STUDIES ON MACROECONOMIC ADJUSTMENT IN OPEN-ECONOMIES

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Abstract

This thesis attempts to focus on several "unresolved" issues that exist in the field of open-economy macroeconomics.

Chapter 2 examines the implications of 'currency substitution' (CS) for the behaviour of a small open economy, subsequent to an unanticipated contraction in the domestic money supply. Chapter 3 concentrates on the role of CS, capital mobility and price stickiness in the international transmission of disturbances. Chapter 4 explores how the degree of openness of national economies might influence the relationships among exchange rates, price levels, interest rates and international balances of payment. Chapter 5 examines the relative effectiveness of various simple policy rules for economic stabilization, under alternative assumptions about the degree of openness of individual economies. In Chapter 6 we study the behaviour of a semi-small open economy subsequent to (unanticipated) increases in foreign interest rates, using a model in which some of the key characteristics of the major debtor countries are incorporated. In Chapter 7 we analyse the effects of exogenous financial disturbances on the economy of a debtor country, under alternative assumptions about the nature of its external debt.

Chapter 1 attempts to provide a "background" for the analysis in the remainder of the thesis, by discussing some of the developments in the theoretical literature and in the world economy that have motivated our study.

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CHAPTER 1

An Introduction

I. *Introduction.*

Like much of the recent theoretical work on open-economy macroeconomics, our analysis in the thesis has been motivated by the financial changes and macroeconomic developments that have occured in the world economy during the period 1973-1985. These changes and developments include the following: (*i*) the Bretton-Woods International Monetary System has been replaced by a regime of market-determined exchange rates; (*ii*) capital mobility among the major industrial countries has increased; (*iii*) new instruments have been introduced in the international financial markets so that a larger variety of assets has become available to private investors; (*iv*) the degree of openness of all economies has risen due to the growth of international trade; (*v*) the Commercial Banks have become the principal source of finance for the debtor-developing countries (DCs), and, as a result, the proportion of the DCs' debts at market-linked interest rates has increased dramatically; (*v*) since 1980 there have been large changes in the real exchange rates between the dollar and the other major currencies, which, in many cases, have had undesirable effects on real activity levels and on inflation rates; and (*vi*) during 1980-85, the large rise in international interest-rates has caused a substantial deterioration in the macroeconomic performance of the DCs.

This Chapter attempts to provide a "background" for the analysis in the remainder of the thesis by discussing some of the developments in the theoretical literature and in the world economy that have motivated our study.

The structure of this Chapter is as follows:

Section IIa describes the evolution from 1973 to 1982 of the main-stream theoretical views on, and models of, how exchange rates behave and interact with other macroeconomic variables. Section IIb examines the challenges that the developments in the empirical exchange-rate literature and in the financial markets during the 1983-1985 period have posed for the theoretical open-economy models of the late 1970s and early 1980s. The subject and the purpose of Chapters 2 to 5 are then discussed, in Section IIc.

Sections IIIa and IIIb focus on the developments in the international lending markets since 1973, and their implications for the debtor countries. The subject and the aim of Chapters 6 and 7 are discussed in Section IIIc.

II. *Exchange Rates and the Open-Economy*

IIa. *1973-1982: The Evolution of the Main-Stream Theoretical Views on, and Models of, How Exchange Rates Behave and Interact With Other Macroeconomic Variables*

When the Bretton-Woods exchange rate system was adandoned in 1973, the advocates of flexible exchange rates made four principle claims: real exchange rates would be stabilized; changes in nominal exchange rates would be small and predictable; individual economies would be insulated against macroeconomic shocks from abroad; deficits or surpluses in current accounts would mainly reflect differences in countries' real economic performance and development; and each country would be able to pursue its chosen monetary policy, independently from the rest of the world [1].

The *flexible-price monetary model* (FPM) [2], which was developed in 1973-1976, was a reflection of these views. The model assumed that interest-bearing assets denominated in different currencies were viewed by international investors as perfect substitutes in portfolios; that monetary assets denominated in a country's currency were held only by domestic residents; that the goods of different countries were perfect substitutes and goods prices were fully flexible; and that expectations were formed rationally. The first and the fourth assumption implied uncovered interest-rate parity (UIP) - i.e. that the expected rates of return on "domestic" and "foreign" non-monetary assets would be equalized. The second assumption meant that the demand for domestic money could be simply expressed as a function of the domestic price level, interest rate and output. The third assumption implied continuous purchasing power parity (PPP), while the implication of the rational expectations assumption, of UIP, and of PPP was that real interest rates would be the same for residents of different countries. Thus the 'small open-economy' FPM model had a conventional equation for domestic monetary equilibrium, an equation for uncovered interest parity, and an equation for purchasing power parity. The model, therefore, made the following propositions: (1) Foreign (unanticipated) disturbances would immediately result in a 'jump' in the domestic price level and in the nominal exchange rate to their new PPP values, thus having no effect on the real exchange rate or on real domestic output. (2) A higher level of the domestic interest-rate would always reflect higher domestic inflation and would be associated with more rapid depreciation of the home currency. And (3) a rise in the rate of growth of the domestic money supply would instantaneously lead to a proportional rise in the rate of inflation and depreciation.

The behaviour of exchange rates during the period 1974-76, however, appeared to be inconsistent with the FPM model. First, most of the nominal exchange rate fluctuations were reflected in variations of real exchange rates [3]. Second, one could observe situations in which a rising interest rate was associated with a strong currency. And, third, there was no close correspondence between contemporaneous changes in monetary aggregates and exchange-rate movements.

These observations led to the development of *the dynamic sticky-price monetary model* (DSPM) in 1976-1980 [4]. The DSPM model retained from the FPM model the assumption of perfect substitutability of nonmoney assets, rational expectations and instantaneous adjustment in the money market. The assumption that domestic residents held no foreign monetary-assets was also maintained. However the model allowed for the possibility that goods prices might adjust slowly to unanticipated disturbances, due to fixed nominal contracts in factor and product markets. Thus, the PPP equation of the small open-economy FPM model was replaced by: a Phillips-curve, which determined the rate of change of the domestic price level; and, an IS equation, which incorporated the relative price of domestic and foreign goods and hence the real exchange rate. The Phillips curve required an unchanged output in the long-run, so that, when the disturbances were purely monetary, the IS equation implied long-run purchasing power parity. The model, however, suggested (1) that real exchange rates would deviate from PPP for as long as it would take prices to adjust fully to the new monetary conditions. It also predicted (2) that, because of price stickiness, unanticipated monetary disturbances could on impact cause a greater than proportional change in the rate of depreciation; and that (3) an unanticipated monetary expansion could initially lower the nominal interest-rate, in which case the requirement of continuous money market equilibrium and of UIP would imply a rising interest rate and an appreciation of the home currency over time. Thus, the SPM model provided an explanation for some of the 'stylized facts' of 1974-1976.

After 1977, however, two developments challenged the DSPM model. First, as early as 1976, evidence emerged that the UIP condition might not hold or that exchange-rate expectations were not formed rationally: i.e. the actual variations of exchange rates around those implied by the hypothesis of uncovered interest parity appeared to be large. Nevertheless, most of the formal tests of UIP in 1976-77 yielded inconclusive results. Also, the majority of the studies that rejected the hypothesis used weekly data: this allowed for the possibility that the deviations from UIP might be a short-run phenomenon. But after 1977, statistical tests of uncovered interest parity were done with monthly and quarterly data as well as with weekly data; and the test results provided no convincing evidence in support of UIP [5]. Second, the theory appeared to have no explanation for the depreciation of the dollar that occured in 1977-1979. During that period the dollar depreciated against all currencies by almost 15 percent in real terms. This large real depreciation was not consistent with the DSPM model: because of the UIP assumption, the model had predicted that real exchange rates would change mainly in response to movements in real interest-rate differentials. However, the magnitude of the appreciation of the dollar in 1977-79 was considerably larger than the differentials between real interest-rates in the U.S and the other countries over the same period [6]. Thus, some market observers expressed the view that the drop of the dollar was partly due to a fall in OPEC investors' demand for dollar-denominated assets, and, more generally, to international diversification of asset portfolios. Others suggested that the U.S. current account deficit was the principal cause of the dollar's weakness. But, none of these two explanations for the decline of the dollar was a theoretical possibility in the context of the DSPM model: in that model, CA deficits and changes in the portfolio preferences of investors among assets denominated in different currencies had no effect on exchange rates.

The development of t*he static and dynamic portfolio-balance model* (PB) [7] in 1977-1983 was partly a theoretical response to the events of 1976-79. In most of the theoretical formulations of the PB model, the rest of the world was assumed to be large so that foreign variables were taken as exogenously given. The theory also assumed that home residents did not demand monetary assets denominated in foreign currencies, and money demand was usually expressed as a function of the domestic interest rate and of nominal income. Expectations in this model were static, regressive or rational. The various formulations of the model also differed in terms of their assumptions about the goods market: in some formulations of the PB model, output was fixed and prices were fully flexible; in other formulations, prices were fixed and output was determined endogenously (through an IS equation). However the central feature of the theory was the assumption that non-monetary assets denominated in different currencies might not be perfect substitutes in portfolios, because private agents might be risk-averse and because exchange risk might not be perfectly diversifiable. Therefore, instead of the UIP condition, the small open-economy PB model had: a demand equation for interest-bearing foreign assets (which included asset returns, wealth and exogenous factors affecting asset preferences, as arguments); and the condition that, at any point in time, the domestic demand for foreign assets must equal the existing supply of such assets. The dynamic version of the PB model also had a current account (CA) equation, which determined the rate of change in the domestic holdings of foreign assets. The role of government deficits as a determinant of the supply of domestic (outside) assets was often ignored. But the dynamic version of the PB model provided a mechanism for CA deficits or surpluses to influence the exchange rate: in that model, CA imbalances, by changing over time the domestic holdings of foreign assets, would affect portfolio balance and hence the dynamic behaviour of the exchange rate [8]. Moreover, the theory suggested that exogenous changes in the portfolio preferences of private investors among assets denominated in different currencies could not be ruled out as an important influence on exchange rates.

IIb. *Open-Economy Macroeconomics: The Challenges of 1983-1985*

After 1983, econometric evidence unfavourable to all the open-economy models of the 1970s and early 1980s began to emerge. Firstly, statistical tests in 1983-85 indicated that one could not predict a relatively large portion of variations in exchange-rates by using reduced-form exchange rate equations derived from the FPM, DSPM and PB models. Several studies, for example, found that 20 to 30 percent of the forecast error variance of the changes in exchange rates could not be attributed to unanticipated changes in the other variables included in these models [9]. Some studies also found that, in post-sample forecasting tests, none of the existing 'structural' exchange rate models could outperform a naive random-walk (RW) exchange rate model [10]. Secondly, the 'structural' models appeared to explain little of the observed variances of exchange rates during the

1980s. Some variants of the PB model proved more successful than the SPM model in terms of explaining exchange-rate fluctuations in the 1980s, but their explanatory power was often not substantially greater than that of a RW model [11]. Thirdly, the statistical significance of the predicted association between changes in exchange rates and changes in CAs, interest-rates, price levels etc. was not found to be the same for all countries and currencies [12]. For example, several studies identified an important influence of CA developments on the dollar-yen rate; but they found no evidence of a strong connection between CA changes and variations in the dollar-mark rate. It was also found that interest-rate fluctuations had little effect on the dollar-pound rate, but that the movements in the dollar-yen rate were closely related to changes in interest rates.

These developments in the empirical literature indicated that the theoretical open-economy models of the 1970s and early 1980s had to be modified to incorporate other potential determinants of variations in exchange rates. Moreover, it became apparent that the existing models could offer no general 'theory' of the relationships between exchange rates and other macroeconomic variables, and, hence, that further theoretical research was required into the factors that might influence them.

Two additional events in 1983-85 also suggested a need for a modification-extention of the theoretical open-economy models of the early 1980s. First, it was pointed out that the residents of most countries held "monetary" as well as "non-monetary" assets denominated in foreign currency. Moreover, in 1985, market commentary began to attribute both the volatility of exchange rates and the instability of the world economy to "currency substitution" (CS). But the likely implications of CS could not be formally considered within the context of the existing models (due to their assumption that domestic monetary assets were held only by the domestic residents). Second, the macroeconomic developments in the major industrial countries during the 1982-85 period made clear that policies pursued abroad could significantly influence economic conditions at home through their impact on the real interest-rate and exchange rate. This indicated a need to formulate theoretical models that could explicitly allow for the interdependence of macroeconomic developments as well as for the 'multicountry' general equilibrium nature of exchange rate determination.

In addition to the above mentioned developments, the period 1983-85 was characterized by considerable volatility in real exchange rates [13]. Real exchange-rates were relatively unstable even in the late 1970s. But since the early 1980s, there have been wide fluctuations in the real exchange rates of almost all of the major currencies. This, together with the relatively poor performance of national economies, led many to modify whatever 'optimistic' views about the functioning of floating-rates they might have held in the late 1970s. Thus, the question of how exchange rates should be managed, rather than that of whether they ought to be managed, became the main policy issue of the 1980s [14].

IIc. *Chapters 2-5*

Given the developments of the early 1980s, attempts have recently been made in the theoretical literature: (i) to formulate more general models of small open economies with a market-determined exchange rate; (ii) to investigate the likely implications of currency substitution (CS) [15]; (iii) to study the effects of policy-induced or exogenous shocks on individual economies within the context of dynamic two-country models [16]; (iv) to examine how the 'stuctural parameters' and characteristics of national economies might influence the relationships among exchange rates, CAs, price levels and interest rates [17]; and (v) to evaluate alternative policy rules for economic stabilization [18]. Chapters 2, 3, 4 and 5 in this thesis attempt to extent that literature.

In the second Chapter we focus on the behaviour of a small open economy under 'currency substitution' (CS), subsequent to an unanticipated contraction in the domestic money supply. We use a dynamic macro model which: permits short-run deviations from purchasing power parity, allows for changes in the stock of foreign assets over time (through CA imbalances) to affect wealth and spending, and assumes that domestic and foreign interest-bearing assets may be regarded by agents as imperfect substitutes. Our analysis aims: (i) to extend the existing CS literature by considering the possibility of CS within a more general framework than that adopted by the earlier studies; (ii) to examine whether CS has any impact on any of the results already established by the recent literature on open-economy macroeconomics which ignores CS; and (iii) to explore whether CS can provide any new insights into the behaviour of exchange rates.

In third Chapter, we concentrate on the role of CS in the international transmission of disturbances under flexible exchange rates. Most of the existing studies on this issue abstract from the specification of complete financial equilibrium, by assuming that domestic and foreign monetary assets are the only assets available to private investors. Thus, as the possibility of interest-bearing financial assets is ruled out, it is not clear which of their findings reflect the consequences of currency substitution and which of them arise from substitution between assets in general. The purpose of the third chapter is to analyse and clarify the role of CS, bond substitution and price stickiness in the international transmission of disturbances. In Section II of Chapter 3 we modify the Buiter-Miller model of a small open economy to include the possibility of CS, and, within that model, we study the effects of (unanticipated) changes in foreign interest rates and in foreign output. In Section III we develop an explicit two-country model with CS: we use this model to examine the impact of unexpected changes in the level and in the rate of growth of the foreign money supply on the real exchange rate and on domestic output.

In the fourth Chapter we focus on the implications of the degree of openness of an economy for: the behaviour of the exchange rate subsequent to unanticipated disturbances; and, the relationships among relative prices, the current account and exchange rates. We present and analyse a dynamic two-country model, which is based on broadly similar assumptions to those that most of the existing papers make, but which explicitly incorporates all the factors that determine "openness". Our analysis attempts: firstly, to illustrate the implications of alternative assumptions about the degree of openness of an economy for the behaviour of open-economy models that are widely used in the literature; and, secondly, to explore in what way the latter may influence the dynamic interactions between the exchange rate and other macroeconomic variables.

The purpose of the fifth Chapter is to investigate whether the degree of openness of national economies has any impact on the relative performance of alternative policy rules for economic stabilization. Our basic model is similar to the one presented in Chapter 4. Section III of the fifth chapter assumes that the shocks to the system are permanent disturbances, and focuses on its short-run and dynamic behaviour, under alternative exchange rate rules. In Section IV we consider a variety of simple policy rules, and we study the asymptotic covariance properties of a stochastic version of the model on the assumption that the shocks to the system are white-noise random disturbances.

III. *Lending Markets and the Debtor Countries*

IIIa. *1970-1980:Capital Flows and International Lending to the Debtor Countries*

The ten years 1970-1980 saw a big increase in foreign finance going to debtor-developing countries (DCs). Disbursements of private and official credits to DCs totalled $12 billion in 1969, and they were only 2 percent of their GNP. By 1980, however, lending to developing countries was $95 billion and amounted to 4.5 percent of their GNP. Although all types of lending to DCs grew over that period, the main reason for the large increase in foreign finance was the surge in lending by commercial banks. Commercial bank claims on the more advanced DCs increased at an (average) annual rate of 31 percent during 1970-1981. Also, the share of bank lending in the total flows to all DCs rose from 15 percent in 1970 to 27 percent in 1981 [19].

In these ten years, the developing countries made substantial economic progress. Their GDP growth averaged 6 percent a year in 1970-1980; their income per head increased at an annual rate of 3 percent over the period

1973-1980; the life expectancy of their people rose from an average of forty-eight years in 1968 to fifty-seven years in 1980, while infant mortality was halved. This progress reflected largerly the efforts of DCs themselves. But the large increase in the lending to these countries during the 1970s did play a significant part.

During the 1970s, however, the terms of lending to DCs and the structure of their debt changed dramatically. First, the bulk of the new lending was in the form of loans denominated in U.S dollars. As a result, the share of dollar-denominated debt in their total debt rose from 50 percent in 1971 to 75 percent in 1981. Second, the loans from the commercial banks (the fastest-growing component of lending) carried relatively short maturities. Thus, the average maturity of their debts fell from 20 years in 1972 to 13 years in 1982. Third, much of the new lending was in the form of syndicated loans at a variable interest-rate. This interest rate was a short-term rate - typically, the London Interbank Offered Rate or LIBOR - plus a 'country spread' (which often reflected the banks' perception of the creditworthiness of individual countries). Lending to developing countries in that form increased from $4 billion in 1972 to almost $50 billion in 1979. Hence, the proportion of their debts at short-term floating rates rose dramatically. For example, the floating-rate debt of the upper-middle income DCs (which obtained the bulk of the commercial capital) increased from 19 percent in 1973 to 51 percent in 1981. Also, the floating-rate debt of all DCs rose from 4 percent of their total debt in 1971 to 19 percent in 1981[19].

IIIb. *Interest-Rate Developments in 1980-1985 and the DCs*

As a result of the changes in the terms and conditions of lending during the 1970s, the developing countries became relatively more vulnerable to international financial fluctuations and to disturbances from abroad.

This became apparent in the early 1980s, when U.S short-term interest rates rose sharply [20]. Due to the increase in short-term U.S. interest rates, LIBOR rose from 6 percent in 1976 to 16 percent in 1981 and from 9 percent in 1983 to 12 percent in 1984. In the period 1979-1984, bank-lending spreads also increased considerably. For example, the spread between LIBOR and the U.S. Treasury-bill rate rose from an average of 3 percentage points in 1970-75 to an average of 9 percentage points in 1980-85 [21]. Moreover, the spread over LIBOR, which had averaged .9 percentage points in 1975-79, increased to an average of 2 and 1/4 percentage points in 1980-84.

These interest-rate developments had significant implications for the upper-middle-income and middle-income DCs (which were the largest borrowers and which had accumulated floating-rate debts during the 1970s). First, because of the rise in LIBOR, the interest charges on their existing debts increased substantially. Second, because of the increase in bank lending spreads, the unit cost of servicing their rescheduled and new debts rose over and above the rise in U.S. short-term interest rates. Third, in general, the increase in lending rates raised the interest costs of short term bank credit, which many DCS used to finance imports of primary foreign inputs. All of these interest-rate changes led to a large fall in the level of real economic activity in DCs. Moreover, despite the large drop in economic activity, inflation in many DCs did not significanly drop, and, in some cases, it actually increased [22].

In addition to the adverse interest-rate developments of the early 1980s, the recession in the OECD countries in 1981-82 reduced the growth of the DCs' export volumes, while the fall in commodity prices during 1982-84 led to a decline in their (total) export earnings. As a result, more than fourty DCs experienced debt-servicing difficulties in 1980-1985 [23], and two of them (Mexico and Peru) declared their inability to service their debts.

Since 1986, optimism as to the prospects of the debtor countries has increased for two reasons. First, the external environment facing the DCs has improved: the rise in U.S. interest rates has been partially reversed, lending rates have declined relative to their levels in 1982-85, and OECD economic growth has been restored. Second, in all DCs the rate of debt accumulation has been reduced. However, in many DCs, the debt-GDP and debt-export ratios continue to be high. For example, in Latin America, external debt as a percentage of GDP is about 60 percent and the debt-export ratio is 20 percent higher than it was in 1970-75. Since interest payments are proportional to outstanding debts, and since the severity of debt-burdens depends on debt-export ratios, it is clear that a renewed runup of short-term U.S. interest rates or renewed recession in OECD (and hence lower DC export growth) can have large adverse consequences for many major debtor countries.

Given that the future evolution of U.S. interest rates, of bank lending rates, of the supply of bank loans and of world demand is in general unknown, recent discussions on the DCs' debt problem have concentrated on one principal issue: the issue is whether new forms of lending to these countries can be found to reduce the adverse impact on their economies of any new external shocks. Thus, in the last few years, a large number of proposals for changing the nature and terms of international lending to developing countries have been made[24]. In most of these proposals, there are strong suggestions for longer-term finance to DCs, for an increased role of nonbank private institutions in the lending process, and for a greater 'securitization' of the lending.

IIIc. *Chapters 6 and 7*

The developments in the lending markets during the early 1980s, the macroeconomic developments in the DCs, and the recent proposals for changing the nature of lending to these countries have motivated our analysis in Chapters 6 and 7.

In the sixth Chapter, we focus on the behaviour of an open less-developed (LD) economy, in which net claims on foreigners are negative, subsequent to an unanticipated increase in foreign interest rates. Our model builds on: (i) recent dynamic macro-models of open economies; (ii) models which concentrate on a closed economy, but which suggest that certain markets in the developing countries differ in their characteristics from those that macroeconomic models usually assume; and (iii) recent models of foreign lending which incorporate the possibility of "debt-default", but which abstract from monetary or macroeconomic considerations. The purpose of the sixth chapter is therefore twofold. First, it aims to extend the existing theoretical literature on the macroeconomics of open-economies by exploring the channels of external financial influences on an open LD-economy and the way in which such influences might affect its behaviour. Second, it aims to complement the literature that focuses on the developments in the lending markets during the early 1980s, and to contribute towards an explanation of some of those developments, by considering the effects of interest rates changes on a DC within an analytical framework.

In the seventh Chapter, we attempt to formally investigate the macroeconomic implications for the borrowing countries of the above mentioned lending proposals. The chapter examines the effects of changes in foreign interest rates on the economy of a debtor country under two assumptions about the nature of its external debt: "variable-priced" debt (VPD) - i.e. debt in the form of issues of long-term marketable securities; and, "fixed-priced" debt (FPD) - i.e. debt in the form of floating-rate loans. In the literature, there exists no study analysing formally the likely implications of VPD for the macroeconomic behaviour of the DCs subsequent to external shocks. In evaluating any alternative lending options, however, one must explicitly consider how the debtor countries' economies might be affected by any change in the nature of the instrument through which international lending takes place. This issue is considered in the seventh chapter.

Notes.

1. The classic academic case for flexible exchange rates during the late 1960s was made by Johnson, in Johnson (1969).

2. Examples of flexible-price monetary models include Frenkel (1976), Mussa (1976) and Bilson (1978).

3. The fact that nominal exchange rates have not conformed well to the PPP theory over the floating rate period is documented for a number of bilateral rates in Frenkel (1981). See also Isard (1987) for a recent survey.

4. The dynamic sticky-price model was developed by Dornbusch (1976,1980), who extended earlier work by Mundell (1968) and Fleming (1962). Other important works in the sticky-price tradition include: Niehans (1977); Wilson (1979); Branson (1979); Frankel (1979,1983); Buiter (1978,1979, 1980); Driskill (1981a,1981b); Buiter and Miller (1981,1982,1983, 1985); Mussa (1982); Obstfeld (1982); Frenkel and Rodriguez (1982); Branson and Buiter (1983); and Eaton and Turnovsky (1983).

5. See e.g. Frankel (1982), Cumby and Obstfeld (1984) and Levich (1986). For evidence on the "covered" interest-rate arbitrage condition, see Frenkel and Levich (1975) and Clinton (1986).

6. See, for example, Shafer and Loopesko (1983a) and Obstfeld (1985) for a discussion of this issue.

7. Examples of portfolio-balance models include: Branson (1977,1983b); Branson, Halttunen and Masson (1977,1979); Kouri (1980); Henderson (1981); Dooley and Isard (1983); Ranuzzi (1983); Branson and Henderson (1985); Lewis (1988). For a review of empirical studies of portfolio-balance models, see Rogoff (1984).

8. Important contributions to the literature on the dynamic interactions between the exchange rate and the current account are the papers by Kouri (1976) and Dornbusch and Fischer (1980). Dynamic macro-models

that incorporate the current account are also analysed in: Penanti (1983); Mussa (1984); Obstfeld and Stockman (1985); Driskill and McCafferty (1985); Pikoulakis (1985); and Kawai (1985). Other studies that stress the importance of current account "news" for the behaviour of exchange rates include Dornbusch (1980) and Hooper and Morton (1982). See also Blackhurst (1983) for a survey.

9. See e.g. Shafer and Loopesko (1983).

10. See, for example, Meese and Rogoff (1983) and Backus (1984). More recently, Schinasi and Swany (1986) have found that some of the models tested by Meese and Rogoff can substantially outperform forecasts of a random-walk model under certain specification changes (which include relaxing the restriction that the coefficients of the models are fixed over time).

11. See e.g. Boughton (1987)

12. See Isard (1987) and the references cited there.

13. For assessments of the floating-rate experience, see Shafer and Loopesko (1983), Bryant (1983), IMF Survey (1984), Obstfeld (1985), Williamson (1985) and Zis (1987).

14. Since 1985, proposals to reform the present International Monetary System have received renewed attention in government and academic circles: See e.g IMF Survey (1985); Sachs (1985c); McKinnon (1984, 1986); Williamsom (1986b,1987); Frenkel and Goldstein (1986); Frenkel (1987); and Mathieson (1988). See also Liviatan (1980), Miller (1983), Cooper (1985,1986), Branson (1986), Dornbusch (1986) and Miller and Williamson (1988) for a discussion of alternatives to the current exchange rate system.

15. Studies of currency substitution include: Calvo and Rodriquez (1977); Miles (1978); Brillembourg and Schadler (1979); Brittain (1981); Giron and Roper (1981); Bordo and Choudhri (1982); Cuddington (1983); Thomas (1985); Daniel (1985); Artis and Gazioglou (1986).

16. See e.g. Aoki (1981); Miller (1982); Obstfeld (1985); Turnovsky (1985a); Buiter (1986); Rankin (1987); Buiter (1988).

17. See, for example, Bhandari, Driskill and Frenkel (1984); Driskill and McCafferty (1985); Engel and Flood (1985); Pikoulakis (1985,1987) and Calvo (1987).

18. See e.g. Currie and Levine (1984,1985); Carlozzi and Taylor (1985); Turnovsky (1985b); Taylor (1985); Miller (1987); Giavazzi and Giovanini (1986); Sachs and McKibben (1986); Edison, Miller and Williamson (1987); Miller and Williamson (1988); Moutos (1987); Alogoskoufis (1987). For some early contributions to this literature, see Boyer (1978); Turnovsky (1980,1983); Turnovsky and Roper (1980); Artis and Currie (1981); and Canzoneri (1982).

19. See World Bank Report (1985, Ch.6 and 8).

20. For a discussion of the interest-rate developments of the period 1980-85, see e.g Dornbusch (1985), World Bank Report (1985, Ch.2), and Bergsten, Cline and Williamson (1985).

21. See, for example, Dornbusch (1985) for a discussion of this issue.

22. This point is stressed by e.g. Diaz-Alejandro (1983,1984) and Sachs (1985a).

23. Sachs and Huizinga (1987), for instance, note that thirty-eight countries have engaged in multilateral debt renegotiations in the period 1981-85. Several other countries, which have not engaged in multilateral debt renegotiations, have entered IMF standby arrangements due to debt-servicing difficulties.

24. For a survey of the existing proposals, see Bergsten, Cline and Williamson (1985).

CHAPTER 2

Exchange Rate Overshooting Currency Substitution and Monetary Policy*

* This Chapter relies on, and extends, ideas that first appeared in Zervoyianni (1985c). Earlier versions of its present form have been presented at the Second Annual Congress of the European Economic Association (Copenhagen, August 1987) and at a Staff-Seminar at Hull, and can be found in Zervoyianni (1986b, 1987b).

I. *Introduction.*

Most of the existing papers on the macroeconomics of open economies, in examining the effects of monetary policy on the exchange rate, assume that domestic investors hold three assets: domestic 'bonds', foreign 'bonds' and domestic 'money'. A recent topic of discussion, however, has been the argument that, in today's integrated world, residents of a country may wish to hold foreign as well as domestic monetary assets. Taking this view, a group of papers has recently concentrated on exchange rate determination under 'currency substitution' (CS), emphasizing the role of CS in the functioning of a floating exchange rate system. Miles (1978) and McKinnon (1982), for example, have suggested that CS may vitiate the monetary independence that prevails under flexible exchange rates. Thomas (1985) and Girton and Roper (1981) seem to point to exchange rate instability under CS and to exchange rate indeterminacy in the case of exogenous shifts in expected depreciation. Daniel (1985), Calvo and Rodriguez (1977) and Bordo and Choudri (1982) note that CS may cause overshooting following unexpected changes in either the level or the rate of growth of the domestic money stock.

Our focus in this chapter is on the behaviour of a small open economy under CS, subsequent to an unanticipated contraction in the domestic money supply. Earlier studies on CS use models of exchange rate behaviour in which the rates of return on the interest-bearing assets are treated as exogenously given. One of their shortcomings, therefore, is that they separate CS from complete financial equilibrium. In addition to ignoring the requirement of complete financial equilibrium, the majority of the existing papers on CS assume continuous purchasing power parity. This assumption appears to preclude any meaningful role for the real sector in exchange rate behaviour under CS. Also, in some studies, exchange rate expectations are taken to be exogenous and hence considerations pertaining to expectations adjustment under CS are ignored.

In this chapter we attempt to introduce currency substitution into a model which, on the one hand, permits the simultaneous determination of CS and the domestic interest rate and, on the other, allows for short-run deviations from purchasing power parity and for endogenous expectations. The model is in the spirit of Dornbusch (1976), Tobin and De Macedo (1980), Branson and Buiter (1983), Eaton and Turnovsky (1983) and Frenkel and Mussa (1985). The purpose of the chapter is therefore twofold: first, it aims to extend the existing CS literature by considering the possibility of CS within a more general framework than that adopted by the earlier studies; second, it aims to explore whether CS has any impact on any of the results already established by the literature on international macroeconomics which ignores CS. As Cuddington (1983) has pointed out, an analysis clarifying the nature of any likely role for CS in such results has yet to be found. This latter issue is one of the concerns of this chapter.

The chapter is organized as follows. Section II contains a presentation of the model. Section III examines the possibility of CS in the case of perfect substitutability of foreign and domestic bonds and no wealth effects on domestic spending. The analysis shows that not only does the presence of CS not affect the likelihood that the exchange rate will overshoot, but actually helps reduce the size of the overshooting through an "expectation" effect. This result might appear surprising in the light of the existing literature on CS which stresses the destabilizing nature of CS. The crux of the matter lies in the interdependence between the money and the bond markets as well as in the endogeneity of exchange rate expectations which our framework allows for. Section IV drops the assumption of perfect substitutability of domestic and foreign bonds, and allows for changes in the stock of foreign assets over time to affect spending on home goods through wealth. In this more general framework, it is shown that CS may cause exchange rate overshooting through an "income" effect. The possibility of overshooting itself, however, is shown to be negatively related to the "expectation" effect of CS. The key to this latter result lies in the dynamics of current account imbalances as well as in the interplay between the financial sector and the real sector of the economy. Section V concludes the chapter.

II. *The Model*

We consider a small open economy with a perfectly flexible exchange rate in which home residents may hold four assets: domestic (outside) money M, domestic-currency-denominated government bonds B, foreign bonds B*, and foreign money M*. We shall assume that domestic payments in this economy are made exclusively in domestic currency. As is conventional in the CS literature, however, we shall postulate that holdings of foreign monetary assets may facilitate international transactions (by reducing the time involved in accomplishing foreign payments). Moreover, these assets can earn the rate of depreciation of the domestic currency with respect to foreign currencies. Thus, home residents may have an international 'transactions' motive as well as a 'speculative' motive for holding foreign money. Since domestic transactions are conducted in home currency, we postulate throughout that private individuals regard M and M* as imperfect substitutes. We shall assume that it might be possible that B and B* may be considered perfect substitutes. We shall further assume that the entire stock of domestic money and bonds is held domestically and that all foreign variables are parametrically given to this small open economy. Also, we take the net foreign asset position of the home country vis-a-vis the rest of the world to be positive, and assume no investment and changes in fixed capital over time.

Defining the exchange rate, E, as the home currency price of one unit of foreign currency, the demand for domestic and foreign money may be specified as follows:

$$M = P_C\, L(Y,\ r,\ \dot{e}^e,\ {}^W\!/P_C) \qquad L_1, L_4 > 0,\ L_2, L_3 < 0 \qquad (1)$$

$$EM^* = P_C\, J(Y,\ r^* + \dot{e}^e,\ \dot{e}^e,\ {}^W\!/P_C) \qquad J_1, J_3, J_4 > 0,\ J_2 < 0 \qquad (2)$$

$$P_C \equiv P^{\alpha}\, EP^{*\,(1-\alpha)} \qquad 0 < \alpha < 1 \qquad (3)$$

where, for every variable X, we define $\dot{X} = dX/_{dt}$ and $\dot{x}^e = \dot{X}^e/_X$, with X^e being the expectation of X.

In (1) the (real) demand for M is shown to be an increasing function of a transaction variable proxied by the volume of domestic output Y, and of private real wealth $({}^W\!/P_C)$. It is a decreasing function of the closest opportunity cost of holding non-interest bearing assets in domestic currency i.e. the rate of return on domestic bonds r, and of the opportunity cost of allocating one unit of liquid assets to M instead of M* i.e. the expected rate of depreciation of the domestic currency $\dot{e}^e$. Similarly, in (2), the demand for M* depends positively on home output and expected depreciation, reflecting, respectively, a transactions and a speculative motive for holding foreign money. It is negatively related to the rate of return on foreign bonds ($r^* + \dot{e}^e$), i.e. to the closest opportunity cost of holding foreign non-interest bearing assets [1]. (3) defines the consumer price index P_C, and the exponent α reflects the share of home goods in domestic residents' aggregate expenditure. P and P* denote, respectively, the prices of the home and the foreign goods.

