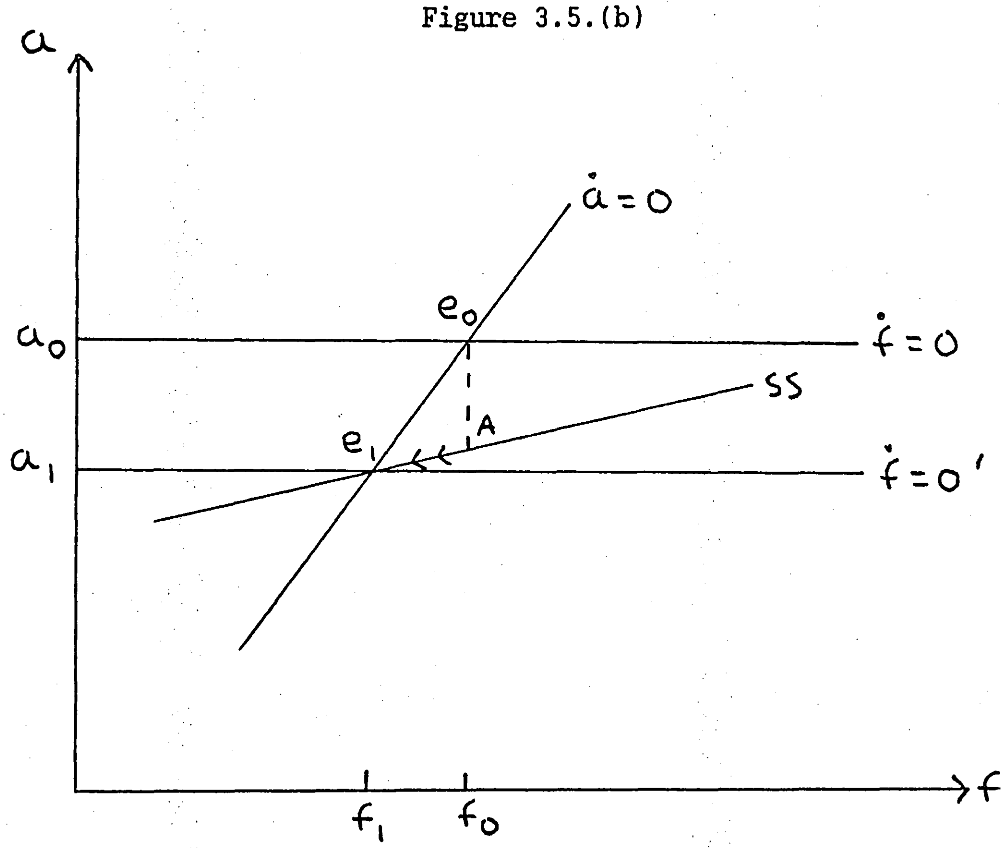


Figure 3.5.(b)



$a_g/2\pi$. The reason for this is that, at the initial stock of wealth a_0, the fiscal deficit would tend to induce rising wealth ($\dot{a} > 0$). In order to offset this (i.e.: to re-attain the $\dot{a} = 0$ locus at $a = a_0$ following the shock) a positive rate of depreciation is required. This can be achieved by shifting the portfolio composition towards foreign assets: a rise in the level of f, given a_0. (Note that the shift will be greater, and the $\dot{a} = 0$ locus flatter, the smaller the value of π). The new steady state e_1 involves a higher level of foreign currency, so the adjustment process from A to e_1 involves a current account surplus.

There is also a substantial initial jump in the exchange rate, which deflates wealth from a_0 to the level represented at point A. This jump is required because, following the shock, actual and anticipated depreciation instantaneously rises. The high degree of currency substitution requires an instantaneous and sizeable reduction in the domestic to foreign currency composition of portfolios in order to preserve portfolio balance at the moment of the shock. Given the stocks of currencies, this is achieved by the exchange rate instantaneously appreciating the value of the initial foreign currency stock.

Figure 3.5.(b) illustrates the case when the degree of currency substitution is negligible (π becomes very large). The real sector of the economy is unaffected - thus the current account balance locus shifts down to the same extent as before. However, the $\dot{a} = 0$ locus (positively sloped as $\pi > |a_a|$) tends not to shift at all.

The reason is that, at the initial level of wealth a_0, agents will only willingly accept a shift in portfolio composition towards foreign currency holdings if they expect to receive a near infinite rate of return (rate of depreciation) on the additional stocks. Since there is no shift in $\dot{a} = 0$, the composition of portfolios will be unchanged across steady states, as agents are indifferent to depreciation (which is the same as before in the steady state). Thus foreign currency stocks fall along with overall wealth, and there is a relatively minor initial jump in the exchange rate.

3.2.3. SPECULATIVE ATTACKS

The conditions for a speculative attack are present in any fixed exchange rate system exhibiting continuing reserve losses. In section 3.2.1., it was seen that such a situation is brought about when the fixed regime is subject to any one of the three shocks. Thus in this section we conduct the same form of analysis as in section 3.1.3.: following the evolution of wealth in the fixed regime to examine the point of linkage with the saddle path of the post-collapse floating regime.

As seen in the foregoing section, a variety of adjustment processes may arise under a permanently floating regime in response to any one of the three shocks considered, depending on the degree of currency substitution. However, the transition process exhibited by the post-collapse regime will be the same in all cases. This is because the level of wealth with which the floating regime commences post-collapse is determined by the fixed regime. We have seen that, whenever the attack occurs, this level of wealth will always be such that the floating regime inherits an external deficit which must be eliminated. Thus, in the diagrammatic exposition that follows, we adopt a maintained assumption about the degree of currency substitution, supposing that the elasticity is sufficiently great to yield $\pi < |a_a|$, and therefore a downward sloping $\dot{a} = 0$ locus according to (3.54).

Figure 3.6.(a) illustrates a gradual process of private sector decumulation and reserve loss from initial equilibrium e_0 during the fixed regime. Thus, qualitatively speaking, this diagram applies to either the shift reduction in the demand for exports, or the shift reduction in the supply of labour. From the dynamics of the fixed regime we know that wealth evolves towards the level $\hat{a}$, at which private sector stock adjustment is complete (so that $\dot{a} = 0$ at $\hat{a}$). However, at this level of wealth there will also be a permanent balance of payments deficit, which is offset by a budget deficit. Thus the external balance locus, $\dot{r} = 0$, requires that wealth should fall further to a_1 (where $a_1 < \hat{a}$ - see note (19)). In figure 3.6.(b), the evolution of the fixed regime is represented by the movement along the path from e_0 to A: wealth is falling and, in the absence of depreciation, portfolio balance simply requires that domestic and foreign currency holdings are decumulated in fixed proportions.

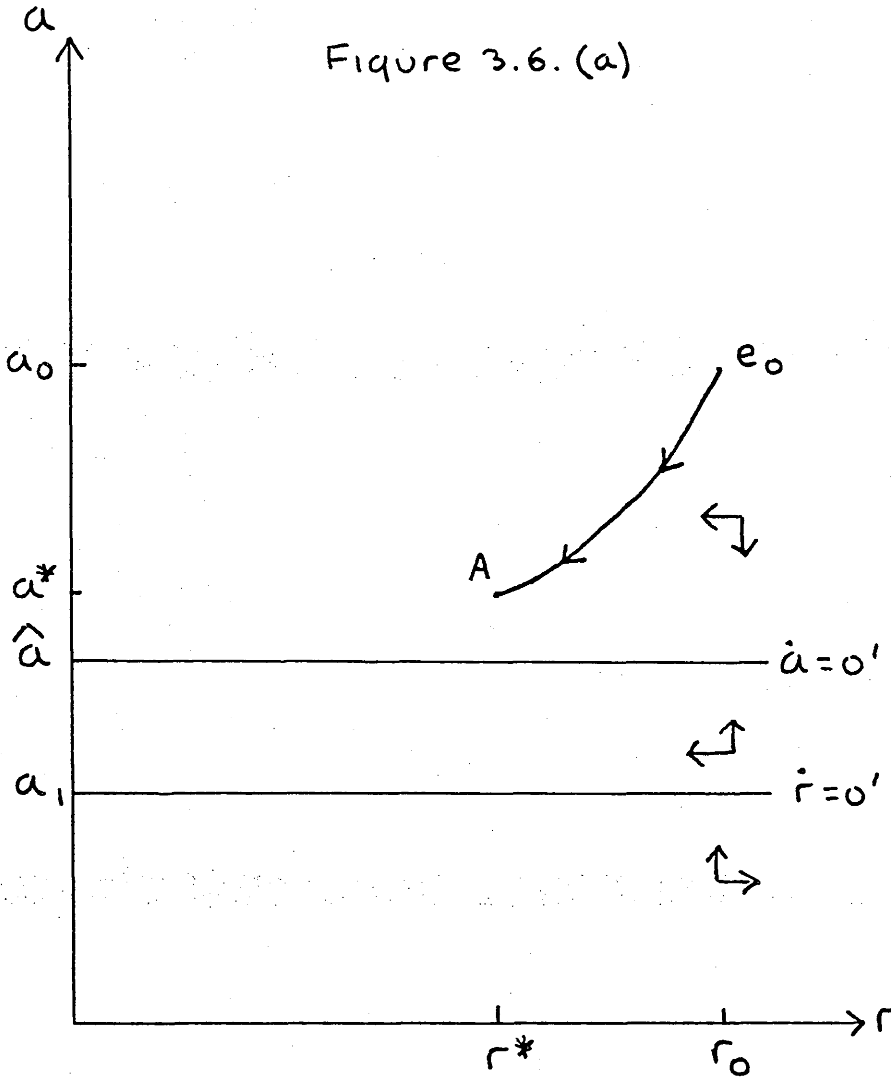


Figure 3.6. (a)

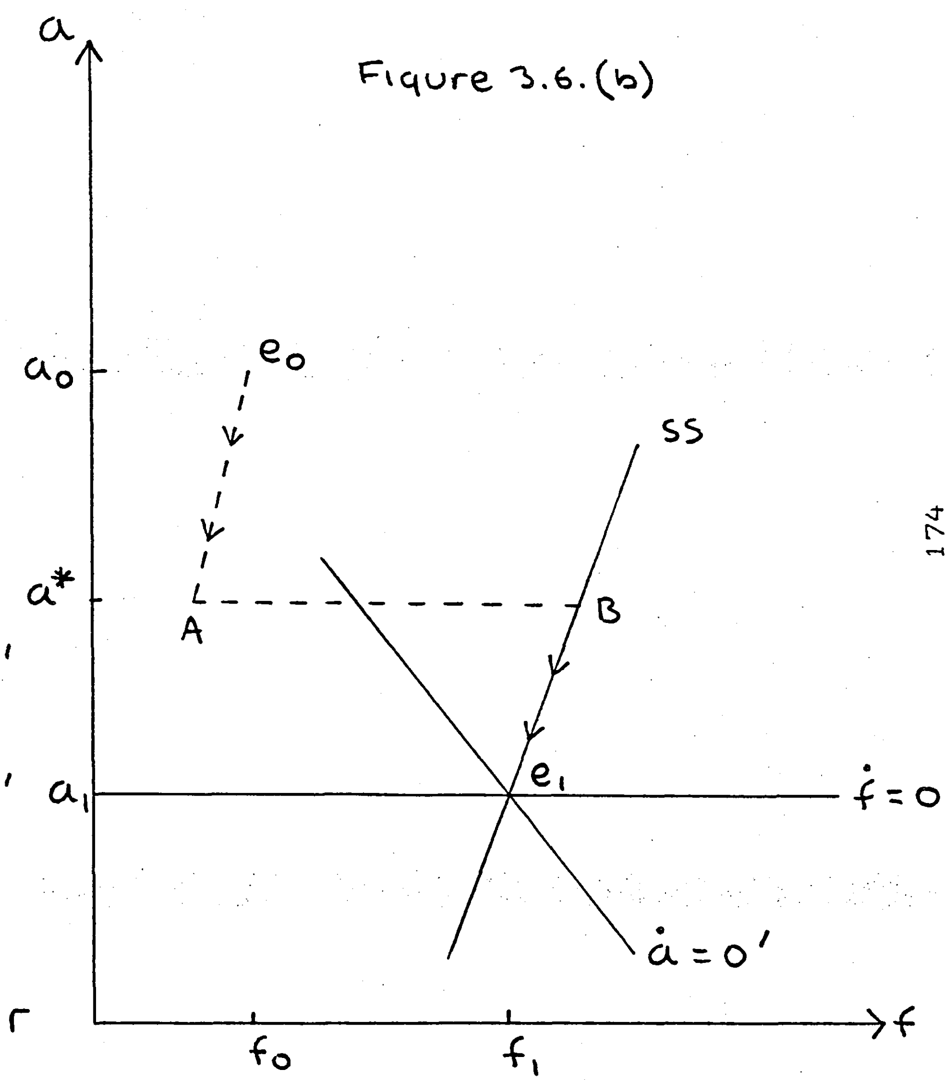


Figure 3.6. (b)

Figure 3.6.(b) also shows the response of the $\dot{a} = 0$ and $\dot{f} = 0$ loci under permanently floating exchange rates, as they are affected by the shock.(24) The $\dot{f} = 0$ locus shifts down to a_1, that level of wealth at which the current account will balance. Given our maintained assumption about π, the $\dot{a} = 0$ locus shifts to the left but is sufficiently elastic such that foreign currency holdings would have risen under permanently floating rates (so $f_1 > f_0$). The saddle path depicted is associated with final equilibrium e_1, and positively sloped, reflecting the acceleration hypothesis relationship.

The trajectory of the fixed regime involves continual reserve loss so that, for any initial stock r_0, reserves would eventually be exhausted whilst wealth is at some level $a \geq \hat{a}$. However, agents foresee this inevitability and also know that there will be an instantaneous jump in expected depreciation when the fixed regime does collapse. They thus desire that their portfolio composition be discretely switched towards foreign currency when the floating regime commences (compared to the composition at point A in figure 3.6.(b), which is associated with zero depreciation).