Bonds market equilibrium may be described by equations (4)-(6):

$$EB^* = P_C\, F(Y, r, r^* + \dot{e}^e, W/P_C) \qquad F_1 \leq 0,\ F_2 < 0,\ F_3, F_4 > 0 \qquad (4)$$

$$B = P_C\, B(Y, r, r^* + \dot{e}^e, W/P_C) \qquad B_1 \gtrless 0,\ B_2, B_4 > 0,\ B_3 < 0 \qquad (5)$$

$$W = M + B + EM^* + EB^* \qquad (6)$$

In (4) the demand for foreign bonds is taken to be related to home output in a non-positive way (as customarily postulated in the portfolio literature), and directly to (private) real wealth (W/P_C). It is shown to be an increasing function of the own rate of return ($r^* + \dot{e}^e$), and a decreasing function of the closest opportunity cost of holding foreign bonds, that is, the rate of return on domestic bonds r. In (5) the (nominal) demand for domestic bonds on the right-hand side equals the existing stock of B. We shall assume for simplicity that the government in this economy always balances its budget by adjusting taxes, so that the stock of domestic bonds remains invariant over time. (6) gives the usual wealth constraint. Since the wealth constraint renders one of the equations (1)-(2), (4) and (5) redundant, in what follows we shall focus on

(1)-(2) (4) and (6), equation (5) being always satisfied by Walras's law.

In the goods market, equilibrium requires domestic production to equal aggregate demand, which is the sum of private domestic spending S, government expenditure G, and the (real) trade balance surplus T. Conventional assumptions regarding the determinants of S and T may give spending as a function of real disposable income Y_1, of the real interest rate r^R and of real wealth W/P_C, and the trade balance as a function of the relative price of domestic and foreign goods (EP^*/P).[2]

$$Y = S(Y_1,\ r^R,\ W/P_C) + G + T(EP^*/P) \qquad S_1, S_3, T_1 > 0,\ S_2 < 0 \qquad (7)$$

where $Y_1 = (Y-G)(P/P_C)$, $r^R = r-\dot{p}_C{}^e$, $\dot{p}_C{}^e = \dot{P}_C{}^e/P_C$

Two sources of dynamics drive this economy from one equilibrium to another and towards the steady state. The first is the accumulation or decumulation of foreign asset holdings through current account imbalances. As regards the second, following, for example, Dornbusch (1976) and Buiter and Miller (1982), we shall postulate that, due to fixed nominal contracts in domestic factor and product markets, the price of the domestic good adjusts sluggishly to movements in current output relative to 'full capacity' output $\tilde{Y}$:

$$E\dot{B}^* + E\dot{M}^* = PT(.) \qquad (8)$$

$$\dot{p} = \nu(Y/\tilde{Y}) \qquad (9)$$

Since current account surpluses lead to accumulation of foreign assets irrespective of whether these assets take the form of foreign money or foreign bonds, in what follows we shall define total foreign-currency holdings as

$$H = M^* + B^*$$

(6) and (8) can, then, be expressed as

$$W = M + B + EH \tag{6'}$$

$$E\dot{H} = PT(.) \tag{8'}$$

It should be noted that while H is predetermined at each moment in time by past current account imbalances, its short-run composition can be altered through exchanges of B* for M* (and vice versa) between the domestic and the foreign residents. In fact, by aggregating equations (2) and (4) we can obtain the demand function for *total* foreign asset holdings as

$$EH = P_C\, H(Y,\ r,\ \dot{e}^e,\ W/P_C,\ r^*) \tag{4'}$$

where

$$H_1 = J_1 + F_1 > 0\ ,\ H_3 = F_3 + (J_3 + J_2) > 0$$
$$H_2 = F_2 < 0,\quad H_4 = F_4 + J_4 > 0,\quad H_5 = F_3 + J_2\ (> 0)$$

With H being given at any point in time, one may use (4') in place of (4). The distribution of H between M* and B* can in turn be obtained from (4') and (2) (or from (4') and (4)).

To complete the model we introduce equation (10), which reflects the assumption of forward-looking expectations:

$$\dot{p}^e = \dot{p}\ ,\quad \dot{e}^e = \dot{e} \tag{10}$$

Noting that $\dot{e}$, $\dot{p}$ and $\dot{p}_c$ are the proportional rates of change of E, P and P_c respectively, equations (1)-(3), (4'), (6') and (7) (together with (10)) determine instantaneous equilibrium solutions for the endogenous variables Y,r,E,P_c,W,M^* as functions of: (i) the predetermined variables H and P, whose dynamic behaviour is governed by (8') and (9); (ii) the policy variables M, B; and (iii) the exogenous variables r*, P* and G, which throughout the chapter are assumed to remain unchanged.

As can be seen from (1)-(10), the possibility that domestic residents may hold foreign as well as domestic monetary assets introduces the following new elements into the model. First, it implies that the demand for domestic money depends directly upon expected depreciation as indicated by equation (1). Second, under the conventional assumption that the value of F_1 in equation (4') is either zero or if negative relatively low, CS causes the demand for total foreign asset holdings to be positively related to changes in the volume of domestic output. Third, if the assets are gross substitutes, CS may increase the elasticity of the demand for foreign assets with respect to changes in expected depreciation. It should be noted that while CS might also enhance the responsiveness of the demand for foreign-currency holdings to changes in real wealth, this effect is expected to be small: as suggested by e.g. Ando and Shell (1975) and Branson and Buiter (1983), monetary assets tend to be dominated by interest bearing assets as a store of value and hence any wealth-related demand for these assets is likely to be small. In the following discussion we shall maintain this assumption and, for simplicity, we shall follow Branson and Buiter (1983) in taking the marginal wealth effect in (1)-(2) to be zero, i.e. we shall assume that L_4, $J_4 \to 0$ and hence $H_4 \to F_4$.[3]

We shall proceed to the analysis of the model in two steps. In Section III, the effects of CS will be analysed in the case in which B and B* are regarded by agents as perfect substitutes and wealth effects on domestic spending are absent. Then, in Section IV, imperfect bond substitutability, as well as wealth effects on spending on domestic goods, will be re-introduced into the model, and the implications of CS will be examined in this more general context.

III. *Currency Substitution With Perfect Bond Substitutability and No Wealth Effects*

With perfect substitutability between domestic and foreign bonds and no wealth effects on domestic spending, the model becomes very close in spirit to that in Dornbusch (1976) and Buiter and Miller (1982). Specifically, imposing the conditions $F_2, F_3 \to \infty$ and $S_3 \to 0$, the demand function for foreign asset holdings (4'), collapses to the interest rate parity,

$$r = r^* + \dot{e}^e \tag{4a}$$

while equations (6') and (8') become redundant and hence can be ignored. The model also exhibits long-run homogeneity properties in M, P and E.

Thus, in the new steady state where $\dot{p} = \dot{e} = 0$, the contraction in the money supply will lead to a proportional appreciation of the exchange rate and a proportional fall in the price of the home good, independently of CS.

To examine the behaviour of this economy during its transition between steady states, we consider, for convenience, a log-linear version of (1), (2), (3), (4a), (7) and (9) as follows:

$$m - p_C = \varphi_1 y - \lambda_1 r - \lambda_2 \dot{e}^e \tag{1a}$$

$$e + m^* - p_C = \varphi_2 y - \lambda_3 (r^* + \dot{e}^e) + \lambda_2 \dot{e}^e \tag{2a}$$

$$p_C \equiv \alpha p + (1-\alpha)(e+p^*) \tag{3a}$$

$$r = r^* + \dot{e}^e \tag{4a}$$

$$y = \gamma(y+p-p_C) + \sigma(e-p+p^*) - \delta(r-\dot{p}_C{}^e) \tag{7a}$$

$$\dot{p} = \nu(y-\tilde{y}) \tag{9a}$$

Lower case letters are used throughout to denote the logarithms of the upper case variables in (1)-(9), except for the interest rates.

Using (10), the dynamics of the model can be described by a second-order differential equation system in e and p. Thus, (1a)-(3a) and (7a) can be solved for y, r, p_C and m^*, in terms of p and e. Inserting the solutions for y and r so obtained into (9a) and (4a), we can write the model in deviation form as in (11):

$$
\begin{bmatrix} \dot{\hat{p}} \\ \dot{\hat{e}} \end{bmatrix} = \frac{1}{\Delta} \begin{bmatrix} -\nu a_{11} & \nu a_{22} \\ b_{11} & b_{22} \end{bmatrix} \begin{bmatrix} \hat{p} \\ \hat{e} \end{bmatrix} \tag{11}
$$

$$
\begin{aligned}
\Delta &= \Delta_1 + \eta_1\lambda_2 > 0 \\
b_{11} &= \eta_1\alpha - \varphi_1\eta_2 \lesseqgtr 0 \\
b_{22} &= \varphi_1\eta_2 + (1-\alpha)\eta_1 > 0 \\
a_{11} &= \eta_2(\lambda_1+\lambda_2) + \alpha^2\delta > 0 \\
a_{22} &= \eta_2(\lambda_1+\lambda_2) - \alpha(1-\alpha)\delta \ (>0) \\
\Delta_1 &= \varphi_1\delta\alpha + \eta_1\lambda_1 > 0 \\
\eta_1 &= 1-\gamma-\nu\alpha\delta \ (> 0), \ \eta_2 = \sigma - (1-\alpha)\gamma \ (>0)
\end{aligned}
$$

where, for every variable $\hat{x}$, we define $\hat{x} = x - \bar{x}$, with $\bar{x}$ being the value of x in the new steady state.

The following features of (11) are worth noting. First, the presence of CS in the reduced-form model can be identified with a non-zero value of the parameter λ_2, indicating the direct impact of changes in expected depreciation on the domestic money demand. The coefficient η_1 represents the short-run income multiplier (at any given level of e and p) which we assume to be positive. The coefficient η_2 captures the net effect of an exchange rate depreciation on spending on home goods: a depreciation boosts the demand for Y through an 'expenditure-switching' effect, but, at the same time, it depresses spending through the fall in real income that results from the deterioration in the terms of trade. Thus, the sign of η_2 turns out in general to be ambiguous. To be in line with most of the recent studies on the macroeconomics of open economies which ignore CS, we shall assume that the expenditure-switching effect dominates so that η_2 is positive. Second, because p is predetermined while e is non-predetermined in (11), unique convergence requires the equilibrium to be a saddle-point.

This condition is satisfied, as the determinant of the state matrix of (11) is negative.

A well-known result in the literature on exchange rate dynamics which disregards the possibility of CS, is that a (previously unanticipated) contraction in the domestic money supply (achieved via an open market sale of domestic bonds) will lead to a real as well as a nominal appreciation which, through its adverse impact on the competitiveness of the home economy, will cause a recession domestically. Moreover, if upon the fall in the money stock the domestic interest rate increases, the initial appreciation will exceed the long-run appreciation (that is, the exchange rate will overshoot), in which case the fall of the real exchange rate and hence of home output will be even larger.

To see the effects of a monetary contraction on the dynamics of the exchange rate under CS, (11) has been plotted in Figure (1). Given our assumptions about the signs of η_1 and η_2, the $\dot{p} = 0$ locus is upward sloping. The sign of the slope of the $\dot{e} = 0$ locus is in general ambiguous, being dependent upon the sign of b_{11} which itself is unclear. Thus, the unique convergent path SS, depending upon whether b_{11} is positive or negative, slopes downwards in Figure (1a) and upwards in Figure (1b).

An algebraic expression for the stable path can be obtained by noting that the solution to (11) is of the following form

$$\hat{e} = D_1\, e^{\rho_1 t} + D_2\, e^{\rho_2 t} \qquad (11a_1)$$

$$\rho_1 < 0,\ \rho_2 > 0$$

$$\hat{p} = D_1 \frac{(\rho_1\Delta - b_{22})}{b_{11}} e^{\rho_1 t} + D_2 \frac{(\rho_2\Delta - b_{22})}{b_{11}} e^{\rho_2 t} \qquad (11a_2)$$

where $e^{\rho_i t} = \exp(\rho_i t)$. ρ_1 denotes the stable root, while ρ_2 is the

Currency Substitution with Perfect Bond Substitutability and No Wealth Effects on Spending

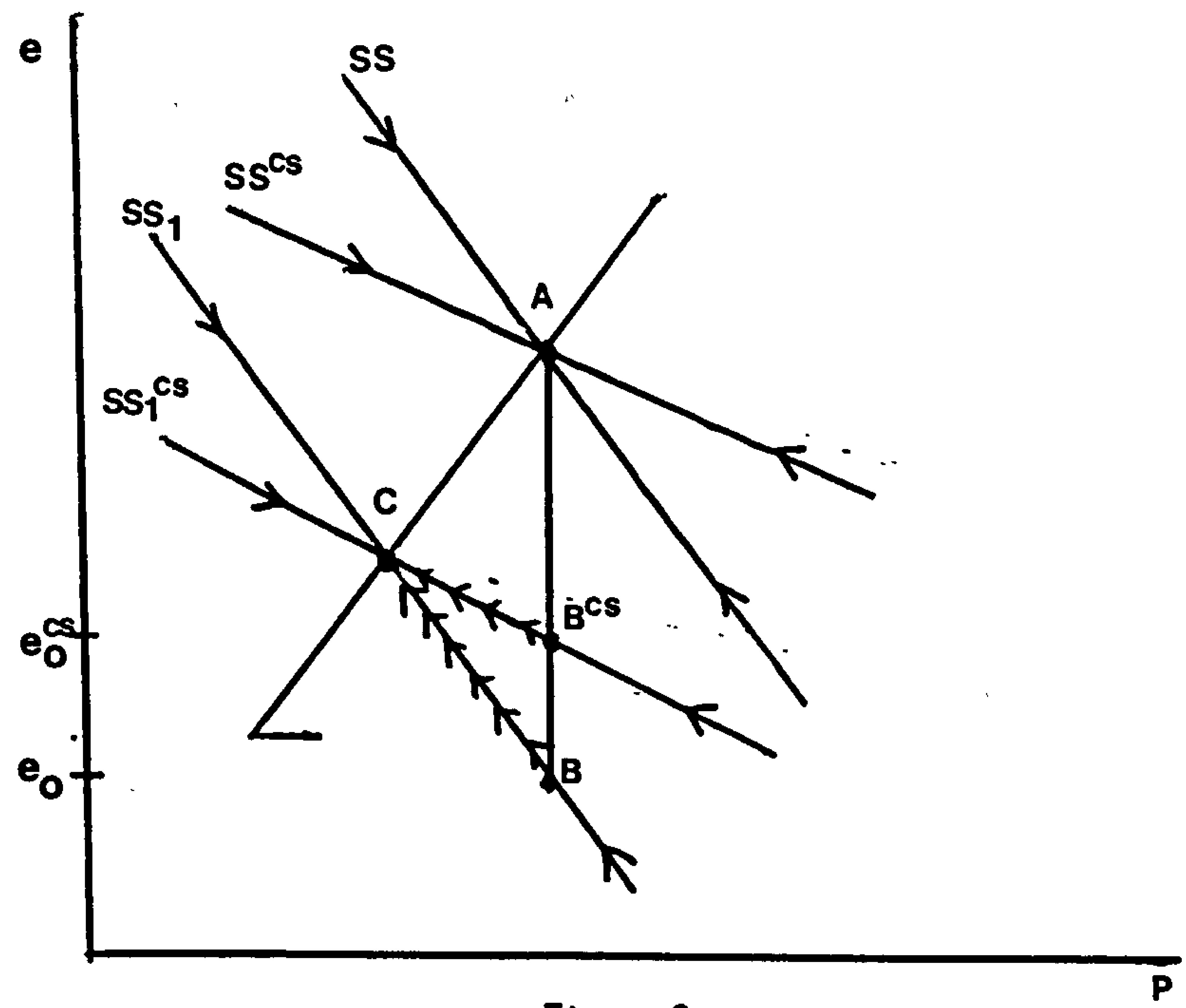


Figure 2

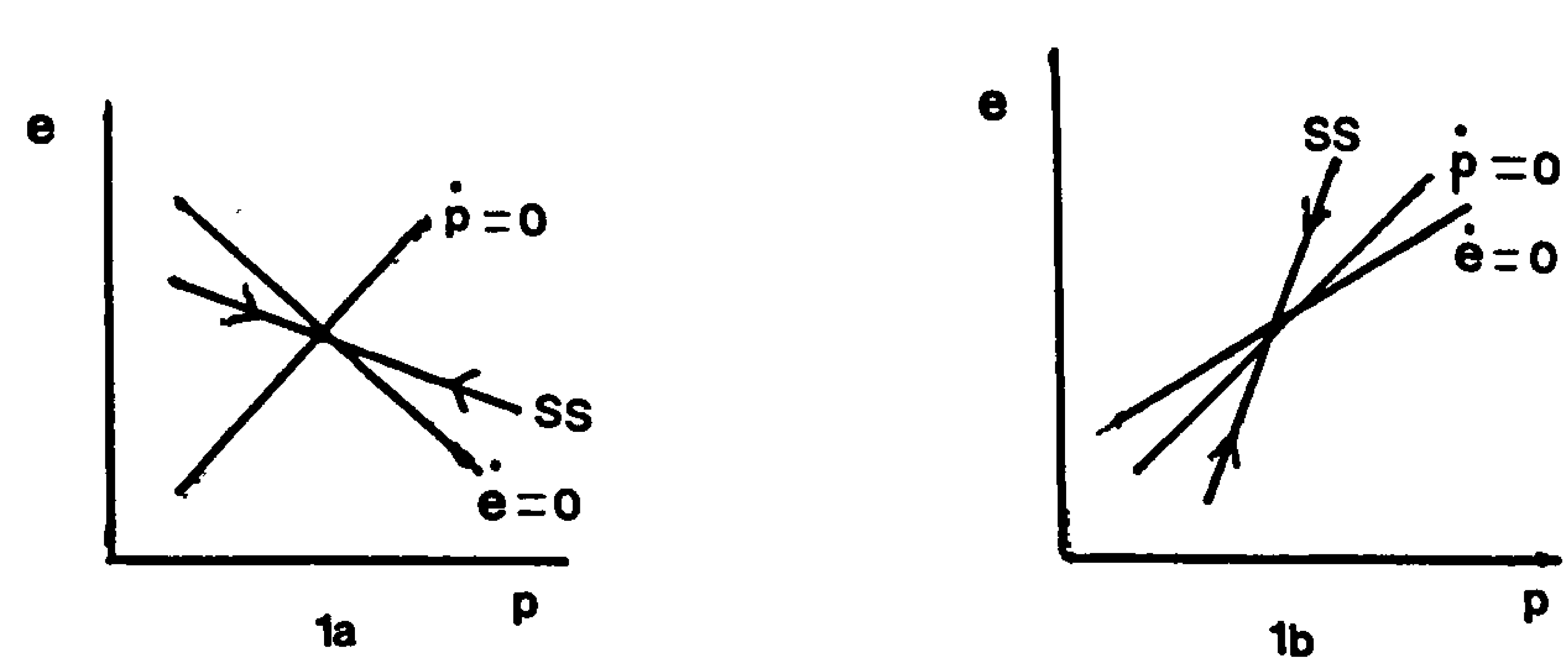


Figure 1

unstable one (associated with the non-predetermined exchange rate).

Restricting the solution to (11) to that on the stable path, requires the coefficient of the unstable root, D_2, in ($11a_1$)-($11a_2$) to be set equal to zero. Imposing this condition, and using ($11a_2$) to eliminate D_1 from ($11a_1$), an expression for the SS locus can be obtained as

$$\hat{e} = -\frac{b_{11}}{(b_{22} - \rho_1\Delta)}\,\hat{p} \qquad (b_{22} - \rho_1\Delta) > 0 \tag{12}$$

On the assumption that rational agents will not choose explosive paths, one can focus on (12) to examine the implications of CS for the behaviour of the exchange rate. Given the long-run homogeneity properties of the model, and with the price of the domestic good being short-run predetermined, the instantaneous value of $\hat{p}$ in (12) will be positive. It can then be seen that the initial appreciation will exceed the long-run appreciation if b_{11} is positive. This condition for exchange rate overshooting might appear complex when compared with that found in some earlier studies, the main reason being exchange-rate effects on real money balances and real income in (1a) and (7a) which are sometimes ignored. While it is possible for these effects to increase on balance the likelihood of overshooting, it is clear that they are independent of structural parameters associated with CS. In fact, as can be seen from (12) and the definition of the reduced-form coefficients, as long as the value of λ_2 is finite, its magnitude is irrelevant for determining whether or not the exchange rate will overshoot. Although CS does not actually cause overshooting in the context of this model, it may still be interesting to see in what way it might influence the size of the overshooting through its likely effect on the absolute slope of the SS locus in Figure (1a). Noting that the determinant of the state matrix of (11) equals the product of the two roots while the trace of this matrix is the sum of the roots, it is easy to demonstrate that

$$\frac{d(b_{22} - \Delta\rho_1)}{d\lambda_2} = \frac{\nu\eta_2}{\Delta(\rho_2 - \rho_1)} (\eta_1 - \Delta\rho_1) > 0 \tag{12a}$$

(12a) suggests that as the value of λ_2 varies between 0 (representing the case with no CS) and ∞, the stable locus in Figure (1a) becomes less steep. This is illustrated in Figure (2), where two stable loci are shown passing through an initial equilibrium point A: SS^{cs} corresponding to the case with CS and SS corresponding to that without CS.

In the figure, upon the unanticipated contraction in the domestic money supply, the SS locus shifts to SS_1 and the SS^{cs} locus to $SS_1{}^{cs}$: the exchange rate appreciates to $e_0{}^{cs}$ in the presence of CS and to e_0 in the absence of CS, with the result that the domestic economy faces a shallower recession at point B^{cs} than at B: in effect, CS seems to have a stabilizing impact on the economy here in contrast to what has been suggested by the earlier literature on CS.

The reason for this outcome stems from two factors which are often not allowed for in the existing studies on CS: first, the requirement of complete financial equilibrium, and, second, the endogeneity of exchange rate expectations. Suppose that the short-run fall in home output does not fully absorb the excess demand for domestic money (brought about by the contraction in the money supply) so that there is a tendency for the excess demand for M to drive the domestic interest rate upwards (in this case, the coefficient b_{11} in (11) will be positive). With r and $\dot{e}^e$ being constrained to move in the same direction via the bond market equilibrium condition (4a), if such excess demand for M is to be eliminated, expectations of future depreciation must be established. As the exchange rate is to appreciate in the new steady state, this can only occur through an initial appreciation that exceeds the long-run appreciation. But, in the presence of CS, this rise in $\dot{e}^e$ (required to equilibrate the domestic money market) need not be too large. In fact, any given increase in expected depreciation will reduce the excess demand for M not only by inducing home residents to switch from domestic money into 'bonds', but also by making foreign money more attractive relative to domestic money. Since the presence of CS reduces the size of the required rise in $\dot{e}^e$, it also lowers the extent to which the exchange rate must overshoot. We refer to this effect of CS as the "expectation effect".

IV. *Currency Substitution With Imperfect Bond Substitutability and Wealth Effects on Spending.*

When imperfect substitutability between the two non-monetary assets B and B* and wealth effects on private domestic spending are re-introduced into the model, its long-run properties need to be re-examined. As is common in models of this sort, long-run neutrality (in the sense that P and E will fall in proportion to the amount by which M will be reduced - through the open market sale of B - while the stock of foreign assets as well as the domestic interest rate will return to their initial steady-state values) will necessarily prevail only if public sector debt is not regarded by private individuals as net wealth. In the opposite case, the long-run value of H might in principle be affected. Imposing the steady-state requirement $\dot{e} = \dot{p} = \dot{H} = 0$, equations (1)-(3), (4'), (6'), (7), (8') and (9) yield (13),

$$\begin{aligned}
&M = P_C\, L(Y,r) \\
&EM^* = P_C\, J(Y,r^*) \\
&P_C = p^{\alpha} EP^{*(1-\alpha)} \\
&EH = P_C\, H(Y,r,r^*,W/P_C) \\
&W = M + B + EH \\
&Y = \tilde{Y} = S(Y_1,r,W/P_C) + T(EP^*/p) + G \\
&T = T(EP^*/p) = 0
\end{aligned} \tag{13}$$

from which, by differentiation, one can obtain the long-run effects of the contraction in the domestic money supply on H, r, P and E as follows:

$$d\bar{H} = -[S_2H_4 - S_3H_2]Z(\widetilde{M+B})(1/\tilde{E})dM \quad (13a) \qquad d\bar{r} = S_3Z(\widetilde{M+B})(1/\tilde{P}_C)dM \quad (13b)$$

$$d\bar{P} = [S_3H_2+S_2(1-H_4)]Z(\tilde{P})dM \quad (13c) \qquad d\bar{E} = (\tilde{E}/p)\, d\bar{P} \quad (13d)$$

$$Z = \{(\widetilde{M+B})S_3L_2+\tilde{M}[(1-H_4)S_2+H_2S_3]\}^{-1} < 0 \ , \ (1-H_4) > 0$$

where '~' is used to denote initial steady-state values and, for notational simplicity, we have set $P^* = 1$.

As can be seen from (13a), the sign of $d\bar{H}$ may be positive or negative depending on the relative size of the structural parameters in the bracketed expression. It should be noted, however, that it is independent of the presence of CS. If, for example, private domestic spending is almost wholly insensitive to interest-rate changes, the constancy of (M+B) in the new steady state, together with the proportional fall in $\bar{E}$ and $\bar{P}$, will always require the stock of foreign assets to decrease in the long run to preserve goods market equilibrium by maintaining real wealth at its initial level. If, on the other hand, the responsiveness of spending on home goods to changes in real wealth is relatively low, the domestic interest rate will tend to be restored to its previous steady-state value. In this case, the stock of foreign assets will have to increase to preserve equilibrium in the foreign exchange market i.e. to satisfy equation (4'). In the general case of $S_2, S_3 \neq 0$, the sign of $d\bar{H}$ cannot be unambiguously established. In the analysis below we shall assume that the opposing forces affecting the steady-state value of foreign asset holdings exactly cancel out each other, that is, on balance $d\bar{H} \to 0$. This assumption will, in fact, maintain our results as comparable as possible with those of the earlier studies on CS which usually assume long-run neutrality of money.

To study the adjustment of the system between steady states, we consider a log-linear version of the model and, for simplicity, we ignore any likely direct impact of exchange rate movements on P_c (by setting the coefficient α in equation (3) equal to unity). Thus, following, for example, Eaton and Turnovsky (1983), we take a log-linear approximation to nominal wealth (6') as

$$w = (1-\mu)\{um+(1-u)b\} + \mu(e + h) \tag{6b}$$

where $(1-\mu)$ denotes the share of total domestic assets in W (in the neighbourhood of the steady state) while μ is the share of foreign assets.

A log-linear version of the demand function for foreign asset holdings

(4'), may be assumed as in ($4b_1$),

$$(e + h - p) = \pi_1 y - \pi_2 r + \pi_3 \dot{e}^e + \pi_4 (w-p) \tag{4b$_1$}$$

which can alternatively be expressed as

$$r = \xi_1 \dot{e}^e + \xi_2 \{ \pi_1 y + \pi_4 (w-p) - (e + h - p)\} \tag{4b}$$

where

$$\xi_2 = 1/\pi_2, \quad \xi_1 = \pi_3/\pi_2$$

Also a log-linear approximation to (8'), and to (1)-(2), (7) and (9) similar to that of the previous section, may be considered:

$$m - p = \varphi_1 y - \lambda_1 r - \lambda_2 \dot{e}^e \tag{1a}$$

$$e + m^* - p = \varphi_2 y - \lambda_3 (r^* + \dot{e}^e) + \lambda_2 \dot{e}^e \tag{2a}$$

$$y = \gamma y - \delta (r - \dot{p}^e) + \sigma (e - p + p^*) + \kappa (w-p) \tag{7a}$$

$$\dot{h} = \sigma (e - p + p^*) \tag{8a}$$

$$\dot{p} = \nu (y - \tilde{y}) \tag{9a}$$

The parameter ξ_2 in (4b) can be taken as a measure of the substitutability of domestic and foreign bonds. It varies inversely with the degree of the latter: as the degree of the substitutability increases, we have $F_2, F_3 \rightarrow \infty$ in (4') and hence π_2, $\pi_3 \rightarrow \infty$ and $\xi_2 \rightarrow 0$, $\xi_1 \rightarrow 1$ in (4b), in which case we obtain (4a) of Section III. Thus, when $\xi_2 \neq 0$, CS will be associated with the presence of the positive parameter π_1 in the foreign-exchange market equilibrium condition (4b), reflecting an "income effect" of CS, as well as with a non-zero value of λ_2 in the domestic money demand function (1a), i.e. an "expectation effect". The parameter κ in (7a) measures the sensitivity of spending on home goods to changes in real wealth, and for the special case of zero wealth effects $\kappa \to 0$.

Using (10), the model can be reduced to a third-order differential equation system in e, p and h as in (14):

$$\begin{bmatrix} \dot{\hat{e}} \\ \dot{\hat{p}} \\ \dot{\hat{h}} \end{bmatrix} = \frac{1}{\Delta} \begin{bmatrix} b_2 & b_1 & b_3 \\ \nu a_2 & -\nu a_1 & \nu a_3 \\ c_2 & c_1 & 0 \end{bmatrix} \begin{bmatrix} \hat{e} \\ \hat{p} \\ \hat{h} \end{bmatrix} \tag{14}$$

where

$$b_1 = (\eta_1-\varphi_1\sigma)+\pi_1\xi_2\{\delta+\lambda_1(\sigma+\kappa)\}-\{\xi_2(1-\pi_4)\Delta_1+\kappa\varphi_1\} \gtrless 0$$

$$b_2 = \sigma(\varphi_1-\pi_1\xi_2\lambda_1)+b_3 > 0$$

$$b_3 = \kappa\mu(\varphi_1-\pi_1\xi_2\lambda_1)+\xi_2(1-\pi_4\mu)\Delta_1 > 0$$

$$a_1 = (\sigma+\kappa)(\lambda_1\xi_1+\lambda_2)+\xi_2(1-\pi_4)\delta\lambda_2+\delta\xi_1 > 0$$

$$a_2 = \sigma(\lambda_1\xi_1+\lambda_2)+a_3 > 0$$

$$a_3 = \kappa\mu(\lambda_1\xi_1+\lambda_2)+\xi_2(1-\pi_4\mu)\delta\lambda_2 > 0$$

$$c_2 = \sigma\Delta > 0, \quad c_1 = -c_2 < 0$$

$$\Delta = \Delta_1\xi_1+\{\eta_1+\delta\pi_1\xi_2\}\lambda_2 > 0, \ \Delta_1 = \eta_1\lambda_1+\varphi_1\delta >, \ \eta_1 = 1-\gamma-\nu\delta \ (> 0)$$

In signing the reduced-form coefficients, we have made the reasonable assumption that $(\varphi_1-\pi_1\xi_2\lambda_1) > 0$. As can be seen from (1a) and (4b), this condition implies that an exogenous increase in home output (by raising the demand for home money by more than it increases the demand for m* and, so, the demand for h) will have a positive effect on the domestic interest rate.

The characteristic equation of (14) is,

$$\rho^3 - \rho^2[(b_2-\nu a_1)/\Delta] - \rho[\nu(b_2a_1+b_1a_2)+c_2(b_3-\nu a_3)]/\Delta^2 - \upsilon = 0 \tag{14a}$$

where

$$\upsilon = [b_3(a_1-a_2)+a_3(b_2+b_1)](\gamma c_2/\Delta^3) > 0$$

From the definition of the b_i's, a_i's and c_i's, it can be shown that the constant term in (14a) (which equals $-(\rho_1\rho_2\rho_3)$) is negative so that (14) has either one or three positive roots. Also, the coefficient of ρ in (14a) (which equals $-(\rho_1\rho_2+\rho_2\rho_3+\rho_1\rho_3)$) is most likely to be positive. This suggests that some of the roots must be negative so that, in fact, (14) can be expected to have two negative roots and one positive roots (denoted, respectively, by $\rho_1,\rho_2 < 0$ and $\rho_3 > 0$) and hence to be saddle-point stable. Accordingly, assuming unique stability, and describing in Appendix I the steps involved in deriving the stable path, we report here the solution to this path:

$$\hat{e} = -(l_2\,\hat{p} + l_3\,\hat{h})/l_1 \tag{15}$$

where

$$\begin{aligned}
l_2 &= b_1 - c_2b_3\psi^{-1} \gtrless 0\\
l_1 &= b_2 - \Delta(\rho_1+\rho_2) + \{b_3c_2+\rho_1\rho_2\Delta^2\}\psi^{-1} > 0\\
l_3 &= b_3 + \{c_2^{-1}b_1\Delta^2\rho_1\rho_2-\Delta(\rho_1+\rho_2)b_3\}\psi^{-1}\ (>0)\\
\psi &= b_2 + b_1\ (>0)
\end{aligned}$$

Consider the impact effects of the contraction in the domestic money supply in (15). On the assumption that on balance there will be no effect on the steady-state value of foreign assets, the instantaneous value of $\hat{h}$ will be zero while that of $\hat{p}$ will be positive. Since $l_1 > 0$, the condition for the initial appreciation to exceed the long-run appreciation is $l_2 > 0$, that is, $(b_1 - c_2b_3\psi^{-1}) > 0$. As can be seen from the definition of the b_i's, except that p has been set equal to p_c here, the first term of the coefficient b_1 is identical to the coefficient b_{11} of Section III. Hence, it requires no particular comment. Also, the last term in b_1 captures certain forces relating the exchange rate to a monetary contraction that are expected to prevail irrespective of the presence of CS. Specifically, with $\xi_2 \neq 0$, any given appreciation, by lowering the domestic-currency value of foreign bond holdings, will always reduce the excess supply in the foreign exchange market (generated by the tendency for r to rise as the stock of home money is decreased). With $\kappa \neq 0$, any given fall in e, by reducing the domestic value of wealth and hence domestic spending and output, will alleviate the excess demand for home money created by the fall in the money supply. Both of these factors will always reduce the size of the exchange rate adjustment required to restore equilibrium and, therefore, will weaken the possibility of overshooting. The notable feature of the overshooting condition in (15) as compared to that in (12), however, is its sensitivity to the value of the second term in b_1 as well as to that of $c_2b_3\psi^{-1}$ in which CS parameters enter. To establish the role of each of the two CS effects in this condition one can differentiate the expression for l_2, first, with respect to λ_2 and, then, with respect to π_1.

Consider first the "expectation effect". Differentiating l_2 with respect to λ_2, letting $\pi_1 \to 0$, we obtain,

$$\frac{dl_2}{d\lambda_2}\Big|_{\pi_1\to 0} = -\sigma\{\xi_2(1-\pi_4\mu)(\eta_1\lambda_1+\varphi_1\delta) + \kappa\mu\varphi_1\}\eta_1\psi_1^{-1} < 0 \qquad (15a)$$

where

$$\psi_1 = \eta_1 + (1-\mu)\{\xi_2\eta_1\lambda_1\pi_4+\varphi_1(\xi_2\pi_4\delta-\kappa)\} \ (>0)$$

The coefficient ψ_1 is almost certainly positive, and for the case in which there is no effect on the long-run stock of foreign assets (i.e. when $(\xi_2\pi_4\delta-\kappa) \rightarrow 0$) it is unambiguously positive. Equation (15a), then, suggests that, unless both perfect bond substitutability and no wealth effects on domestic spending are assumed, the prospect of overshooting itself will be negatively related to λ_2: the "expectation effect" of CS has significant qualitative implications in this more general model: not only does it lower the extent to which overshooting will occur, if it does occur, but it also reduces the possibility that overshooting will take place at all.