However, speculative behaviour prevents this switch occurring via a jump in the exchange rate. This is because speculative behaviour requires that before the government's reserves of foreign exchange (which can be bought out at a fixed cost) are exhausted, the remaining stock be bought out at that moment in time when the dynamics of adjustment are consistent with no arbitrary profits accruing to agents who exchange domestic for foreign currency - i.e.: such that the exchange rate does not jump and instantaneously appreciate the value of foreign currency.

In figures 3.6. this is shown as occurring at that moment in time when wealth has evolved to the level a^*. This leaves r^* reserves of foreign exchange available for a discrete currency swap which enables the saddle path to be obtained (the horizontal shift from A to B) without a discrete depreciation being required to meet the jump in expected depreciation (and therefore without a discrete change in wealth from the level a^*). After the attack wealth is gradually reduced as the inherited deficit is removed, with a consequent decline in foreign currency holdings, and, via the acceleration hypothesis, with depreciation in excess of its steady state.

Figures 3.7. provide the same method of illustration of an attack on reserves that precipitates the collapse of a fixed regime that is subject to a fiscal expansion. The same basic analysis applies. Once again there is some unique point in time in which wealth has attained a level, a^*, such that a quantity of reserves, r^*, remains available for the private sector to buy out in order to satisfy a desired discrete shift in portfolio composition without violating the speculative condition of no arbitrary profits or the convergence of the floating system from the level of wealth a^*. This is again denoted by the horizontal shift from A to B in figure 3.7.(b).

Figure 3.7 (a)

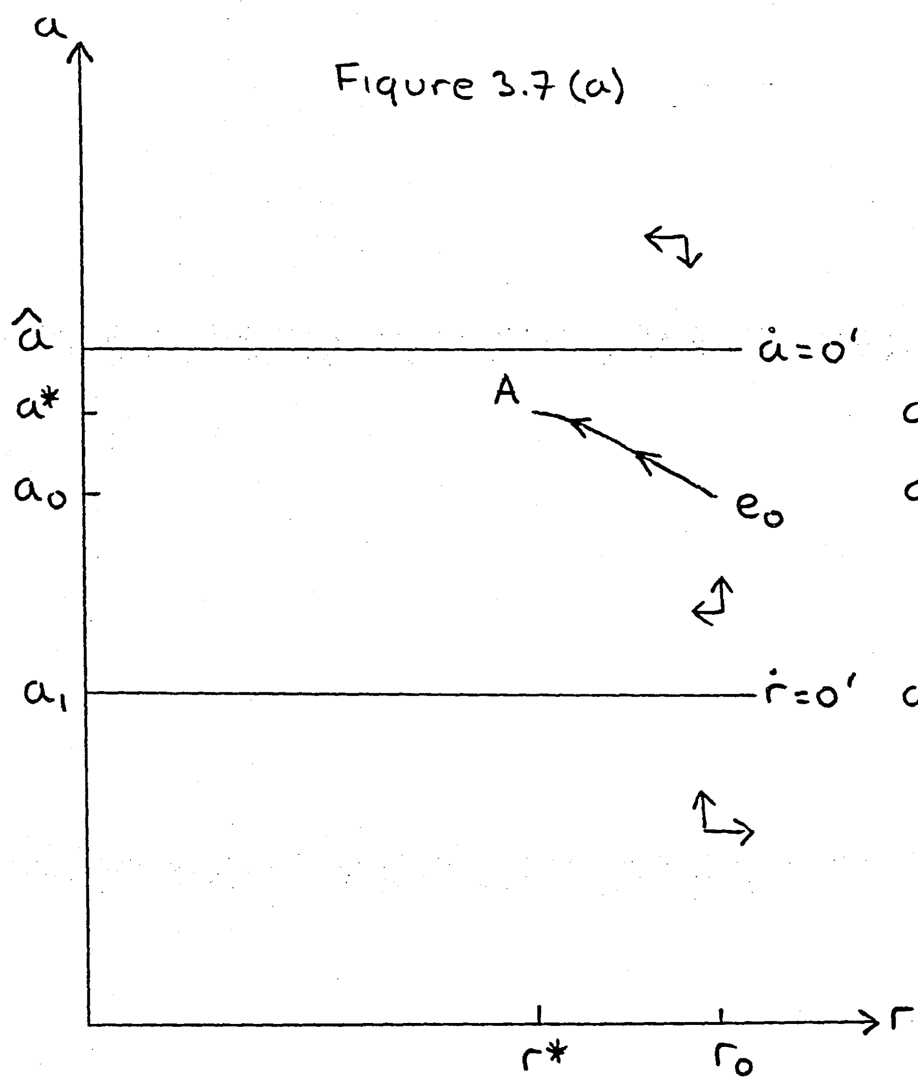
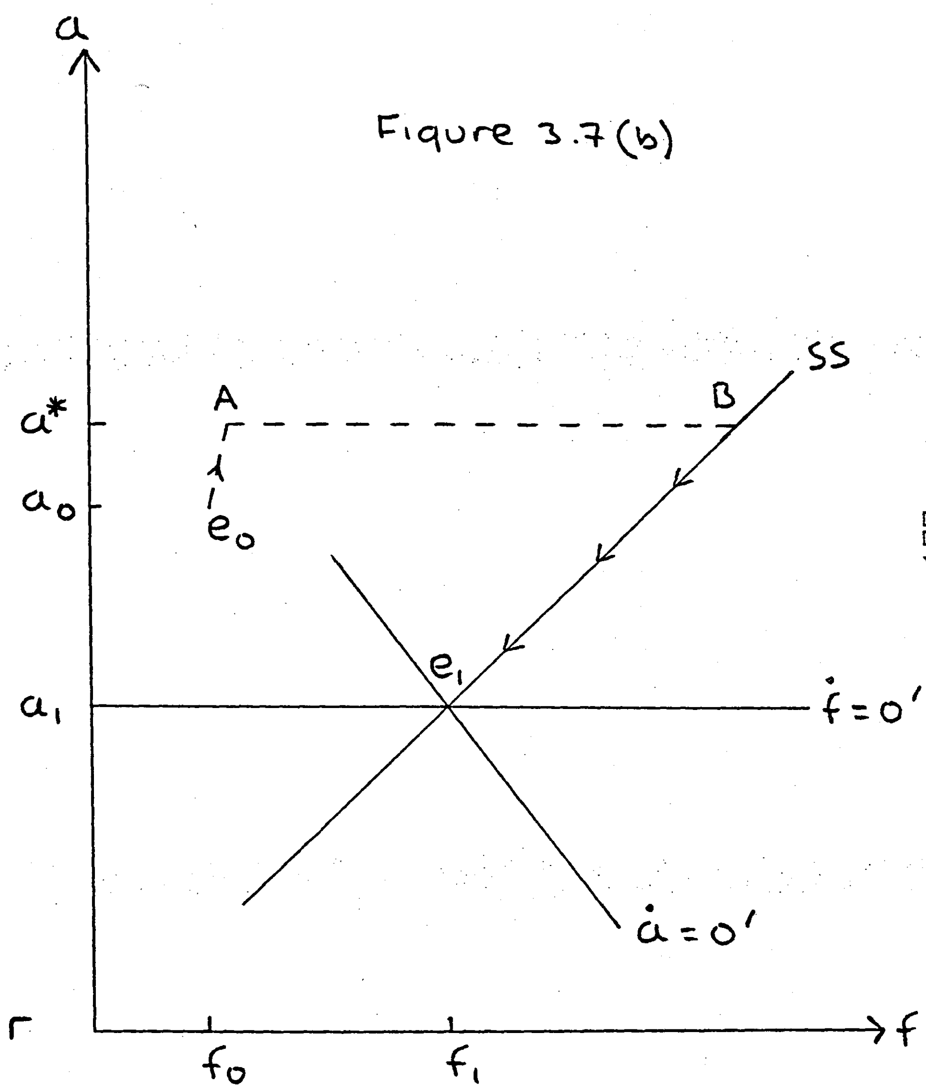


Figure 3.7 (b)



The requirement that external balance ultimately be achieved means that the post-collapse dynamics (the adjustment from B to e_1 in figure 3.7.(b)) will be similar to that which holds for the real shocks.

However, a difference emerges from the overall process that follows the real shocks in that wealth is being accumulated for however long the fixed regime lasts. Thus, from initial equilibrium e_0 in figure 3.7.(a), wealth is rising towards its desired stock under fixed rates, $\hat{a}$, whilst external balance would require a fall in wealth to a_1. This is likely to imply both a more rapid depletion of reserve during the fixed regime, and that wealth will be further from its steady state value at the moment of collapse. The latter point entails that depreciation will also be further in excess of its steady state when the floating regime is instigated, which in turn implies a greater desired stock exchange of nominal assets (a greater quantity of reserves attacked) is required to satisfy portfolio balance.

Finally we conclude by again noting the incompleteness of the foregoing analysis in its omission of a solution for the endogenous timing of the collapse of the fixed regime, for reasons that have been advanced earlier. In the next chapter the present model, under both flexible and sticky wage assumptions, is simulated to provide this final part of our analysis of balance of payments crises in monetary approach models.

In that chapter there are a number of points we draw on and seek to confirm from the foregoing analysis. Firstly that the key to finding the timing of a speculative attack will lie in examining how portfolio balance is instantaneously achieved following an attack on reserves at some arbitrary point in time. If the domestic and foreign currency stocks entailed by attacking reserves remaining at that point in time are such that portfolio balance still requires the exchange rate to jump to ensure these stocks are willingly held, then attacking reserves at that time implies either losses will be incurred (a discrete appreciation) or that potential profits were ignored in the past (a discrete depreciation).

Secondly we know that wealth is the key dynamic variable in a monetary approach model, and its evolution determines the values of currency stocks and the jump in expected depreciation that are critical to the timing of the attack. We also know that a speculative attack must provide a smooth link between the adjustment dynamics imposed by sluggish stock adjustments under fixed and floating rates, as the level of wealth should not be altered by a speculative attack.

Thirdly we look to confirm our analysis of the adjustment dynamics surrounding the collapse, as well as obtaining some insight into their effect on collapse timing. From the analysis of dynamics under fixed rates, we look at the influence of sticky wages and economic structure on the timing of collapse. From the floating regime analysis we look for the common adjustment process that should emerge post-collapse. This is that there will be gradually falling wealth associated with a depreciating real exchange rate and falling output to eliminate the current account deficit, and that, by the acceleration hypothesis, that the adjustment with a current account deficit involve depreciation in excess of its steady sate.

Finally some conjectures about collapse times suggested by the foregoing analysis are examined. In the above discussion we have already ventured reasons for supposing fiscal expansion will bring about a relatively early collapse. A further point is raised by looking at two steady state results we have derived that should provide a guide to likely collapse times - the rates of reserve loss (μ^r) and depreciation (μ^e). These results were:

$$d\mu^r/dg = (\delta+s_1\Gamma(1-t)) / \Sigma, \qquad d\mu^e/dg = (\delta+s_1\Gamma(1-t)) / \tau,$$

$$d\mu^r/dz = ts_1 / \Sigma, \qquad d\mu^e/dz = ts_1 / \tau,$$

$$d\mu^r/dw^t = ts_2\delta / \Sigma, \qquad d\mu^e/dw^t = ts_2\delta / \tau$$

where $\Sigma = (\delta+s_1(\Gamma+\Gamma(1-t))) > \tau = (\delta+s_1\Gamma) > 0.$(25)

Note from these results that we have $d\mu^r/dg = (1 - d\mu^e/dz)$, and $d\mu^e/dg = (1 - d\mu^e/dz)$, reflecting the symmetrical structural change represented by fiscal expansion and a reduction in demand for exports (a structural demand shift towards and away from home goods respectively). thus we concentrate on the symmetrical nature of adjustment following the fiscal and export shocks in chapter four.

The results also suggest that δ, the responsiveness of substitution between the domestically and foreign produced good with respect to their relative price (the real exchange rate σ), is likely to be a key parameter in determining collapse times.

Hence in the next chapter the simulations are conducted for two different values of δ. In particular we consider a scenario in which δ tends to zero (so that the Marshall-Lerner condition is only just satisfied). In this case the effects of the structural changes on output dominate those on relative prices. Thus the fiscal expansion inflicts damage on external balance through the channel of imports rising with disposable income ($d\mu^r/dg$ tends to $\Gamma(1-t)/\Sigma$), whilst the induced real appreciation is relatively less significant. The reduction in export demand works primarily via the induced budget deficit that results from the loss of tax revenue ($d\mu^r/dz$ tends to t/Σ) whilst the real depreciation has little effect in re-stimulating exports.[26] Finally, the "cost push" (real appreciation) effects of the reduction in labour supply produces little effect on external balance ($d\mu^r/dw^t$ tends to zero). We find that these intuitive explanations are further aided by relating the simulation results to the effect of δ on the aggregate demand-aggregate supply framework, and the links between this and the monetary flows approach to the balance of payments.

NOTES

(1) The distinction between this approach and that adopted by other contributions to the literature on balance of payments crises is drawn below.

(2) In the simulations conducted in chapter four, wages are re-introduced as a dynamic state variable.

(3) Driskill and McCafferty (1987) present a model which incorporates a role for the real exchange rate on both the supply and demand side, but omit wealth from aggregate demand.

(4) Kawai introduces an endogenous deficit in a model that combines current account and sticky price dynamics. However, he assumes regressive, rather than rational, expectations.

(5) The payments deficits considered are temporary. During the adjustment process the government devalues the official exchange rate in order to satisfy a reserve target. The timing of this policy switch is exogenous (i.e.: it is assumed that reserves do not reach a critical level that would precipitate a speculative attack before the switch) and known to the private sector. There is a dual exchange rate system, and the dual rate cannot jump when the official rate is actually devalued. This condition is used for a diagrammatic exposition of the economy before and after the policy switch.

(6) Khan and Lizondo (1987) and Calvo and Rodriguez (1977) analyse exogenous budget deficits in monetary approach models of fixed and floating regimes respectively. (Their models assume the dependent economy goods specification and an exogenous labour supply). Khan and Lizondo assume ongoing capital flight despite a permanently pegged exchange rate - our analysis effectively introduces rational expectations to link the two systems by speculative behaviour.

(7) This definition of wealth is drawn from the above papers.

(8) Recall that desired flows for individual assets cannot be specified in stock adjustment terms under floating rates.

(9) This differs from chapter two, where nominal wage adjustments shift aggregate supply, so that combinations of appreciating real exchange rates and falling output are possible during adjustment.

(10) The impact effect for the labour supply shock again follows from the assumption of instantaneous labour market clearing.

(11) Steady state results for the real exchange rate and output are:

$$\begin{bmatrix} d\sigma \\ dy \end{bmatrix} = \frac{1}{(\delta+s_1\Gamma)} \begin{bmatrix} 1 & -s_2\Gamma & -(1-\Gamma) \\ -s_1 & -s_2\delta & s_1(1-\Gamma) \end{bmatrix} \begin{bmatrix} dz_t \\ dw^t \\ d\mu \end{bmatrix}$$

(12) MacDonald (1988) re-specifies the Calvo and Rodriguez model in terms of overall wealth and foreign currency holdings

(13) Thus the outcomes for σ and y are as in note (11) above.

(14) The transition process that follows monetary expansion is the same irrespective of the slope of $\dot{a} = 0$, since the saddle path is always positively sloped.

(15) We implicitly assume the reserve limit is zero. Note that the uniqueness of r^* derives from the transversality condition. If a greater quantity of reserves were transferred to foreign currency holdings in attack (and the condition of no exchange rate jump imposed so that wealth remain at a^*) the floating regime would commence at a point below the saddle path. This would require that agents predict a divergent path of ever increasing depreciation and ever falling wealth.

(16) These models are clearly outside the scope and framework of this thesis. We do not suppose to provide a detailed description, but merely to indicate how they provide a solution for the timing of collapse.

(17) Steady state results for the real exchange rate and output are:

$$\begin{bmatrix} d\sigma \\ dy \end{bmatrix} = \Sigma^{-1} \begin{bmatrix} -1 & 1 & -s_2(\Gamma(1-t)+t) \\ s_1 & -s_1 & -s_2\delta \end{bmatrix} \begin{bmatrix} dg \\ dz_t \\ dw^t \end{bmatrix}$$

Note that the steady state results are the same as in chapter two (where the labour market clears in the long run). Comparison with Table 2.2. of chapter two can be made by noting that $s_1 = \alpha(1-\mu_a)$ and $s_2 = \alpha\mu_c$. (Σ above equals Σ in Table 2.2).

(18) Equivalently, μ^r may be derived form the steady state budget deficit.

(19) Denoting initial wealth as a_0, and letting $\hat{a}$ and a_1 represent the steady state levels under fixed and floating rates respectively, then $\hat{a} > a_0$, $a_1 < a_0$ for the fiscal expansion. For the real shocks it can be seen that wealth falls more under floating rates since we have $\hat{a} = (a_0 - a_i/a_a)$, $a_1 = (a_0 - b_i/b_a)$, so:

$$\hat{a} - a_1 = (b_i d_a - d_i b_a) / a_a b_a > 0$$

as a_a, b_a, $d_a < 0$; $b_i < 0$, $d_i > 0$.

where subscripts are the partial derivatives taken from (3.38), (3.39) and (3.47) of the text, and we index $i = z, w^t$.

(20) Sachs (1980) notes that an "expenditure switching" fiscal expansion will have a positive long run effects, even if real wages are rigid.

(21) Steady state results for the real exchange rate and output are:

$$\begin{bmatrix} d\sigma \\ dy \end{bmatrix} = \tau^{-1} \begin{bmatrix} -\Gamma & 1 & -s_2\Gamma \\ \Gamma s_1 & -s_1 & -s_2\delta \end{bmatrix} \begin{bmatrix} dg \\ dz_t \\ dw \end{bmatrix}$$

(22) However, recall the "counter intuitive" Calvo and Rodriguez result.

(23) The same arguments hold for the other shocks (although these shocks shift $\dot{a} = 0$ in the opposite direction for $\pi \to 0$).

(24) Note that all initial loci (passing through e_0) are suppressed in figures 3.6. and 3.7. for the sake of clarity.

(25) Since $\Sigma > \tau$ steady state depreciation exceeds steady state reserve loss, as the greater fall in wealth (and tax revenue) under floating rates entails a greater budget deficit.

(26) Note that δ does not appear in the numerator for $d\mu^r/dz$ and $d\mu^e/dz$: thus the higher the value of δ the less "damage" inflicted by the export shock, since the real depreciation has a more substantial mitigating effect in re-stimulating export demand.

CHAPTER FOUR

THE MONETARY APPROACH, FLEXIBLE AND STICKY WAGES, ENDOGENOUS BUDGET DEFICITS AND THE TIMING OF SPECULATIVE ATTACKS

INTRODUCTION

This chapter completes our analysis of speculative attacks by developing a method that solves for the time at which a monetary approach model of a fixed rate system will collapse. The collapses are brought about by the structural changes in the economy (and fiscal expansion) which were considered in chapter two and the second half of chapter three. The government does not adjust its fiscal stance, so the rate of credit expansion is endogenously determined according to these structural conditions.

The sticky wage model of chapter two demonstrated cases of chronic payments deficits that emerge in such a model, and chapter three conducted an analysis of the inevitable attack and post-collapse floating regime for a flexible wage version of this model. In this chapter a simulation analysis of both flexible and sticky wage models is made that demonstrates the entire process of reserve loss, the timing of collapse and subsequent enforced floating that results when a structural shock hits the fixed regime.(1) The simulation package used was the London Business School's PRISM (or ACES) package for rational expectations models.

The simulation results, by tracking the dynamic behaviour of the economy during adjustment, enable the consequences of the private sector enforcing a floating regime by attacking the government's reserves at any point in time to be examined. The attack occurs when the value(s) for the state variable(s) inherited from attacking the fixed regime imply the process of eliminating the external deficit under floating rates (foreseen by the private sector) provides a time path for foreign currency such that no initial jump in the exchange rate is required to maintain continuous portfolio balance. At such a time a speculative attack thereby provides the method of smoothly linking the two regimes such that the requirements of continuous portfolio equilibrium (and avoidance of windfall gains/losses) are reconciled with the fundamental stock-flow dynamics of the monetary approach under fixed and floating regimes.

A framework for the simulations is provided by the issues arising from the theoretical analysis, as noted at the end of chapter three.

4.1. THE MODELS

The models used in the simulations are outlined in equations (4.1) through (4.12) and derive from those presented in chapters two and three. There are four models in all : a flexible and sticky wage variant, each run under both fixed and floating exchange rate regimes. The models are written in log-linear form and discrete time, with D being the change operator: $Dx_{t+1} = x_{t+1} - x_t$.[(2)]

The Fixed Regime

Demand Side:

$$Df_{t+1} = \Phi Da_{t+1} \qquad (4.1)$$

$$Dd_{t+1} = g_t - ty_t \qquad (4.2)$$

$$Dr_{t+1} = -\delta p_t - \beta\Gamma(1-t)y_t - \theta\Gamma a_t - Df_{t+1} - z_t \qquad (4.3)$$

$$y^d_t = \beta(1-\Gamma)(1-t)y_t + \theta(1-\Gamma)a_t - \delta p_t + g_t - z_t \qquad (4.4)$$

Supply Side:

$$y^s_t = s_1 p_t - s_2 w^t_t \qquad (4.5a)$$

$$y^s_t = -\alpha(w_t - p_t) \qquad (4.5b)$$

$$Dw_{t+1} = \phi(\mu_1 p_t + \mu_2 w^t_t - w_t) \qquad (4.6)$$

The Floating Regime

Demand Side:

$$Df_{t+1} = \delta(e_t - p_t) - \beta\Gamma(1-t)y_t - \theta\Gamma a_t - z_t \qquad (4.7)$$

$$Dd_{t+1} = g_t - ty_t \qquad (4.8)$$

$$m_t - e_t - f_t = -\pi (E_t e_{t+1} - e_t) \qquad (4.9)$$

$$y^d_t = \beta(1-\Gamma)(1-t)y_t + \theta(1-\Gamma)a_t + \delta(e_t - p_t) + g_t - z_t \qquad (4.10)$$

Supply Side:

$$y^s_t = -s_1(e_t - p_t) - s_2 w^t_t \qquad (4.11a)$$

$$y^s_t = -\alpha(w_t - p_t) \qquad (4.11b)$$

$$Dw_{t+1} = \phi(\mu_1 p_t + (1-\mu_1)e_t + \mu_2 w^t_t - w_t) \qquad (4.12)$$

<u>The Parameter Values</u>

Demand Side - $\beta = 0.85$, $\theta = 0.15$, $\Gamma = 0.25$, $t = 0.2$, $\pi = 5.0$, $\delta = 2.5$ or 0.01

Supply Side - $s_1 = 0.1$, $s_2 = 0.4$, $\alpha = 0.8$, $\mu_1 = 0.875$, $\mu_2 = 0.5$, $\phi = 0.1$

Equations (4.1)-(4.5a) constitute the (endogenous budget deficit) fixed exchange rate model seen in chapter three. Note that the model is in fact first order in total private sector real wealth, a_t, accumulated via an overseas sector surplus and a public sector deficit.(3) The reason for entering separate equations for the evolution of the components of wealth will become apparent.

Equation (4.1) reflects the assumption that, under fixed exchange rates, a fixed proportion of accumulation is devoted to foreign currency; (4.2) gives the evolution of domestic credit via the endogenous budget deficit; and (4.3) the evolution of reserves through the balance of payments.(4) The aggregate demand and supply curves (4.4) and (4.5a) are again as found in chapter three, and jointly determine the endogenous variables price and output in terms of the state variable wealth and exogenous variables g_t, z_t and w^t_t.

For the sticky wage variant under fixed exchange rates, the demand block is unaltered, but the supply curve is now provided by (4.5b) and the additional equation (4.6) is required for the evolution of wages, now also a state variable.[5] This is the model which received theoretical analysis in chapter two, with a second order system in wealth and wages.

For the floating regime, equations (4.7)-(4.11a) provide the flexible wage variant of the model as analysed in chapter three. The system is second order, though, as was the case above, it is expedient to maintain equations to provide separate time paths for foreign and domestic currency and the exchange rate, rather than making the substitutions which could express the model as seen in chapter three.[6]

Equation (4.7) determines the evolution of foreign currency via the current account; (4.8) is the budget deficit; (4.9) is the portfolio balance relationship with expected depreciation causing currency substitution away from domestic currency, and (4.10) is the aggregate demand schedule. As before aggregate supply is determined either by (4.11a) in the case of flexible wages, or by (4.11b) if wages are sticky, in which case the further equation (4.12) is required to determine the evolution of wages.[7]

The parameters values are drawn from other simulation studies (e.g: Currie et al. (1986)), and two values are included for δ, the elasticity of substitution with respect to the real exchange rate, following the discussion at the end of chapter three.

Each model is simulated by issuing a permanent unit rise to one of the three exogenous variables g_t, z_t and w^t_t, representing a fiscal expansion, a loss of exports, and higher wage demands respectively.

4.2. THE SEARCH PROCEDURE

This section describes the procedure used to determine the timing of a speculative attack. The exchange rate must not jump at the moment of a speculative attack, thus we must search for that level of reserves, which, if attacked, will satisfy portfolio equilibrium at the moment of attack without requiring instantaneous depreciation.

At t = 0, one of the three shocks is delivered to the fixed exchange rate regime. The initial values of all endogenous variables are set to zero. The economy will start to evolve towards a new stock-flow equilibrium in which the private sector holds its desired stock of wealth. However, as has been seen in previous chapters, this stock of wealth is in excess of that required to eliminate the external deficit. Thus all simulations provide a time path for reserves in which they are continually depleted.

At t = 0 there is some known limit for the stock of reserves which the government is prepared to use to defend the exchange rate parity, which we denote as R^{lim}(8). Thus, in the absence of a speculative attack, at that point in time in which reserves reach R^{lim} the economy would switch to a floating regime. However, in the presence of external and public sector deficits, this switch is accompanied by an instantaneous jump in expected depreciation. Hence, by the portfolio condition (4.9), an instantaneous jump depreciation of the exchange rate is required to ensure the given stocks of domestic and foreign currency are willingly held. An exchange rate jump, however, is incompatible with speculative behaviour.

However, at any point in time t = T prior to the exhaustion of reserves, a stock of reserves $R^a{}_T$ remains, and this is given by:

$$R^a{}_T = (R_T - R^{lim}) > 0 \qquad (4.13)$$

If the private sector were to buy out this stock of reserves with their holdings of domestic currency, they would alter their holdings of foreign and domestic currency as follows:

$$F_{T+} = F_T + R^a{}_T \qquad (4.14)$$

$$M_{T+} = R_T + D_T - R^a{}_T \qquad (4.15)$$

where for a variable X, X_T denotes its value immediately prior to attack, and X_{T+} its value immediately after an attack. Thus an attack provides an alternative way of reducing the allocation of domestic currency in the portfolio to meet the instantaneous jump in expected depreciation when the floating regime commences.

Hence, to examine the consequences of an attack launched at t = T, the floating regime is run with F_{T+} and M_{T+}, as derived from the evolution of the fixed regime, as initial values. (Note that in the sticky wage case, the value for W_T is also carried over as an initial value for the floating regime simulation).