The crux of the matter lies in the dynamics of adjustment to current account imbalances. The real as well as nominal short-run appreciation induced by the monetary contraction creates a current account deficit: immediately after the unanticipated monetary shock, the stock of foreign assets will decline with a tendency to produce a depreciation of the home currency through portfolio balance effects (when $\xi_2 \neq 0$) and/or wealth-spending effects (when $\kappa \neq 0$). Spending effects actually work in the same direction as portfolio effects: when h falls, wealth decreases and so does the demand for the home good and hence home output; this, through the income effect on the demand for money, tends to reduce the domestic interest rate and, as a result, depreciates the exchange rate. With forward-looking asset markets, in addition to the forces governing the behaviour of the exchange rate noted earlier, we will therefore have the anticipated depreciation associated with the fall in h in the immediate future. Under CS, this will induce agents to decrease their domestic money balances and increase their foreign money holdings: the excess demand in the domestic money market (brought about by the fall in the money supply) will be alleviated and, consequently, the likelihood of overshooting will be reduced. If, however, continuous purchasing power parity and hence a fixed real exchange rate is assumed - as is done in most of the earlier CS papers - there is no room for this effect. This case can be approximated by considering a situation where $\sigma \to 0$ in (15a).

Turn next to the "income effect" of CS. Letting $\lambda_2 \to 0$, and differentiating l_2 with respect to π_1 we obtain

$$\frac{dl_2}{d\pi_1}\Big|_{\lambda_2\to 0} = \xi_2\{\delta+\lambda_1(\sigma+\kappa)\} + \xi_2\sigma\Delta_1\psi^{-1}\{\kappa\mu\lambda_1+b_3[\delta+\kappa(1-\mu)\lambda_1]\psi^{-1}\} > 0 \tag{15b}$$

What is at once clear from (15b) is that, as long as $\xi_2 \neq 0$, CS can create overshooting through an "income" effect.

To understand this result note that the unexpected monetary contraction causes home output to fall in the short run: as output declines, the demand for foreign money balances falls with a tendency to produce an excess supply of M*. At the same time, because the total stock of foreign assets is instantaneously given by past current account imbalances, an increase in the domestic holdings of foreign bonds is the only mechanism whereby any undesirable, excess holdings of foreign money can be reduced (for any given $\dot{e}^e$). CS, then, via the "income effect" tends to induce a shift in the instantaneous composition of foreign assets towards foreign bonds which, in turn, affects the composition of the non-monetary assets in the short-run equilibrium. When foreign bonds are not regarded by agents as perfect substitutes for domestic bonds, this tendency for the supply of B* to increase (relative to B) generates additional pressures on the exchange rate that must adjust to maintain overall portfolio balance. When, on the contrary, bond substitutability is perfect, the income effect of CS has no effective impact on the bonds market equilibrium.

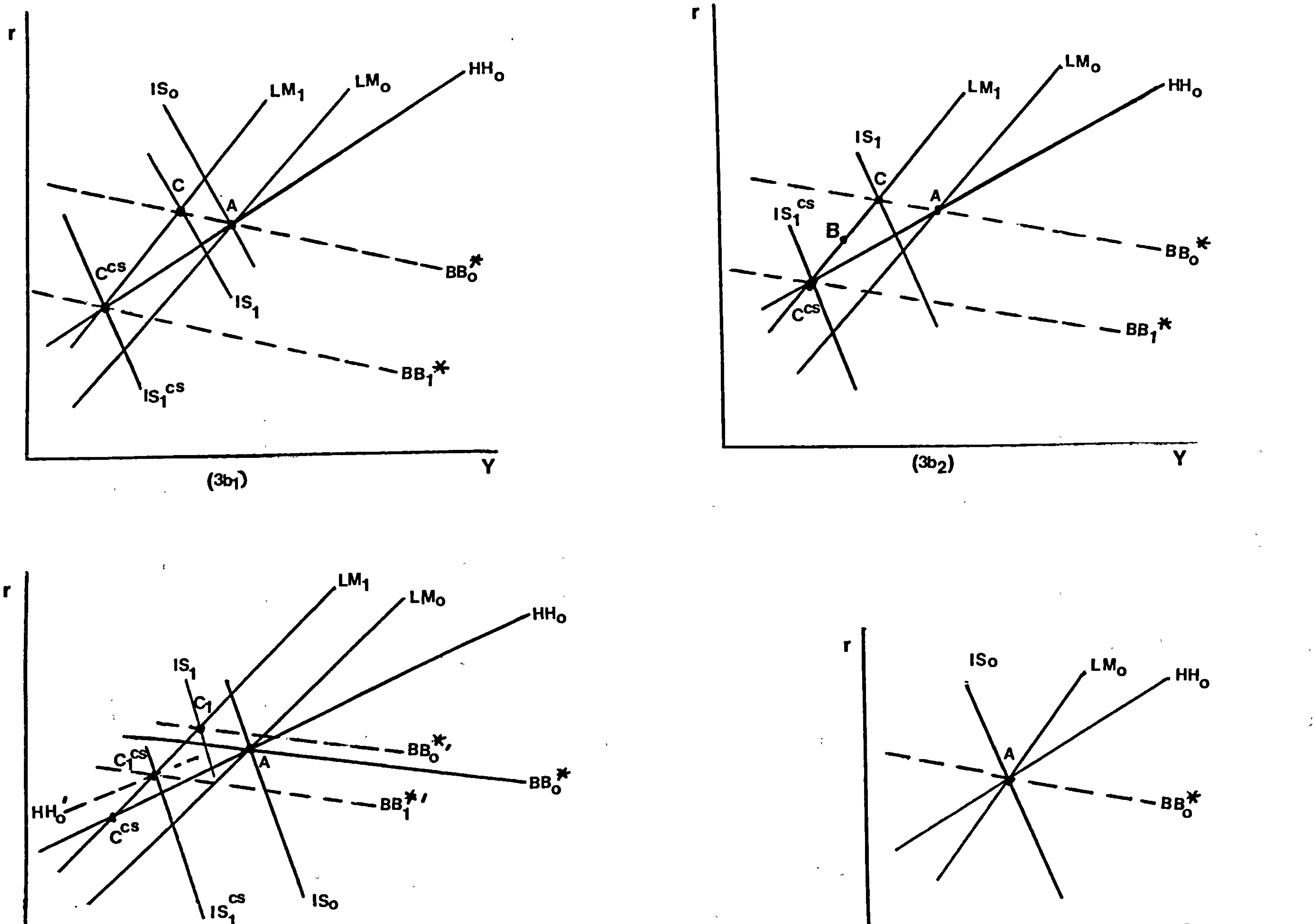
More formally, in the context of the foreign exchange market equilibrium condition ($4b_1$), the fall in home output increases the excess supply of total foreign assets (generated by the tendency for the domestic interest rate to rise as the stock of domestic money is reduced): a return to equilibrium requires either a relatively large appreciation (which will reduce the home-currency value of foreign assets and induce expectations of future depreciation) or a drop in the domestic interest rate relative to its current level. But, a drop in r alone would tend to create excess demand for domestic money: it must, therefore, be supplemented by a large appreciation to restore overall financial equilibrium (which will achieve adjustment partly by absorbing the excess supply in the foreign exchange market, and partly by reducing the excess demand for home money through a reduction in output).

Since it is the "income effect" of CS that appears to be a source of overshooting, the question arises as to whether policy measures exist that could eliminate this destabilizing effect. In principle, the "income" elasticity of the demand for foreign money could be reduced through the introduction of a tax on holdings of M* for international transaction purposes. This measure may be rejected, however, on the grounds that it might be difficult for the government to distinguish between 'transactions' demand for foreign money and 'speculative' demand. Rather than altering the cost to home residents of holding M* for international transactions purposes through a tax measure, it may be more sensible for the government to use exchange market "intervention" to reduce the destabilizing impact of the income effect of CS. In fact, the reason why the income effect of CS can create overshooting is that it tends to induce a shift in the short-run composition of privately held interest-bearing assets towards foreign bonds. This can be avoided if the government buys sufficient B* with B through foreign-exchange market "intervention", at the same time that the open market operation is conducted. The former operation would leave the domestic money supply unchanged and, therefore, would not interfere with the government's intention to lower it. But it would prevent private holdings of B* from increasing relative to B, following the attempt by home residents to reduce their foreign money balances as domestic output drops.

Figure (3) provides a simple diagrammatic illustration of the "income effect" of CS in a conventional IS/LM framework. In order to focus on this effect of CS, and for simplicity of the diagrammatic exposition, we ignore here the impact of changes in expectations on the system (by considering a situation where $\dot{e}^e = \dot{p}^e = 0$).

Figure (3a) shows standard (short-run) IS and LM curves along with an upward-sloping HH schedule. HH depicts the foreign exchange market equilibrium condition under CS, namely equation (4') of Section I. Under CS an increase in home output, by raising the desired holdings of foreign money, creates excess demand in the foreign exchange market: to restore equilibrium, a rise in the domestic interest rate is required to reduce the demand for foreign bonds. The HH schedule is shown to be flatter than the LM curve on the plausible assumption that, keeping r constant, an exogenous rise in home output increases the demand for home money by more than it raises the demand for M* and hence that for total foreign assets H. The BB* line represents the market for foreign bonds, and corresponds to equation (4) of Section II. Now, except for valuation effects on domestic foreign asset holdings (which result from exchange rate changes), the HH

Figure 3: The "Income" Effect of Currency Substitution



curve remains unchanged after the monetary shock: that is, unless the government intervenes in the foreign exchange market, the total stock of privately-held foreign assets, H, is instantaneously given. The BB* line may shift up or down since the short-run composition of H and, as a result, the stock of B* may change. In the absence of CS, however, the BB* schedule would represent the foreign exchange market: valuation effects notwithstanding, its short-run position would be given since B* would be predetermined by past current account imbalances.

In Figure ($3b_1$), the unanticipated contraction in the domestic money supply shifts upwards the instantaneous LM curve. Without CS, and ignoring for the moment valuation effects, a modest appreciation of the exchange rate takes place shifting the IS_0 curve to IS_1. Short-run equilibrium occurs at point C, i.e. on the BB^*_0 curve. Under CS, point C corresponds to an excess supply of foreign money: to restore equilibrium M* must fall, while B* must increase in order to maintain a given H. This tends to push the BB^*_0 schedule down to the left, thus requiring a larger appreciation to achieve overall equilibrium, which, in turn, shifts the IS_0 curve down to IS_1^{cs}. Short-run equilibrium under CS occurs at point C^{cs}, i.e. on the HH_0 curve. As can be seen from the figure, the "income effect" of CS, by causing a relatively large appreciation, does increase the size of the domestic recession. Adding valuation effects does not seem to change the overall picture as Figure ($3c_1$) indicates: the short-run equilibrium tends to be at a point like C_1^{cs} with CS as compared to a point like C_1 without CS. This impact effect of the contraction in the money supply on home output can also be seen from Appendix II.

A purchase of B* with B by the government through a foreign exchange market "intervention" (at the same time that the open market operation is conducted), would shift both the BB^*_1 curve and the HH_0 curve upward in Figure ($3b_1$). This would give a short-run equilibrium point like that at B in Figure ($3b_2$). At point B the size of the exchange rate appreciation, as well as the size of the fall in output, would be smaller than the corresponding to point C^{cs}.

V. *Conclusions*

A number of papers have focused recently on the implications of CS for the behaviour of the exchange rate. In examining this issue, little attention has been given to complete financial equilibrium and to the interactions between the monetary and the other sectors of the economy. On the other hand, the recent studies on the macroeconomics of open economies, which are in many respects more general than the CS literature, seem to have little to say about the likely effects of CS.

The results of our analysis can be broadly stated as follows. Once the possibility of CS is considered within an explicit macroeconomic framework, the conclusions regarding its consequences may easily change. At the same time, some of the results established by standard analyses of open economies may require some qualification once the possibility of CS is allowed for. The likelihood of the occurrence of overshooting, for example, may be influenced (among other factors) by the importance of the "transactions" motive relative to the "speculative" motive for holding foreign monetary assets and hence the relative significance of the "income effect" and the "expectation effect" of CS.

Appendix I

The solution to (14) is of the following form:

$$\hat{e} = V_1\, e^{\rho_1 t} + V_2\, e^{\rho_2 t} + V_3\, e^{\rho_3 t} \qquad (14.a_1)$$

$$\hat{p} = B_1\, e^{\rho_1 t} + B_2\, e^{\rho_2 t} + B_3\, e^{\rho_3 t} \qquad (14.a_2)$$

$$\hat{h} = C_1\, e^{\rho_1 t} + C_2\, e^{\rho_2 t} + C_3\, e^{\rho_3 t} \qquad \rho_1,\ \rho_2 < 0, \quad \rho_3 > 0 \qquad (14.a_3)$$

where $e^{\rho_i t} = \exp(\rho_i t)$. ρ_3 denotes the unstable root (associated with the non-predetermined exchange rate), while ρ_1 and ρ_2 are the stable roots (associated with the predetermined variables p and h). It can be easily shown that for any arbitrary constant V_i, the coefficients B_i and C_i must satisfy the constraints

$$B_i = V_i\{c_2 b_3 + \Delta\rho_i(b_2 - \Delta\rho_i)\}/\omega_i$$

$$C_i = V_i\{c_1(b_2 - \Delta\rho_i) - c_2 b_1\}/\omega_i \qquad (14.b)$$

where

$$\omega_i = -(b_1\rho_i\Delta + b_3 c_1), \quad i = 1, 2, 3$$

Specifically, $(14.a_1)$-$(14.a_3)$ must satisfy equation (14) of Section IV. Substituting $(14.a_1)$-$(14.a_3)$ into (14) yields

$$\begin{bmatrix} \dot{\hat{e}} \\ \dot{\hat{p}} \\ \hat{h} \end{bmatrix} = 1/\Delta \begin{bmatrix} x_{11} & x_{12} & x_{13} \\ x_{21} & x_{22} & x_{23} \\ x_{31} & x_{32} & x_{33} \end{bmatrix} \cdot \begin{bmatrix} e^{\rho_1 t} \\ e^{\rho_2 t} \\ e^{\rho_3 t} \end{bmatrix} \qquad (14.c)$$

where
$$x_{1i} = b_2 V_i + b_1 B_i + b_3 C_i$$
$$x_{2i} = [a_2 V_i - a_1 B_i + a_3 C_i]\gamma$$
$$x_{3i} = c_2 V_i + c_1 B_i$$
for $i = 1,2,3$ $\qquad (14.c_1)$

Taking the time derivative of $(14.a_1)$-$(14.a_3)$, we obtain:

$$\begin{bmatrix} \dot{\hat{e}} \\ \dot{\hat{p}} \\ \dot{\hat{h}} \end{bmatrix} = \begin{bmatrix} V_1\rho_1 & V_2\rho_2 & V_3\rho_3 \\ B_1\rho_1 & B_2\rho_2 & B_3\rho_3 \\ C_1\rho_1 & C_2\rho_2 & C_3\rho_3 \end{bmatrix} \begin{bmatrix} e^{\rho_1 t} \\ e^{\rho_2 t} \\ e^{\rho_3 t} \end{bmatrix} \tag{14.d}$$

Consistency between (14.c) and (14.d) requires:

$$x_{1i} = \{b_2V_i+b_1B_i+b_3C_i\} = \rho_iV_i\Delta \qquad (14.e_1)$$

$$x_{3i} = \{c_2V_i+c_1B_i\} = \rho_iC_i\Delta \qquad (14.e_3)$$

$$x_{2i} = \{a_2V_i-a_1B_i+a_3C_i\}\gamma = \rho_iB_i\Delta \qquad (14.e_2)$$

for $i = 1, 2, 3$

Solving $(14.e_1)$ and $(14.e_3)$ for B_i and C_i in terms of V_i, we can in fact obtain (14.b). (See also Eaton and Turnovsky (1983) for a similar approach).

Thus, restricting the solution to (14) to that on the unique stable path, requires the coefficient of the unstable root, V_3, in $(14.a_1)$ to be set equal to zero. From (14.b) it follows that $B_3 = 0$ and $C_3 = 0$. (14.b) can then be solved for B_1, B_2, C_1, C_2 in terms of V_1 and V_2. Substituting the resulting expressions for B_1, B_2 and C_1, C_2 into $(14.a_2)$ and $(14.a_3)$, we can solve for V_1 and V_2. Further inserting the solutions for V_1 and V_2 so obtained into $(14.a_1)$, we can arrive at an expression for the stable path as shown by equation (15) of Section IV.

Appendix II

The model in Figure (3) can be obtained from equations (1), (4'), (4) and (7), by setting $\dot{e}^e = \dot{p}^e = 0$, $P_c = P$ and $L_4 = J_4 = 0$.

Totally differentiating these equations, and assuming that in the initial steady-state $E = P = P^* = 1$, we obtain

LM curve

$$dr = -\,(L_1/L_2)\,dY + (1/L_2)\,dM \tag{A.1}$$

HH curve

$$dr = -\,[(J_1 + F_1)(F_2)^{-1}]dY + [\tilde{H}(1-F_4)(F_2)^{-1}]dE \tag{A.2}$$

BB* curve

$$dr = -\,(F_1/F_2)dY + [(\tilde{B}^*-F_4\tilde{H})(F_2)^{-1}]dE + (1/F_2)dB^* \tag{A.3}$$

IS curve

$$dr = [(1-S_1)(S_2)^{-1}]dY - [(T_1 + S_3\tilde{H})(S_2)^{-1}]dE \tag{A.4}$$

where

$$(J_1 + F_1) > 0,\ F_1 < 0,\ (1-S_1) > 0,\ (\tilde{B}^* - F_4\tilde{H})\ (>0)$$

In (A.1)-(A.4), $\tilde{H}$ and $\tilde{B}^*$ are the initial steady-state values of H and B*. The condition $[L_1 - (J_1+F_1)(L_2F_2)^{-1}] > 0$ implies that the LM curve slopes more steeply than the HH curve. Solving (A.1)-(A.4) for dY, we obtain

$$dY = \frac{(T_1 + S_3\tilde{H}) + \tilde{H}(1-F_4)S_2(F_2)^{-1}}{\Delta_2 + (T_1 + S_3\tilde{H})[L_1 - (J_1+F_1)(L_2F_2)^{-1}]}\, dM < 0 \tag{A.5}$$

where

$$\Delta_2 = \tilde{H}(1 - F_4)L_2[L_1S_2(L_2)^{-1} + (1-S_1)](F_2)^{-1} > 0.$$

As can be seen from (A.5), the size of the short-run fall in output is positively related to "income effect" of CS, i.e. to the size of the parameter J_1.

Notes.

1. The exclusion of the rate of return on foreign bonds from (1) (and of r from (2)) can be rationalized on the basis that money provides utility via its transaction services: as suggested by the finite horizon optimizing behaviour of a single consumer (see e.g. Eaton and Turnovsky (1981)), in this case the cost of holding non-interest bearing assets in domestic currency is solely the domestic interest rate. Note that the inclusion of $(r^*+\dot{e}^e)$ in (1) and of r in (2) is not expected to affect qualitatively our results, as long as one makes the assumption of gross substitutability between the assets to sign the rate-of-return effects.

2. This simple specification of the trade balance is adopted here for the purpose of keeping down the analytical complexity of the model. The inclusion of Y in the T function, for example, is not expected to have any qualitative effect on the results provided the Biderdike-Metzler-Robinson condition for successful devaluation is satisfied. (For this condition, see e.g. Tobin and De Macedo (1980))

3. In Ando and Shell (1975), for example, the wealth effect in the money demand function is literally zero.

CHAPTER 3

The International Transmission of Disturbances under Flexible Exchange Rates: Currency Substitution, Bond Substitution and Price Stickiness *

* This Chapter relies on, and extends, ideas that first appeared in Zervoyianni (1986a). An earlier version of its present form has been presented at the Tenth IESG Annual Conference (Sussex, September 1985) and can be found in Zervoyianni (1987a).

I. *Introduction*

A recent topic of discussion among international economists has been the argument that 'currency substitution' (CS) is a channel for the transmission of disturbances between countries. Daniel (1985), for example, notes that CS, combined with perfect foresight, can be responsible for overshooting in real exchange rates and in national levels of consumption. Miles (1978) points out that when domestic residents hold foreign monetary assets, a floating exchange-rate can no longer shield the home economy from the repercussions of macroeconomic developments abroad. Mckinnon (1982) has also suggested that CS can prevent national monetary growth and inflation from moving together, and has proposed an average of national money supplies for explaining variations in individual inflation rates. Furthermore, similar views can be found in many other papers[1].

In examining the role of CS in the international transmission of disturbances, however, most authors abstract from the specification of complete financial equilibrium by assuming that 'domestic' and 'foreign' money are the only assets available to private agents. Thus, as the possibility of interest-bearing assets is ruled out, it is not clear which of their findings are the outcomes of CS and which are due to substitution between assets in general. Also, as mentioned in Chapter 2, the majority of the existing studies on CS use models in which the assumption of continuous purchasing power parity (PPP) is made. This assumption precludes any meaningful role for real exchange rate changes in the behaviour of an open economy under CS.

In this chapter we attempt to study and clarify the role of 'currency substitution, 'bond substitution' and 'price stickiness' in the international transmission of disturbances, by introducing the CS possibility into an explicit dynamic macro-model. The model is in the spirit of Buiter and Miller (1982,1983), Aoki (1981) and Miller (1982). Thus, our model, on the one hand, assumes that domestic residents may hold interest-bearing assets as well as 'domestic' and 'foreign' money, and, on the other, allows for deviations from PPP and for the possibility of continuing inflation. While we assume that only the national currency is used in domestic transactions (as is indeed the case in most of the major industrial countries), we follow the CS literature in postulating 'international transactions' motives and 'speculative' motives for CS.

The structure of the chapter is as follows:

Section II studies the behaviour of a small open economy under CS, subsequent to (unanticipated) disturbances of foreign origin. The analysis demonstrates that CS limits the size of the initial real exchange-rate jump in the case of disturbances to foreign interest rates, but that it increases the size of the short-run change of the real exchange rate in the case of disturbances to foreign output. In both cases, however, it is shown that the variation in (real) domestic output is smaller with CS than without CS.

In Section III, the CS possibility is introduced into a two-country model. It is demonstrated that the real exchange rate overshoots its equilibrium value following (unanticipated) disturbances either to the level or to the rate of growth of any of the two national money supplies, irrespective of CS. The overshooting is transmitted to the other country's output. Under currency substitution, the significance of the transmission effect is mitigated through a "terms-of-trade" effect and a "foreign-inflation" effect. A "foreign income" effect associated with CS is found to be a source of real exchange rate overshooting.

The analysis is concluded in Section IV.

II. *Foreign Disturbances and Currency Substitution in a Small-Country Model*

We consider an economy which is small in relation to the rest of the world so that it is confronted with aggregate 'foreign' variables that are exogenous to its macroeconomic equilibrium. We shall assume that the residents of this economy may hold as assets: domestic (outside) money M; domestic and foreign bonds, which, for simplicity, are taken to be perfect substitutes; and a foreign monetary asset M*. As in Chapter 2, we shall postulate that only the home currency is used domestically. However home residents may wish to hold M* to facilitate transactions with the rest of the world, earning at the same time the rate of depreciation of the domestic currency vis-a-vis foreign currencies. For the purposes of this section, we will further assume that foreign residents do not hold assets denominated in the currency of the home economy. Thus, using asterisks to denote foreign variables, the behaviour of this economy may be described by equations (1a)-(15a):

$$M = P_C L(Y,\ r,\ \dot{e}^e,\ \dot{p}_C{}^e) \qquad L_1 > 0,\ L_2, L_3, L_4 < 0 \qquad (1a)$$

$$EM^{d*} = P_C J(Y,\ r,\ \dot{e}^e,\ \dot{p}_C{}^e) \qquad J_1, J_3 > 0,\ J_2, J_4 < 0 \qquad (2a)$$

$$P_C = p^{\alpha}\ EP^{*(1-\alpha)} \qquad 0 < \alpha < 1 \qquad (3a)$$

$$\dot{p}_C = \alpha\dot{p}^e + (1-\alpha)(\dot{e}^e + \dot{p}^{*e}) \qquad (4a)$$

$$r = r^* + \dot{e}^e \qquad (5a)$$

$$Y = Y_d = A(r-\dot{p}_c{}^e,\ EP^*/P,\ Y,\ Y^*) + G \qquad A_2,\ A_3,\ A_4 > 0,\ A_1 < 0 \qquad (6a)$$

$$\dot{p} = v(Y/\tilde{Y}) + \dot{m} \qquad (7a)$$

$$\dot{e}^e = \dot{e},\ \dot{p}^e = \dot{p},\ \dot{p}_c{}^e = \dot{p}_c \qquad (8a)$$

where $\dot{e} = \dot{E}/E$, $p_c = \dot{P}_c/P_c$, $\dot{p} = \dot{P}/P$, $\dot{m} = \dot{M}/M$.

Equation (1a) describes equilibrium in the domestic money market, with the total stock of home money being equal to the home residents' demand on the right-hand side. The demand for (real) domestic money balances L(.) is taken to be a positively related to a transactions variable, proxied by the volume of domestic output Y. It is a negative function of the opportunity cost of holding M, that is: (a) the rate of return on bonds or the domestic interest rate r; (b) the rate of return on M* relative to that on M i.e. the expected rate of depreciation of the home currency $\dot{e}^e$; and (c) the (expected) retail price inflation $\dot{p}_c{}^e$, itself reflecting the possibility of substitution between monetary assets and commodities. p_c and $\dot{p}_c$ are defined in (3a) and (4a): the exponent α measures the share of domestic goods in total domestic consumption, P denotes the price of home output, while P* is the price of the foreign output Y*. In a similar way, (2a) specifies the demand for foreign money by the home residents [2]. Equation (5a) represents the equilibrium condition in the bond markets, with the assumption of perfect substitutability between domestic and foreign bonds implying that r will always equal the foreign interest rate r* plus the expected rate of depreciation of the home currency. Equations (6a)-(7a) describe the domestic goods market. (6a) states that output produced equals aggregate demand Y_d, which depends on the real domestic interest rate $r-\dot{p}_c{}^e$, the real exchange rate (EP^*/p), government spending G, domestic income (set equal to output), and foreign income Y^*. In (7a), it is assumed that, due to fixed nominal contracts in domestic factor and product markets, P cannot jump instantaneously. Thus (7a) is an augmented Phillips curve, where the augmentation term has been set equal to the rate of growth of domestic money $\dot{m}$ [3]. Finally, (8a) reflects the assumption of rational expectations.

Noting that $\dot{p}$ and $\dot{e}$ are the proportional rates of change of P and E respectively, (1a)-(6a), together with (8a), determine instantaneous solutions for the endogenous variables Y, r, P_c, $\dot{p}_c$, E, M^{*d} as functions of: (i) the predetermined variable P, whose behaviour is governed by (7a); (ii) the domestic policy variables $\dot{m}$, M, G; and (iii) the exogenous foreign variables r^*, Y^*, P^* and $\dot{p}^*$. For the purposes of this section we shall assume that there is no trend inflation in the rest of the world and hence $\dot{p}^* = 0$. Thus, r^* in (5a) can be interpreted as being both the nominal and the real foreign interest-rate.

As can be seen, the specification of our model is fairly orthodox except that it takes account of the CS possibility. In fact, by expressing (3a) as

$$P_c = P\,(EP^*/P)^{(1-\alpha)}$$

we can describe domestic macroeconomic equilibrium as follows:

$$\frac{M}{P} = L(Y,\ r,\ \dot{e},\ \dot{p}_c)\left(\frac{EP^*}{P}\right)^{(1-\alpha)} \qquad (1b)$$

$$\dot{p}_c = \alpha\dot{p} + (1-\alpha)\dot{e} \qquad (4b)$$

$$\dot{e} = r - r^* \qquad (5b)$$

$$Y = A(r-\dot{p}_C,\ EP^*/P,\ Y,\ Y^*) + G \tag{6b}$$

$$\dot{p} = v(Y/\tilde{Y}) + \dot{m} \tag{7b}$$

In terms of equations (1b), (4b)-(7b), currency substitution simply implies that the demand for home money *in terms of the home-currency price level* will depend on the expected rate of depreciation, through a "*rate-of-return effect*" of CS (i.e. via a speculative motive for holding monetary assets denominated in foreign currency).

We shall study the behaviour of this economy subsequent to: (a) a previously unanticipated decline in the foreign interest-rate r^* and (b) an unexpected fall in foreign output Y^*. For convenience, we use a log-linear version of the model. Thus, without loss of generality, we set $\tilde{Y} = P^* = 1$ so that $\tilde{y} = \log\tilde{Y} = 0$ and $p^* = \log P^* = 0$. By log-linearizing the system at initial steady state where $E = P = M = 1$, we can describe domestic macreoconomic equilibrium as follows

$$m - p = (1-\alpha)(e-p) + \varphi_1 y - \lambda_1 r - \kappa_1 \dot{p}_C - \beta_1 \dot{e} \tag{1c}$$

$$\dot{p}_C = \alpha\dot{p} + (1-\alpha)\dot{e} \tag{4c}$$

$$\dot{e} = r - r^* \tag{5c}$$

$$y = \sigma(e-p) - \delta(r-\dot{p}_C) + \upsilon y^* + g \tag{6c}$$

$$\dot{p} = \nu y + \dot{m} \tag{7c}$$

where lowercase letters other than interest rates are natural logarithms. Thus, in the context of (1c) and (4c)-(7c), currency substitution (the rate-of-return effect) can be identified with the non-zero value of the coefficient β_1.

Given the possibility of continuing domestic inflation, it is convenient to define 'liquidity' (the stock of home money in terms of the home currency price level) as

$$\ell = m - p \tag{9c$_1$}$$

and 'competitiveness' (the real exchange rate) as

$$c = e - p \tag{9c$_2$}$$

Using ($9c_1$) and ($9c_2$), we can express the model as follows:

$$\ell = (1-\alpha)c + \varphi_1 y - (\lambda_1+\beta_1)r - \kappa_1\dot{p}_C + \beta_1 r^* \tag{1}$$

$$\dot{p}_C = \dot{p} + (1-\alpha)\dot{c} \tag{4}$$

$$\dot{c} = (r - \dot{p}) - r^* \tag{5}$$

$$y = \sigma c - \delta(r-\dot{p}_C) + \upsilon y^* + g \tag{6}$$

$$\dot{p} = \nu y + \dot{m} \tag{7}$$

$$\dot{\ell} = \dot{m} - \dot{p} \tag{10}$$

Except when m changes discontinuously as a result of an open market operation by the domestic monetary authorities, liquidity is a predetermined variable. Competitiveness, however, is a non-predetermined variable since it depends on the forward-looking nominal exchange rate e.

Through appropriate substitutions, the dynamics of the system can be summarized in terms of ℓ and c:

$$\begin{bmatrix} \dot{\hat{c}} \\ \\ \dot{\hat{\ell}} \end{bmatrix} = \frac{1}{\Delta} \begin{bmatrix} b_1 & b_2 \\ \\ a_1 & a_2 \end{bmatrix} \begin{bmatrix} \hat{c} \\ \\ \hat{\ell} \end{bmatrix} \tag{11}$$

$$\begin{aligned} \Delta &= \eta\theta + (\varphi_1 - \nu\kappa_1\alpha)\delta\alpha > 0 \\ b_1 &= (1-\alpha) + \sigma(\varphi_1 - \nu\kappa_1\alpha) - \nu\sigma\theta \gtrless 0 \\ b_2 &= -1 < 0 \\ a_1 &= -\nu\{\sigma\theta - \delta\alpha(1-\alpha)\} \ (< 0) \\ a_2 &= -\nu\delta\alpha < 0 \\ \eta &= 1 - \nu\delta\alpha > 0 \\ \theta &= \lambda_1 + \beta_1 + \kappa_1(1-\alpha) > 0 \end{aligned} \tag{11a}$$

where the circumflex over the variables denotes deviations from final equilibrium values.

The coefficient η in (11a) represents the short-run income multiplier (at any given level of c) which we take to be positive. The sign of $(\varphi_1-\nu\kappa_1\alpha)$ will be positive if an exogenous increase in home output raises the transactions demand for (home) money by more than it reduces money demand through its impact on $\dot{p}_C$ via the domestic inflation rate $\dot{p}$. Following most of the literature, we shall assume this to be the case. Hence, $\Delta > 0$. The coefficient b_1 captures the net effect of an improvement in competitiveness on the rate of real exchange-rate depreciation. An increase in c, by raising the domestic price index and by stimulating aggregate demand and output, creates excess demand for liquidity ℓ: given (1), (4), and (5), it must be accompanied by a rise in the rate of real depreciation to maintain overall financial equilibrium. At the same time, however, an improvement in competitiveness lowers the (ex-post) real domestic interest-rate, by driving up domestic inflation $\dot{p}$: this requires a fall in $\dot{c}$ to preserve bond markets equilibrium i.e. to satisfy (5). Depending on which of these two effects dominates, b_1 will therefore be positive or negative.

Figure (1) gives the phase plane representation of (11). Without loss of generality, the coefficient a_1 can be assumed to be negative. Thus, in both panels of the figure, the $\dot{\ell} = 0$ locus is drawn as a negatively sloping curve. The sign of the slope of the $\dot{c} = 0$ locus is in general ambiguous, as it depends on the sign of b_1. However it can be verified[4] that if the $\dot{c} = 0$ locus slopes downwards (as in the case of panel (b)) it will be steeper than the $\dot{\ell} = 0$ locus provided that $\Delta > 0$. Hence, on the assumption that the coefficients η and $(\varphi_1 - \nu\kappa_1\alpha)$ are positive, the equilibrium will always be a saddle-point and the unique stable-path will be upward-sloping, irrespective of CS. In Figure (1), the unique stable path is shown as the schedule SS.