Suppose that this procedure is followed, and it is discovered that an initial discrete appreciation of the exchange rate occurs at the start of the floating regime, immediately after T. This implies a capital loss for agents who bought out $R^a{}_T$, so that there is no incentive to launch a speculative attack as early as t = T, and the fixed regime would survive for at least one more period. Expressed alternatively, from the portfolio condition (4.9), the transfer of $R^a{}_T$ from domestic to foreign currency holdings constitutes an excessive reduction in the portfolio allocation to domestic currency for the extent of the initial jump in expected depreciation - hence a discrete appreciation is required to raise the value of domestic currency holdings at that time. By extending the fixed regime one more period, the extent of reserves transferred, $R^a{}_{T+1}$, must be less (since reserves are continually depleted) and the extent of initial appreciation reduced.

This procedure is repeated until that critical time period, which we denote by $t = T^*$, is reached when attacking R^a_{T*} cause no movement in the exchange rate, and thus no capital losses or gains. In fact, since the model is in discrete time, we are unlikely to obtain a value for R^a_{T*} that yields precisely no change in the exchange rate (except by coincidence). Thus the time of attack $t = T^*$ is defined as that time period for which transferring R^a_{T*} in an attack yields the minimum initial depreciation of the exchange rate when the floating regime commences. Thus, if the fixed regime were extended one more period to $t = (T^* + 1)$, the exchange rate would depreciate further implying unexploited capital gains from not attacking at $t = T^*$. If the attack occurred at $t = (T^* - 1)$ the exchange rate would appreciate so that speculators attacking reserves would incur a capital loss.

Finally, note that the attack leaves the state variable(s) unchanged. To see this, suppose that the attack does indeed leave the exchange rate unaltered, so that $E_{T+} = 0$. Then from the definition of private sector wealth (and using (4.14) and (4.15)) :

$$A_{T+} = M_{T+} - E_{T+} + F_{T+} = R_T + D_T = A_T \qquad (4.16)$$

so that the value of real private sector wealth immediately after the attack is the same as that inherited from the collapse of the fixed regime. (In the sticky wage case, since the value for W_T is simply carried over, $W_{T+} = W_T$, leaving both state variables unaltered). Since the state variable(s) wealth (and wages) are the same after attack, the jointly endogenous variables price and output will also be continued at the levels determined by A_T (and W_T). Hence the post attack floating regime smoothly links up with the fixed regime at the point of a collapse that results from a speculative attack.

4.3. THE RESULTS

The discussion of the simulation results are arranged as follows. Firstly, in section 4.3.1., we comment on the overall process of the evolution of wealth and the balance of payments deficit in the fixed regime and the smooth transition to the post-collapse regime caused by a speculative attack. The fundamental dynamics of the post-collapse regime then require that the inherited levels of wealth and the external deficit be reduced, and that depreciation exceed its steady state rate during this adjustment. The requirement that the regimes be linked in a smooth manner, and the post collapse dynamics are the same irrespective of the source of shock. As an illustrative example, the results for fiscal expansion are described, for the "benchmark" simulation (flexible wages; $\delta = 2.5$).[9] The manner in which sticky wages and the lower δ value effect post-collapse dynamics are briefly discussed.

Secondly, in section 4.3.2., the results for the collapse times for each of the twelve cases are presented. The simulation results obtained are explained with reference to the theoretical analyses conducted earlier in the thesis. This facilitates an interpretation of how the relative collapse times are influenced according to the source of the shock, the value of δ, and the structure of the model (flexible or sticky wages). In this regard the earlier presentation of the monetary approach within a Keynsian aggregate demand-aggregate supply framework, and of the equivalence of the trade and monetary flows expressions for the balance of payments, is found particularly useful.

4.3.1. Transition and the Post-Collapse Regime

In this section the point of transition to the floating regime, and the dynamics of that post-collapse regime, are examined.

Although the evolution of the fixed regime differs according to the source of the shock (and forms the basis of discussion in the following section), the post-collapse regime exhibits the same adjustment process for all shocks since an excessive level of wealth ($a \geq \hat{a}$ in our previous notation) and therefore a current account deficit is always inherited.

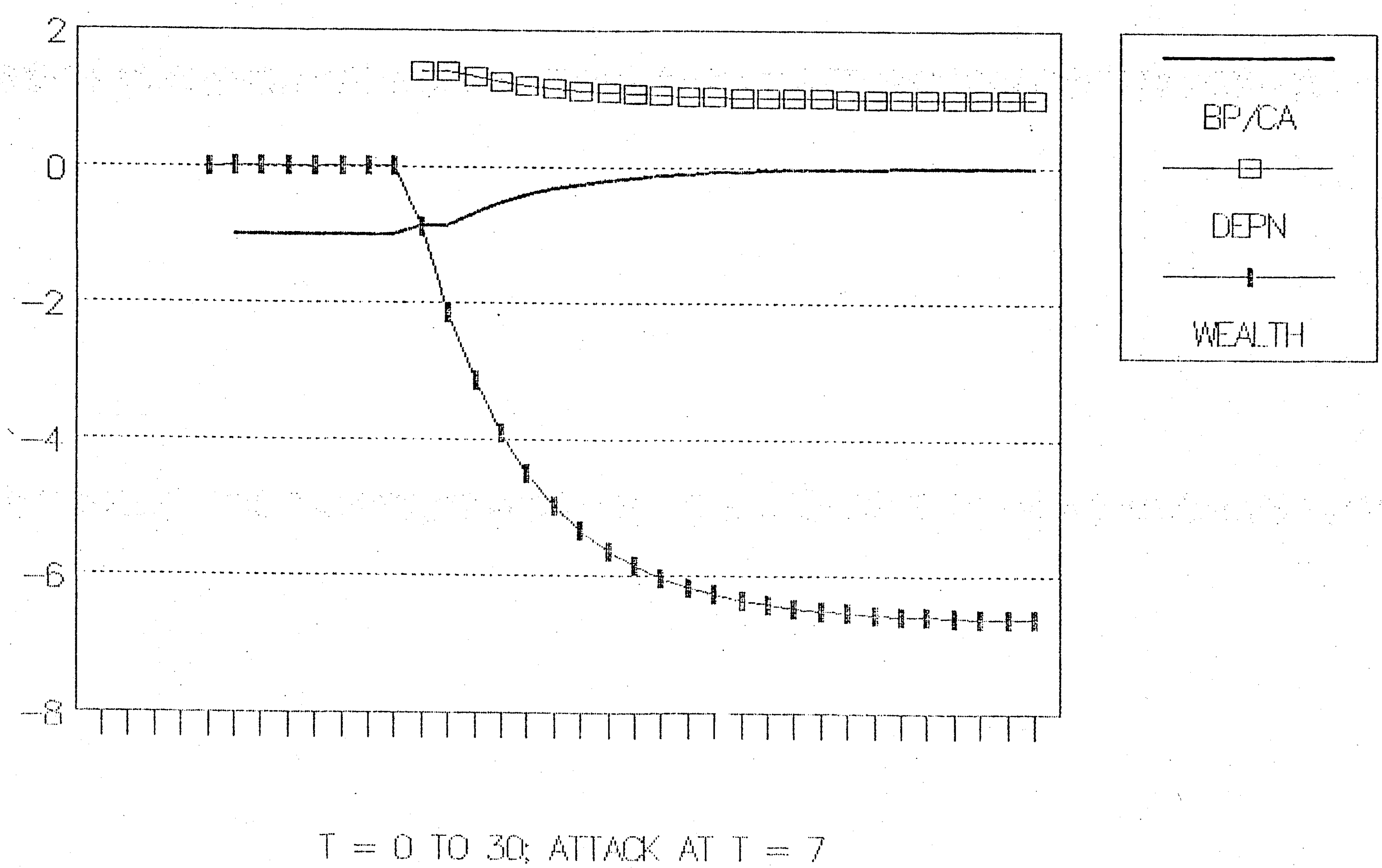
The fundamental dynamics of current account-portfolio balance models in the presence of an overvalued exchange rate (as inherited from the fixed regime) - i.e.: the relationship between current account deficits, falling wealth, and depreciating exchange rates (relative to trend) were confirmed for both flexible and sticky wage models and both values for δ. Thus the "acceleration hypothesis" description of monetary approach models during adjustment under floating rates is confirmed.

However, the choices of value for the parameter δ and of the flexible or sticky wage model, do alter some attendant aspects of adjustment, as we shall see below. Here the fiscal shock is taken as an illustrative example, but the following discussion holds true for all shocks vis-a-vis the floating system.

Figure 4.1. shows the fundamental adjustment process in terms of wealth, depreciation and the current account that is exhibited in all cases. During the fixed regime wealth is being accumulated (since the fiscal shock is illustrated) and the balance of payments is deteriorating. Before reserves are exhausted a speculative attack eliminates the remaining stock (Table 4.1. provides the quantity of reserves attacked) as the private sector swaps domestic for foreign assets in such a way as to prevent an exchange rate jump. The attack both enforces a floating regime and ensures the transition is smooth since there is no instantaneous jump in wealth (and therefore other endogenous variables). At the moment of transition, the current account deficit is inherited and the rate of depreciation that instantaneously emerges exceeds its steady state (in figure 4.2. wealth is omitted from the graph in order to illustrate the time path of depreciation more clearly). In the floating regime the current account deficit is gradually eliminated as wealth falls to a level compatible with external balance ($a = a_1$ in the notation of

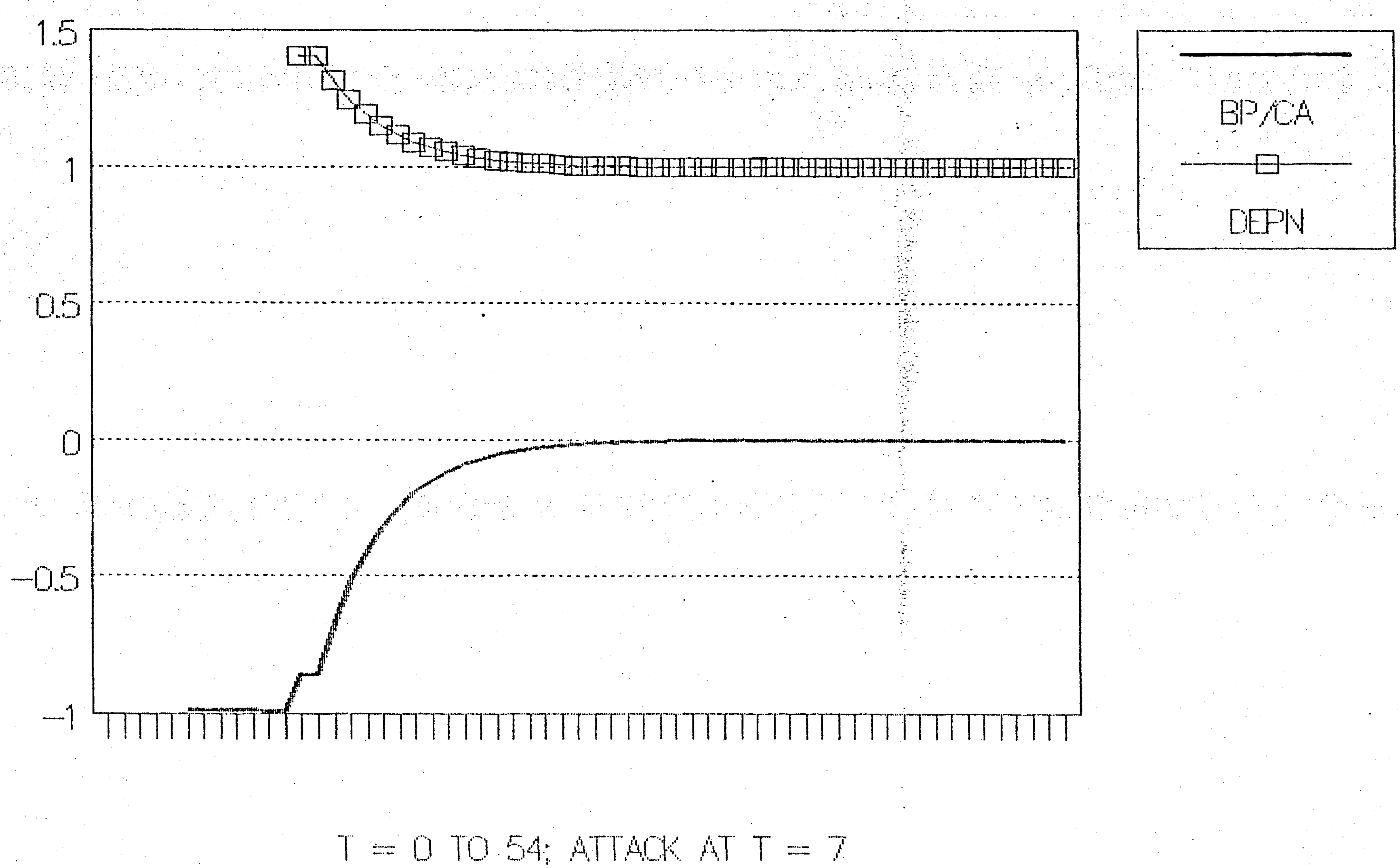
FISCAL SHOCK : FLEX WAGES; DELTA=2.5

FIGURE 4.1



FISCAL SHOCK : FLEX WAGES; DELTA=2.5

FIGURE 4.2.



chapter three). The deficit is financed by a reduction in foreign currency holdings, implying a gradual reduction in their portfolio share. The level of foreign currency holdings immediately post-attack (which depend on the level of reserves attacked) constitute a greater share in the portfolio that is willingly held since the rate of depreciation during adjustment implies agents anticipate an appreciation in their value. When wealth has fallen sufficiently for the current account to attain balance the rate of depreciation attains its steady state (which offsets domestic credit expansion) and the portfolio composition is unaltered as all stock adjustments are finally completed.

The above results confirm the acceleration hypothesis as the fundamental post-collapse adjustment process between wealth, the current account deficit, and depreciation. It describes the process that emerges in all post-collapse regimes. However other aspects of adjustment, particularly that of the real exchange rate, vary according to the chosen parameter set and model structure.