It is useful to determine the long-run response of the domestic variables to the foreign disturbances before examining the dynamics of adjustment. In this model, long-run equilibrium requires that all real variables are constant i.e. $\dot{\ell} = 0$ and $\dot{c} = 0$. Imposing the long-run equilibrium condition $\dot{\ell} = \dot{c} = 0$, equations (1), (4)-(7) and (10) yield (12):

$$\dot{p} = \dot{m}$$

$$\dot{e} = \dot{p}$$

$$\dot{e} = r - r^*$$

$$\sigma c - \delta(r - \dot{p}) + \upsilon y^* + g = 0$$

$$\ell = (1-\alpha)c - (\lambda_1 + \beta_1)r - \kappa_1 \dot{p} + \beta_1 r^* \tag{12}$$

Differentiating (12) with respect to r* and y*, we obtain the following effects on competitiveness, on liquidity, and on the domestic interest rate:

Effects of an unanticipated decline in the foreign interest-rate under currency substitution

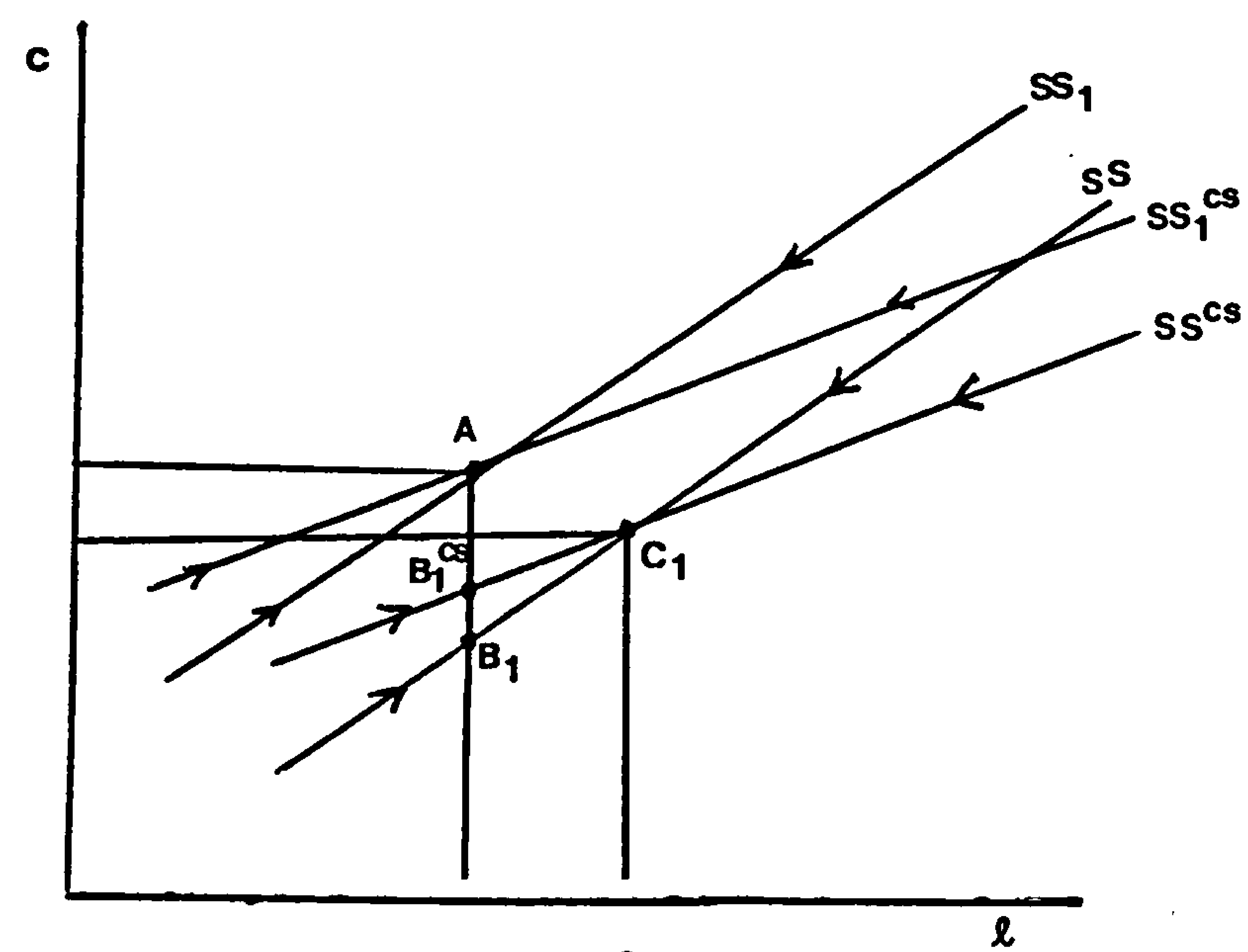


Figure 2a

Effects of an unanticipated fall in foreign output under currency substitution

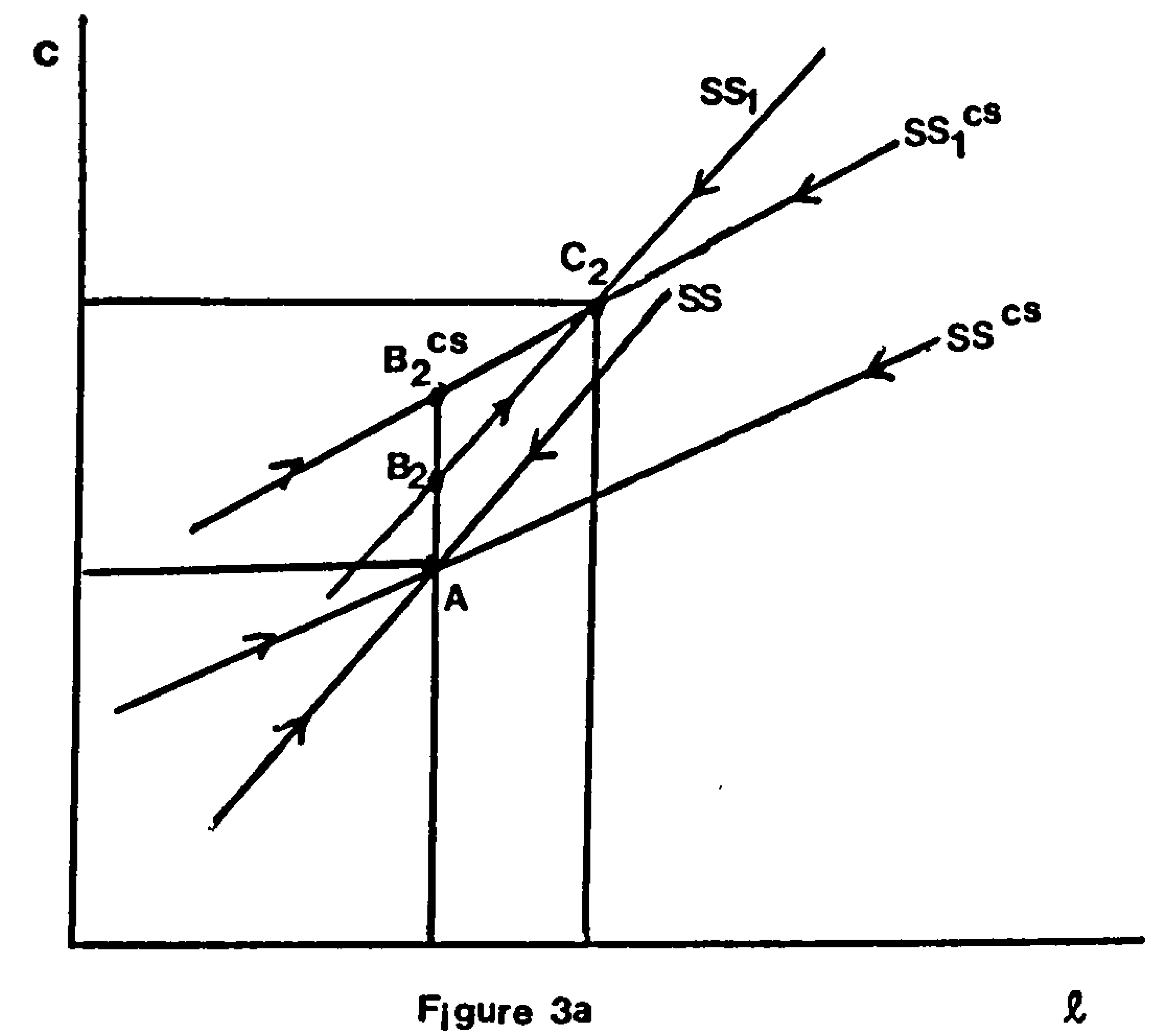


Figure 3a

Currency Substitution in a Small-Country Model

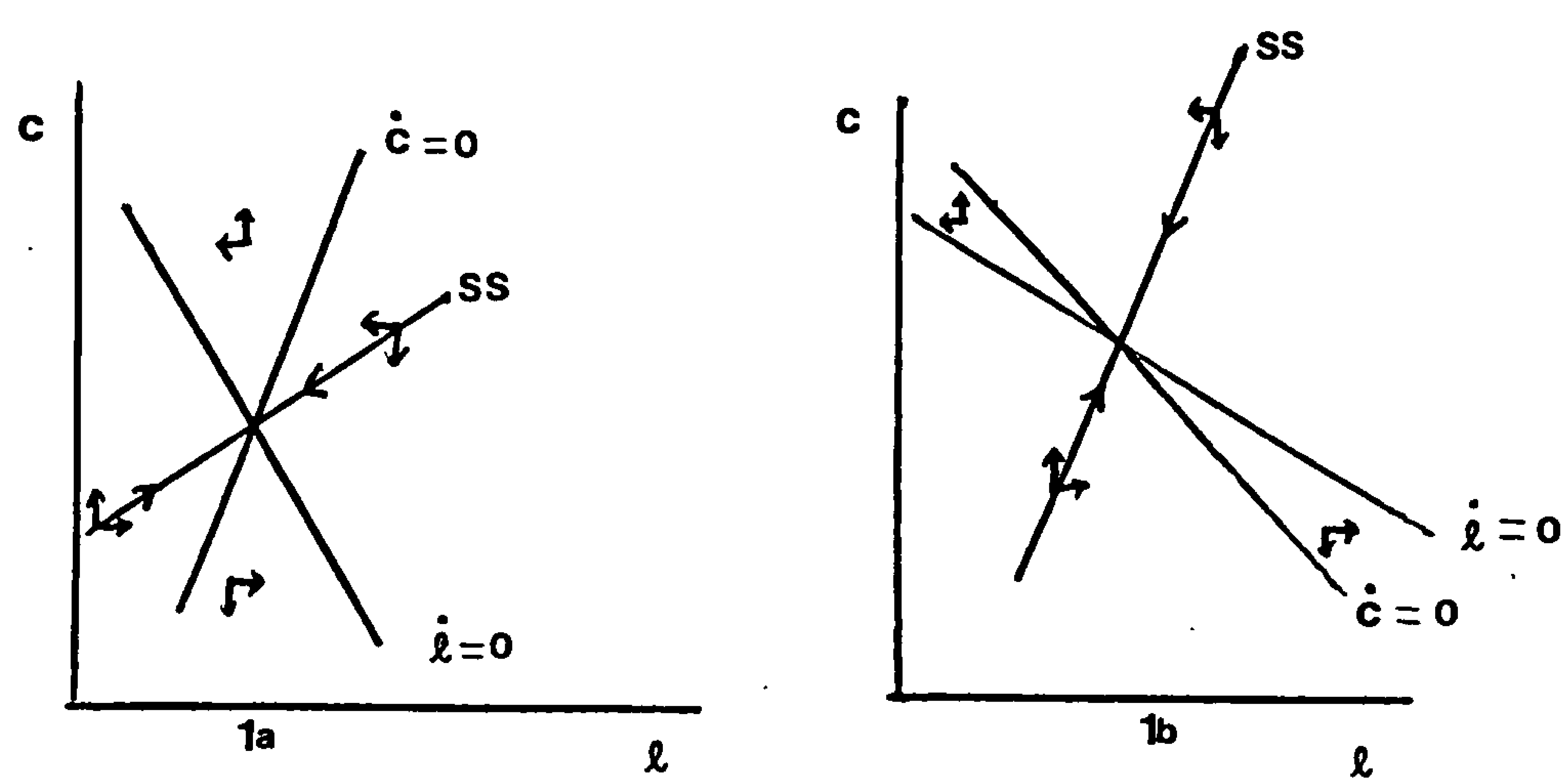


Figure 1

$$d\bar{c} = \frac{\delta}{\sigma} dr^* \qquad (12a_1) \qquad d\bar{\ell} = -\{\lambda_1 - (1-\alpha)\frac{\delta}{\sigma}\} dr^* \qquad (12a_2) \qquad d\bar{r} = dr^* \qquad (12a_3)$$

$$d\bar{c} = -\frac{\upsilon}{\sigma} dy^* \qquad (12b_1) \qquad d\bar{\ell} = -\frac{\upsilon}{\sigma}(1-\alpha)dy^* \qquad (12b_2) \qquad d\bar{r} = 0 \qquad (12b_3)$$

where bars are used to denote steady-state values. In $(12a_1)$-$(12a_3)$, r falls in proportion to the fall in the foreign interest rate to maintain equilibrium in the bond markets. Accordingly, the real exchange rate appreciates to balance the demand for home goods with the given, full-capacity output $\tilde{y}$. In $(12b_1)$-$(12b_3)$, however, r returns to its initial steady-state level. Hence, c increases as necessary to offset the reduced demand for home goods caused by the fall in foreign output. As r decreases in $(12a_1)$-$(12a_3)$, real domestic money balances $(m-p_C)$ will have to be higher in the new steady-state than what they were initially. This is partly achieved through the impact of the long-run real appreciation on p_C. But, it is to be expected that ℓ - the stock of home money in terms of the price of domestic output - will have to increase as well. In $(12b_1)$-$(12b_3)$, as c depreciates, ℓ must also rise to preserve equilibrium in the domestic money market.

It may be noted that both $(12a_2)$ and $(12b_2)$ indicate that the domestic inflation rate must temporarily fall below its initial value to allow the steady-state p to be lower relative to m. Since the long-run changes in liquidity and in competitiveness are independent of the CS parameter β_1, this implies that disturbances will still be transmitted across countries even in the absence of currency substitution. Because $\dot{e}$ may change between steady states, however, CS may influence the significance of the transmission effect.

To examine that possibility it is necessary to establish how CS will influence the slope of the stable-path SS in Figure (1). The solution to (11) is of the form

$$\hat{c} = D_1\, e^{\rho_1 t} + D_2\, e^{\rho_2 t}$$

$$\hat{\ell} = D_1 \frac{(\rho_1\Delta - b_1)}{b_2}\, e^{\rho_1 t} + D_2 \frac{(\rho_2\Delta - b_1)}{b_2}\, e^{\rho_2 t} \qquad \begin{matrix}\rho_1 < 0\\ \rho_2 > 0\end{matrix} \tag{11b}$$

where ρ_1 and ρ_2 denote, respectively, the stable and the unstable root of (11). Restricting the response of the system to the stable-path (by setting the coefficient of the unstable root, D_2, equal to zero), we can arrive at the following expression for the SS locus:

$$\hat{c} = -\frac{b_2}{(\Delta\rho_2 - a_2)}\hat{\ell} = -\frac{b_2}{(b_1 - \Delta\rho_1)}\hat{\ell} \qquad \begin{matrix}(\Delta\rho_2 - a_2) > 0\\ (b_1 - \Delta\rho_1) > 0\end{matrix} \tag{11c$_1$}$$

where

$$\rho_1, \rho_2 = \frac{(a_2 + b_1) \mp \sqrt{(a_2 + b_1)^2 + 4\sigma r\Delta}}{2\Delta} \tag{11c$_2$}$$

Differentiating the denominator of (11c$_1$) with respect to β_1, we obtain

$$\frac{d(\Delta\rho_2 - a_2)}{d\beta_1} = \nu\sigma(\eta - \Delta\rho_2)/[\Delta(\rho_2 - \rho_1)] \qquad \Delta(\rho_2 - \rho_1) > 0 \tag{11d}$$

Also, using the definition of $\hat{c}$ and of $\hat{\ell}$, we can re-write (11c$_1$) as

$$\hat{e} = -[(\eta - \Delta\rho_2)/(\Delta\rho_2 - a_2)]\hat{p} + [1/(\Delta\rho_2 - a_2)]\hat{m} \tag{11e}$$

From (11e) it is apparent that the sign of the expression (11d) depends upon the relationship between movements in e and p along the unique saddle-path i.e. for any given $\hat{m}$. As we have shown in Chapter 2, the sign of this relationship is in general invariant to the CS possibility. Furthermore, in the context of models like the present one, that relationship is most likely to be negative, and, hence, the relationship between $\hat{c}$ and $\hat{e}$ can be expected to be positive. What this implies is that CS will cause the SS locus to become flatter. This is illustrated in Figures (2a)-(3a), which can be used to analyse the effects of the foreign disturbances on the home economy. Both Figures show an initial equilibrium at point A. Given ($12a_1$)-($12a_3$) and ($12b_1$)-($12b_3$), final equilibrium is assumed to be at point C_1 in Figure (2a) and at point C_2 in Figure (3a).

Consider first the effects of the decline in the foreign interest rate. Upon the unanticipated fall in r*, the stable locus in Figure (2a) is shifted down to the right: irrespective of CS the real exchange rate appreciates, overshooting the amount necessary for achieving long-run equilibrium. With CS, however, the size of the initial real appreciation is actually smaller as short-run equilibrium occurs at point B_1^{CS}. Consider next the adjustment of the system to the unanticipated decrease in the level of the foreign output y*. In Figure (3a), the drop in y* causes a moderate short-run depreciation, with c converging gradually to its new, higher steady-state value. As the instantaneous response of c occurs at point B_2^{CS} under CS, here currency substitution leads to a larger initial jump in the real exchange rate. However, the domestic recession induced by *both* disturbances will be shallower in the presence of CS than in the absence of CS: in Figure (2a), and with the ultimate consequence of CS being to limit the size of the immediate real appreciation, the contraction in home output is to be expected to be smaller as well; and, in Figure (3a), part of the short-run adverse impact of the fall in y* on domestic output is offset by the relatively larger rise in competitiveness.

Our findings might appear suprising in view of the earlier work on currency substitution, which stresses that CS enhances rather than mitigates the significance of the international trasmission of disturbances. The crux of the matter lies in the requirement of complete financial equilibrium which our model takes into account. In the case of the decline in r*, the tendency for the domestic interest-rate to decrease (via the bond markets equilibrium condition (5a)) creates excess demand in the domestic money market: with or without CS, this requires an instantaneous nominal *and* real appreciation to maintain overall equilibrium. The reason why the size of the appreciation is relatively small under CS is that the expectation of a rising c and e along SS_1, by raising the incentives for holding foreign money, reduces the excess demand for home money. In the case of the fall in y*, the initial real and nominal depreciation is relatively large under CS because, given the anticipated future rise in c and e, a portfolio shift towards foreign money as well as towards bonds takes place in the short run. This intensifies the excess supply forces in the home money market (brought about by the negative impact of the fall in y* on home output), and, hence, it increases the size of the change in c required to maintain overall equilibrium.

Table I in Appendix I provides a numerical illustration of the effects of the foreign disturbances on home output and real exchange rate under CS.

III. *Currency Substitution in a Two-Country Model.*

We shall now consider two countries - hereafter called 'home economy' and 'overseas economy'- assuming that neither of them is small in relation to the other. Accordingly, we shall postulate that the residents of both countries may wish to hold as assets: the two national monetary assets M and M*; and the two national bonds, which, as in Section II, are assumed to be perfect substitutes. Using asterisks to denote variables pertaining to the overseas economy's macroeconomic aggregates, and defining the exchange rate E as the price of home currency per unit of overseas currency, we may specify equilibrium in the home money market as follows:

$$M_h = P_c L_h(Y, r, \dot{e}, \dot{p}_c) \qquad L_{h_1} > 0,\ L_{h_2}, L_{h_3}, L_{h_4} < 0 \qquad (1a.1)$$

$$M_o = EP_c{*}L_o(Y^*, r^*, \dot{e}, \dot{p}_c{*}) \qquad L_{o_1} > 0,\ L_{o_2}, L_{o_3}, L_{o_4} < 0 \qquad (1a.2)$$

$$M = M_h + M_o \qquad (1a.3)$$

$$P_c \equiv P(EP^*/P)^{(1-\alpha)} \qquad (1a.4)$$

$$P_c{*} \equiv P^*(P/EP^*)^{(1-\alpha^*)} \qquad (1a.5)$$

where, for any variable $\dot{x}^e$, we have set $\dot{x}^e = \dot{x}$ to indicate forward-looking expectations.

Equation (1a.1) gives the home residents' desired holdings of M, and it is similar to equation (1a) of the previous section. In (1a.2), overseas (real) demand for home money is expressed as: (a) a positive function of an overseas scale variable, proxied by real overseas output Y*; (b) an increasing function of the rate of return on M relative to that on M* from the overseas residents' point of view - i.e. the expected rate of depreciation of the overseas currency; and (c) a negative function of the opportunity cost of holding M, that is, the rate of return on bonds r^* and the overseas price-index inflation $\dot{p}_c^*$. p_c and p_c^* are defined in (1a.4) and (1a.5) respectively. Equilibrium in the market for home money is attained when the sum of home and overseas demand for M equals the existing stock of M: this is indicated by equation (1a.3).

Similarly, equilibrium in the market for overseas money can be specified as

$$M_o^* = P_c^* J_o(Y^*, r^*, \dot{e}, \dot{p}_c^*) \qquad J_{o1}, J_{o3} > 0, J_{o2}, J_{o4} < 0 \qquad (2a.1)$$

$$M_h^* = (\frac{1}{E}) P_c J_h(Y, r, \dot{e}, \dot{p}_c) \qquad J_{h1}, J_{h3} > 0, J_{h2}, J_{h4} < 0 \qquad (2a.2)$$

$$M^* = M_o^* + M_h^* \qquad (2a.3)$$

where $J_o(.)$ denotes the (real) demand for M^* by the overseas residents and $J_h(.)$ is the (real) demand for M^* by the home residents.

Substituting (1a.1)-(1a.2) into (1a.3) and (2a.1)-(2a.2) into (2a.3), we obtain,

$$M = P_c L_h(Y, r, \dot{e}, \dot{p}_c) + E P_c^* L_o(Y^*, r^*, \dot{e}, \dot{p}_c^*) \qquad L_{h1} - L_{o1} \ (>0) \qquad (1a')$$

$$M^* = P_c^* J_o(Y^*, r^*, \dot{e}, \dot{p}_c^*) + \frac{1}{E} P_c J_h(Y, r, \dot{e}, \dot{p}_c) \qquad J_{o1} - J_{h1} \ (>0) \qquad (2a')$$

and using (1a.4)-(1a.5) to eliminate p_c and p_c^* from (1a')-(2a'), we can express the global demand for each national monetary asset in terms of *the own-currency price level* as

$$\frac{M}{P} = L_h(.) \left(\frac{EP^*}{P}\right)^{(1-\alpha)} + \frac{EP^*}{P} L_o(.) \left(\frac{P}{EP^*}\right)^{(1-\alpha^*)}$$

$$\frac{M^*}{P^*} = J_o(.) \left(\frac{P}{EP^*}\right)^{(1-\alpha^*)} + \frac{P}{EP^*} J_h(.) \left(\frac{EP^*}{P}\right)^{(1-\alpha)}$$

Accordingly, financial equilibrium in the world economy can be descrided as follows:

$$\frac{M}{P} = L_h(\cdot)\left(\frac{EP^*}{P}\right)^{(1-\alpha)} + \frac{EP^*}{P} L_o(\cdot)\left(\frac{P}{EP^*}\right)^{(1-\alpha^*)} \qquad (1a)$$

$$\frac{M^*}{P^*} = J_o(\cdot)\left(\frac{P}{EP^*}\right)^{(1-\alpha^*)} + \frac{P}{EP^*} J_h(\cdot)\left(\frac{EP^*}{P}\right)^{(1-\alpha)} \qquad (2a)$$

$$r = r^* + \dot{e} \qquad (3a)$$

where (3a) is the equilibrium condition in the bond markets.

As for the real sectors, the equilibrium condition in the home economy's goods market is given by (4a) and the behaviour of the price of home output is described by (5a):

$$Y = A(Y,\ r^R,\ EP^*/p,\ Y^*) + G \qquad (4a) \qquad\qquad \dot{p} = \gamma(Y/\tilde{Y}) + \dot{m} \qquad (5a)$$

$$A_1,\ A_3,\ A_4 > 0,\ A_2 < 0$$

where

$$r^R = r - \dot{p}_C,\ \dot{p}_C = \dot{p} + (1-\alpha)(\dot{e}+\dot{p}^*-\dot{p})$$

The overseas economy's real sector is described in a similar way by (6a) and (7a):

$$Y^* = A^*(Y^*,\ r^{*R},\ EP^*/p,\ Y) + G^* \qquad (6a) \qquad\qquad \dot{p}^* = \gamma^*(Y^*/\tilde{Y}^*) + \dot{m}^* \qquad (7a)$$

$$A_1^*,\ A_4^* > 0,\ A_2^*,\ A_3^* < 0$$

where

$$r^{*R} = r^* - \dot{p}_C^*,\ \dot{p}_C^* = \dot{p}^* + (1-\alpha^*)(\dot{p}-\dot{e}-\dot{p}^*)$$

Our two-country model is now complete. Consider the characteristics of this model. From (1a')-(2a') and (1a)-(2a), it can be seen that the "*rate-of-return effect*" of CS once again implies that changes in the nominal rate of depreciation may directly disturb the equilibrium of the national money markets. Consider, however, the additional elements that CS introduces into this two-country model. Firstly, the global demand for each individual monetary asset now depends on foreign interest rates as well as on domestic interest rates. Secondly, for a given Y and a given Y*, current movements in the real exchange rate ($EP^*/_E$), by affecting the real value of home and overseas money held by non-residents, will directly influence the demand for M and for M* in terms of the own-currency price levels. It is worth noting that, in the context of this model, such a direct impact of real exchange-rate variations on the national monetary sectors occurs even when national price indices are relatively insensitive to changes in the prices of goods produced abroad (i.e. even when α and α^* in (1a)-(2a) are close to unity). In the following discussion, we shall assume, for simplicity, that α_1, $\alpha_1^* \to 1$ and hence $P_C = P$, $P_C^* = P^*$, $\dot{p}_C = \dot{p}$, $\dot{p}_C^* = \dot{p}^*$. Thirdly, with $L_{01} \neq 0$ in (1a') and with $J_{h1} \neq 0$ in (2a'), fluctuations in the level of real economic activity abroad will directly affect each country's domestic monetary equilibrium. Fourthly, an exogenous increase in the rate of inflation overseas will change the overseas residents' demand for all nominal assets, including home money M. Similarly, a rise in the rate of inflation at home will lower the home residents' demand for all nominal assets, including overseas money. We refer to these additional effects of CS as: the "*foreign interest-rate effect*", the "*terms-of-trade effect*", the "*foreign-income effect*" and the "*foreign-inflation effect*".

In what follows, we shall study the behaviour of the system subsequent to unilateral and previously unanticipated monetary policy actions, namely:

(a) an unexpected contraction in the level of overseas money supply, and (b) an unexpected slowdown in the rate of overseas money growth.

For convenience, we shall use a log-linear version of the model. To make our analysis as simple as possible, we shall also assume that the structural parameters of the two economies are the same. Accordingly, by log-linearizing (1a)-(7a) around the initial steady state (taken to be characterized by $EP^*/P = M/P = M^*/P^* = 1$, $Y = Y^* = 1$), we can write the model as follows:

$$\ell_h = \varphi_1 y - \lambda_1 r - \kappa_1 \dot{p} - \beta_1 \dot{e} \qquad (1.1) \qquad \ell_o^* = \varphi_1 y^* - \lambda_1 r^* - \kappa_1 \dot{p}^* + \beta_1 \dot{e} \qquad (2.1)$$

$$\ell_o = \varphi_2 y^* - \lambda_2 r^* - \kappa_2 \dot{p}^* - \beta_2 \dot{e} + \psi c \qquad (1.2) \qquad \ell_h^* = \varphi_2 y - \lambda_2 r - \kappa_2 \dot{p} + \beta_2 \dot{e} - \psi c \qquad (2.2)$$

$$\ell = \ell_h + \ell_o \qquad (1.3) \qquad \ell^* = \ell_o^* + \ell_h^* \qquad (2.3)$$

$$\ell = m - p \qquad (1.4) \qquad \ell^* = m^* - p^* \qquad (2.4)$$

$$\dot{e} = r - r^* \qquad (3)$$

$$y = \sigma c - \delta(r - \dot{p}) + \upsilon y^* \qquad (4) \qquad y^* = -\sigma c - \delta(r^* - \dot{p}^*) + \upsilon y \qquad (6)$$

$$\dot{p} = \nu y + \dot{m} \qquad (5) \qquad \dot{p}^* = \nu y^* + \dot{m}^* \qquad (7)$$

$$c = e - p + p^* \qquad (8)$$

The parameter ψ in (1.2) and (2.2) can be taken to measure the share of the overseas holdings of M and of the domestic holdings of M* in the total stock of these assets (in the neighbourhood of the steady-state). Thus, in the context of equations (1)-(8), a non-zero value of ψ represents the "*terms-of-trade effect*" of CS. Analogously, a non-zero λ_2, φ_2 and κ_2 can be taken to represent, respectively, the "*foreign interest-rate effect*", *the* "*foreign income effect*" and the "*foreign inflation effect*" of CS.

Using Aoki's (1981) device of expressing the system in terms of 'relative' and 'global' variables, we can reduce (1.1)-(1.4), (2.1)-(2.4) and (3)-(8) to

$$\ell^d = 2\psi c+(\varphi^*-\nu\kappa^*)y^d-(\lambda_1+\lambda^*)r^d-\kappa^*\dot{m}^d$$

$$y^d = [2\sigma c - \delta(r^d - \dot{m}^d)]\eta_1$$

$$\dot{\ell}^d = -\nu y^d$$

$$\dot{c} = r^d - \nu y^d - \dot{m}^d \qquad (9)$$

where

$\varphi^* = \varphi_1-\varphi_2$ (> 0), $\kappa^* = (\kappa_1-\kappa_2)$(> 0)

$\lambda^* = 2\beta-\lambda_2$, $\beta = (\beta_1+\beta_2)$

$\eta_1 = (1+\upsilon-\nu\delta)^{-1}$ (>0) (9a)

$$\ell^w = (\pi_1^*-\nu\pi_2^*)y^w-\gamma^*r^w-\pi_2^*\dot{m}^w$$

$$y^w = -\delta(r^w - \dot{m}^w)\eta_2$$

$$\dot{\ell}^w = -\nu y^w \qquad (10)$$

where

$\pi_1^* = \varphi_1+\varphi_2$, $\pi_2^* = \kappa_1+\kappa_2$

$\gamma^* = \lambda_1+\lambda_2$

$\eta_2 = (1-\upsilon-\nu\delta)^{-1}$ (>0) (10a)

where, for any variable x, we define $x^w = x + x^*$ and $x^d = x - x^*$. Thus ℓ^d, for example, can be taken to represent the *composition* of global liquidity while ℓ^w is the *aggregate* level of liquidity. This device not only simplifies the dynamic analysis of the model, but it also enables us to examine the implications of CS for the behaviour of 'relative' variables (such as the real exchange rate) separately from that of 'global' variables. Noting that $x = 1/2(x^w + x^d)$ and $x^* = 1/2(x^w - x^d)$, solutions for the variables x and x* can be easily derived from (9)-(10).

Through appropriate substitutions, the dynamics of the model can be summarized in terms of ℓ^d, c and ℓ^w:

$$\begin{bmatrix} \hat{\dot{c}} \\ \hat{\dot{\ell}}^d \end{bmatrix} = \frac{1}{\Delta_1}\begin{bmatrix} b_{11} & b_{21} \\ a_{11} & a_{21} \end{bmatrix}\begin{bmatrix} \hat{c} \\ \hat{\ell}^d \end{bmatrix} \qquad (11)$$

$$\hat{\dot{\ell}}^w = -\frac{\nu\delta}{\Delta_2}\hat{\ell}^w \qquad (12)$$

$\Delta_1 = \delta(\varphi^*-\nu\kappa^*)+\eta_1(\lambda_1+\lambda^*) > 0$

$b_{11} = 2\{(1+\upsilon)\psi+\sigma(\varphi^*-\nu\kappa^*)-\sigma\nu(\lambda_1+\lambda^*)\} \lesseqgtr 0$

$b_{21} = -(1+\upsilon) < 0$

$a_{21} = -\nu\delta < 0$

$a_{11} = -2\nu\{(\lambda_1+\lambda^*)\sigma-\delta\psi\}$ (< 0) (11a)

$\Delta_2 = \delta\pi_1^* + \theta^* > 0$

$\theta^* = \gamma^*(1-\upsilon-\nu\delta)-\pi_2^*\nu\delta > 0$ (12a) where the circumflex indicates deviations from final equilibrium values.

Consider first the 'relative' model (11). It can be demonstrated that (11) will be saddle-point stable provided that $\Delta_1 > 0$, an assumption we make. Assuming (saddle-point) stability, an expression for the unique stable path (shown as the schedule SS in Figure (4)) can be derived as

$$\hat{c} = -\frac{b_{21}}{(\Delta_1\rho_2-a_{21})}\hat{\ell}^d = -\frac{b_{21}}{(b_{11}-\Delta_1\rho_1)}\hat{\ell}^d \qquad \begin{array}{l}\rho_1 < 0,\ \rho_2 > 0\\ (\Delta_1\rho_2-a_{21}) > 0\\ (b_{11}-\Delta_1\rho_1) > 0\end{array} \qquad \text{(11b)}$$

where ρ_1 and ρ_2 denote, respectively, the stable root and the unstable root of (11), and they are given by

$$\rho_1,\ \rho_2 = \frac{(a_{21}+b_{11}) \mp \sqrt{(a_{21}+b_{11})^2+8\sigma\gamma\Delta_1}}{2\Delta_1} \qquad \text{(11c)}$$

From (9a) and (11a)-(11c), one can easily establish that both the "terms-of-trade effect" ($\psi \neq 0$) and the "foreign-inflation effect" ($\kappa_2 \neq 0$) of CS will cause the SS locus to slope less steeply. Given our earlier points, the explanation for this result is straightforward: irrespective of CS, when the current composition of global liquidity ℓ^d is above its steady-state value, the real exchange rate c must depreciate relative to its steady-state level to maintain overall equilibrium. Under CS, however, any given rise in c, by lowering the value of the overseas residents' real holdings of home money and by increasing the value of the home residents' real holdings of overseas money, will raise the desired level of ℓ and will reduce the desired level of ℓ^*. To preserve equilibrium along SS, any given change in the current composition of global liquidity ℓ^d will, therefore, require a relatively small change in the real exchange rate c. Also, a given short-run change in any individual inflation rate, by

Currency Substitution in a Two-Country Model

Fig.4

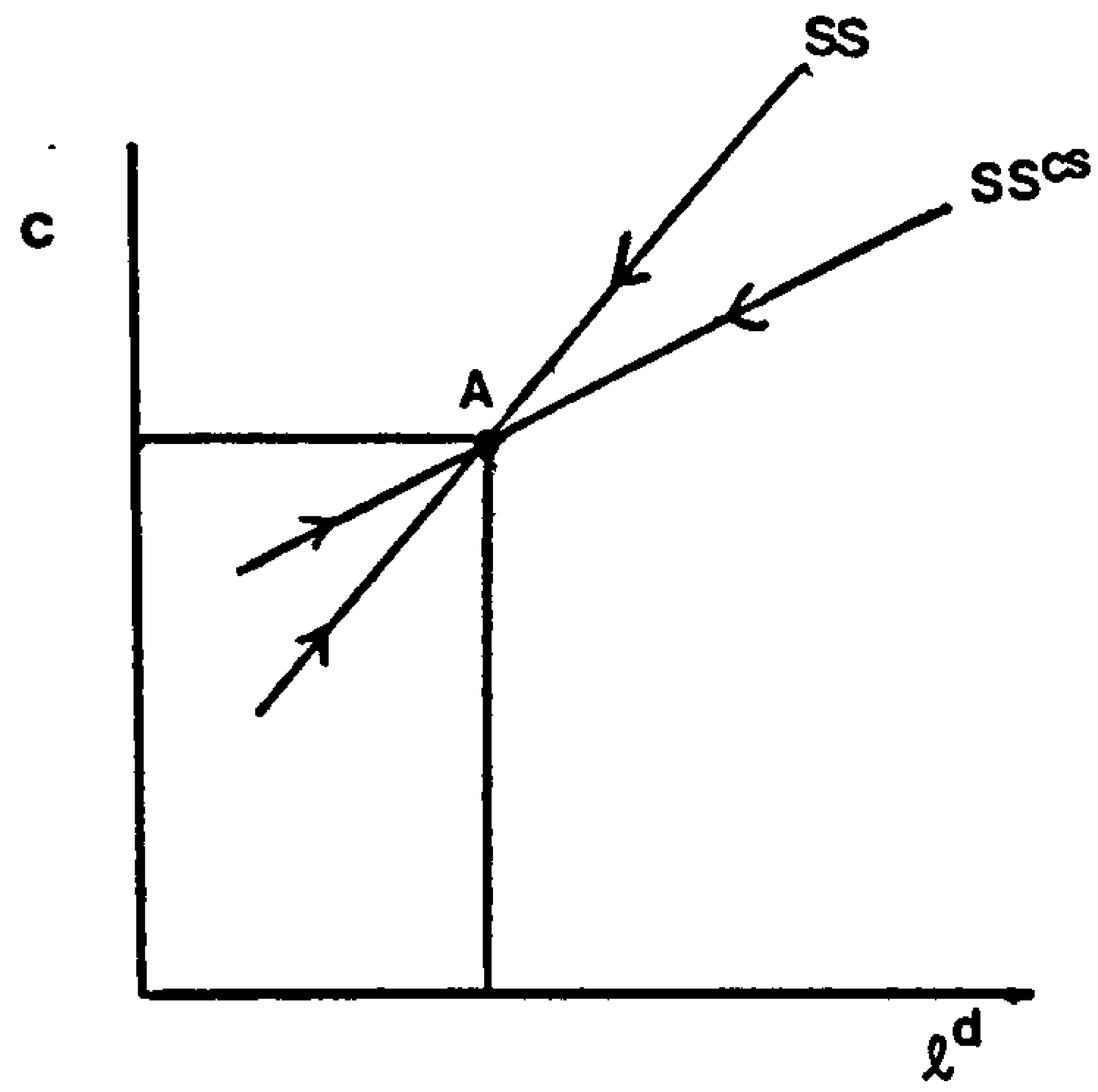
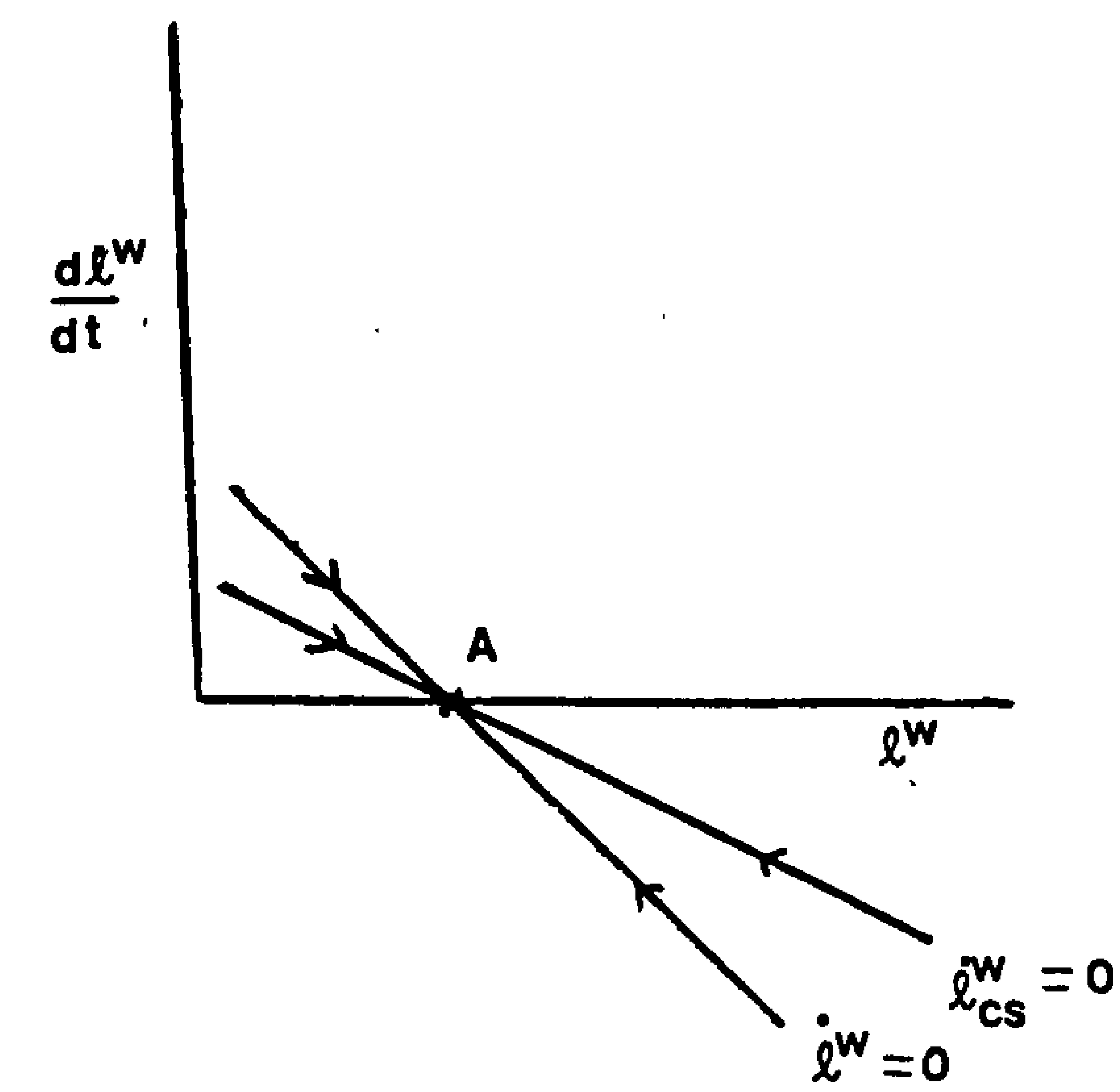
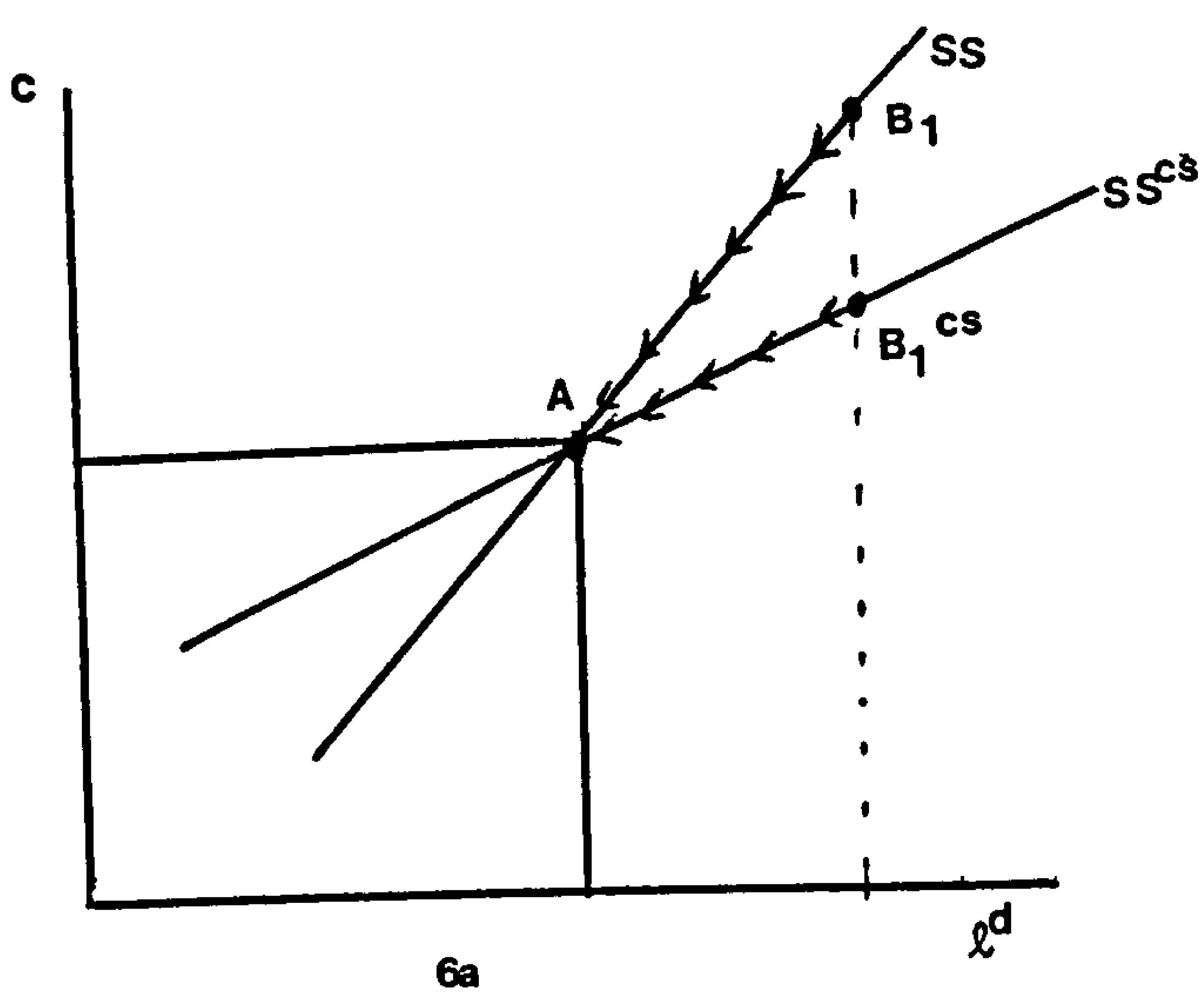


Fig.5



Monetary Disturbances and CS



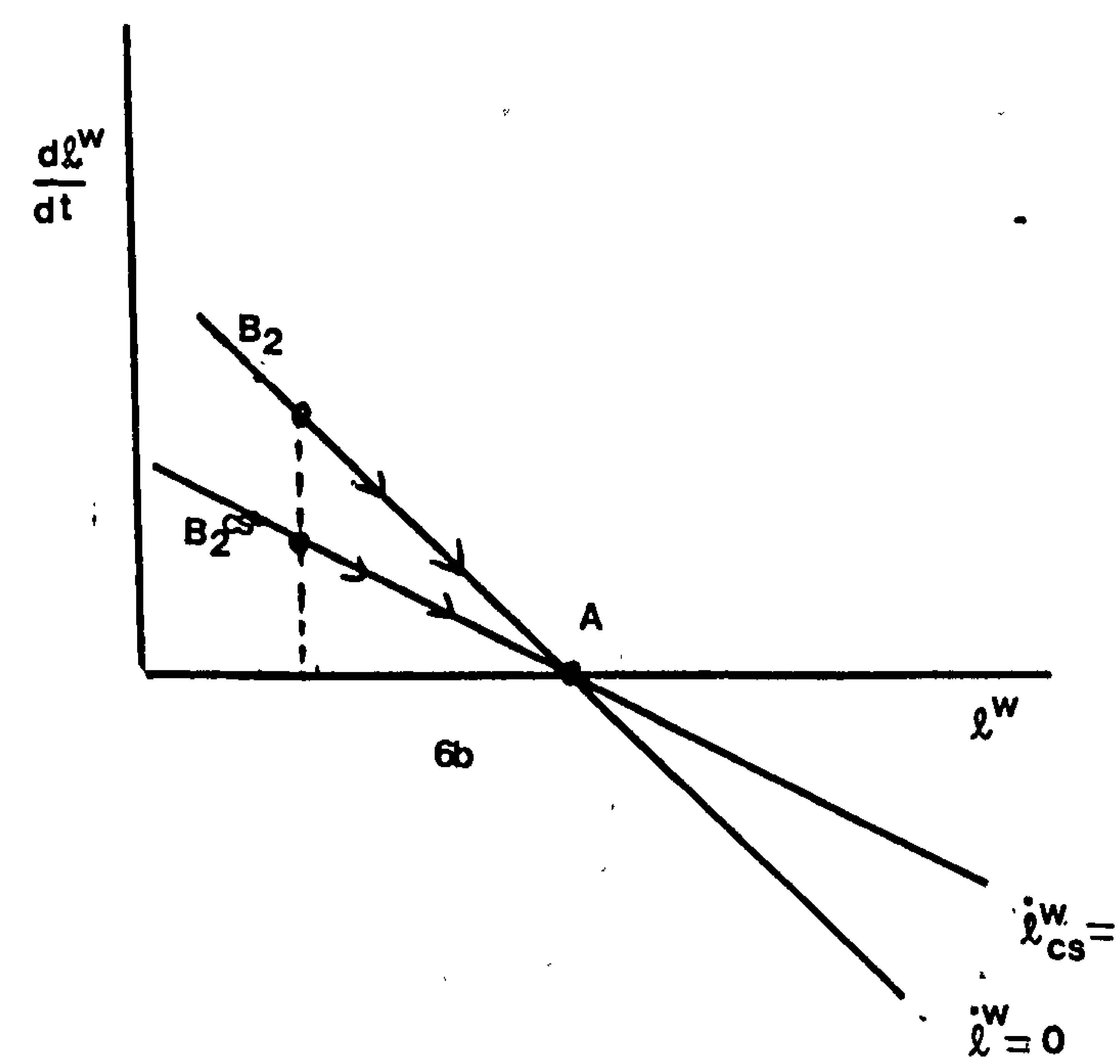


Figure 6

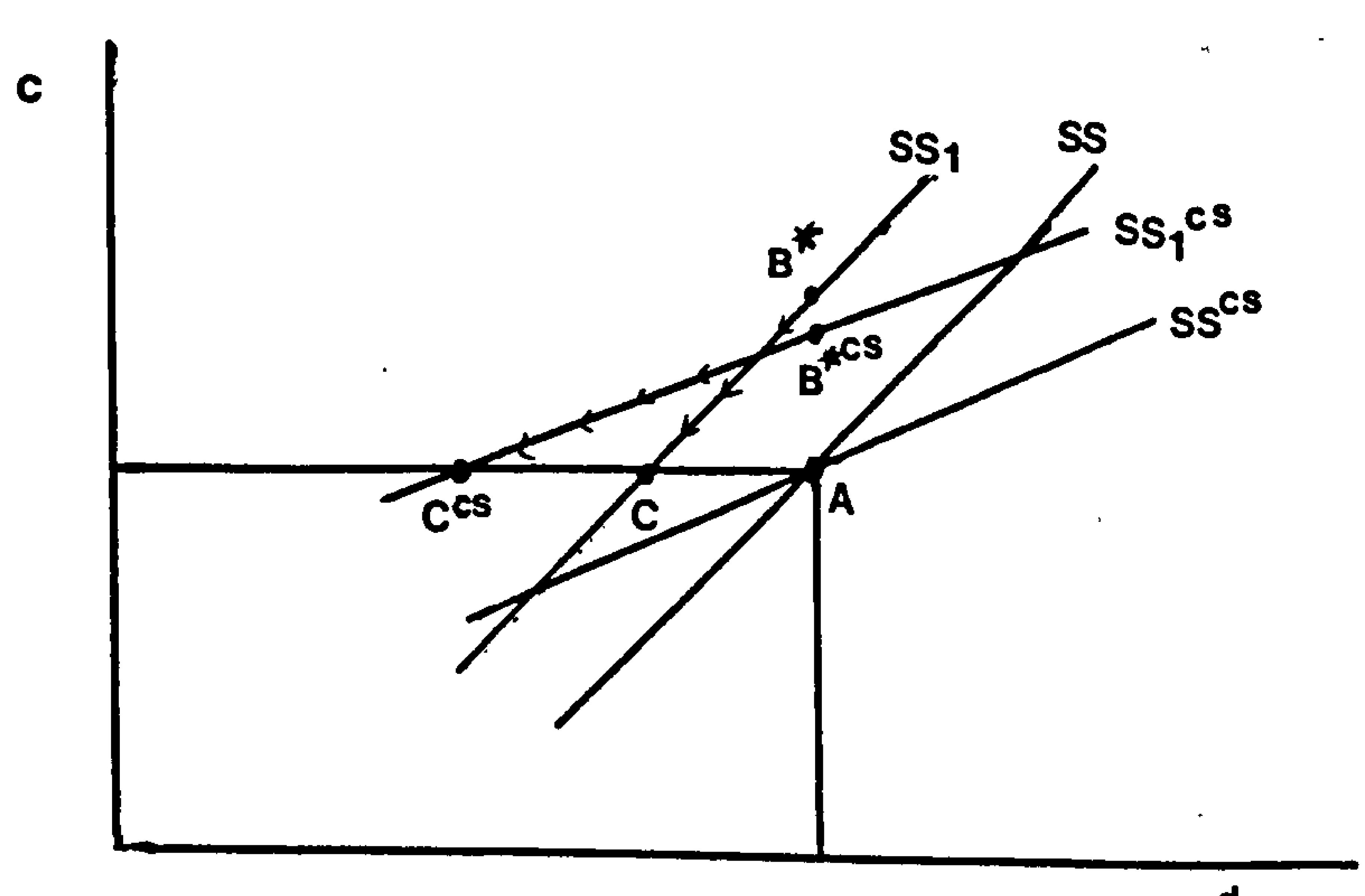


Figure 7

altering the global demand for M and M* in the same direction, will have a relatively small destabilizing effect on the desired level of ℓ^d and hence on c itself.

From (9a) and (11a)-(11c) it can be further verified that the implication of the "rate-of-return effect" ($\beta \neq 0$) of CS for the slope of the stable path is analogous to that observed in the model of Section II. Given the requirement of bond markets equilibrium, however, in this two-country model the influence of that effect on the SS locus is subjected to one opposing force, namely, the "foreign interest-rate effect" ($\lambda_2 \neq 0$). Thus, the coefficient λ^* in (9a) is likely to be relatively small in absolute size, especially when the speculative motive for holding money assets denominated in different currencies (reflected in the values of β_1 and β_2) is relatively weak. Finally, the "foreign income effect" ($\varphi_2 \neq 0$) of CS tends to increase the steepness of the SS locus by lowering the denominator of (11b). As can be seen from (9) and (9a) that effect reduces the sensitivity of the relative demand for domestic and foreign money to changes in the relative level of home and foreign output. It therefore implies that a comparatively large adjustment of y^d must occur in the short run to preserve equilibrium if the current composition of global liquidity is above or below its steady-state value. A relatively large adjustment of y^d, in turn, requires a relatively large short-run adjustment of c and hence a relatively steep SS locus.

Consider next the 'aggregate model' (12). Equation (12) is plotted in Figure (5) as the $\dot{\ell}^w = 0$ locus. The absolute value of the slope of the locus depends partly on the size of Δ_2. From (10a) and (12a), it can be seen that the opposing effects of a non-zero λ_2 and a non-zero κ_2 on the value of θ^* tend to cancel out. Accordingly, the net influence of CS on the $\dot{\ell}^w = 0$ locus will mainly be through the "foreign-income effect" ($\varphi_2 \neq 0$): this will cause the locus to slope less steeply.

A contraction in the level of overseas money supply.

Figures (6a)-(6b) can be used to illustrate the implications of CS for the response of the system to an unanticipated contraction in the level of overseas money (achieved, for example, via an open market operation by the overseas government). It is easy to show that this disturbance will affect neither the steady-state value of c nor those of ℓ^d and ℓ^w, so that adjustments will take place along the original SS and $\dot{\ell}^w = 0$ loci. Consequently, and in view of our earlier considerations, CS can be expected to be, on the whole, 'stabilizing'. Firstly, in Figure (6a), upon the unanticipated contraction in m*, and with ℓ^d being increased instantaneously, the real exchange rate depreciates and overshoots irrespective of CS. Provided that the foreign-income effect is not unduly strong, however, CS will reduce the size of the overshooting as the initial response of c will occur at point B_1^{cs}. Secondly, in Figure (6b), the global recession is, due to the foreign-income effect of CS, less profound at point B_2^{cs} than at point B_2. Thirdly, given the definition of the $x^w{}_i$'s and $x^d{}_i$'s, points B_1^{cs} and B_2^{cs} suggest that CS will almost certainly limit both the extent of the short-run fall in the overseas economy's real output and the significance of the transmission effect to the home country's real income.

A slowdown in the rate of overseas money growth.

An unanticipated slowdown in the rate of overseas money growth will also lead to an instantaneous depreciation of the real exchange rate irrespective of CS, as it will raise the real interest rate differential in favour of the overseas economy in the short-run. The main change from the previous analysis is that now the steady-state equilibrium will be altered. Imposing the steady-state requirement that all real variables are constant, it can be shown that the home country's nominal and real interest rate will remain unchanged while the overseas economy's nominal interest rate will fall in proportion to the reduction in $\dot{m}^*$. Thus, r^d will rise and the rate of nominal exchange-rate depreciation will increase to maintain bond markets equilibrium. The real exchange rate, however, will return to its previous steady-state level. The long-run change in the composition of global liquidity ℓ^d is given by

$$d\bar{\ell}^d = (\lambda_1 + \lambda^* + \kappa^*)d\dot{m}^* \tag{13}$$

where $\lambda^* = 2\beta - \lambda_2$

$\kappa^* = \kappa_1 - \kappa_2$

From (13) it can be seen that the steady-state value of ℓ^d is influenced by the presence of CS in a way that is in principle ambiguous. As $\dot{e}$ is increased, CS, through the "rate-of-return effect" ($\beta \neq 0$), contributes to the desired shift of global liquidity away from home money and towards overseas money. As r^* and $\dot{p}^*$ are lower in the new steady state than what they were initially, however, overseas demand is shifted towards both of the two nominal monetary assets M and M*: this, through the "foreign-interest-rate effect" ($\lambda_2 \neq 0$) and the "foreign-inflation effect" ($\kappa_2 \neq 0$) of CS, reduces the extent to which $\bar{\ell}^d$ must fall. It follows that the net impact of CS on the long-run change in ℓ^d will depend upon the size of β and hence upon the relative significance of speculation on monetary assets denominated in different currencies. In a world in which interest-bearing assets as well as monetary assets are present, one can expect the latter to be relatively small [5]. It is then apparent that, on balance, CS may in principle weaken the effect of the reduction in $\dot{m}^*$ on the long-run composition of global liquidity ℓ^d. And even if $\bar{\ell}^d$ falls by more with CS than without CS, the extent of the net influence of CS on the steady-state level ℓ^d is most likely to be relatively small. In the light of these considerations, and if account is taken of the implications of CS for the slope of the stable path SS, the short-run response of the real exchange rate to the reduction in the rate of growth of overseas money may be such as that illustrated in Figure (7).

Upon the unanticipated reduction in $\dot{m}^*$, and with $\dot{m}^d$ being increased instantaneously, both the SS locus and the SS^{cs} locus shift upwards as $\bar{\ell}^d$ must be lower than what it was initially. Compared to point B*, CS limits the extent of the real exchange rate overshooting. It may nevertheless imply that c stays away from equilibrium for a longer period, as $\bar{\ell}^d$ might have to fall by a larger amount under CS than without CS (see, e.g. point C^{cs} in Fig.(7)).

As for the 'aggregate' model, it can be easily verified that the steady-state change in the level of global liquidity is,

$$d\bar{\ell}_1{}^w = -\{\gamma^* + \pi_2{}^*\}d\dot{m}^* \tag{14a}$$

where

$$\pi_2{}^* = \kappa_1 + \kappa_2$$
$$\gamma^* = \lambda_1 + \lambda_2$$

and hence the short-run response of global output to the disturbance is

$$dy^w(o) = \delta/\Delta_2\{\gamma^* + \pi_2^*\}d\dot{m}^* \tag{14b}$$

where

$$\Delta_2 = \pi_1^*\delta + \theta^* \qquad \gamma^* = \lambda_1 + \lambda_2$$

$$\pi_1^* = \varphi_1 + \varphi_2 \qquad \pi_2 = \kappa_1 + \kappa_2$$

$$\theta^* = \gamma^*/\eta_2 - \pi_2^*\gamma\delta$$

Given the definition of γ^* and of Δ_2, the net effect of a non-zero value of λ_2 on $dy^w(o)$ is most likely to be close to zero. Moreover, the "foreign income effect" ($\varphi_2 \neq 0$) of CS is again stabilizing in the sense that it tends to reduce the size of the initial global recession. It may be noted, though, that here the "foreign inflation effect" ($\kappa_2 \neq 0$) of CS has a destabilizing impact on y^w.

A numerical illustration of the possible overall implications of CS, as well as some indication of the separate contribution of the individual CS-effects to the initial response of the system to monetary disturbances, is provided in Tables II and III of Appendix II. The tables show numerical solutions for the impact effects of the disturbances studied above on y, c and y*, for alternative values of ψ, φ_2, β and for $\lambda_1 = \lambda_2 = 2$, $\kappa_1 = \kappa_2 = 1$. In Table III, the initial steady state is assumed to be characterized by $\dot{m}^* = .04$, $\dot{m} = 0$ and $c = y = y^* = 0$, while final equilibrium is taken to be characterized by $\dot{m}^* = \dot{m} = 0$ and $c = y = y^* = 0$. In Table II, both the initial and the final equilibrium are assumed to be characterized by $\dot{m}^* = 0$ $\dot{m} = 0$, and $c = y = y^* = 0$.

As is apparent from Table II, currency substitution is on balance unambiguously 'stabilizing' for an unanticipated contraction in the level of the overseas money supply; note, however, the 'destabilizing' influence of the "foreign -income effect" on c. Moreover, the proposition that CS is a channel for the international transmission of disturbances (and a source of real exchange rate overshooting) may not survive even for the case of a reduction in the rate of growth of overseas money if β is not unduly large: Table III shows that, in this case, CS may in fact reduce the impact of the disturbance on home output and on the real exchange-rate, the fundamental reason for which is price inflexibility combined with high bond substitutability and not CS *per se*. Furthermore, parts (a) and (b) of Table III make the obvious point that whether or not CS is on the whole 'destabilizing' following unanticipated changes in the rate of growth of national money supplies, is a matter that depends on the structural parameters of the model.

IV. *Conclusions.*

Our aim in this chapter has been to study and clarify the role of currency substitution, bond substitution and price stickiness in the international trasmission of disturbances under flexible exchange rates.

In the first part of the chapter we have attempted to analyse the behaviour of a small open-economy under CS, subsequent to (unanticipated) changes in the foreign interest rate and in foreign output. It has been shown that under CS, flexible exchange rates may provide greater insulation in the short-run from real disturbances originating abroad. These conclusions contain surprises in view of the existing CS studies, which cite currency substitution as the principal cause of the transmission of disturbances between countries.

In the second part of the chapter we have considered the behaviour of two large economies under CS, subsequent to unilateral monetary policy actions. It has been shown that CS reduces both the overshooting of the real exchange rate and the transmission effect to the home country's real output of changes in the level of the overseas country's money stock. It has also been argued that it cannot be asserted that CS is necessarily a channel for the international transmission of disturbances even when these disturbances are unanticipated changes in the rate of growth of national money supplies. In fact, if speculation on national monetary assets is not unduly strong (as one would expect to be the case in a world in which other assets besides money exist), currency substitution (a) may mitigate the transmission effect of a change in the rate of monetary growth in one country to the other country's output and (b) may reduce the size of the short-run real exchange rate jump. As these results appear to be in conflict with the earlier findings about the effects of CS, it is worth comparing them with those of the previous CS models. First, in the majority of the existing CS models, private agents are assumed to hold their wealth only in the form of 'domestic' and 'foreign' money. As is apparent from our model, in this case $\lambda_1 = \lambda_2 = \kappa_1 = \kappa_2 = 0$. With p and p* being less than perfectly flexible, the real exchange rate would still overshoot in such a case, following a reduction in either the level or the rate of growth of overseas money. However, the overshooting, as well as any required long-run adjustment in the composition of global liquidity, would be entirely attributed to CS -i.e. to the fact that $\beta \neq 0$ in (1)-(8). By restricting the available menu of assets to domestic and foreign money, without abandoning the assumption of price stickiness, one may therefore conclude that CS *per se* is a channel for the international transmission of disturbances. Second, most of the earlier CS models assume continuous purchasing power parity (PPP). By imposing the PPP assumption, however, the parameter ψ in (1)-(8) becomes zero. Hence one of the 'stabilizing' influences of CS on the real exchange rate, the "terms-of-trade effect", is automatically eliminated.

Appendix I.

Table (Ia)(+): *Impact effects of a fall in r^**

$\delta = .3$

(Assumed Initial Values: $r = r^* = .06$, $y = y^* = \dot{m} = 0$, $c = .036$, $\ell = -.111$

Final Values: $r = r^* = 0$, $y = y^* = \dot{m} = c = \ell = 0$)

β_1	Real Exchange Rate c	Real Domestic Output y
0	-.159	-.095
.5	-.153	-.091
.75	-.151	-.089
1	-.149	-.088
2	-.142	-.083

$\delta = .5$

(Assumed Initial Values: $r = r^* = .06$, $y = y^* = \dot{m} = 0$, $c = .06$, $\ell = -.105$

Final Values: $r = r^* = y = y^* = \dot{m} = c = \ell = 0$)

β_1	Real Exchange Rate c	Real Domestic Output y
0	-.145	-.098
.5	-.140	-.093
.75	-.138	-.092
1	-.136	-.090
2	-.131	-.086

(+) Parameter values: $\varphi_1 = \kappa_1 = 1$, $\lambda = 2$, $\alpha = .75$, $\gamma = \sigma = .5$, $\nu = .25$

Table (Ib)(+): *Impact effects of a fall in y^**

(Assumed Initial Values: $y^* = 1$, $y = \dot{m} = r = r^* = 0$, $c = -.5$, $\ell = -.125$

Final Values: $y^* = y = \dot{m} = r = r^* = 0$, $c = \ell = 0$)

$\delta = .3$

β_1	Real Exchange Rate c	Real Domestic Output y
0	-.179	-.107
.5	-.172	-.102
.75	-.170	-.100
1	-.168	-.099
2	-.160	-.094

$\delta = .5$

β_1	Real Exchange Rate c	Real Domestic Output y
0	-.172	-.116
.5	-.167	-.111
.75	-.164	-.109
1	-.162	-.107
2	-.156	-.102

Appendix II

Table (II)(+): Impact effects of a contraction in m^*

(Initial values: $p^* = m^* = 1,\ m = p = 0$
$y = y^* = \dot{m} - \dot{p} = \dot{m}^* - \dot{p}^* = c = 0$
Final values: $p^* = m^* = p = m = 0$
$y = y^* = \dot{m} - \dot{p} = \dot{m}^* - \dot{p}^* = c = 0$)

(a) $\delta = .3$

ψ	φ_2	β	Domestic Output y	Foreign Output y^*	Real Exchange Rate c
0	0	0	.509	-.731	1.307
.1	.1	1	.388	-.512	.991
.1	.2		.413	-.535	1.037
.2	.25		.373	-.495	.960
.25	.25		.349	-.471	.913
.1	.1	1.5	.389	-.512	.993
.1	.2		.409	-.531	1.030
.2	.25		.377	-.498	.967
.25	.25		.357	-.478	.928
.1	.1	2	.390	-.513	.994
.1	.2		.407	-.529	1.026
.2	.25		.380	-.501	.972
.25	.25		.362	-.484	.939
.1	.1	4	.391	-.514	.996
.1	.2		.402	-.523	1.015
.2	.25		.385	-.506	.983
.25	.25		.374	-.495	.962

(b) $\delta = .5$

ψ	φ_2	β	Domestic Output y	Foreign Output y^*	Real Exchange Rate c
0	0	0	.467	-.867	1.250
.1	.1	1	.351	-.595	.956
.1	.2		.381	-.619	1.000
.2	.25		.341	-.576	.933
.25	.25		.316	-.551	.890
.1	.1	1.5	.356	-.599	.964
.1	.2		.381	-.619	1.000
.2	.25		.348	-.584	.945
.25	.25		.327	-.562	.909
.1	.1	2	.359	-.603	.969
.1	.2		.381	-.619	1.000
.2	.25		.353	-.589	.953
.25	.25		.335	-.570	.923
.1	.1	4	.366	-.610	.981
.1	.2		.381	-.619	1.000
.2	.25		.364	-.600	.971
.25	.25		.353	-.588	.952

Table (III)(+): Impact effects of a reduction in $\dot{m}^*$

(a) $\delta = .3$

ψ	φ_2	β	Domestic Output y	Foreign Output y^*	Real Exchange Rate c
0	0	0	.061	-.088	.157
.1	.1	1	.021	-.051	.079
.1	.2		.023	-.052	.083
.2	.25		.020	-.049	.077
.25	.25		.018	-.047	.073
.1	.1	1.5	.039	-.069	.119
.1	.2		.042	-.071	.124
.2	.25		.038	-.067	.116
.25	.25		.036	-.065	.111
.1	.1	2	.057	-.087	.159
.1	.2		.060	-.089	.164
.2	.25		.056	-.085	.156
.25	.25		.053	-.082	.150
.1	.1	4	.130	-.160	.319
.1	.2		.133	-.163	.325
.2	.25		.128	-.157	.314
.25	.25		.125	-.154	.308

(b) $\delta = .5$

ψ	φ_2	β	Domestic Output y	Foreign Output y^*	Real Exchange Rate c
0	0	0	.056	-.104	.150
.1	.1	1	.009	-.067	.076
.1	.2		.011	-.069	.080
.2	.25		.008	-.065	.075
.25	.25		.006	-.063	.071
.1	.1	1.5	.028	-.087	.116
.1	.2		.031	-.089	.120
.2	.25		.028	-.084	.113
.25	.25		.025	-.082	.109
.1	.1	2	.048	-.106	.155
.1	.2		.051	-.109	.160
.2	.25		.047	-.1036	.153
.25	.25		.044	-.101	.148
.1	.1	4	.127	-.185	.314
.1	.2		.128	-.187	.315
.2	.25		.126	-.182	.311
.25	.25		.122	-.179	.1305

(+) Parameter values: $\varphi_1 = 1,\ \nu = \sigma = .5,\ \upsilon = .25,\ \lambda_1 = \lambda_2 = 2,\ \kappa_1 = \kappa_2$

Notes

1. See the references cited in Chapter 1.

2. We implicitly assume that M and M* pay no interest. As long as the banking sector is competitive and there is a required reserve ratio, this assumption can be easily relaxed without essentially altering any of our main conclusions. See Miller and Spencer (1980) and Miller and Wise (1982) for a discussion of the implications of introducing interest-bearing money in an open economy model.

3. See also Buiter and Miller (1981, 1982) for a similar specification and economic interpretation.

4. The slope of the $\dot{\ell} = 0$ locus is

$$d\hat{c}/d\hat{\ell} = -a_2/a_1$$

while the slope of the $\dot{c} = 0$ locus is given by

$$d\hat{c}/d\hat{\ell} = -b_2/b_1$$

From the definition of the a_i's and b_i's it can be shown that if the $\dot{c} = 0$ locus slopes downwards, it will be steeper than the $\dot{\ell} = 0$ locus provided that

$$\gamma\delta\alpha[v\sigma\theta-(1-\alpha)-\sigma(\varphi_1-\gamma k_1\alpha)] < [\gamma\sigma\theta+\delta\alpha(1-\alpha)] \qquad (a)$$

After some algebraic manipulations, (a) reduces to

$$-\gamma\sigma\Delta < 0 \qquad (b)$$

5. Cuddington (1983), in a survey of the empirical literature on CS, notes that the value of the coefficient of $\dot{e}$ in many estimated aggregate money demand functions is relatively small, and that, in some cases, it is less than unity.

CHAPTER 4

Openness, and the Relationships among Exchange Rates, Relative Prices and International Balances of Payment in the Short-Run and in the Long-Run.*

* This Chapter relies on ideas that first appeared in Zervoyianni (1986c) and were presented at a Staff-Seminar at Hull University.