From the previous analytical results we know that, if the fixed regime were extended indefinitely, the real exchange rate would be permanently misaligned (overvalued) for external balance. Consequently we expect the real exchange rate to be depreciating post-collapse.

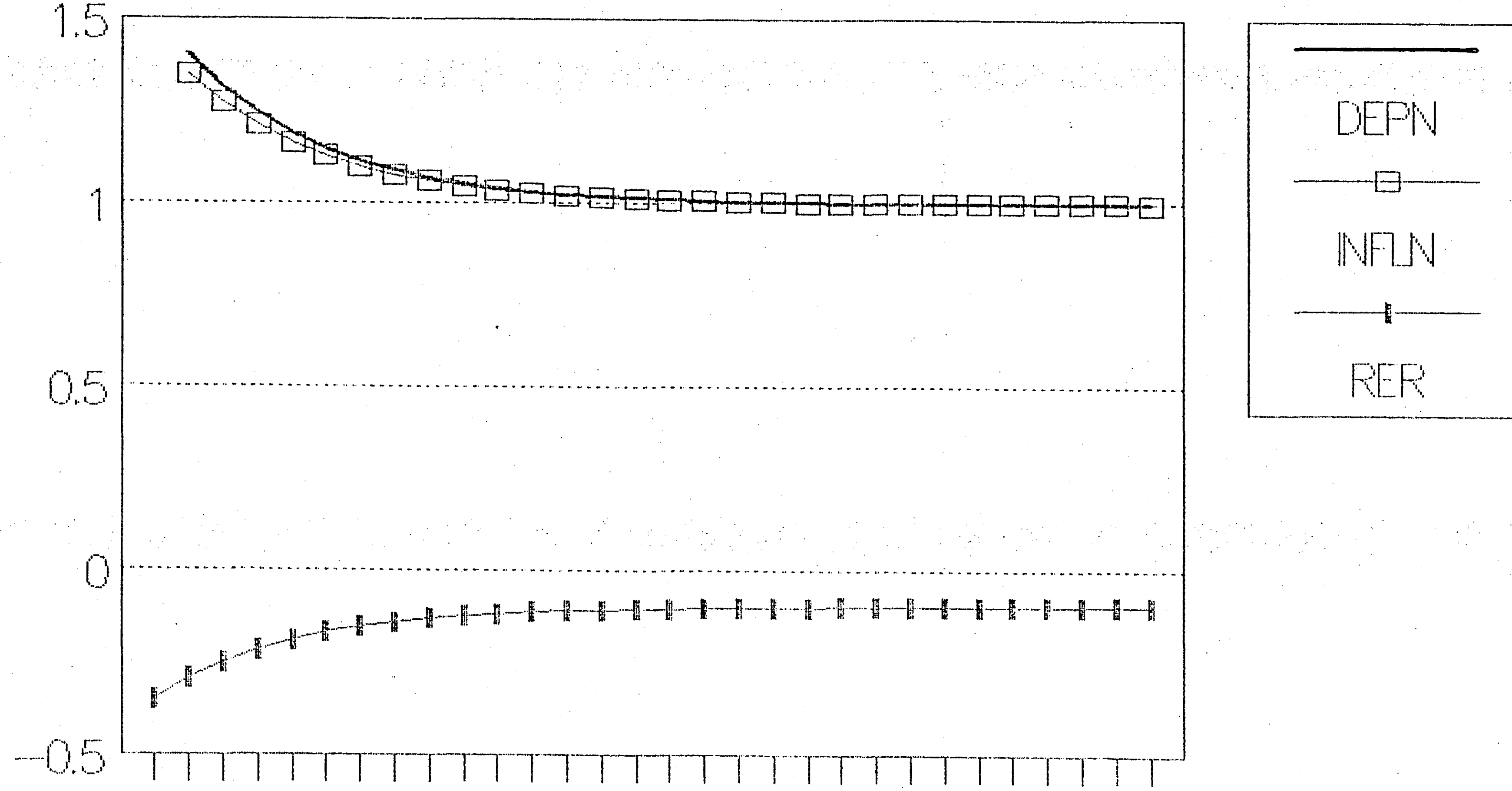
This is indeed the case for the flexible wage model. When $\delta = 2.5$, this is achieved in an "unsurprising" manner: the rate of depreciation exceeds inflation during adjustment, with consequent real depreciation until depreciation equals inflation in the steady state (see fig 4.3). Similar time paths obtain in the sticky wage model.

However, when $\delta = 0.01$, there is initially negative inflation post-collapse (see fig 4.4). From the theoretical analysis we know both that inflation and depreciation must be equal in the steady state (so relative prices are constant), and that depreciation must be positive and exceed its steady state rate in adjustment (the acceleration hypothesis). However, real depreciation has little effect in improving the current account, adjustment requires the degree of depreciation be more substantial (or greater depreciation is consistent with the fall in wealth) - hence the time path for inflation.

When the low value of δ is combined with sticky wages a further issue arises. Firstly, for the fiscal shock (and for this shock alone)[(10)] the real exchange rate appreciates relative to its initial post-collapse value (see fig 4.5). This is a consequence of the attack occurring at a relatively early stage of monetary approach adjustment under fixed rates - i.e.: sticky wages prevented substantial appreciation occurring. Thus compare the initial post-collapse real exchange rate in figs 4.4. and 4.5. (the steady state value under fixed rates is minus twenty).

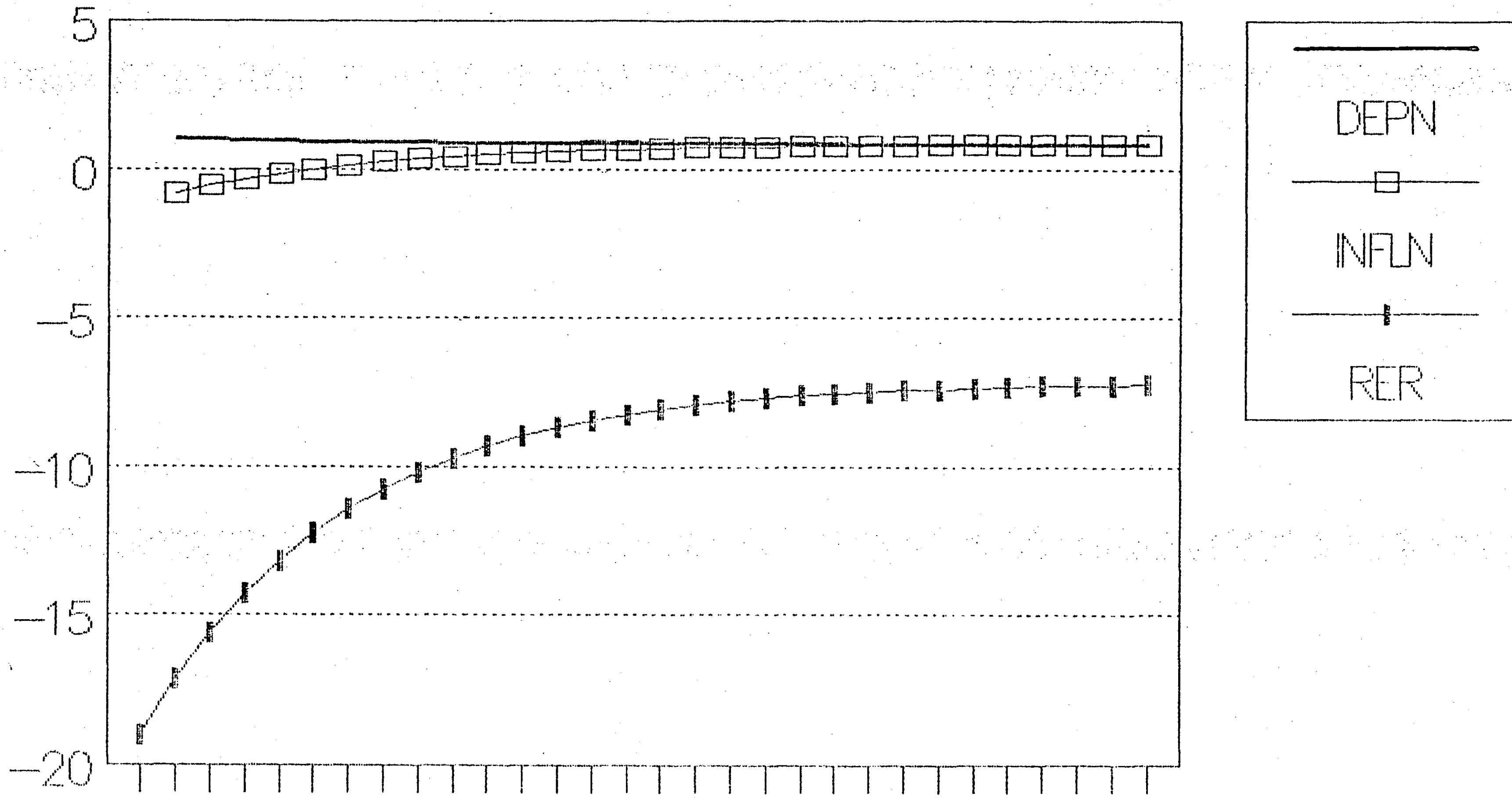
FLEXIBLE WAGES; DELTA = 2.5

FIGURE 4.3.



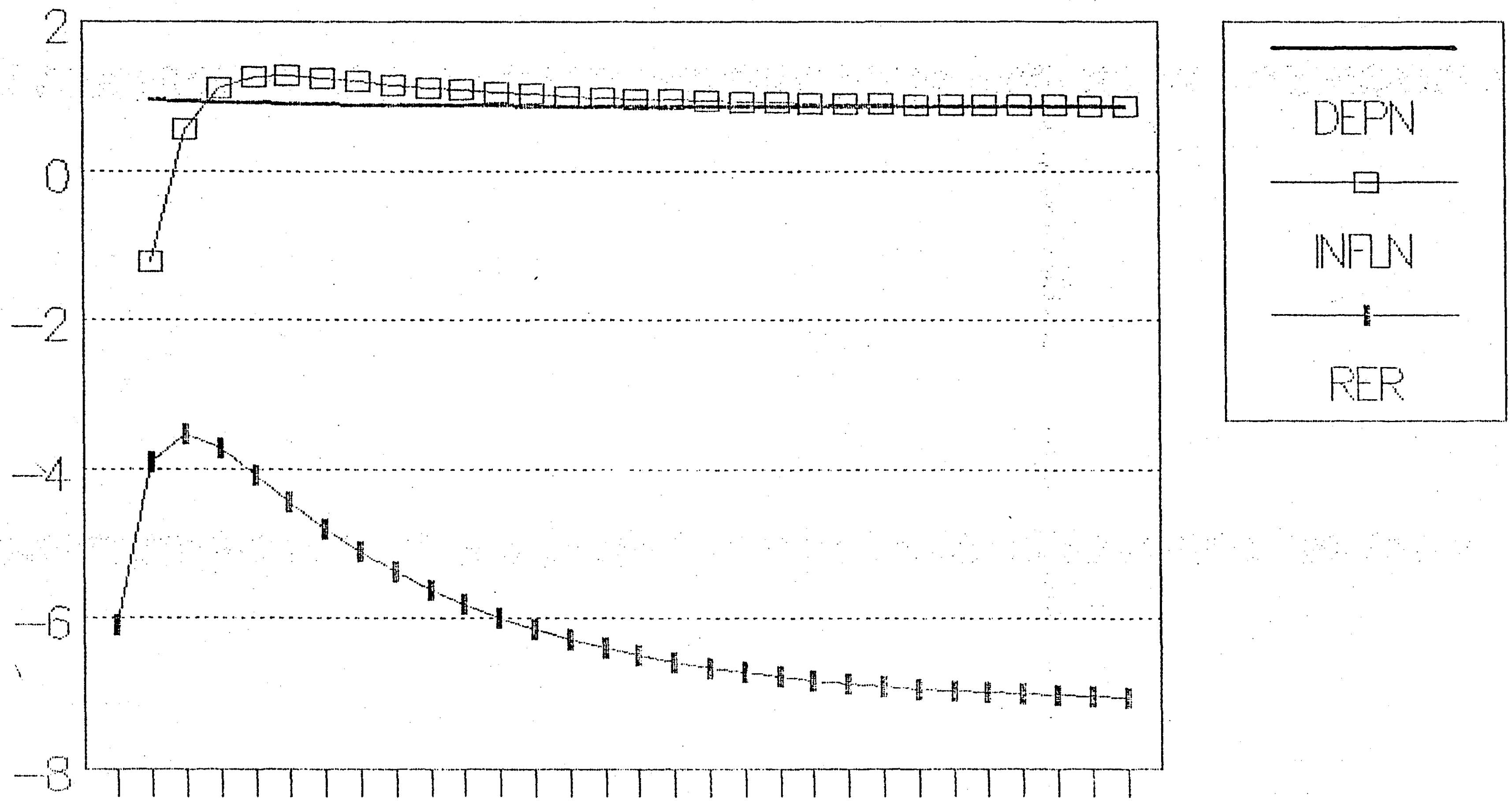
FLEXIBLE WAGES; DELTA = 0.01

FIGURE 4.4.



STICKY WAGES; DELTA = 0.01

FIGURE 4.5.



Secondly (a process that is common to all shocks), fig 4.5. shows an "overshooting" of the real exchange rate. The overshoot (which is more substantial for the real shocks, since the fixed regime survives longer so that the real exchange rate is overvalued at the moment of transition) requires subsequent appreciation (where inflation exceeds depreciation) to the steady state value (which is the same as under flexible wages). However, the fundamental process of falling wealth occurs the while, so that a period of falling wealth and an appreciating real exchange rate is encountered. This can only occur under sticky wages, because the stock-flow relationship between falling wealth and falling income is also preserved post-collapse. Under flexible wages falling output must be continually associated with a depreciating real exchange rate, since the market clearing level of employment would rise if the real exchange rate ever appreciated (thereby enabling a lowering of the producer real wage for a given consumer real wage). However, when wages are sticky, there is no necessary supply side relation between real appreciation and rising employment.