I. *Introduction.*

In the literature, emphasis has recently been placed on the role that the "structural parameters" of individual economies play in determining how exchange rates interact with other economic variables. Bruce and Purvis (1985), Kawai (1985) and Pikoulakis (1985), for example, note that the adjustment speed of domestic prices can significantly influence the association between the current account (CA) and the exchange rate. Engel and Flood (1985), Driskill and McCafferty (1985) and Penanti (1983) show that the sensitivity of spending to changes in relative prices or wealth is an important determinant of how exchange rate variations affect the domestic price level. On the other hand, Frenkel and Rodriguez (1982), Branson and Buiter (1983), Frenkel and Mussa (1985) and Frenkel and Razin (1987) note that the relationships among exchange rates, national price levels, CAs and interest rates depend crucially on the degree of capital mobility as well as on several other factors that influence the demand for assets. In this chapter we concentrate on a factor whose importance has been ignored. That factor is the degree of openness of the economy.

Three "parameters" can be taken to measure the degree of openness of an economy: the import content of total domestic absorption; the share of foreign demand in the total demand for goods produced domestically; and the sensitivity of the domestic price index to changes in the prices of foreign goods. Although all these three "parameters" can be expected to influence the response of an economy to disturbances, their effects have not yet been thoroughly investigated in the literature.

For example, the analyses of Driskill and McCafferty (1985), Engel and Flood (1985), Pikoulakis (1985) and Kawai (1985) are based on models in which none of these three parameters is taken into consideration. Also, Penanti (1983) and Branson and Buiter (1983), who use models in which all of the components of domestic absorption have an import content, treat the rest of the world as given. Thus, they do not explicitly consider the role of the second determinant of "openness" in the response of the home economy to policy actions or exogenous shocks. Furthermore, in studies such as Obstfeld (1985), Turnovsky (1985a), Buiter (1986), Frenkel and Razin (1987) and Miller and Williamson (1988), in which a two-country framework is used, there is no explicit assumption about the import content of domestic absorption.

In this chapter we develop a model, which is based on broadly similar assumptions to those that most of the above mentioned studies make, but which explicitly incorporates all the determinants of the degree of openness of an economy. We use this model to examine: the effects of exogenous or policy-induced disturbances on the steady-state levels of the exchange rate, interest rates, prices, and net foreign-asset holdings; and, the behaviour of the exchange rate, of the relative prices of goods and of the CA between steady states. Our purpose in this analysis is twofold. First, we wish to illustrate the implications of alternative assumptions about the "openness" of an economy for the behaviour of open-economy models that are widely used in the literature. Second, we wish to examine in what way the degree of openness of national economies may influence the dynamic interactions between exchange rates and other macroeconomic variables.

The chapter is organized as follows:

Section II sets out the model. Our model describes two economies which are linked by net trade and financial capital flows. At any point in time, the prices of goods are taken to be predetermined; net foreign asset positions are given; and real outputs, interest rates, and the exchange rate are determined by the equilibrium conditions in the goods, bonds and money markets. Over time, prices are assumed to adjust gradually to movements in the current level of (real) outputs relative to 'full capacity' outputs , while the supplies of foreign assets change through current account imbalances.

Section III studies the steady-state properties of this model, while Sections IV and V examine the behaviour of the model between steady states. Our analysis shows that the relationships among exchange rates, prices and CAs, as well as the dynamic, short-run and long-run effects of disturbances can be expected to depend crucially on the degree of openness of national economies. Thus, our findings suggest that "openness" is one of the factors that can explain the observed differences in the correlation between the exchange rate and the level of other macroeconomic variables in different countries.

Section VI contains concluding comments.

II. *The Model*

We consider two economies with a flexible exchange rate: the 'home economy' and the 'foreign economy'. We shall assume that the home economy specializes, completely, in the production of the domestic good and that the foreign economy specializes, completely, in the production of the foreign good. In each economy, private individuals are assumed to demand both types of goods. We shall also assume that they may hold as assets: money, home-currency-denominated bonds, and foreign-currency-denominated bonds. 'Currency substitution' is ignored in this chapter. Several other simplifications are also introduced not only to highlight the implications of our model with the greatest possible clarity, but also to make our results as comparable as possible with the existing literature. Thus we assume no budget deficits or investment, and we take the prices of goods to be determined by simple Phillips curves.

The goods markets

The demand for domestic output is composed of domestic demand and foreign demand. This demand, Y^d, can be expressed as the sum of total private domestic absorption, the trade balance surplus, and government spending on domestic goods:

$$Y^d = A + T + G \qquad (1.1)$$

where

A : is (total) private domestic absorption (domestic demand for domestic and foreign goods)

T : is the trade balance surplus (the excess of exports over imports)

G : is home-government spending (which, for simplicity, is assumed to be entirely absorbed by expenditures on the domestic good).

Similarly, the demand for foreign output, Y^{*d}, may be specified as

$$Y^{*d} = A^* - (P/_{EP^*})T + G^* \qquad (2.1)$$

where

A* : is (total) private foreign absorption (foreign demand for foreign and domestic goods)

G* : is foreign-government spending

P : is the price of domestic output

P* : is the price of foreign output

E : is the exchange rate (defined as the home currency price of one unit of foreign currency).

The trade balance T can be taken to be a decreasing function of A, an increasing function of A* and of the real exchange rate ($^{EP^*}/_P$), and a function of exogenous factors s_1 that may affect the relative demand for domestic and foreign goods:

$$T = T(A,\ A^*,\ ^{EP^*}/_P,\ s_1) \qquad T_1 < 0,\ T_2, T_3,\ T_4 > 0 \tag{2.2}$$

Setting $Y = Y^d$, $Y^* = Y^{*d}$, and using (2.2), equilibrium in the goods markets can be described as follows:

$$Y = A + T(A,\ A^*,\ ^{EP^*}/_P,\ s_1) + G \tag{1}$$

$$Y^* = A^* - (^P/_{EP^*})T(A,\ A^*,\ ^{EP^*}/_P,\ s_1) + G^* \tag{2}$$

We shall postulate that, due to fixed nominal contracts in factor and product markets, the prices of the domestic and the foreign goods at any instant are predetermined. The rate of change in P and P* will be assumed to be determined by

$$^{\dot{P}}/_P = v(^Y/_{\tilde{Y}}) \tag{3}$$

$$^{\dot{P}^*}/_{P^*} = v(^{Y^*}/_{\tilde{Y}^*}) \tag{4}$$

where $\tilde{Y}$ denotes the domestic 'capacity' output and $\tilde{Y}^*$ is the foreign 'capacity' output.

Private domestic absorption A can be taken to depend negatively on the (expected) real interest rate $(r - ^{\dot{P}_c{}^e}/_{P_c})$, and positively on real domestic income ($^{Y_D}/_{P_C}$) and real wealth ($^W/_{P_C}$):

$$A = A(r - \dot{P}_C{}^e/P_C,\ Y_D/P_C,\ W/P_C) \qquad A_1 < 0,\ A_3, A_2 > 0 \qquad (5)$$

$$P_C = I(P,\ EP^*) \qquad I_1, I_2 > 0,\ I_1 + I_2 = 1 \qquad (6)$$

where r is the nominal domestic interest rate, Y_D is nominal disposable income, and W represents the nominal wealth of the home residents. P_C denotes the domestic price index, which is a function of the prices of home goods and imports.

Similarly, foreign private absorption A* can be taken to be a function of the foreign real interest rate $(r^*-\dot{P}_C{}^{*e}/P_C^*)$, of foreign real income (Y_D^*/P_C^*) and of foreign real wealth (W^*/P_C^*):

$$A^* = A(r^*-\dot{P}_C{}^{*e}/P_C^*,\ Y_D^*/P_C^*,\ W^*/P_C^*) \qquad A_1 < 0,\ A_2, A_3 > 0 \qquad (7)$$

$$P_C^* = I^*(P^*,\ P/E) \qquad I_1^*, I_2^* > 0,\ I_1^* + I_2^* = 1 \qquad (8)$$

We shall assume that, in each economy, private individuals may hold money, and two types of interest-bearing assets: home-government bonds (which are denominated in domestic currency), and foreign-government bonds (which are denominated in foreign currency). Accordingly, the nominal wealth of the domestic residents is given by

$$W = M + B_d + EB^*_d \qquad (9.1)$$

while foreign nominal wealth is

$$W^* = M^* + B^*_f + (B_f/E) \qquad (10.1)$$

In (9.1), M denotes the supply of domestic money (which we assume is held only domestically); B_d denotes the stock of domestic bonds held domestically; and B^*_d is the stock of foreign bonds held domestically. In (10.1), M^* denotes the supply of foreign money, and B^*_f and B_f are, respectively, the stocks of foreign and domestic bonds held by the foreign private sector.

We shall assume, for simplicity, that the government in each economy always balances its budget (by adjusting taxes) so that the total stock of domestic bonds and that of foreign bonds remain invariant over time. Denoting then the total private holdings of domestic bonds by B and the total private holdings of foreign bonds by B^*,

$$B = B_d + B_f \tag{9.2}$$

$$B^* = B^*_f + B^*_d \tag{10.2}$$

we can write equations (9.1)-(10.1) as follows:

$$W = M + B + (EB^*_d - B_f) \tag{9}$$

$$W^* = M^* + B^* - {}^1/_E(EB^*_d - B_f) \tag{10}$$

Since M and M^* are determined exogenously by the monetary authorities, and since B and B^* remain invariant over time, changes over time in $(EB^*_d-B_f)$ can be taken to represent changes in the home residents' net foreign assets and in the foreign residents' net liabilities. The rate of change in net foreign assets or liabilities is determined by current account imbalances:

$$(EB^*_d\dot{-}B_f) = PT(A, A^*, EP^*/_E, s_1) + (EB^*_d r^* - B_f r) \tag{11}$$

Similarly, the nominal disposable income of the home and the foreign residents can be specified as in (12.1)-(13.1)

$$Y_D = P(Y-T_x) + (EB^*_d r^* + B_d r) \tag{12.1}$$

$$Y^*_D = P^*(Y^*-T_x^*) + {}^1/_E(B_f r + EB^*_f r^*) \tag{13.1}$$

where PT_x and $P^*T_x^*$ denote nominal tax revenues. Since the assumption of no budget deficits implies that $PT_x = PG + Br$ and $P^*T_x^* = P^*G^* + B^*r^*$, we can write (12.1)-(13.1) as follows:

$$Y_D = PY + (EB^*_d r^* - B_f r) - PG \tag{12}$$

$$Y_D^* = P^*Y^* - {}^1/_E(EB^*_d r^* - B_f r) - P^*G^* \tag{13}$$

The bond and money markets

The bond markets can be described by the following equations:

$$({}^B/_{EB^*})^d = F_d(r - r^* - {}^{\dot{E}^e}/_E, s_{21}) \tag{14.1}$$

$$({}^B/_{EB^*})^d = F_f(r - {}^{\dot{E}^e}/_E - r^*, s_{22}) \tag{14.2}$$

$$({}^B/_{EB^*}) = F_d(.) + F_f(.) \tag{14.3}$$

$$({}^B/_{EB^*}) = F(r - r^* - {}^{\dot{E}^e}/_E, s_2) \tag{14}$$

(14.1) expresses the home residents' relative demand for domestic and foreign bonds as a function of the difference between the expected rates of return on B and B*, and of other exogenous factors s_{21} influencing asset preferences. In a similar way, (14.2) specifies the foreign residents' relative demand for bonds. Equilibrium requires that the relative demands for bonds, $[F_d(.)+ F_f(.)]$, equal the (total) relative supplies of bonds, $({}^B/_{EB^*})$. Substituting then (14.1)-(14.2) into (14.3) yields (14) as the equilibrium condition in the bond markets.

Equilibrium in the money markets can be described by (15)-(16):

$$M = P_C L(Y,\ r,\ \dot{P}_C{}^e/P_C) \qquad (15)$$

$$L_1 > 0,\ L_2,\ L_3 < 0$$

$$M^* = P_C{}^* L(Y^*,\ r^*,\ \dot{P}_C{}^{*e}/P_C{}^*) \qquad (16)$$

In (15) the demand for (real) money balances by the domestic residents, L(.), is assumed to depend positively on domestic output Y, and negatively on the domestic interest-rate and the (expected) price index inflation $\dot{P}_C{}^e/P_C$. Similarly, L(.) in (16) is an increasing function of Y*, and a decreasing function of r* and $\dot{P}_C{}^{*e}/P_C{}^*$. It may be noted that no wealth variables are included in (15)-(16): as we pointed out in Ch.2, any wealth-related demand for money can be expected to be small and, hence, for simplicity, can be ignored.

Expectations formation

Finally, we introduce equation (17) which reflects the assumption of forward-looking expectations:

$$\dot{P}^e/P = \dot{P}/P,\quad \dot{P}^{*e}/P^* = \dot{P}^*/P^*,\quad \dot{E}^e/E = \dot{E}/E \qquad (17)$$

Our model is now complete. Equations (1)-(16), together with (17), determine values for the endogenous variables Y, P, A, P_C, W, Y_D, r, E and Y*, P*, A*, P_C*, W*, Y_D*, r*, ($EB^*_d - B_f$), as functions of the exogenous variables s_1, s_2, M, M*, B, B*, G, G*, $\tilde{Y}$ and $\tilde{Y}$*.

As is evident from (1)-(16), our model takes account of all the factors that may be regarded as determinants of the "openness" of an economy. In fact, in terms of (1)-(16), three parameters can be taken to reflect how open the home economy is: first, T_1 - the domestic private sector's marginal propensity to import; second, T_2 – the foreign resident's marginal propensity to consume domestic goods; and third, I_2 - the sensitivity of the domestic price index to changes in the prices of foreign goods. Analogously, the size of the parameters T_2, T_1 and I_2* can be taken as a measure of how open the foreign economy is.

III. *The Steady-State Properties of the Model*

The steady state of the model is attained when the goods markets, money markets and bond markets are in equilibrium with $\dot{P}/P = \dot{P}^*/P^* = \dot{E}/E = 0$, and when the CA is in balance i.e. $(E\dot{B}^*_d - B_f) = 0$. Imposing these conditions yields the equations

$$Y = A + T(.) + G \qquad Y^* = A^* - P/EP^* T(.) + G^*$$
$$A = A(r, Y^R, W^R) \qquad A^* = A(r^*, Y^{*R}, W^{*R})$$
$$P_c = I(P, EP^*) \qquad P_c^* = I^*(P^*, P/E)$$
$$W = M + B + (EB^*_d - B_f) \qquad W^* = M^* + B^* - 1/E(EB^*_d - B_f)$$
$$Y_D = PY + (EB^*_d r^* - B_f r) - PG \qquad Y_d^* = P^*Y^* - 1/E(EB^*_d r^* - B_f r) - P^*G^*$$
$$M = P_c L(Y, r) \qquad M^* = P_c^* L(Y^*, r^*)$$
$$(B/EB^*) = F(r - r^*, s_2)$$
$$T = T(A, A^*, EP^*/P, s_1)$$
$$PT(.) + (EB^*_d r^* - B_f r) = 0$$

where

$$Y^R = Y_D/P_C, \quad W^R = W/P_C, \quad Y^{*R} = Y_D^*/P_C^*, \quad W^{*R} = W^*/P_C^* \tag{18}$$

Suppose that, in the initial steady state, economic conditions at home and abroad are the same and that (real) interest rates are zero. Also, assume that the initial domestic holdings of foreign bonds are equal to the foreign holdings of domestic bonds, and let us consider the effects on the system in the new steady state of:

(i) a fiscal expansion at home ($dG > 0$)
(ii) an exogenous decline in the relative demand for home goods ($ds_1 < 0$)
(iii) an exogenous decline in the relative demand for claims on the home-country government ($ds_2 < 0$), and
(iv) an increase in the domestic money supply, achieved via an open market sale of domestic bonds ($dM = - dB$).

<u>(i) Fiscal expansion in the home country</u>

Differentiating (18) with respect to G, we obtain the following effects on the real exchange rate E^R, on (real) domestic absorption A, and on (real) foreign absorption A*:

$$d\tilde{E}^R = \frac{T_1}{[T_3 + \xi_1 \bar{B}^*_d(1+T_1-T_2)(1-I_2-I_2^*)\theta_1]} dG < 0 \tag{18.a$_1$}$$

$$d\tilde{A} = - dG + \xi_1 \bar{B}^*_d \theta_1 (1-I_2-I_2^*) d\tilde{E}^R < 0.$$

$$d\tilde{A}^* = - \xi_1 \bar{B}^*_d \theta_1 (1-I_2-I^*_2) d\tilde{E}^R > 0 \tag{18.a$_2$}$$

$$d(\tilde{A/}_{A^*})\bar{A} = - dG + 2\xi_1 \bar{B}^*_d \theta_1 (1-I_2-I_2^*) d\tilde{E}^R < 0$$

where

$$\theta_1 = \bar{M}(\bar{M} - L_2\xi_1)^{-1} > 0$$

$$\xi_1 = F_1^{-1}$$

Bars are used to denote the values of the variables in the initial steady state (taken to be characterized by $\bar{Y} = \bar{Y}^* = \bar{P} = \bar{P}^* = \bar{E} = 1$, $\bar{A} = \bar{A}^*$, $\bar{G} = \bar{G}^*$ $\bar{B}^*_d = \bar{B}_f$, $\bar{r} = \bar{r}^* = 0$, $\bar{B} = \bar{B}^*$ and $\bar{M} = \bar{M}^*$).

The steady-state change in the relative price of domestic and foreign goods is

$$d(\tilde{P/p*}) = -\{(I_2+I_2*)\theta_1 + \theta_2\}d\tilde{E}^R > 0 \tag{18.a$_3$}$$

where $\theta_2 = -\xi_1 L_2(\bar{M} - L_2\xi_1)^{-1} > 0$

while the effect of the fiscal expansion on the distribution of wealth between the domestic and the foreign residents is given by

$$d(\tilde{W^R/W^{*R}})\bar{W} = -\frac{(1-A_2)}{A_3}dG + \frac{\{A_2(I_2+I_2*)(\bar{Y}-\bar{G})+\xi_1\Psi_1\}}{A_3}d\tilde{E}^R < 0 \tag{18.a$_4$}$$

where

$$\Psi_1 = -\theta_1[A_1+2(1-A_2)\bar{B}*_d](1-I_2-I_2*) \gtreqless 0.$$

Consider equations (18.a_1)-(18.a_4). A well-known result of Mundell (1963), Sachs (1980), Branson and Buiter (1983), and Obstfeld (1985) (who use models in which the degree of openness of the economy is not explicitly specified) is that, as long as asset substitutability is perfect ($\xi_1 \rightarrow 0$), the increase in G will lead to a long-run real appreciation, a rise in the prices of home goods, and a reduction in the home residents' real wealth. It is evident from our model that the precise characteristics of the long-run will depend on T_1, T_2, I_2 and I_2*. First, equation (18.a_1) suggests that, even when $\xi_1 \neq 0$, the size of the real appreciation will be determined by the domestic private sector's marginal propensity to import. Second, (18.a_3) shows that the size of the long-run change in ($P/p*$) will be positively related to the sensitivity of the national price indices P_C and P_C* to variations in the prices of goods produced abroad. Third, (18.a_4) indicates that the extent to which real domestic wealth will decrease relative to real foreign wealth will depend on the size of I_2 and of I_2* as well as on the size of T_1.

The explanation for these results is to be found in that, in our model, (a) import demand is taken to be a function of all the variables that may influence the demand for domestically produced goods and (b) real income depends upon the prices of both the domestic and the foreign goods.

Consider first equation (18.a_1), and assume that $\xi_1 \to 0$. Since domestic output is given in the long-run, the fiscal expansion creates an excess demand for home goods. Other things being equal, equilibrium in the domestic goods market can be restored by a fall in private domestic absorption A, through a reduction in real wealth W^R, a drop in real income Y^R, or a rise in the domestic interest rate r. If the home residents' marginal propensity to import is relatively large, however, any change in W^R, Y^R or r will have a significant effect on the CA: a given reduction in W^R or Y^R, or a given rise in r, will cause a large drop in imports and this will create a CA surplus. In order to maintain both CA balance and goods market equilibrium, any drop in A will have to be accompanied by a relatively large real appreciation. Consider next equations (18.a_4) and (18.a_2). Since in the new equilibrium the interest-rate differential (r-r*) is to remain unchanged when $\xi_1 \to 0$, and since $(A/A*)$ will have to fall, domestic income Y^R must decline relative to foreign income Y^{*R} or domestic wealth W^R must decrease relative to foreign wealth W^{*R}. But when national price indices are relatively sensitive to changes in the prices of goods produced abroad, the real appreciation will increase Y^R and will reduce Y^{*R}. Accordingly, a fiscal expansion in the home country will require a large change in the distribution of wealth between the domestic and the foreign residents to maintain long-run equilibrium.

(ii) A decrease in the relative demand for domestic goods

Totally differentiating the system with respect to s_1, we obtain the following effects on $\tilde{E}^R$, $\tilde{A}$ and $\tilde{A}^*$:

$$d\tilde{E}^R = -\frac{T_4}{[T_3 + \xi_1\bar{B}^*_d(1+T_1-T_2)(1-I_2-I_2^*)\theta_1]}ds_1 > 0 \qquad (18.b_1)$$

$$d\tilde{A} = \xi_1\bar{B}^*_d\theta_1(1-I_2-I_2^*)d\tilde{E}^R > 0$$

$$(18.b_2)$$

$$d\tilde{A}^* = -\xi_1\bar{B}^*_d\theta_1(1-I_2-I_2^*)d\tilde{E}^R < 0$$

The change in the steady-state level of the nominal exchange rate is

$$d\tilde{E} = \theta_1(1-I_2-I_2^*)d\tilde{E}^R > 0 \qquad (18.b_3)$$

while the long-run effect of the disturbance on the home residents' net foreign asset position is given by

$$d\tilde{F} = -\frac{1}{2A_3}[(1-I_2-I_2^*)(2A_3\bar{B}^*_d\theta_1+\xi_1\Psi_2)-A_2(I_2+I_2^*)(\bar{Y}-\bar{G})]d\tilde{E}^R \gtrless 0 \qquad (18.b_4)$$

where

$$\Psi_2 = A_3\bar{W}(1-I_2-I_2^*)\theta_2 + \Psi_1$$

Equation $(18.b_3)$ suggests that the steady-state value of the nominal exchange rate will depend the values of I_1 and I_2^*. Moreover, equation $(18.b_4)$ indicates that the size of the parameters I_2 and I_2^* will determine the sign of $d\tilde{F}$. For example, when asset substitutability is perfect, $\tilde{F}$

may decrease, increase or remain unchanged, depending on whether

$$A_3\theta_1\bar{B}^*{}_d \gtreqless (I_2+I_2^*)\{A_3\bar{B}^*{}_d\theta_1 + \tfrac{1}{2} A_2(\bar{Y}-\bar{G})\} \qquad (18.b_5)$$

This result contrasts with a number of previous models in which, under similar assumptions but with the condition $I_2 = I_2^* = 0$ holding, a decline in the relative demand for domestic goods necessarily leads to a long-run fall in the net foreign-asset holdings of domestic residents [1].

Our result can be explained as follows. Because Y and Y* are given in the long-run, the disturbance creates an excess demand for foreign goods and an excess supply of domestic goods. Other things being equal, equilibrium in the goods markets can be restored by an increase in E^R - i.e. a real exchange rate depreciation. However, if national price indices are insensitive to changes in the prices of goods produced abroad, and if bond substitutability is perfect, money markets equilibrium will require $(P/_{p*})$ to remain unchanged in the new steady state. Thus, when I_2, $I_2^* \to 0$, the rise in E^R will be accompanied by a proportional rise in the nominal exchange rate. This will revalue the domestic holdings of foreign bonds, and it will reduce the foreign-currency value of the foreign holdings of domestic bonds. W^R will increase relative to W^{*R} and, as a result, private domestic spending A will rise while private foreign spending A* will fall. To restore A and A* to their initial steady-state levels, F will have to decrease in the new equilibrium.

If, on the other hand, $I_2 \neq 0$ and $I_2^* \neq 0$, the relative price of domestic goods $(P/_{p*})$ will fall in the long-run and, hence, the nominal depreciation will be relatively small. Moreover, the steady-state real depreciation will reduce real domestic income and will raise real foreign income. In the new steady-state, then, F may have to increase to maintain A and A* at their initial long-run levels. In fact, in this case, the home country may run CA surpluses on the adjustment to the steady state, despite the decline in the relative demand for home goods.

(iii)-(iv) Changes in the relative demand for domestic bonds and in the domestic money supply.

A fall in the relative demand for domestic bonds has the following steady-state effects on the nominal exchange rate, on the relative price of domestic and foreign goods, and on interest rates:

$$d\tilde{E} = -\{[(T_3\theta_2 + \Psi_3)\Psi_5]F_2\}\, ds_2 > 0 \qquad (18.c_1)$$

$$d(r\tilde{-}r^*) = -\{(\xi_1 T_3\theta_1\Psi_5)F_2\}ds_2 > 0, \quad d\tilde{r}/ds_1 = -\, d\tilde{r}^*/ds_1 \qquad (18.c_2)$$

$$d(P\tilde{/}_{p^*}) = -\{[(T_3\theta_2-\Psi_4)\Psi_5]F_2\}\, ds_2 \;(>0) \qquad (18.c_3)$$

where $\Psi_3 = \xi_1\bar{B}^*{}_d(1-I_2-I_2^*)(1+T_1-T_2)\theta_1$

$\Psi_4 = \xi_1\bar{B}^*{}_d(I_2+I_2^*)(1+T_1-T_2)\theta_1$

$\Psi_5 = (T_3+\Psi_3)^{-1}$

Since the value of Ψ_4 remains roughly unchanged when both $(T_2 - T_1)$ and $(I_2 + I_2^*)$ rise, the sign of $d(P\tilde{/}p*)$ is almost wholly independent of the degree of openness of the two economies. Also, the signs of $d\tilde{E}$ and $d(r\tilde{-}r^*)$ do not depend on the size of Ψ_3. Thus, a decrease in the relative demand for domestic bonds will always lead to a long-run rise in the interest-rate differential $(r-r^*)$, and to a nominal exchange rate depreciation. However, the steady-state value of the real exchange rate may be affected by the openness of the domestic and the foreign economy. The effect of the change in s_2 on $\tilde{E}^R$ is

$$d\tilde{E}^R = - \Psi_6 F_2 \, ds_2 > 0. \tag{18.c$_4$}$$

where

$$\Psi_6 = (\Psi_3 + \Psi_4)\Psi_5$$

Differentiating Ψ_6 with respect to Ψ_3, and letting $\Psi_4 \rightarrow 0$, yields the expression (18.c$_5$),

$$\frac{d\Psi_6}{d\Psi_3} = \frac{T_3}{(T_3 + \Psi_3)^2} > 0 \tag{18.c$_5$}$$

from which it follows that, other things being equal, the size of the long-run change in the real exchange rate will be negatively related to the value of (T_2-T_1).

This result can be understood as follows. As in the initial steady state $\overline{B}^*_d = \overline{B}_f$, the long-run rise in the interest differential $(r-r^*)$ worsens the service-account of the home country's CA and must be accompanied by an improvement in the trade balance to maintain equilibrium. When marginal propensities to import are relatively large, no change in the real exchange rate will be required to improve the home country's trade balance: the increase in r will reduce the home residents' demand for foreign goods, while the fall in r* will raise the foreign residents' demand for home goods. When, on the other hand, marginal propensities to import are relatively small, the real ecxchange rate may have to appreciate to preserve CA equilibrium.

If one ignores the effects of changes in interest-rates on the service account of the CA, $(18.c_1)$-$(18.c_4)$ become

$$d\tilde{E} = d(\tilde{P/p*}) = -\theta_2 F_2\, ds_2 > 0 \tag{18.c$_6$}$$

$$d(\tilde{r-r*}) = -(\xi_1\theta_1F_2)\, ds_1 > 0 \tag{18.c$_7$}$$

and the steady-state change in the net domestic holdings of foreign assets is given by

$$d\tilde{F} = \frac{-\xi_1F_2}{A_3}\{(2A_2\bar{B}*_d - A_1)\theta_1 + A_3(\bar{M} + \Psi_7)\theta_2\}ds_2 > 0 \tag{18.c$_8$}$$

where

$$\Psi_7 = \bar{B}_d - \bar{B}*_d > 0$$

Thus $\tilde{E}$ and $(\tilde{P/p*})$ rise by the same amount, and $\tilde{F}$ increases. In this case, the characteristics of the steady state are completely independent of the T_i's and the I_i's. This is also true for an increase in the domestic money supply (achieved via an open market sale of domestic bonds):

$$d\tilde{E} = d(\tilde{P/p*}) = \frac{\theta_1}{\bar{M}}(1 + \xi_1L_2/\bar{B})dM \gtrless 0 \tag{18.d$_1$}$$

$$d\tilde{F} = \frac{\theta_1}{2A_3}\{A_3(\bar{M} + \Psi_7) + \xi_1\Psi_8\}dM \gtrless 0 \tag{18.d$_2$}$$

$$d(\tilde{r-r*}) = -\frac{\theta_1}{\bar{M}}\xi_1\ (1 + \bar{M}/\bar{B})dM < 0 \tag{18.d$_3$}$$

where

$$\Psi_8 = L_2A_3(\bar{M}+\Psi_7)/\bar{B} - (1 + \bar{M}/\bar{B})[2A_2\bar{B}*_d - A_1] < 0$$

In $(18.d_1)$-$(18.d_3)$ the steady-state values of E, $(P/_{p*})$ and F depend only upon the degree of asset substitutability. When asset substitutability is perfect, $d\tilde{E} > 0$, $d(\tilde{p/p*}) > 0$ and $d\tilde{F} > 0$. When asset substitutability is imperfect, E, (P/p_*) and F may, in principle, fall in the new steady state.

However, even when the characteristics of the steady state are unaffected by the size of the T_i's and the I_i's, the behaviour of the system between steady-states may be significantly affected. To establish this point, we proceed to examine the behaviour of the system outside steady states.

IV. *The Behaviour of the System Outside Steady States*

To study the behaviour of the system between steady states, we consider a log-linear version of the model and, for simplicity, we ignore any effects of interest-rate changes on the service account of the CA. We also set real income equal to real output in (5) and (7), and we assume that the structural parameters of the two economies are the same. Thus, following, for example, Eaton and Turnovsky (1983), we take a log-linear approximation to the nominal wealth W of the domestic private sector as

$$w = \mu_1 b_d + \mu_2(b^*_d + e) + (1-\mu_1-\mu_2)m \tag{9.1a}$$

where μ_1 denotes the share of domestic bonds in W (in the neighbourhood of the steady state) and μ_2 is the share of foreign bonds.

A similar approximation to foreign private wealth W* is given by (10.1a),

$$w^* = \mu_1 b^*_f + \mu_2(b_f - e) + (1-\mu_1-\mu_2)m^* \tag{10.1a}$$

and a log-linear approximation to the total supplies of bonds (9.2)-(10.2) is

$$b = \mu_3 b_d + \mu_4 b_f \tag{9.2a}$$

$$b^* = \mu_3 b^*_f + \mu_4 b^*_d \tag{10.2a}$$

where
$$\mu_3 = (\bar{B}d/\bar{B}) = (\bar{B}^*f/\bar{B}^*), \quad \mu_4 = (\bar{B}_f/\bar{B}) = (\bar{B}^*d/\bar{B}^*)$$

Using equations (9.2a)-(10.2a) and the assumption that in the initial steady state $\bar{B}^*_d = \bar{B}_f$, we can write (9.1a)-(10.1a) as follows [2]

$$w = (\mu_1/\mu_3)b + \mu_2(f+e) + (1-\mu_1-\mu_2)m \tag{9a}$$

$$w^* = (\mu_1/\mu_3)b^* - \mu_2(f+e) + (1-\mu_1-\mu_2)m^* \tag{10a}$$

where we define $f \equiv b^*_d - b_f$. Thus, changes over time in f can be taken to represent changes in the home residents' net foreign asset holdings (and in the foreign residents' net liabilities) through CA imbalances.

A log-linear version of the bond markets equilibrium condition (14) is given by (14.1a):

$$(b - b^* - e) = \beta_1[(r - r^* - \dot{e}^e) + s_2] \tag{14.1a}$$

Using (17), equation (14.1a) can be written as

$$r = r^* + \dot{e} - \xi[(e + b^* - b)] - s_2 \qquad \xi = 1/\beta_1 \tag{14a}$$

where ξ can be taken as a measure of the degree of asset substitutability.

Similarly, the aggregate demand functions (1.1) and (2.1) can be expressed as in (1.1a)-(2.1a)

$$y = a + t + g \tag{1.1a}$$
$$y^* = a^* - t + g^* \tag{2.1a}$$

and the trade balance (2.2) can be described by (2.2a):

$$tb = \sigma(e-p+p^*) - \sigma_1 a + \sigma_2 a^* + s_1 \tag{2.2a}$$

Accordingly, the equilibrium conditions in the goods markets become

$$y = (1-\sigma_1)a + \sigma_2 a^* + \sigma(e-p+p^*) + g + s_1 \qquad (1-\sigma_1)+\sigma_1 = 1 \tag{1a}$$
$$y^* = (1-\sigma_2)a^* + \sigma_1 a - \sigma(e-p+p^*) + g^* - s_1 \qquad (1-\sigma_2)+\sigma_2 = 1 \tag{2a}$$

while the prices of the domestic and the foreign goods are determined by

$$\dot{p} = v(y-\tilde{y}) \tag{3a}$$
$$\dot{p}^* = v(y^*-\tilde{y}^*) \tag{4a}$$

We also consider a log-linear version of equations (5)-(8), (11) and (15)-(16) as follows:

$$a = \gamma y - \delta(r-\dot{p}_C) + k(w-p_C) \tag{5a}$$

$$a^* = \gamma y^* - \delta(r^*-\dot{p}_C^*) + k(w^*-p_C^*) \tag{6a}$$

$$p_C = \alpha_1 p + (1-\alpha_1)(e+p^*) \qquad \alpha_1 + (1-\alpha_1) = 1 \tag{7a}$$

$$p_C^* = \alpha_2 p^* + (1-\alpha_2)(p-e) \qquad \alpha_2 + (1-\alpha_2) = 1 \tag{8a}$$

$$\dot{f} = \sigma(e-p+p^*) - \sigma_1 a + \sigma_2 a^* + s_1 \tag{11a}$$

$$m - p_C = \varphi_1 y - \lambda r - \varphi_2 \dot{p}_C \tag{15a}$$

$$m^* - p_C^* = \varphi_1 y^* - \lambda r^* - \varphi_2 \dot{p}_C^* \tag{16a}$$

The parameter σ_2 in (1a) can be taken to measure the sensitivity of the demand for home output to changes in total foreign spending. Analogously, σ_1 in (2a) measures the sensitivity of the demand for foreign goods to changes in total domestic spending. $(1-\alpha_1)$ in (7a) denotes the share of foreign goods in domestic consumption, while $(1-\alpha_2)$ in (8a) is the share of home goods in foreign consumption. In the context of equations (1a)-(11a) and (14a)-(16a), therefore, the size of the parameters σ_1, σ_2, $(1-\alpha_1)$ and $(1-\alpha_2)$ can be taken to reflect the degree of openness of the two economies (DOFO).

Let us define the interest rate differential in favour of the home country as

$$r_1 = r - r^* \tag{19a$_1$}$$

and, for all other variables, define $X_1 = {}^{X}/_{X^*}$, so that

$$x_1 = x - x^* \tag{19a$_2$}$$

Also, let

$$x_2 = x + x^* \tag{19a$_3$}$$

Using $(19a_1)$-$(19a_3)$, and setting, for simplicity, $\sigma_2 = \sigma_1$ and $\alpha_2 = \alpha_1$, we can write equations (1a)-(11a) and (14a)-(16a) as follows:

$$\begin{aligned}
y_1 &= (1-2\sigma_1)a_1 + 2\sigma(e-p_1) + 2s_1 + g_1 \\
a_1 &= \gamma y_1 - \delta(r_1-\dot{p}_{C1}) + k(w_1-p_{C1}) \\
w_1 &= \mu_5 b_1 + 2\mu_2(f+e) + \mu_6 m_1 \\
p_{C1} &= (2\alpha_1-1)p_1 + 2(1-\alpha_1)e \\
m_1 - p_{C1} &= \varphi_1 y_1 - \lambda r_1 - \varphi_2 \dot{p}_{C1} \\
\dot{p}_1 &= v(y_1-\tilde{y}_1) \\
\dot{f} &= \sigma(e-p_1) - \sigma_1 a_1 + s_1 \\
\dot{e} &= r_1 + \xi(e-b_1) + s_2
\end{aligned} \tag{20a$_1$}$$

$$\begin{aligned}
y_2 &= a_2 + g_2 \\
a_2 &= \gamma y_2 - \delta(r_2-\dot{p}_2) + k(w_2-p_2) \\
w_2 &= \mu_5 b_2 + \mu_6 m_2 \\
p_2 &= p_{C2} \\
m_2 - p_2 &= \varphi_1 y_2 - \lambda r_2 - \varphi_2 \dot{p}_2 \\
\dot{p}_2 &= v(y_2-\tilde{y}_2)
\end{aligned} \tag{20a$_2$}$$

where $\mu_5 = ({}^{\mu_1}/\mu_3)$, $\mu_6 = (1-\mu_1-\mu_2)$

Thus, y_1 and a_1 in $(20a_1)$ represent, respectively, the relative level of national outputs and absorption. p_1 denotes the relative price of national outputs, while variations in w_1 can be taken to represent changes in the distribution of global wealth between the domestic and the foreign residents. w_2 in $(20a_2)$ is the total level of private wealth, while y_2, a_2 and p_2 denote, respectively, the aggregate level of national outputs, absorption and prices.

Expressing $(20a_1)$-$(20a_2)$ in deviation-form we obtain

$$
\begin{aligned}
\hat{y}_1 &= (1-2\sigma_1)\hat{a}_1 + 2\sigma(\hat{e}-\hat{p}) \\
\dot{\hat{p}}_1 &= v\hat{y}_1 \\
\hat{a}_1 &= \gamma\hat{y}_1 - \delta(\hat{r}_1-\dot{\hat{p}}_{c1}) + k(\hat{w}_1-\hat{p}_{c1}) \\
\hat{m}_1 - \hat{p}_{1c} &= \varphi_1\hat{y}_1 - \lambda\hat{r}_1 - \varphi_2\dot{\hat{p}}_{c1} \\
\hat{p}_{c1} &= (2\alpha_1-1)\hat{p}_1 + 2(1-\alpha_1)\hat{e} \\
\hat{w}_1 &= 2\mu_2(\hat{f} + \hat{e}) \\
\dot{\hat{f}} &= \sigma(\hat{e}-\hat{p}_1) - \sigma_1\hat{a}_1 \\
\dot{\hat{e}} &= \hat{r}_1 + \xi\hat{e}
\end{aligned}
\tag{20b$_1$}
$$

$$
\begin{aligned}
\hat{y}_2 &= \hat{a}_2 \\
\dot{\hat{p}}_2 &= v\hat{y}_2 \\
\hat{a}_2 &= \gamma\hat{y}_2 - \delta(\hat{r}_2-\dot{\hat{p}}_2) - \kappa\hat{p}_2 \\
\hat{m}_2 - \hat{p}_2 &= \varphi_1\hat{y}_2 - \lambda\hat{r}_2-\varphi_2\dot{\hat{p}}_2
\end{aligned}
\tag{20b$_2$}
$$

where, for any variable $\hat{x}_i$, we define $\hat{x}_i = x_i - \bar{x}_i$ with $\bar{x}_i$ being the value of x in the new steady state. From this formulation of our model it is evident that the size of the parameters σ_1 and $(1-\alpha_1)$ have no influence on the evolution of 'aggregate' variables - i.e. on the dynamic system $(20b_2)$. Also, the variables in that system are independent of those in $(20b_1)$. This implies that one can focus on $(20b_1)$ to examine the implications of how open the two economies are for the dynamic interactions between the relative prices of goods p_1, the CA and the exchange rate.

Through appropriate substitutions, we can express the dynamics of e, p_1 and f as follows:

$$\begin{bmatrix} \dot{\hat{p}}_1 \\ \dot{\hat{f}} \\ \dot{\hat{e}} \end{bmatrix} = \frac{1}{\Delta} \begin{bmatrix} -q_1 v & q_2 v & q_3 v \\ -c_1 & -c_2 & c_3 \\ h_1 & h_2 & h_3 \end{bmatrix} \begin{bmatrix} \hat{p}_1 \\ \hat{f} \\ \hat{e} \end{bmatrix} \tag{21a}$$

where

$$\begin{aligned}
q_1 &= 2\sigma\lambda_1 + \pi_1(1-\pi_2)\epsilon \\
q_2 &= \pi_1\lambda_1\kappa\mu \\
q_3 &= 2\sigma\lambda_1 + \pi_1[(\lambda_1\kappa\mu-\pi_2\epsilon)+ \pi_2\delta\xi\lambda_2] \\
c_1 &= \sigma\lambda_1\theta_1 + \sigma\varphi\delta(1-\pi_2) - \tfrac{1}{2}(1-\pi_1)(1-\pi_2)\epsilon \\
c_2 &= \tfrac{1}{2}(1-\pi_1)\lambda_1\kappa\mu \\
c_3 &= \sigma\lambda_1\theta_1 + \sigma\varphi\delta(1-\pi_2) - \tfrac{1}{2}(1-\pi_1)[(\lambda_1\kappa\mu-\pi_2\epsilon)+ \pi_2\delta\xi\lambda_2] \\
h_1 &= (1-\pi_2)\theta + [2\sigma+\kappa(1-\pi_2)\pi_1]\varphi_2(1-\pi_2)v - [2\sigma+\kappa(1-\pi_2)\pi_1]\varphi_1 \\
h_2 &= \pi_1\varphi k\mu \\
h_3 &= 2\sigma\varphi + \pi_2\theta + \pi_1\kappa\varphi(\mu-\pi_2) + \xi(\lambda\theta+\delta\varphi\pi_1)
\end{aligned}$$

and

$$\begin{aligned}
&\Delta = \theta\lambda_1 + \pi_1(1-\pi_2)\delta\varphi > 0, \ \theta = (1-\pi_1)+\pi_1\theta_1 \ (> 0) \\
&\lambda_1 = \lambda+\pi_2\varphi_2 > 0, \ \lambda_2 = \lambda_1 + (1-\pi_2)\varphi_2 > 0 \\
&\varphi = \varphi_1 - \varphi_2 v(1-\pi_2) \ (>0), \ \epsilon = \lambda_1\kappa+\delta(1-\pi_2) > 0 \\
&\theta_1 = \theta_2 + v\delta\pi_2 > 0, \ \theta_2 = 1-\gamma-v\delta \ (> 0), \ \mu = 2\mu_2 > 0 \\
&\pi_1 = (1-2\sigma_1), \quad \pi_2 = 2(1-\alpha_1)
\end{aligned}$$

Since in (21a) e is a forward-looking variable while p_1 and f are short-run predetermined, a necessary condition for the existence of a unique stable path converging to equilibrium is the existence of two stable and one unstable characteristic roots. The characteristic equation of (21a) is

$$\rho^3 - \tau_3\rho^2 - \tau_2\rho - \tau_1 = 0 \tag{22a$_1$}$$

where

$$\begin{aligned}
\tau_1 &= v\kappa\mu\sigma(1 + \xi\lambda)\Delta^{-1} > 0 \\
\tau_2 &= \kappa\mu[\sigma\varphi + \tfrac{1}{2}(1-\pi_1)(\pi_2+\xi\lambda)]\Delta^{-1} + v\tau_4\Delta^{-1} > 0 \\
\tau_3 &= [(h_3-c_2) - vq_1]\Delta^{-1} \gtrless 0 \\
\tau_4 &= 2\sigma(1+\xi\lambda)+\kappa\pi_1(1-\pi_2)(\mu+\xi\lambda)+\xi\delta\pi_1(1-\pi_2)-\kappa\mu\sigma\lambda_1 \ (> 0)
\end{aligned}$$

and the solution to the system is of the form

$$\hat{p}_1 = A_1 \exp(\rho_1 t) + A_2 \exp(\rho_2 t) + A_3 \exp(\rho_3 t)$$

$$\hat{f} = B_1 \exp(\rho_1 t) + B_2 \exp(\rho_2 t) + B_3 \exp(\rho_3 t)$$

$$\hat{e} = C_1 \exp(\rho_1 t) + C_2 \exp(\rho_2 t) + C_3 \exp(\rho_3 t) \qquad (22a_2)$$

where ρ_1, ρ_2 and ρ_3 are the roots of ($22a_1$). The constant term in ($22a_1$) (which equals $-\rho_1\rho_2\rho_3$) is unambiguously negative. Thus, the system will in general have either one or three positive roots. Also, the coefficient of ρ in ($22a_1$) (which equals $-(\rho_1\rho_2+\rho_2\rho_3+\rho_3\rho_1)$) is almost certainly positive. This suggests that some of the roots will be negative, so that (21a) must have two stable roots (denoted by $\rho_1 < 0$, $\rho_2 < 0$) and one unstable root (denoted by $\rho_3 > 0$). Irrespective of the size of the parameters σ_1 and $(1-\alpha_1)$, therefore, the dynamic system (21a) can be expected to be (saddle-point) stable.

Consider, however, the solution to the stable path. An expression for this path can be derived from (21a) and ($22a_2$) as [3]

$$\hat{e} = -\{\ell_2\hat{p}_1 + \ell_3\hat{f}\}\ell_1^{-1} \qquad (23a)$$

where

$$\ell_2 = h_1 - c_1\psi_2\psi_1$$
$$\ell_1 = h_3 - \Delta(\rho_1+\rho_2) + [c_3\psi_2 + c_1\Delta^2\rho_1\rho_2]\psi_1$$
$$\ell_3 = h_2 + [h_1\Delta^2\rho_1\rho_2 - \Delta(\rho_1+\rho_2)\psi_2 - c_2\psi_2]\psi_1$$

and

$$\psi_1 = (h_1c_3 + c_1h_3)^{-1}$$
$$\psi_2 = h_2c_1 - h_1c_3$$

From the definition of the ℓ_i's, h_i's and c_i's, it is evident that the characteristics of the stable path depend upon the size of the parameters

π_1 and π_2, which in turn depend upon the size of σ_1 and of $(1-\alpha_1)$. Since equation (23a) must hold at all times, it follows that the magnitude of σ_1 and of $(1-\alpha_1)$ will also influence:

(i) the effects on the exchange rate of changes over time in the relative price of national outputs and in net foreign asset positions

(ii) the dynamic interactions between the exchange rate and the current account

(iii) the short-run response of the exchange rate to disturbances.

To establish how the magnitude of σ_1 and $(1-\alpha_1)$ may affect the dynamic behaviour of e, p_1 and f, one can concentrate on two cases: first, a case in which DOFO is very high, and, second, a case in which DOFO is very low. In the context of our model, the first case can be approximated by considering a situation where $\sigma_1 = (1-\sigma_1)$ and $(1-\alpha_1) = \alpha_1$ and hence $\pi_1 \to 0$ and $\pi_2 \to 1$. Also, the second case can be approximated by letting $\sigma_1 \to 0$ and $(1-\alpha_1) \to 0$ and hence $\pi_1 \to 1$ and $\pi_2 \to 0$.

Consider, first, the relationship between the exchange rate $\hat{e}$ and the relative price of national outputs $\hat{p}_1$. Differentiation of (23a) with respect to $\hat{p}_1$ when $\pi_1 \to 0$ and $\pi_2 \to 1$, yields the expression $(23a_1)$ [4]

$$\left.\frac{d\hat{e}}{d\hat{p}_1}\right|_{\substack{\pi_1 \to 0 \\ \pi_2 \to 1}} = - \ell_{21}\ell_{11}^{-1} \qquad (23a_1)$$

where

$$\ell_{21} = h_{11} < 0,\ \ell_{11} = h_{31} - \Delta_1\rho_1 > 0$$

$$h_{11} = - 2\sigma\varphi_1 < 0,\ h_{31} = 2\sigma\varphi_1 + (1+\xi\lambda) > 0$$

$$\Delta_1 = \lambda + \varphi_2 > 0$$

Differentiating (23a) with respect to $\hat{p}_1$ when $\pi_1 \to 1$ and $\pi_2 \to 0$, we obtain

$$\left.\frac{d\hat{e}}{d\hat{p}_1}\right|_{\substack{\pi_1 \to 1 \\ \pi_2 \to 0}} = -\{\ell_{22} + \ell_{32}\,(d\hat{f}/d\hat{p}_1)\}\ell_{12}^{-1} \qquad (23a_2)$$

where

$$\ell_{22} = h_{12} - c_{32}h_{22}\psi_{12} \gtrless 0$$
$$\ell_{12} = h_{32} - \Delta_2(\rho_1+\rho_2) + [c_{32}h_{22} + \Delta_2^2\rho_1\rho_2]\psi_{12} > 0$$
$$\ell_{32} = h_{22} + [c_{32}^{-1}h_{12}\Delta_2^2\rho_1\rho_2 - \Delta_2(\rho_1+\rho_2)h_{22}]\psi_{12} \quad (> 0)$$

and

$$\psi_{12} = \{\theta_2(1+\xi\lambda) + \xi\delta\varphi_2 + \kappa(1-\mu)v\varphi_2 - \kappa(1-\mu)\varphi_1\}^{-1} \quad (> 0)$$
$$h_{12} = \theta_2 + (2\sigma+\kappa)\varphi_2 v - (2\sigma+\kappa)\varphi_1 \quad (> 0)$$
$$h_{22} = \kappa\mu(\varphi_1-\varphi_2 v) > 0$$
$$h_{32} = (2\sigma+\kappa)(\varphi_1-\varphi_2 v) + \xi[\lambda\theta_2+\delta(\varphi_1-\varphi_2 v)] > 0$$
$$c_{32} = \sigma\lambda\theta_2 + \sigma\delta(\varphi_1-\varphi_2 v) > 0$$
$$\Delta_2 = \lambda\theta_2 + \delta(\varphi_1-\varphi_2 v) > 0$$

In signing the reduced form coefficients in ($23a_2$) we have made use of the fact that ψ_{12} is almost certainly positive and that h_{12} is most likely to be positive. Accordingly, equation ($23a_2$) suggests that, for any given $\hat{f}$, changes over time in p_1 and changes in e may be negatively related. However, equation ($23a_1$) indicates that the relationship between $\hat{p}_1$ and $\hat{e}$ can be expected to be positive.

The explanation for these results is to be found in the effect on national interest rates of variations in the prices of national outputs. If the degree of openness of the two economies is relatively high, a change in the relative price of domestic and foreign goods p_1 will have little effect on the relative level of national price indices p_{C1}. In fact, in this case, changes in p_1 will influence interest-rates at home and abroad mainly by affecting the relative level of national outputs, through the change in the real exchange rate. An increase in p_1, for example, will reduce the real exchange rate and, therefore, will cause home output to fall and foreign output to rise. Other things being equal, the demand for liquidity in the home economy will decrease while the demand for liquidity in the foreign economy will increase. Accordingly, a given *rise* in p_1 will require a fall in the interest rate differential r_1 to maintain equilibrium in the money markets. And, the fall in r_1 will, in turn, require *a depreciation* of the nominal exchange rate to maintain equilibrium in the bond markets (by creating expectations of future appreciation and by revaluing the private holdings of foreign currency-denominated bonds). If, however, the degree of openness of the two economies is relatively low, the relative level of national price indices p_{C1} will mainly be determined by p_1. Other things being equal, a given *rise* in p_1 will now create an excess demand for liquidity in the domestic economy and an excess supply of liquidity the foreign economy. Overall financial equilibrium will then require an increase in the interest rate differential r_1 and, hence, an *appreciation* of the nominal exchange rate.

Consider next the effect on the exchange rate of changes in net foreign asset positions. Differentiating (23a) with respect to $\hat{f}$, we obtain the expressions ($23b_1$)-($23b_2$)

$$\frac{d\hat{e}}{d\hat{f}}\bigg|_{\substack{\pi_1 \to 0 \\ \pi_2 \to 1}} = 0 \tag{$23b_1$}$$

$$\frac{d\hat{e}}{d\hat{f}}\bigg|_{\substack{\pi_1 \to 1 \\ \pi_2 \to 0}} = -[\ell_{32} + \ell_{22}(d\hat{p}_1/d\hat{f})]\ell_{12}^{-1} \neq 0 \tag{$23b_2$}$$

from which we infer that: the sensitivity of exchange rates to current and future changes in (net) national foreign asset positions can be expected to be inversely related to the degree of openness of national economies.

Also, consider the relationship between CA imbalances and the exchange rate. Letting $\pi_1 \to 0$, $\pi_2 \to 1$ and using (23a) to substitute out $\hat{e}$ from (21a), we can express the dynamics of the three variables e, p_1 and f as follows:

$$\dot{\hat{f}}_H = -\{n_{11}\hat{p}_1 + n_{12}\hat{f}\}(\ell_{11}\Delta_1)^{-1} \tag{24a$_1$}$$

$$\dot{\hat{p}}_{1H} = -vn_{21}(\ell_{11}\Delta_1)^{-1}\hat{p}_1 \tag{24a$_2$}$$

$$\dot{\hat{e}}_H = n_{31}(\ell_{11}\Delta_1)^{-1}\hat{p}_1 \tag{24a$_3$}$$

where

$n_{11} = c_{11}[(1+\xi\lambda)-\Delta_1\rho_1] - h_{11}[\delta\xi-\kappa(1-\mu)]\Delta_1 > 0$

$n_{12} = c_{21}\ell_{11} > 0$

$n_{21} = q_{11}[(1+\xi\lambda)-\Delta_1\rho_1] > 0$

$n_{31} = -\ell_{21}\Delta_1\rho_1 < 0$

and

$q_{11} = 2\sigma\Delta_1$, $c_{11} = \sigma\Delta_1$, $c_{21} = \kappa\mu\Delta_1$, $h_{11} = -2\sigma\varphi_1$

Letting $\pi_1 \to 1$, $\pi_2 \to 0$, and using (23a), we can write (21a) as

$$\dot{\hat{f}}_L = -c_{32}\{\omega_{11}\hat{p}_1 + \omega_{12}\hat{f}\}(\ell_{12}\Delta_2)^{-1} \tag{24b$_1$}$$

$$\dot{\hat{p}}_L = -v\{\omega_{21}\hat{p}_1 - \omega_{22}\hat{f}\}(\ell_{12}\Delta_2)^{-1} \tag{24b$_2$}$$

$$\dot{\hat{e}}_L = \{\omega_{31}\hat{p}_1 + \omega_{32}\hat{f}\}(\ell_{12}\Delta_2)^{-1} \tag{24b$_3$}$$

where

$\omega_{11} = \ell_{12} + \ell_{22}$

$\omega_{12} = \ell_{32}$

$\omega_{21} = q_{32}\ell_{22}+q_{12}\ell_{12}$

$\omega_{22} = q_{22}\ell_{12}-q_{32}\ell_{32}$

$\omega_{31} = h_{12}\ell_{12}-h_{32}\ell_{22}$

$\omega_{32} = h_{22}\ell_{12}-h_{32}\ell_{32}$

and

$q_{12} = \lambda(2\sigma+\kappa)+\delta$, $q_{22} = \lambda\kappa\mu$, $q_{32} = \lambda(2\sigma+\kappa\mu)$

Equations ($24a_1$)-($24a_3$) and ($24b_1$)-($24b_3$) are plotted, respectively, in Fig.(1) and Fig.(2), which can be used to examine the association between the CA and the exchange rate along the path to equilibrium.

First, consider Figure (1). The FF_H schedule describes the combinations of the relative prices of goods p_1 and of the (net) domestic holdings of foreign assets f, which are required to maintain CA balance and which are consistent with (23a). This schedule plots ($24a_1$), and its slope is

$$\left.\frac{d\hat{f}}{d\hat{p}_1}\right|_{FF_H} = -\frac{n_{11}}{n_{12}} < 0$$

From the definition of the reduced-form coefficients in ($24a_1$) and ($23a_1$), it can be seen that the sign of n_{12} is positive. Also, the coefficient n_{11} is almost certainly positive. Thus, the FF_H schedule is negatively sloped. Above the FF_H schedule, the (net) domestic holdings of foreign assets are decreasing i.e. $\dot{f} < 0$. Hence the home country's current account (CA_h) is in deficit (and the foreign country's current account (CA_f) is in surplus). Below the FF_H locus , $\dot{f} > 0$ and, therefore, the CA_h is in surplus (and the CA_f is in deficit). Equations ($24a_2$) and ($24a_3$) are plotted jointly in the figure as the EP_H curve. Since in ($24a_2$) $n_{21} > 0$, to the left of the EP_H schedule the prices of the domestic goods will be rising relative to the prices of the foreign goods, and, so, $\dot{p}_1 > 0$. Also, as n_{31} in ($24a_3$) is negative, to the left of this schedule $\dot{e} > 0$. To the right of the EP_H schedule, $\dot{p}_1 < 0$ and $\dot{e} < 0$. Accordingly, the area in Figure (1)

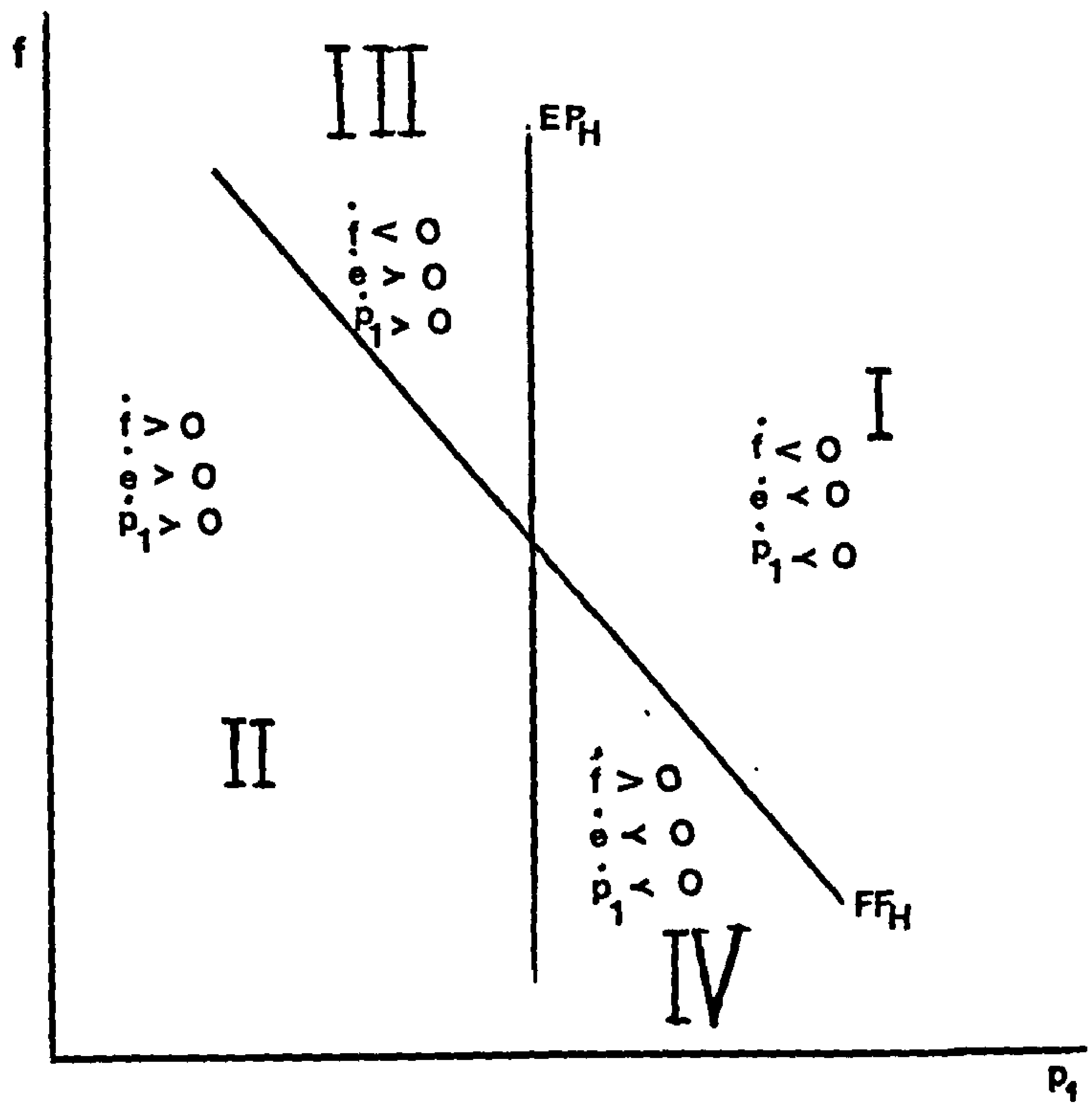

f
III
EP_H
$\dot{f} < 0$
$\dot{e} > 0$
$\dot{p}_1 > 0$
$\dot{f} > 0$
$\dot{e} > 0$
$\dot{p}_1 > 0$
I
$\dot{f} < 0$
$\dot{e} < 0$
$\dot{p}_1 < 0$
II
$\dot{f} > 0$
$\dot{e} < 0$
$\dot{p}_1 < 0$
FF_H
IV
p_1

Figure 1

can be divided into the following regions: (i) In region I, the domestic currency appreciates and the home country's CA (CA_h) is in deficit. (ii) In region II, the CA_h is in surplus and the home currency depreciates. And (iii) it is only in regions III and IV that the CA_h is in deficit while the exchange rate depreciates, or the CA_h is in surplus while the exchange rate appreciates.

Consider, however, Figure (2). From equations ($24b_1$)-($24b_3$), the slope of the FF_L schedule is,

$$\left.\frac{d\hat{f}}{d\hat{p}_1}\right|_{FF_L} = -\frac{\omega_{11}}{\omega_{12}} < 0 \qquad \omega_{11},\ \omega_{12} > 0$$

and, given the definition of the ℓ_i's in ($23a_2$), it is negative. Thus, above the FF_L schedule $\dot{f} < 0$ and below that schedule $\dot{f} > 0$.

The slope of the PP_L schedule is given by

$$\left.\frac{d\hat{f}}{d\hat{p}_1}\right|_{PP_L} = \frac{\omega_{21}}{\omega_{22}} \quad (>0)$$

while the slope of the EE_L schedule is

$$\left.\frac{d\hat{f}}{d\hat{p}_1}\right|_{EE_L} = -\frac{\omega_{31}}{\omega_{32}} \quad (<0)$$

After some algebraic manipulations, the expressions for ω_{21}, ω_{31}, ω_{22} and ω_{32} reduce to

$$\omega_{21} = (2\sigma+\kappa\lambda)\omega_{11} + \delta\ell_{12} + \lambda\kappa(1-\mu)[h_{22}c_{32}\psi_{12} - h_{12}] \quad (>0)$$
$$\omega_{31} = c_{32}h_{22} + [\Delta_2{}^2\rho_1\rho_2\psi_{12} - \Delta_2(\rho_1+\rho_2)]h_{12} > 0$$
$$\omega_{22} = \kappa\mu(i_1 + i_2 + i_3h_{12})\psi_{12} \quad (>0)$$
$$\omega_{32} = (h_{22}i_1 + i_4h_{12})\psi_{12} \quad (>0)$$

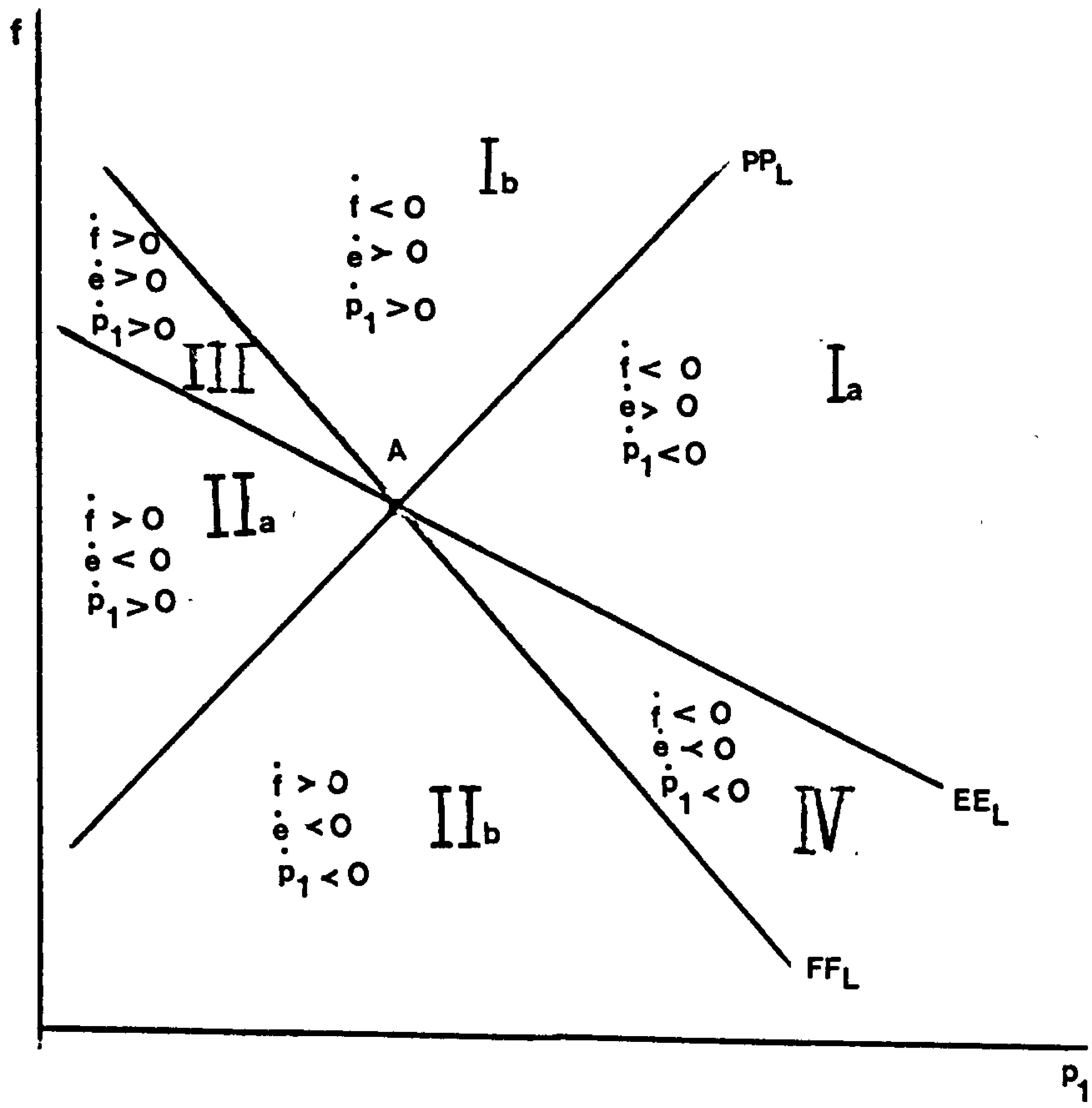


Figure $2a_1$

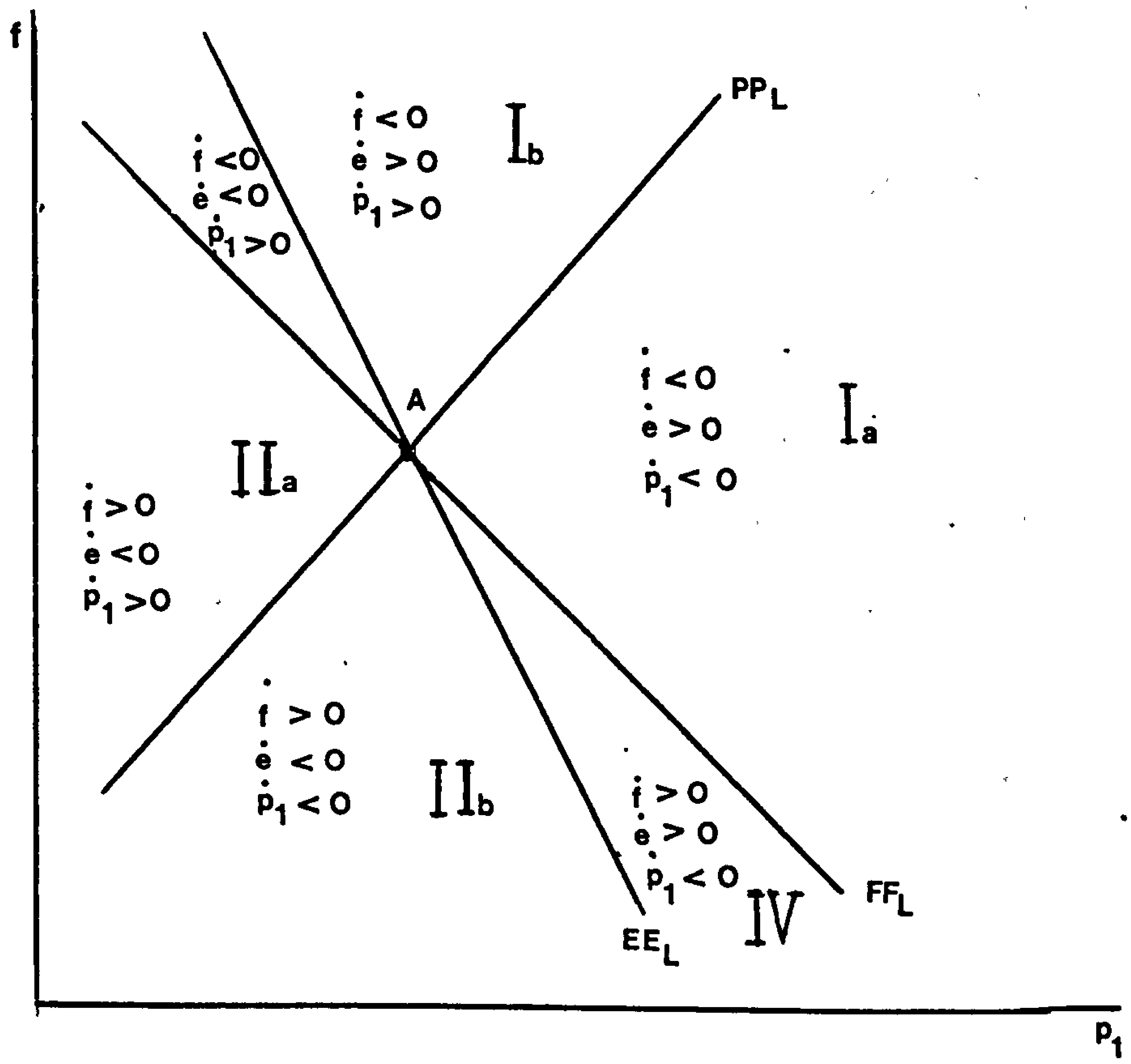


Figure $2a_2$

where

$$\iota_1 = c_{32}h_{22} + \Delta_2{}^2\rho_1\rho_2 \quad > 0$$
$$\iota_2 = c_{32}\xi[\psi_{12}{}^{-1} - \Delta_2(\rho_1+\rho_2)](^1/_\sigma) > 0$$
$$\iota_3 = -[\Delta_2(\rho_1+\rho_2) + \Delta_2{}^2\rho_1\rho_2(2\sigma+\kappa\mu)(\kappa\mu c_{32})^{-1}] \gtrless 0$$
$$\iota_4 = -[\Delta_2(\rho_1+\rho_2)h_{22} + \Delta_2{}^2\rho_1\rho_2 h_{32}c_{32}{}^{-1}] \gtrless 0$$

The coefficient ω_{21} is almost certainly positive, and when $(1-\mu) \rightarrow 0$ it is unambiguously positive. Also, $\omega_{31} > 0$. Given the definition the ι_i's, the coefficient ω_{22} is also most likely to be positive. Hence, the PP_L schedule can be taken to be upward-sloping. The EE_L schedule can be assumed to be downward-sloping, although it may be steeper or flatter than the FF_L curve as shown in Figs.($2a_1$)-($2a_2$). Accordingly, above the PP_L schedule $\dot{p}_1 > 0$. Below the PP_L locus $\dot{p}_1 < 0$. To the left of the EE_L locus $\dot{e} < 0$. To the right of this locus $\dot{e} > 0$.