4.3.2. The Collapse Times

The results for the timing of the collapse of the fixed regime are listed in Table 4.1. There are twelve results in all: each of the two models (flexible and sticky wages) are subjected to each of the three shocks, and the models are run under two different parameter sets. The parameter sets differ in the choice of a value for δ,

TABLE 4.1.

THE TIMING OF SPECULATIVE ATTACKS

PARAMETER SET ONE: $\delta = 2.5$

		FLEXIBLE WAGES		STICKY WAGES	
	TIME	R^*	E+	R^*	E+
	T=6	4.0457	-0.5756		
FISCAL	T=7	3.0753	0.8908		
SHOCK					
	T=6			4.3841	-1.1035
	T=7			3.4242	0.3292
	T=1264	0.0174	-0.0036		
EXPORT	T=1265	0.0095	0.0081		
SHOCK					
	T=1195			0.0184	-0.0052
	T=1196			0.0106	0.0063
	T=121	0.1751	-0.0378		
LABOUR	T=122	0.0963	0.0787		
SHOCK					
	T=132			0.1832	-0.0508
	T=133			0.1044	0.0656

NOTES: R^* is the quantity of reserves remaining to be attacked. At t=0, R^*=10.
E+ is the initial exchange rate that emerges immediately after the attack when the floating regime commences.

TABLE 4.1.

THE TIMING OF SPECULATIVE ATTACKS

PARAMETER SET TWO: $\delta = 0.01$

	TIME	FLEXIBLE WAGES R^*	FLEXIBLE WAGES E+	STICKY WAGES R^*	STICKY WAGES E+
FISCAL SHOCK	T=12	3.6365	-0.7961		
	T=13	3.0624	0.2448		
	T=14			3.6285	-0.8550
	T=15			3.1185	0.0126
EXPORT SHOCK	T=19	1.4386	-0.6048		
	T=20	1.0260	0.0984		
	T=16			1.3952	-0.6848
	T=17			0.9125	0.0912
LABOUR SHOCK	T=619	0.0543	-0.0229		
	T=620	0.0383	0.0051		
	T=686			0.0383	-0.0018
	T=687			0.0223	0.0246

NOTES: R^* is the quantity of reserves remaining to be attacked. At t=0, R^*=10.

E+ is the initial exchange rate that emerges immediately after the attack when the floating regime commences.

which measures the responsiveness of the trade balance to the real exchange rate. This choice follows the arguments presented in chapter three (section 3.2.3.) that δ was likely to prove a critical parameter in altering the times of collapse.[11]

We now turn to an explanation of the results presented in Table 4.1. In order to capture the most interesting features of the results, the explanation is structured as follows. Firstly we consider how the collapse time is influenced according to the source of the shock. In this regard the most salient feature is that the fiscal expansion always causes the earliest collapse. Secondly the effects of altering the value of δ are studied. The principal interest in this regard is the dramatic alteration in the relative collapse times brought about by the fiscal and export shocks. When $\delta = 2.5$ the fixed regime survives the export shock for substantially longer than the fiscal expansion; when $\delta = 0.01$, the difference in collapse times is negligible. Finally we consider the influence of flexible and sticky wage specifications - sticky wages delay collapse in the case of the fiscal and wage shocks, whilst they precipitate collapse in the case of the export shock.

As a prelude to the following analysis, note that the most salient factor in determining the variation of collapse times is the rate at which reserves are lost during the fixed regime (Figs.4.6 to 4.8 illustrate the time path of reserves).[12] Thus the exposition below mainly focuses on the dynamics of the fixed regime (having looked at the dynamics of the post-collapse regime in section 4.3.1. above).

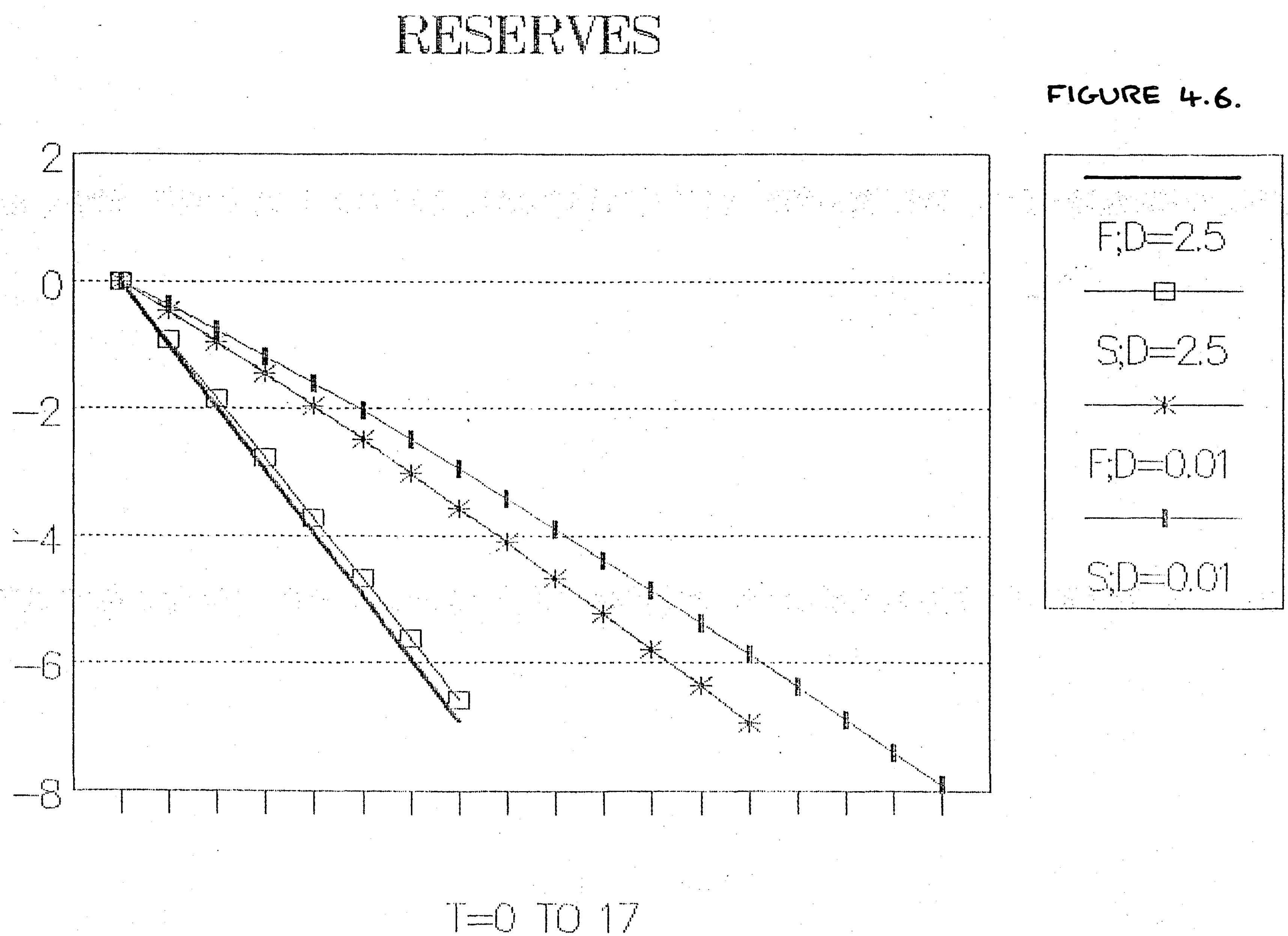
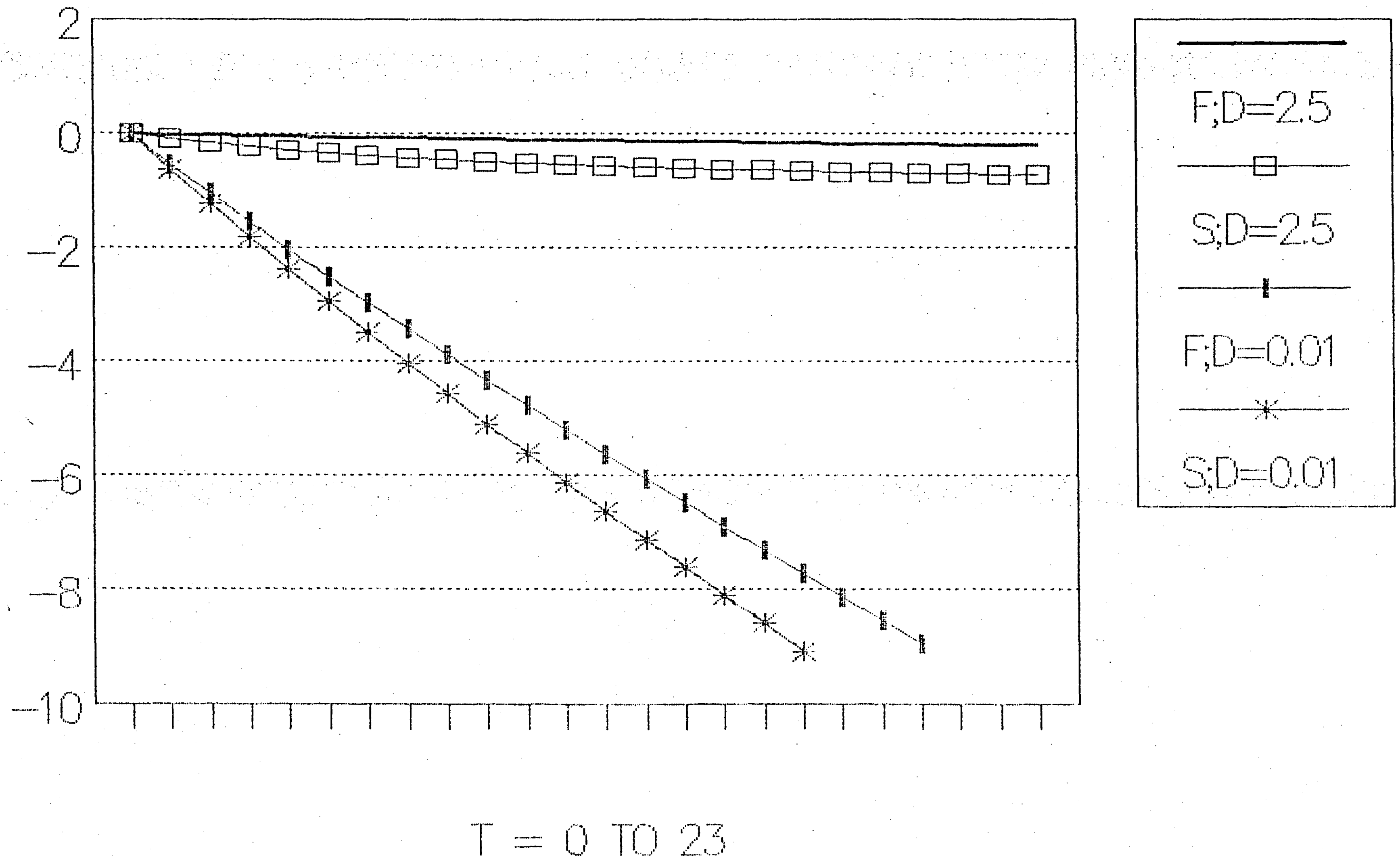


FIGURE 4.6.

FIXED REGIME : EXPORT SHOCK

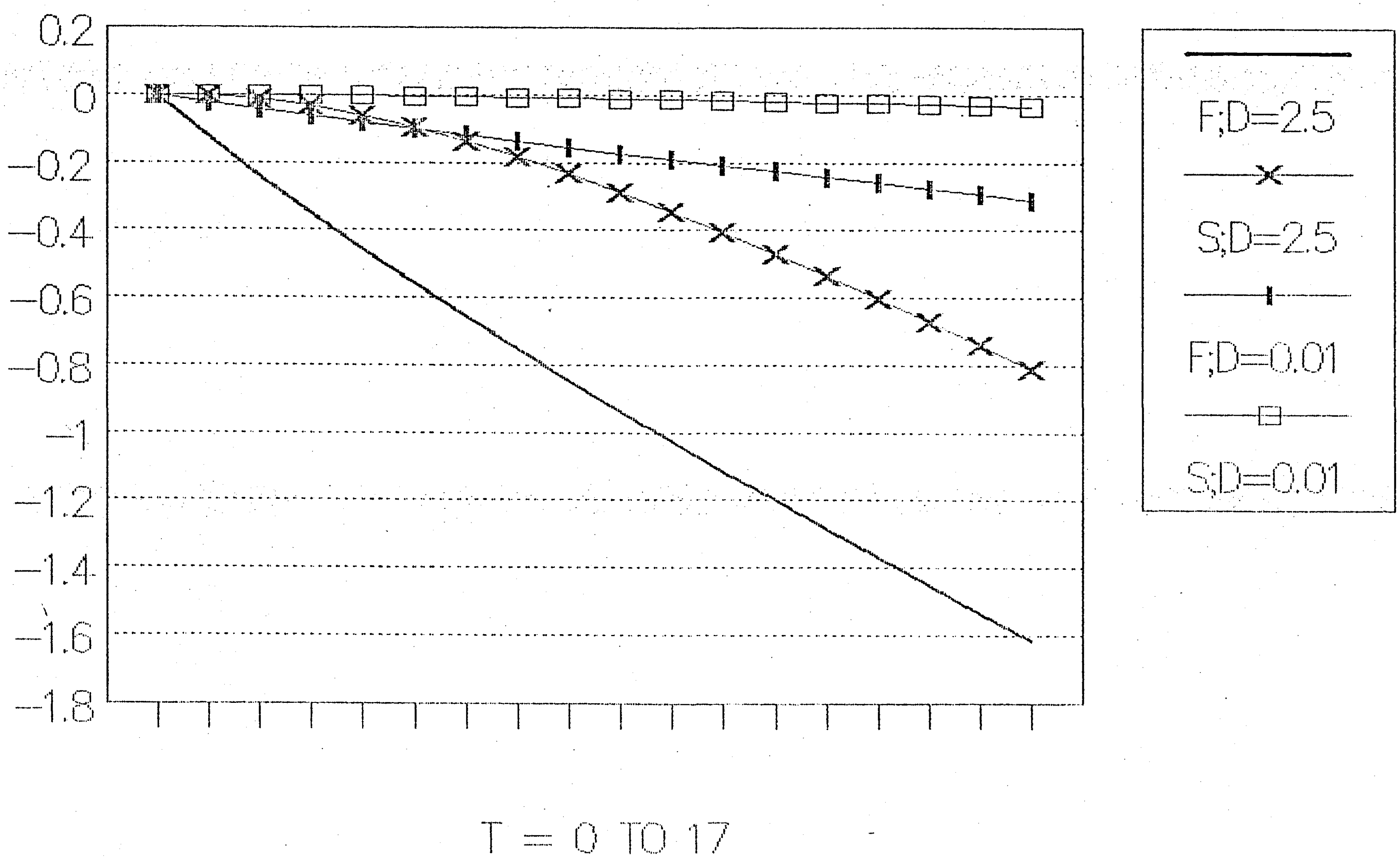
RESERVES

FIGURE 4.7.



RESERVES

FIGURE 4.8.



1. The Collapse Time and the Source of Shock

For each model and parameter set, the fixed regime collapses earliest when subject to the shock of fiscal expansion. This outcome can be primarily ascribed to the effect fiscal expansion has on the economy during the fixed regime and thereby on the state of the economy immediately post-collapse.

In the fixed regime the fiscal expansion is the only shock that has an adverse influence on all endogenous variables affecting the balance of payments, since it is the only shock that induces positive savings and accumulation by the private sector. A higher level of government expenditure is the only shock to produce positive effects on wealth and output, as well as rendering home goods less competitive. By contrast the export and wage shocks reduce wealth and output, which mitigates the deterioration of the balance of payments. The export shock has the further helpful effect of inducing a real depreciation (although the relative importance of this factor depends on δ, as considered below).

Since fiscal expansion is the only shock leading to accumulation in the fixed regime, the discrepancy between the inherited and current account clearing levels of wealth at the point of collapse is be greater, hence, via the acceleration hypothesis, depreciation at the time of collapse will be further above its steady state rate. Since a high rate of depreciation emerges immediately post-collapse, a greater quantity of reserves must be attacked to preserve portfolio balance at the instant of attack. Table 4.1. shows that a substantially greater reserve stock is attacked in the case of fiscal expansion for any given model.

Furthermore, this means that even if reserves are not being depleted so rapidly during the fixed regime, the collapse still occurs earlier in the case of the fiscal shock. Indeed, when $\delta = 0.01$, and wages are sticky, remaining reserves are lower, at any point in time, when the regime is hit by the export shock compared to fiscal expansion (as explained later). However, Table 4.1. shows that the fiscal shock still collapses the regime earlier, because the quantity of reserves bought out in the speculative attack is greater (compare R^* for the two shocks for the case of $\delta = 0.01$ and sticky wages in Table 4.1.).

2. The Influence of δ on the Collapse Time

The next point we consider about the results is how altering the value of δ changes the collapse times. The most dramatic effect is on the relative collapse times for the fiscal and export shocks. Table 4.1. reports that, in both sticky and flexible wage models, when $\delta = 2.5$ the fiscal shock induces collapse substantially earlier than the export shock; when $\delta = 0.01$, the collapse times are almost equal. Table 4.1. also shows that the lower value for δ delays collapse following the labour supply shock (again for either the sticky or flexible wage model).

In explaining these outcomes (and those for the influence of sticky or flexible wage wages for a maintained value of δ, as discussed in the next section), it is useful to cast the simulation results within our aggregate demand-aggregate supply framework for the fixed regime. This framework can then be linked to both trade and monetary flows expressions for the balance of payments (having demonstrated their equivalence within the present model earlier in the thesis). We first present the fiscal and export shocks within this framework, and then the labour supply shock.

As has been explained in chapters two and three, the fiscal and export shocks produce symmetrically opposite outcomes for the evolution of the state variable(s) wealth (and wages) and jointly endogenous variables price and output. The reason for the difference that emerges in the timing of attacks is because the size and composition of the two components of domestic wealth differs during the evolution of the fixed regime (although the time paths for overall wealth are precisely symmetrical). Thus here we examine how the different values for δ alter the evolution of the two components of domestic wealth: domestic credit and reserves.

Figure 4.9. illustrates the time paths for price and output during the fixed regime which were produced when the fiscal and export shocks were simulated in both sticky and flexible wage models and for both values of δ.(13) Thus in all the diagram covers eight different simulations. For the present our concern is with the influence of δ within a given (flexible or sticky wage) model.

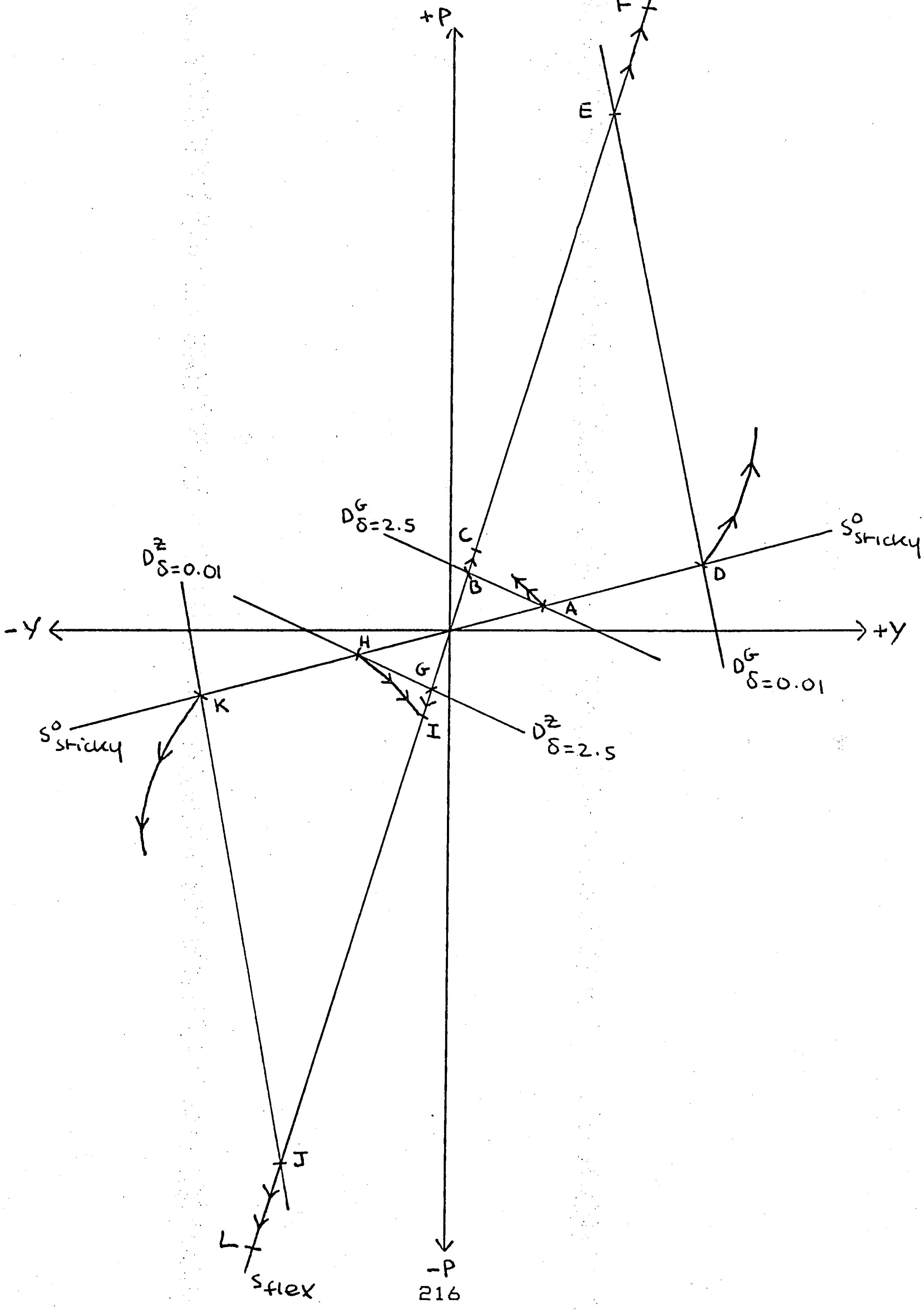
However, we shall refer back to figure 4.9. in the next section (the influence of wage specification for given δ), thus we provide an explanation all points on the diagram before proceeding further.

Consider the four results for the fiscal shock. The rise in government expenditure shifts the demand schedule up from the origin (the shift is greater, and the demand schedule steeper, when δ=0.01), establishing a short run equilibrium at the intersection with aggregate supply. Aggregate supply is steeper when wages are flexible. Points A,B,D and E show the short run outcomes for the four cases. Points A and B are the outcomes for δ = 2.5 (for sticky and flexible wage models respectively); points D and E for δ = 0.01 under sticky and flexible wages.

From these short run equilibria, the arrowed paths indicate the dynamic results derived from the simulations. In the flexible wage cases the dynamics derive from accumulation alone, which shifts the demand schedule further up over time, so that both price and income gradually rise along the supply schedule S_{flex} as the steady state is approached. Thus there is a movement from point B towards C for δ = 2.5; from E towards F for δ = 0.01.

The same long run equilibria are approached in the sticky wage case, since the wage must clear the labour market in the long run. However, during the dynamic adjustment, rising wage pressure gradually pushes the supply curve S^0_{sticky} up and to the left, providing a series of short run equilibria at intersections with the

Figure 4.9



+P
-P
+Y
-Y
S_{flex}
S_{flex}
S^{o}_{sticky}
S^{o}_{sticky}
$D^{G}_{\delta=2.5}$
$D^{G}_{\delta=0.01}$
$D^{Z}_{\delta=0.01}$
$D^{Z}_{\delta=2.5}$
A
B
C
D
E
F
G
H
I
J
K
L

shifting demand schedule. Price will be rising whilst output may be rising or falling.[14] Thus the sticky wage case dynamics are represented by the movements from point A towards C for $\delta = 2.5$, and from point D towards F for $\delta = 0.01$.

The four outcomes for the export shock are symmetric and opposite from the origin to those described above - a movement form points H and G towards long run equilibrium I (for $\delta = 2.5$, sticky and flexible wages respectively), and from points K and J towards long run equilibrium L ($\delta = 0.01$; sticky and flexible wages).[15]

We now use this framework to interpret the results of Table 4.1. that show changing the value of δ from $\delta = 2.5$ to $\delta = 0.01$ delays collapse for the fiscal shock and brings forward the collapse time for the export shock. For the present our maintained assumption is that wages are flexible (under sticky wages the following comments still hold, but the export shock inflicts additional damage, as explained below).

The most obvious influence of δ is that it measures the extent to which expenditure flows for the domestic and foreign good respond to induced relative price changes. The fiscal shock leads to a process of real appreciation (from points B towards C and E towards F in figure 4.9.) so that the greater the value of δ the greater the damage the loss of competitiveness inflicts on the external balance position and the rate of reserve loss (even though the real appreciation is greater when $\delta = 0.01$). By contrast, following the structural shift reduction in the demand for exports, there is a process of real depreciation (points G towards I and J towards L) which helps to re-stimulate exports (moving down and along the new demand schedule for exports). In the case $\delta = 2.5$ this gain in competitiveness provides relatively significant alleviation for the balance of payments position and helps mitigate the rate of reserve loss; whilst when $\delta = 0.01$ this beneficial effect is all but nullified.

The other chief influence of δ is its macroeconomic role in determining the size of the income response to the two shocks. When $\delta = 0.01$ the determination of output approximates a simple Keynsian multiplier process. Thus, in response to an exogenous increase (decrease) in the demand for home goods represented by the fiscal (export) shock, output rises (falls) to almost the full extent of the open economy multiplier (i.e.: the reciprocal of one minus the propensity to spend on domestic goods) since the rise (fall) in price causes negligible substitution away from (towards) home goods. At the end of chapter three we saw that when δ tends to zero, the rate of reserve loss in the steady state is determined by the propensity to import (from disposable income) for the fiscal shock, and the loss of tax revenue for the export shock. Thus, given the similar values for the tax rate and import propensity we have assumed, a similar rate of reserve loss follows the two shocks.

This point is best understood with reference to the "fundamental equation" for the monetary approach - considering the rate of reserve loss required to maintain flow monetary equilibrium for the two shocks. For the export shock, the output fall causes a substantial reduction in the flow demand for money and also in tax revenue. The significant loss of tax revenue induces a relatively high rate of credit expansion, and thus a relatively significant increase in one component of the flow supply of money. Hence, given the reduction in the flow demand for money, there must be a substantial fall in the other endogenous component of the money supply (i.e.: reserves) to remove the incipient excess flow supply. As noted above, reserve losses will indeed be substantial since the fall in the price of home goods yields only a minor recovery of exports from their new lower structural level when $\delta = 0.01$. Hence the rate of reserve loss following the export shock is much greater for $\delta = 0.01$ than for $\delta = 2.5$.

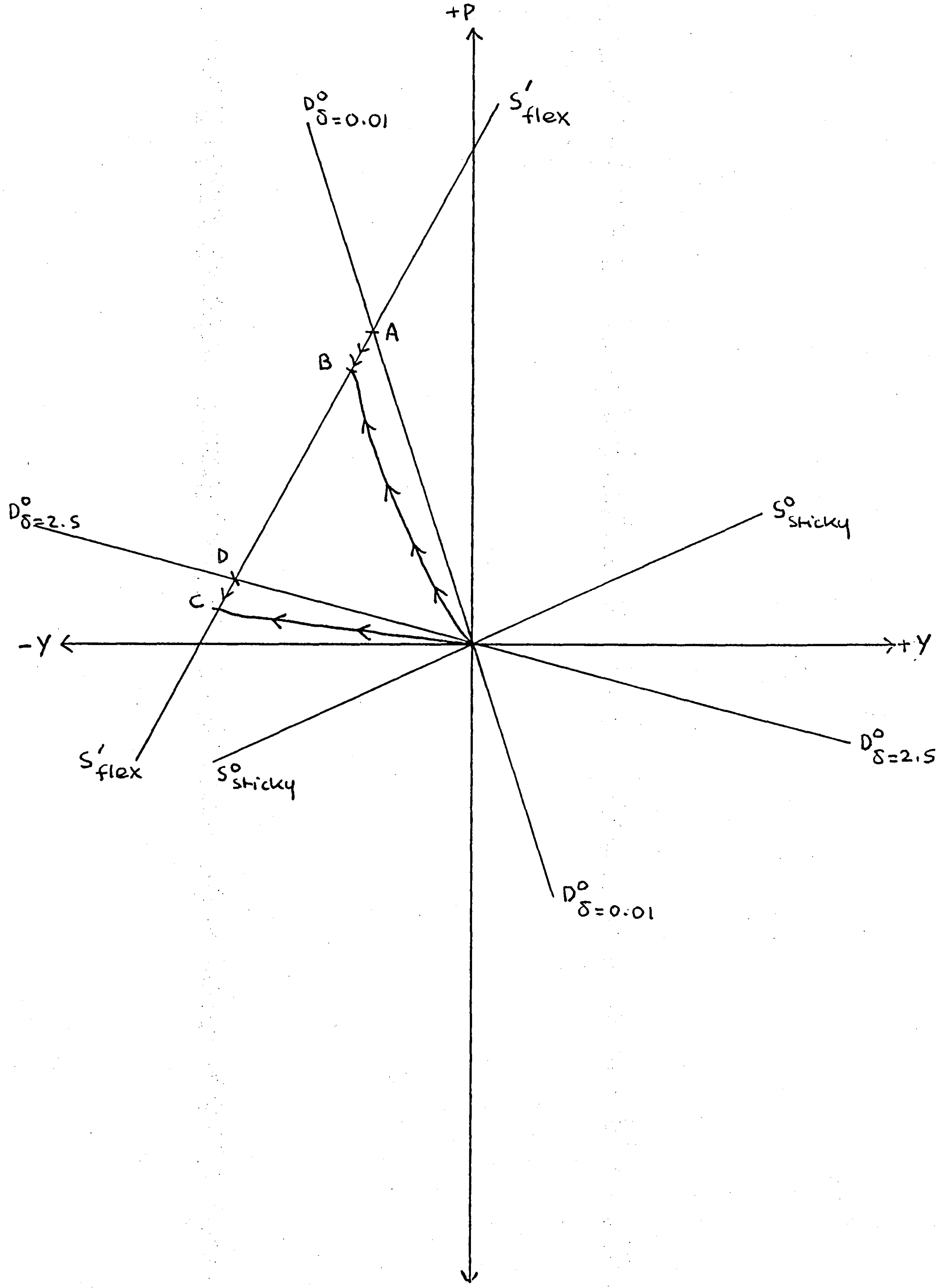
However, for the fiscal shock, when $\delta = 0.01$ the substantial rise in output brings substantial tax revenues and thus helps to reduce the extent of the incipient excess flow supply of money caused by higher government expenditures. Furthermore the flow demand for money also rises substantially, so that the rate of reserve loss required to preserve monetary equilibrium is relatively low, and the low elasticity of goods substitution helps ensure that the balance of payments does not significantly deteriorate because of the real appreciation. Thus the rate of reserve loss is lower than that encountered when $\delta = 2.5$.

We now turn to the effects of a shift reduction in the supply of labour. Table 4.1. shows that collapse is delayed when $\delta = 0.01$.

The effects of the shock are illustrated in figure 4.10: an impact (short run) effect only arises when wages are flexible, in which case the supply curve shifts up as shown. The outcomes for price and output will depend on the slope of aggregate demand: when $\delta = 0.01$, aggregate demand is steep, and the economy moves to point A. Aggregate demand is flatter when $\delta = 2.5$, so the rise in price is lower, and the fall in output greater (at point C). From the short run there is a process of decumulation: so the economy moves from point A towards B ($\delta = 0.01$), or from C towards D ($\delta = 2.5$).[16]

It is again fruitful to combine this Keynsian style analysis of price and output determination with the monetary flows approach to the balance of payments. The relatively large fall in output that occurs when $\delta = 2.5$ yields substantial loss of tax revenue and a relatively high rate of credit expansion, along with a relatively large fall in the flow demand for money. The incipient excess flow supply of money that results is eliminated by a relatively large balance of payments deficit, since the real appreciation produces a larger expenditure switch away from domestic goods (even though the extent of appreciation is less than when $\delta = 0.01$). Consequently the fixed regime collapses earlier when $\delta = 2.5$.

Figure 4.10


+P
$D^o_{\delta=0.01}$
S'_{flex}
A
B
$D^o_{\delta=2.5}$
S^o_{sticky}
D
C
-Y
+Y
S'_{flex}
S^o_{sticky}
$D^o_{\delta=2.5}$
$D^o_{\delta=0.01}$
-P

3. Flexible vs Sticky Wages and the Timing of Collapse

Finally we turn to the effects of flexible against sticky wage specifications on the timing of collapse. Table 4.1. shows that when wages are sticky the collapse of the fixed regime is delayed when subject to the fiscal or labour supply shocks, but that collapse occurs earlier in the case of the export shock.

These results can again be explained by turning to the aggregate demand-aggregate supply framework in figures 4.9 and 4.10. The following argument rests on some simple Keynsian open economy analysis, and holds true for either value of δ - the case of $\delta = 2.5$ is adopted below.

Consider figure 4.9. Following the fiscal shock, the economy moves along the trajectory from B towards C when wages are flexible, and from A towards C when wages are sticky.(17) Thus when wages are sticky domestic goods market equilibrium is established at a point further down a given demand schedule from the flexible wage equilibrium point - e.g.: contrast points A and B. This remains true throughout adjustment towards point C, so that output is higher, and price lower, during adjustment under sticky wages.(18)

From our Keynsian analysis of a given short run equilibrium in chapter two (figure 2.1.(a). refers), the only way an economy can sustain the higher levels of output involved in moving down and along its demand curve is by an improvement in external balance. For instance, moving to the right of point A to that level of output associated with point B implies incipient excess supply of domestic goods since the marginal propensity to spend on domestic goods is less than unity. This is eliminated by a fall in the relative price of home goods, which removes the incipient excess supply by switching expenditures towards home goods. Hence the balance of payments deficit is smaller, and reserves less rapidly depleted, when wages are sticky.

From figure 4.10 it is readily confirmed that the same argument holds for the labour supply shock. When wages are flexible, adjustment is from C towards D; under sticky wages the economy evolves from the origin towards point D. The sticky wage equilibria are always south west along a given demand curve from the flexible wage equilibria.

However, the converse applies for the shock of a shift reduction in demand for exports. When wages are sticky, the economy lies at a point on its demand curve that is north east of the flexible wage equilibrium - e.g.: point H lies north east of G in figure 4.9. This relationship holds true throughout adjustment towards point I. Thus it is under flexible wages that a relatively improved external balance position (a lesser deficit) is required to sustain higher levels of output; conversely the balance of payments deficit is greater, and reserves more rapidly depleted, when wages are sticky. Hence the collapse occurs earlier in the sticky wage model.

NOTES:

(1) The three structural shocks analysed in chapters two and three are examined. These are a fiscal expansion (on home goods), a shift reduction in the demand for exports, and a shift reduction in the supply of labour.

(2) With the discrete time formulation, a problem of synchronisation arises between the treatment of stock levels and the levels of flows and prices in time periods. Here stocks are defined as being at beginning of period levels. Thus, for instance, f_{t+1} is the stock of foreign currency held at the start of period t+1; whilst $E_t e_{t+1}$ denotes the expectation formed in time t of the level of the exchange rate during period t+1.

(3) As in chapter three real wealth is defined $a_t = m_t - e_t + f_t$, where $m_t = r_t + d_t$.

(4) In (4.3) the first three terms define the trade account; Df_{t+1} is the capital account surplus.

(5) As in chapters two and three, the supply side is derived from the labour market and single factor production function:

$$y^s_t = an_t$$
$$n^d_t = -b(w_t - p_t)$$
$$n^s_t = c(w_t - (1-\Gamma)p_t - \Gamma e_t) - w^t_t$$

With sticky wages employment is demand determined in the short run and wages sluggishly adjust towards their market clearing level. As seen in chapter two, this defines the parameter used in supply curve (4.5b) and $\alpha = ab$. The parameters in the wage adjustment equation (4.6) are $\mu_1 = (b+(1-\Gamma)c)/(b+c)$ and $\mu_2 = 1/(b+c)$.

When wages are flexible the labour market clears continuously as in chapter three. This defines the parameters in the supply curve

(4.5a) as $s_1 = abc\Gamma/(b+c)$ and $s_2 = ab/(b+c)$.

These parameter combinations provide a relation between the supply side parameters of the flexible and sticky wage models, which is given by $s_1 = \alpha(1-\mu_1)$ and $s_2 = \alpha\mu_2$. These relationships are incorporated in the choice of parameters, so that the two models have the same long run equilibrium.

(6) For confirmation the model was also simulated in the form specified in chapter three (with wealth and foreign currency as state variables. The same results obtained.

(7) The sticky wage case under flexible exchange rates, requiring a third order model, has not been analytically described. However, as has been shown in the fixed exchange rate case, the steady-state results are not affected by the assumption of sticky wages, since wages must be at their market clearing level in the steady state. This property allowed the simulation results for this model to be cross checked with the analytical model.

(8) As all variables are initially normalised to zero, R^{lim} is a negative number, and $R^{lim} = -10$ was chosen.

(9) This "benchmark" was chosen because the entire process from initial equilibrium to the final post-collapse steady state occurs most rapidly in this case.

(10) The possibility does not arise in the case of a shift reduction in demand for exports since the real exchange rate is depreciating in the fixed regime.

For the case of a shift reduction in the supply of labour the possibility is excluded because the real exchange rate attains its steady state value before the fixed regime collapses, and this value must be appreciated with respect to the steady state value post-collapse.

(11) The choices made were $\delta = 2.5$ and $\delta = 0.01$ (so in the latter case the Marshall-Lerner condition is only just met). Some tests were run on the sensitivity of the results to changes in the values of other parameters, but these parameters were not found to be as critical as δ.

(12) The key to figures 4.6. to 4.8. is coded as follows: F denotes flexible wages, S denotes sticky wages, D is δ. Thus, for instance, the time path for reserves shown to correspond to F; D = 2.5. refers to the time path from the flexible wage model, run on the parameter value $\delta = 2.5$.

The graphs are constrained by the number of points that may be plotted. Thus for those cases in which the fixed regime survives for a considerable length of time only the early part of the reserve time path is shown. However, the trend is clear in all cases.

(13) Figure 4.9 is not drawn to scale (see the actual values in note (15) below). It is intended for expository purposes.

(14) Output is falling when supply curve shifts, from wage dynamics, outweigh demand curve shifts, from wealth dynamics. When $\delta = 2.5$ output is falling between the short and long run. When $\delta = 0.01$ output is first rising, and then falling to its long run level.

Further complications could arise from cycles. In fact the simulations produced a process in which wages are rising continuously, whilst wealth is first rising, and then falling to its steady state. The period in which wealth is falling and wages are rising could produce a falling price level, but this was not the case in the simulations. (For the fiscal shock collapse occurs prior to this period of adjustment in any case).

When the fixed regime is subject to the export shock symmetrical conclusions hold.

(15) The actual price-output combinations, denoted (P, Y) for the various points in figure 4.9. are as follows:

δ = 2.5:

A: (0.3458, 0.2766), B: (0.3923, 0.0392), C:(0.3937, 0.0394) with H, G, I symmetrically opposite.

δ = 0.01:

D: (2.4876, 1.9901), E:(16.9491, 1.6491), F:(20.0, 2.0) with K, J, L symmetrically opposite.

The attacks occur at the following points (the corresponding times are given in Table 4.1). For the fiscal shock:

δ = 2.5:

Sticky wages: (0.3726, 0.1663); Flexible wages: (0.3933, 0.0393)

δ = 0.01:

Sticky wages: (6.1627, 2.2904); Flexible wages: (19.479, 1.9479)

For the export shock:

δ = 2.5: Attack occurs at point I: (-0.3937, -0.0394) for flexible and sticky wages.

δ = 0.01:

Sticky wages: (-6.584, -2.2944); Flexible wages: (-19.7989, -1.979)

(16) Figure 4.10 is not to scale. The actual (P, Y) values corresponding to the points are:

δ = 2.5:

C: (0.0769, -0.3923); D: (0.063, -0.3937)

δ = 0.01:

A: (3.322, -0.0678); B: (3.2, -0.08)

The collapses occur when the steady state values have been attained - at point D for δ = 2.5 (under flexible or sticky wages); at point B for δ = 0.01 (under flexible or sticky wages).

The simulations show no cyclical adjustment in the sticky wage model for the labour supply shock (wages are always rising, and wealth is always falling).

(17) At all points in time the external balance locus (which is not drawn) lies below and to the left of the successive aggregate demand-aggregate supply equilibria, so there is always a balance of payments deficit.

(18) This point is established since wages are rising throughout the adjustment process.

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