By comparing Figures (1) and (2) it is clear that the degree of openness of national economies can play a key role in determining the association between exchange rates and CAs. Firstly, in regions Ia and Ib of Figures ($2a_1$) and ($2a_2$) the home country's CA is in deficit, but now the home currency depreciates. Secondly, in region IIa and IIb of the same figures, the CA_h is in surplus but the home currency appreciates. Thirdly, situations in which e and f move in the same direction can be observed only in regions III and IV.

The key to these results lies in the relationship between changes in the distribution of global wealth among countries and changes in the distribution of global demand among goods produced in different countries. Consider, for example, equations (1a)-(11a) and (14a)-(16a). Irrespective of the degree of openness of the home and the foreign economy, the exchange rate is determined at each point in time by the conditions for equilibrium in the goods, money and bond markets. Also, short-run exchange rate movements create CA imbalances, which, in turn, change over time the distribution of global wealth between the domestic and the foreign residents. If, however, the degree of openness of the two economies is relatively high, the impact of these redistributions of wealth on the relative demand for domestic and foreign goods, and hence on national interest-rates and the relative demands for national money balances and bonds, will be small. As a result, imbalances in current accounts will have little effect on the path of the exchange rate, and CA dynamics will be mainly "determined" by exchange rate dynamics. If, on the other hand, the openness of two economies is relatively low, the distribution of global wealth between the home and the foreign residents will be a crucial determinant of the distribution of global demand between home and foreign goods. Thus, redistributions of wealth that result from CA imbalances will significantly influence relative activity levels, and, hence, interest rates, relative money demands, bond demands, and the path of the exchange rate. A CA *deficit* in the home country, for example, will reduce over time the wealth of the home residents and will increase the wealth of the foreign residents. If $\pi_1 \to 1$, $\pi_2 \to 0$, this will lead to a fall in the relative demand for domestic output and, hence, will cause a reduction in the interest rate differential r_1. Other things being equal, in this case, the exchange rate will have to *depreciate* to maintain equilibrium in the money and bond markets. If the degree of openness of the two economies is relatively high, however, a CA *deficit* in the home economy will be mainly the reflection of the *appreciation* of the exchange rate and hence the reflection of low exports of home goods.

Our results have important implications for a number of recent studies of exchange rate, price and CA dynamics that use open-economy models in which the "openness" of the economy is not explicitly specified. For example, a well-known result of Dornbusch and Fischer (1980) and of Henderson (1981) is that when nominal (unanticipated) disturbances occur, CA surpluses and appreciations are positively correlated. This is certainly true under the assumption that, in (1a) and (7a), $\sigma_2 \rightarrow 0$ and $(1-\alpha_1) \rightarrow 0$ (i.e. that the home country is small enough to take all real foreign variables as parametrically given, and that real domestic wealth, real money balances etc. depend only upon the prices of home goods). However, it may not be generally true in a two-country set-up, when the degree of openness of the two economies is relatively high. Also, Pikoulakis (1985), who uses a two-country framework of analysis, makes the assumption that $(1-\alpha_1) = (1-\alpha_2) = 0$ and that spending by domestic residents on foreign goods is independent of wealth. Hence, his results may not be preserved if these assumptions are relaxed. Moreover, Obstfeld and Stockman (1985), Engel and Flood (1985), Driskill and McCafferty (1985) and Kawai(1985), who focus on the factors that might influence the dynamic interactions between the exchange rate and the CA, implicitly assume that the conditions $\sigma_1 \rightarrow 0$, $\sigma_2 \rightarrow 0$ or $(1-\alpha_1)$, $(1-\alpha_2) \rightarrow 0$ hold. Thus, their results may not apply in the more case where σ_1, $\sigma_2 \neq 0$ and $(1-\alpha_1),(1-\alpha_2) \neq 0$.

To illustrate the importance of the size of these parameters for the complete dynamic response of the system to unanticipated disturbances, in the following section we solve numerically the model for the time path of e, p_1 and f. We focus on the effects of: (i) a decline in the relative demand for domestic bonds, (ii) an increase in the relative demand for home goods, and (iii) a contraction in the domestic money supply, achieved via an open market sale of domestic bonds.

V. *'Openness' and Dynamic Adjustment to Unanticipated Disturbances*.

We consider two 'variants' of the model of equations (1a)-(11a) and (14a)-(16a), depending on how open the two economies are. The first variant assumes that $\sigma_1 = \sigma_2 = (1-\alpha_1) = (1-\alpha_2) = .4$, i.e. that the degree of openess of the home and foreign economy is relatively high: we refer to it as the 'Model-H'. The other assumes that $\sigma_1 = \sigma_2 = (1-\alpha_1) = (1-\alpha_2) = .1$, and we refer to it as the 'Model-L'. For the other parameters of the model we choose the following values

$$\varphi_1 = \varphi_2 = 1,\ \lambda = 2\ (\lambda = 3),\ \xi = .1\ (\xi = .02/2)$$

$$v = .5,\ \gamma = .7,\ \kappa = .07,\ \delta = \sigma = .2$$

$$\mu_1 = \mu_2 = (1-\mu_1-\mu_2),\ \mu_3 = \mu_4 = .5$$

Our results are reported in Tables (1)-(3).

The first thing to note from the tables is the diffference in the dynamic characteristics of Model-H and Model-L. Consider the effects of the decline in the relative demand for domestic bonds (Table (1)). Both in Model-H and in Model-L, in the long-run the exchange rate depreciates, the relative price of the domestic good rises, and the net domestic holdings of foreign assets increase. During the adjustment period, however, the relationship between p_1, f and e is very different in the two models. During the adjustment period, in Model-H, the relative price of domestic output p_1 *rises* and e *increases*. Also, e and f move in the *same* direction. Hence, the home country's CA is in *surplus* as the home currency *depreciates*. In Model-L, on the other hand, p_1 *rises* and e *falls* during

TABLE (1)-*Dynamic adjustment to a decline in the relative demand for domestic bonds* ($\xi = .1$, $\lambda = 2$)
(Deviations from initial steady-state values)

	'MODEL-H'			'MODEL-L'		
Time	Exchange Rate e	Relative Prices p_1	Net Foreign Assets f	Exchange Rate e	Relative Prices p_1	Net Foreign Assets f
0	1.51	0	0	1.95	0	0
1	1.54	.30	.18	1.92	.71	.21
2	1.56	.54	.33	1.90	1.09	.36
3	1.59	.74	.48	1.89	1.30	.48
4	1.60	.90	.61	1.88	1.41	.58
6	1.63	1.14	.84	1.87	1.51	.76
8	1.64	1.29	1.04	1.86	1.55	.91
10	1.66	1.40	1.21	1.85	1.60	1.06
20	1.67	1.59	1.91	1.81	1.58	1.69
40	1.67	1.63	2.85	1.76	1.61	2.63
∞	1.67	1.67	4.40	1.67	1.67	4.40

TABLE (2)-*Dynamic adjustment to an increase in the relative demand for domestic goods* ($\xi = .1$, $\lambda = 2$)
(Deviations from initial steady-state values)

	'MODEL-H'			'MODEL-L'		
Time	Exchange Rate e	Relative Prices p_1	Net Foreign Assets f	Exchange Rate e	Relative Prices p_1	Net Foreign Assets f
0	-1.29	0	0	-2.98	0	0
1	-1.20	.78	.23	-3.01	.69	.24
2	-1.13	1.42	.41	-3.03	1.06	.41
3	-1.08	1.93	.56	-3.05	1.27	.56
4	-1.03	2.35	.69	-3.06	1.38	.69
6	- .96	2.97	.87	-3.07	1.48	.91
8	- .92	3.37	1.00	-3.08	1.51	1.12
10	- .89	3.64	1.09	-3.09	1.52	1.31
20	- .84	4.10	1.26	-3.14	1.55	2.16
40	- .83	4.16	1.34	-3.21	1.59	3.44
∞	- .83	4.17	1.44	-3.33	1.67	5.76

the adjustment period. In addition, e and f move over time in *opposite* directions. Thus, there is a CA *surplus* in the home country and an *appreciation* of the domestic currency. Similar results are obtained for the case of an increase in the relative demand for home goods (Table (2)).

Tables ($3a_1$)-($3a_2$) show the effects of an (unanticipated) contraction in the domestic money supply (achieved via an open market sale of domestic bonds) under two situations: (a) 'strong substitutability' between domestic and foreign bonds i.e. $\xi = .02$ and $\lambda = 2$ (Table ($3a_1$)); and (b) 'weak substitutability' between B and B* and strong substitutability between home money (foreign money) and home bonds (foreign bonds) i.e. $\xi = 2$ and $\lambda = 3$ (Table ($3a_2$)). When $\xi = .02$ and $\lambda = 2$, the contraction in the domestic money supply leads to a long-run appreciation, a drop in the relative price of the domestic good, and a decrease in the net domestic holdings of foreign assets. When $\xi = 2$ and $\lambda = 3$, in the long-run, the exchange rate depreciates, p_1 rises and f increases. Irrespective of the degree of bond substitutability, however, the dynamic relationship between e and p_1 is *positive* in Model-H. Thus, when $\xi = .02$ and $\lambda = 2$, e appreciates and p_1 falls during the adjustment period. When $\xi = 2$ and $\lambda = 3$, e depreciates and p_1 increases. In Model-L, on the other hand, e and p_1 move over time in *opposite* directions. Also, the relationship between e and f is different in the two models. In Model-H: when $\xi = .02$ and $\lambda = 2$, there is a *deficit* in the home country and an *appreciation* of the home currency; and when $\xi = 2$ and $\lambda = 3$, there is a *surplus* and a *depreciation* along the path to equilibrium. In Model-L, however, there is a *deficit* and a *depreciation* when $\xi = .02$ and $\lambda = 2$, and a *surplus* and an *appreciation* when $\xi = 2$ and $\lambda = 3$. These results illustrate the point we have made in Section IV: that the dynamic interactions among exchange rates, prices and CAs can be expected to depend crucially on the degree of openness of

TABLE ($3a_1$)-*Dynamic adjustment to an unanticipated contraction in the domestic money supply* (ξ =.02, λ = 2)
(Deviations from initial steady-state values)

	'MODEL-H'			'MODEL-L'		
Time	Exchange Rate e	Relative Prices p_1	Net Foreign Assets f	Exchange Rate e	Relative Prices f	NetForeign Assets f
0	-.830	0	0	-.993	0	0
1	-.851	-.175	-.051	-.975	-.429	-.079
2	-.868	-.317	-.092	-.965	-.662	-.124
3	-.882	-.433	-.126	-.959	-.788	-.150
4	-.893	-.527	-.154	-.956	-.857	-.166
6	-.910	-.667	-.197	-.953	-.915	-.183
8	-.921	-.759	-.226	-.952	-.932	-.193
10	-.928	-.821	-.246	-.952	-.937	-.200
20	-.941	-.926	-.290	-.950	-.940	-.229
40	-.942	-.941	-.314	-.947	-.941	-.271
∞	-.942	-.942	-.348	-.942	-.942	-.348

TABLE ($3a_2$)-*Dynamic adjustment to an unanticipated contraction in the domestic money supply* (ξ = 2, λ = 3)
(Deviations from initial steady-state values)

	'MODEL-H'			'MODEL-L'		
Time	Exchange Rate e	Relative Prices p_1	Net Foreign Assets f	Exchange Rate e	Relative Prices p_1	Net Foreign Assets f
0	.280	0	0	.305	0	0
1	.282	.049	.058	.304	.068	.050
2	.283	.089	.113	.303	.107	.093
3	.283	.120	.164	.302	.130	.134
4	.284	.146	.212	.302	.143	.171
6	.285	.183	.302	.301	.158	.243
8	.286	.207	.384	.301	.165	.310
10	.286	.223	.460	.300	.171	.375
20	.286	.253	.780	.297	.192	.662
40	.286	.267	1.230	.294	.222	1.090
∞	.286	.286	1.980	.286	.286	1.980

national economies.

The second thing to note from Tables (1) and (3) is that the impact effects on the exchange rate of the changes in the relative demand for domestic bonds and in the supply of home money are more pronounced in Model-L than in Model-H. Thus, in Table (1) and in Tables $(3a_1)$-$(3a_2)$, the exchange rate initially undershoots its new steady-state level when $\sigma_1 = \sigma_2 = (1-\alpha_1) = (1-\alpha_2) = .4$; and it overshoots its long-run equilibrium value when $\sigma_1 = \sigma_2 = (1-\alpha_1) = (1-\alpha_2) = .1$. However, the opposite applies in the case of Table (2). In Table (2): e 'overshoots' when $\sigma_1 = \sigma_2 = .4$, $(1-\alpha_1) = (1-\alpha_2) = .4$; and it 'undershoots' when $\sigma_1 = \sigma_2 = (1-\alpha_1) = (1-\alpha_2) = .1$. It follows that the degree of openness of national economies can also influence the short-run sensitivity of exchange rates to disturbances. In fact, when it is relatively high, exchange rates can be expected to react less sharply to nominal disturbances and more sharply to real disturbances.

VI. *Conclusions*

In seeking a theoretical explanation for the differencies in the macroeconomic behaviour of individual countries subsequent to exogenous or policy-induced disturbances, economists today place much emphasis on the "structural parameters" of the economy. A factor that the existing literature still largerly neglect is the degree of openness of national economies.

Our results suggest this factor can significantly influence the short-run and long-run effects of unanticipated disturbances, as well as the dynamic relationships among exchange rates, national price levels and international balances of payment.

Notes.

1. See e.g. Obstfeld (1985).

2. Note that $(1/\mu_3)(\mu_1\mu_4) = \mu_2$

3. For the steps involved in deriving the stable-path (23a), see Appendix I of Chapter 2.

4. Note that with $\pi_2 \to 1$ and $\pi_1 \to 0$, we have $\Delta\rho_2 = - c_{21}$. Hence $\ell_{31} = 0$, $\ell_{21} = h_{11}$ and $\ell_{11} = (h_{31} - \Delta\rho_1)$.

CHAPTER 5

Simple Policy Rules, Openness and Macroeconomic Adjustment to Permanent and Stochastic Shocks. *

* Some of the ideas expounded in this Chapter can be traced to Zervoyianni (1983): a paper presented at the author's thesis proposal at Warwick and at Research Students Workshops at Warwick.

I. *Introduction*

A dominant theme in recent work on stabilization-policy in open economies is the question of whether the authorities of individual countries can mitigate the adverse effects of exogenous disturbances on their economies by following simple policy rules.

In addressing this issue, one group of studies employs stochastic macroeconomic models, in which the disturbances are treated as transitory shocks [1]. In most of these studies, the performance of alternative policy rules is evaluated in terms of their influence on the steady-state or 'asymptotic' variances of real activity levels and general price levels. Several other papers use deterministic macro-models, in which prices are less than perfectly flexible and in which the disturbances are assumed to be permanent unanticipated shocks [2]. The analysis in these papers is based on the principle that unanticipated disturbances may, in the short-run, cause exchange rate misalignments (because of the differential speeds of adjustment in the goods and asset markets). Since exchange rate misalignments can have undesirable effects on real activity levels or on inflation rates, it is argued that national authorities may have an insentive to influence the short-run behaviour of exchange rates. Thus, these studies typically compare the 'short-run' effects of exogenous disturbances under floating exchange rates with those that occur when the authorities adjust in the short-run the money supply with the view to reducing the deviations of the nominal or real exchange rates from their 'equilibrium' levels. McKinnon (1984,1986), for example, has expressed the view that, in the short-run, the nominal exchange rate should be used by the authorities as an 'information variable' for the adjustment of the money supply. Williamson (1985, 1987), on the other hand, has suggested that, in the short-run, monetary policy should aim to limit deviations of the real exchange rate from its equilibrium value.

In both the deterministic and the stochastic literature, however, little attention has been given to the question of whether the effectiveness of these simple policy rules may depend on the degree of openness of national economies. In the present chapter we attempt to examine this issue by analysing the behaviour of two interdependent economies subsequent to disturbances, under alternative assumptions about their "openness" and about the policy rules that the authorities follow.

The chapter is organized as follows:

Section II presents the model. Our basic model is a variant of the two-country model that we have developed in Chapter 4. To this model we add a set of simple rules for the adjustment of the domestic money supply, of the foreign money supply, and of the relative supplies of domestic and foreign bonds held by private agents. Section III studies the behaviour of a deterministic version of the model, in which the disturbances are assumed to be permanent unanticipated shocks. Section IV examines the asymptotic covariance properties of a stochastic version of the model, under the assumption that the shocks to the system are white-noise random disturbances. Our analysis demonstrates that the degree of openness of national economies can significantly influence the effects of simple policy rules on real activity levels and general price levels, as well as the ranking of alternative policy rules in terms of an 'overall performance' measure.

The chapter ends with a very brief Section V, which discusses the directions in which our analysis can be extended.

II. *The Model*

Our basic model is similar to the one examined in Chapter 4. In this chapter, however, we ignore wealth effects (which are not essential for our conclusions) [3]. We also assume a set of rules for the adjustment of the three policy variables: M - the domestic money supply; M* - the foreign money supply; and $(^B/_{B*})^p$ - the relative supplies of domestic and foreign bonds held by private agents. Expressed in logarithms, these three variables are

$$m, \quad m^*, \quad (b-b^*)^p \tag{1a.1}$$

To simplify matters, we shall postulate that the entire stock of the domestic assets at the possession of the domestic monetary authorities consists of home-government bonds. We shall further assume that they hold all their foreign exchange reserves in the form of foreign-government bonds, and that they do not monetize (or demonetize) the capital gains (or losses) which may result from revaluations in the home-currency value of these foreign assets at their possession. Accordingly, their asset constraint can be specified as follows:

$$m = b_d{}^a + b^*{}_d{}^a \tag{1a.2}$$

Making similar assumptions about the monetary authorities in the foreign economy we may specify their asset constraint as

$$m^* = b^*{}_f{}^a + b_f{}^a \tag{1a.3}$$

As in Ch.4, we shall assume for simplicity that the home and the foreign government always balance their budgets by adjusting taxes. Accordingly, the *total* stock of home-government bonds and that of foreign-government bonds (i.e. the stocks of bonds held by the domestic and the foreign private sector and by the domestic and the foreign monetary authorities) can be taken to remain invariant over time. Thus

$$(b-b^*)^a + (b-b^*)^p = (b-b^*) \tag{1a.4}$$

where

$$b^a = b_d{}^a + b_f{}^a$$

$$b^{*a} = b^*{}_f{}^a + b^*{}_d{}^a,$$

and (b-b*) denotes the total relative stocks of bonds, which we take to be given. Under these conditions, it is possible for the monetary authorities in the two countries to use independently the policy "instruments" m, m* and $(b-b^*)^p$ in (1a.1). First, they can keep m and m* constant, and they can alter $(b-b^*)^p$ by exchanging with private agents home-government bonds for foreign-government bonds (and vice versa). We shall refer to this policy as "sterilized intervention" [4]. As long as bond substitutability is less than perfect, sterilized-intervention can be used to influence the behaviour of the exchange rate. Second, the domestic monetary authorities can keep $(b-b^*)^p$ constant, and they can alter m by exchanging with the domestic private sector home *and* foreign government bonds for home money. Similarly, the foreign monetary authorities can keep $(b-b^*)^p$ constant and alter m* by exchanging with the foreign private sector foreign *and* home government bonds for foreign money. We shall refer to that policy as "monetary policy".

Accordingly, the policy behaviour of the monetary authorities in the two countries can be described by (1b.1)-(1b.3):

$$m = \bar{m} - x_h\{x_1(e-e^t)+ x_2(e^R-e^{Rt})+ x_3(p_C-p_C{}^t)- x_4(y^n-y^{nt})\} \tag{1b.1}$$

$$m^* = \bar{m}^* + x_f\{x_1(e-e^t)+ x_2(e^R-e^{Rt})- x_3(p_C{}^*-p_C{}^{*t})+ x_4(y^{*n}-y^{*nt})\} \tag{1b.2}$$

$$(b-b^*)P = (\bar{b}-\bar{b}^*)P - \upsilon\{\upsilon_1(e-e^t) + \upsilon_2(e^R-e^{Rt})\} \tag{1b.3}$$

where

e = the nominal exchange rate (defined as the price of foreign currency per unit of home currency)

e^R = $(e-p+p^*)$ = the real exchange rate

p = the price of domestic output

p^* = the price of foreign output

p_C = the domestic price index

p_{C^*} = the foreign price index

y^n = $(y+p)$ = the nominal domestic GDP

y^{*n} = (y^*+p^*) = the nominal foreign GDP

$\bar{m}$, $\bar{m}^*$, $(\bar{b}-\bar{b}^*)P$ = the initial steady-state levels of m, m^*, $(b-b^*)P$

e^t, e^{Rt}, $p_C{}^t$, $p_C{}^{*t}$, y^{nt} and y^{*nt} = the targeted e, e^R, p_C, $p_C{}^*$, y^n and y^{*n} of the authorities.

By making alternative assumptions about the values of the x_i's and υ_i's in (1b.1)-(1b.3), we can consider several policy regimes. For example,

(a) x_h, x_f, $x_1 > 0$ and $\upsilon = x_2 = x_3 = x_4 = 0$ can be taken to represent the case where the domestic and the foreign monetary authorities have targets for the nominal exchange rate, and they change the money supply when their targeted exchange rate is above or below the current exchange rate. Similarly, x_h, x_f, $x_2 > 0$ and $\upsilon = x_1 = x_3 = x_4 = 0$

represents the case where the authorities have a real exchange rate target.

(b) $x_h = x_f = 0$, $\upsilon > 0$ describes a situation in which the authorities keep the money supply constant, and they attempt to influence the behaviour of the nominal or the real exchange rate by altering the composition of interest-bearing assets held by private agents.

(c) x_h, x_f, $x_3 > 0$ and $x_1 = x_2 = x_4 = \upsilon = 0$ implies that monetary policy in the two economies aims to stabilize the general price level. Also, x_h, x_f, $x_4 > 0$ and $x_1 = x_2 = x_3 = \upsilon = 0$ implies that monetary policy aims to influence the nominal GDP.

(d) x_h, x_f, x_3, $\upsilon > 0$ and $x_1 = x_2 = x_4 = 0$ represents a regime in which the authorities in each country adjust the money supply so as to stabilize the price level, and they use sterilized intervention to influence the behaviour of the nominal or the real exchange rate.

(e) $x_h = x_f = \upsilon = 0$ indicates that the domestic and the foreign money supply are held constant, and that the authorities have no targets for the nominal or the real exchange rate.

The rest of our model consists of the equations specified in Section IV of Chapter 4. Assuming rational expectations and ignoring wealth effects, they are given by (2b)-(12b):

$$y = (1-\sigma_1)a + \sigma_1 a^* + \sigma(e-p+p^*) + s_1 \tag{2b}$$

$$y^* = (1-\sigma_1)a^* + \sigma_1 a - \sigma(e-p+p^*) - s_1 \tag{3b}$$

$$\dot{p} = v(y-\tilde{y}) \tag{4b}$$

$$\dot{p}^* = v(y^*-\tilde{y}^*) \tag{5b}$$

$$a = \gamma y - \delta(r-\dot{p}_C) \tag{6b}$$

$$a^* = \gamma y^* - \delta(r^*-\dot{p}_C^*) \tag{7b}$$

$$p_C = \alpha_1 p + (1-\alpha_1)(e+p^*) \tag{8b}$$

$$p_C^* = \alpha_1 p^* + (1-\alpha_1)(p-e) \tag{9b}$$

$$m - p_C = \varphi_1 y - \lambda r - \varphi_2 \dot{p}_C + s_{41} \tag{10b}$$

$$m^* - p_C^* = \varphi_1 y^* - \lambda r^* - \varphi_2 \dot{p}_C^* + s_{42} \tag{11b}$$

$$r = r^* + \dot{e} - \xi[e + (b^* - b)P] - s_2 \tag{12b}$$

Expressing (1b.1)-(1b.3) in terms of 'relative' and 'aggregate' variables, and assuming that $x_h = x_f$, we can write

$$m_1 = \bar{m}_1 - x\{2x_1(e-e^t) + 2x_2(e^R-e^{Rt}) + x_3(p_{1C}-p_{1C}^t) - x_4(y_1^n-y_1^{nt})\} \tag{1b$_1$}$$

$$m_2 = \bar{m}_2 - x\{x_5(p_{C2}-p_{C2}^t) - x_4(y_2^n-y_2^{nt})\} \tag{1b$_2$}$$

$$b_1 P = \bar{b}_1 P - \upsilon\{\upsilon_1(e-e^t) + \upsilon_2(e^R-e^{Rt})\} \tag{1b$_3$}$$

where

$m_1 = m - m^*$, $p_{1C} = p_C - p_C^*$, $y_1^n = y^n - y^{*n}$, $b_1 P = (b - b^*)P$

$m_2 = m + m^*$, $p_{2C} = p_C + p_C^*$, $y_2^n = y^n + y^{*n}$

The variables in $(1b_1)$-$(1b_3)$ have the same interpretation as those in the model of Ch.4. For example, p_{C1} is the relative level of the domestic and foreign price index; y_1^n denotes the relative level of the domestic and foreign (nominal) GDP; and y_2^n is the aggregate level of (nominal) outputs. Also, m_1 denotes the relative level of the domestic and foreign money stock, while m_2 is the global money stock. Thus, the case in which $x = 1$, $0 < x_1 < 1$ and $x_2 = x_3 = x_4 = \upsilon = 0$ can be taken to represent a version of the monetary rule proposed by McKinnon (1984, 1986). According to this rule, the authorities of national economies are to maintain the global money stock unchanged and adjust the supplies of national monies in proportion to movements in nominal exchange rates. Also, the case where $x = 1$, $0 < x_2 < 1$ and $x_1 = x_3 = x_4 = \upsilon = 0$ can be taken to represent a version of the monetary rule proposed by Williamson (e.g. 1986b, 1987). According to that rule, monetary policy in the short run is to be used to limit the deviations of real exchange rates from their 'equilibrium' levels.

Similarly, equations (2b)-(12b) can be expressed as

$$\begin{aligned}
y_1 &= (1-2\sigma_1)a_1 + 2\sigma(e-p_1) + 2s_1 \\
a_1 &= \gamma y_1 - \delta(r_1-\dot{p}_{c1}) \\
\dot{p}_1 &= vy_1 + s_3 \\
m_1 - p_{c1} &= \varphi_1 y_1 - \lambda r_1 - \varphi_2 \dot{p}_{c1} + s_4 \\
p_{c1} &= (2\alpha_1-1)p_1 + 2(1-\alpha_1)e \\
\dot{e} &= r_1 + \xi(e-b_1 P) + s_2
\end{aligned} \qquad (13b_1)$$

where

$y_1 = y - y^*$, $r_1 = r - r^*$

$a_1 = a - a^*$, $p_1 = p - p^*$

$s_3 = -(\tilde{y}-\tilde{y}^*)v, s_4 = s_{41}-s_{42}$

$$\begin{aligned}
y_2 &= a_2 \\
a_2 &= \gamma y_2 - \delta(r_2-\dot{p}_{2c}) \\
\dot{p}_2 &= vy_2 + s_3^o \\
m_2 - p_{2c} &= \varphi_1 y_2 - \lambda r_2 - \varphi_2 \dot{p}_{2c} + s_4^o \\
p_{2c} &= p_2
\end{aligned} \qquad (13b_2)$$

where

$y_2 = y + y^*$, $r_2 = r + r^*$

$a_2 = a + a^*$, $p_2 = p + p^*$

$\dot{s}_3 = -(\tilde{y}+\tilde{y}^*)v, s_4^o = s_{41}+s_{42}$

The terms s_1 and s_2 in ($13b_1$) have exactly the same interpretation as in the model of Ch.4. Thus s_1 can be regarded as an exogenous disturbance to the relative demand for domestic and foreign goods, while s_2 describes an exogenous shock to the relative demand for domestic and foreign bonds. In ($13b_1$), an increase in s_3 can be interpreted as an exogenous decline in the level of domestic 'capacity' output combined with a rise in the level of foreign 'capacity' output. Also, an increase in s_4 can be taken to describe a rise in the demand for liquidity in the home economy combined with a fall in the demand for liquidity in the foreign economy. If the decline in domestic capacity-output (the rise in the demand for liquidity in the home economy) is exactly equal to the rise in the foreign-capacity output (the fall in the demand for liquidity in the foreign economy), such disturbances will have no effect on the 'aggregate' model ($13b_2$) since $s_3^\circ \rightarrow 0$ and $s_4^\circ \rightarrow 0$. Without essential loss of generality, and given the purpose of this chapter, we shall assume this to be the case. In what follows, therefore, our model will consist of ($1b_1$), ($1b_3$) and ($13b_1$).

We shall proceed to the analysis of the model as follows. In Section III, the s_i's will be assumed to be permanent (unexpected) disturbances, and only exchange-rate rules will be considered. Also, the targeted nominal or real exchange rate of the authorities will be taken to be the long-run equilibrium exchange rate. In Section IV, all the policy rules described by ($1b_1$)-($1b_3$) will be re-introduced into the model, and the s_i's will be treated as transitory, stochastic disturbances. In that section the variables e^t, e^{Rt}, ${p_{C1}}^t$, ${y_1}^{nt}$ will be assumed to be constant and, for simplicity, will be set equal to zero. Accordingly, in the general case where $x_i \neq 0$ and $\upsilon_i \neq 0$, equations ($1b_1$), ($1b_3$) and ($13b_1$) contain eight endogenous variables, i.e. y_1, a_1, p_1, p_{C1}, r_1, e, m_1, b_1P.

III. *Nominal Exchange-Rate Rules, Real-Exchange Rate Rules and Permanent Unanticipated Disturbances.*

In this section we consider the following version of (1b.1)-(1b.3):

$$m = \bar{m} - \{x_1(e-\bar{e}) + x_2(e^R-\bar{e}^R)\} \qquad (1c.1)$$

$$m^* = \bar{m}^* + \{x_1(e-\bar{e}) + x_2(e^R-\bar{e}^R)\} \qquad (1c.2)$$

$$(b-b^*)^P = (\bar{b}-\bar{b}^*)^P - \{\upsilon_1(e-\bar{e}) + \upsilon_2(e^R-\bar{e}^R)\} \qquad (1c.3)$$

where the x_i's and υ_i's are assumed to be positive parameters lying between zero and unity, and where

$\bar{e}$ = the long-run equilibrium level of the nominal exchange rate
$\bar{e}^R$ = $\bar{e}-\bar{p}+\bar{p}^*$ = the long-run equilibrium level of the real exchange rate
e = the current level of the nominal exchange rate
e^R = the current level of the real exchange rate
m = the current level of the domestic money supply
m^* = the current level of the foreign money supply
$(b-b^*)^P$ = the current, relative supplies of domestic and foreign bonds held by private agents
$\bar{m}$, $\bar{m}^*$, $(\bar{b}-\bar{b}^*)^P$ = the targeted, long-run values of m, m* and $(b-b^*)^P$ (assumed to be fixed)

Equations (1c.1)-(1c.3) imply that in the steady state $m = \bar{m}$, $m^* = \bar{m}^*$ and $(b-b^*)^P = (\bar{b}-\bar{b}^*)^P$, since $e = \bar{e}$ and $e-p-p^* = \bar{e}-\bar{p}-\bar{p}^*$. Outside steady states, however, the monetary authorities will adjust m, m* and $(b-b^*)^P$ with a view to reducing the deviation of the nominal or the real exchange rate from their equilibrium levels. As we pointed out in Section I, these policies aim to limit exchange rate misalignments that may have an adverse impact on real activity levels or on inflation rates in the short-run.

Defining m_1, m_2 and b_1 as in Section II, we can express (1c.1)-(1c.3) as follows

$$m_1 = \overline{m}_1{}^* - \{2x_1(e-\overline{e}) + 2x_2[(e-p+p^*)-(\overline{e}-\overline{p}+\overline{p}^*)]\} \tag{1c$_1$'}$$

$$b_1P = \overline{b}_1{}^*P - \{\upsilon_1(e-\overline{e}) + \upsilon_2[(e-p+p^*)-(\overline{e}-\overline{p}+\overline{p}^*)]\} \tag{1c$_2$'}$$

$$m_2 = \overline{m}_2 \tag{1c$_3$'}$$

Letting a circumflex over a variable denote the deviation of the variable from its steady-state value, we can write (1c$_1$')-(1c$_3$') as

$$\hat{m}_1 = -\psi_{11}\hat{e} - \psi_{12}(\hat{e} - \hat{p}_1) \tag{1c$_1$}$$

$$\hat{b}_1P = -\psi_{21}\hat{e} - \psi_{22}(\hat{e} - \hat{p}_1) \tag{1c$_2$}$$

where

$$\psi_{11} = 2x_1, \quad \psi_{21} = \upsilon_1$$
$$\psi_{12} = 2x_2, \quad \psi_{22} = \upsilon_2$$

The equations in (13b$_1$) of Section II can be written in deviation-form as follows

$$\begin{aligned}
\hat{y}_1 &= (1-2\sigma_1)\hat{a}_1 + 2\sigma(\hat{e}-\hat{p}_1) \\
\hat{\dot{p}}_1 &= v\hat{y}_1 \\
\hat{a}_1 &= \gamma\hat{y}_1 - \delta(\hat{r}_1-\hat{\dot{p}}_{C1}) \\
\hat{p}_{C1} &= (2\alpha_1-1)\hat{p}_1 + 2(1-\alpha_1)\hat{e} \\
\hat{m}_1 - \hat{p}_{C1} &= \varphi_1\hat{y}_1 - \lambda\hat{r}_1 - \varphi_2\hat{\dot{p}}_{C1} \\
\hat{\dot{e}} &= \hat{r}_1 + \xi(\hat{e} - \hat{b}_1P)
\end{aligned} \tag{13c$_1$}$$

To study the stability properties of the system, it is convenient to summarize the dynamics of the model in terms of e (the non-predetermined nominal exchange rate) and p_1 (the predetermined relative price of domestic and foreign goods). Thus,

$$\begin{bmatrix} \dot{\hat{p}} \\ \\ \dot{\hat{e}} \end{bmatrix} = \frac{1}{\Delta} \begin{bmatrix} -vb_{11} & vb_{12} \\ \\ b_{21} & b_{22} \end{bmatrix} \begin{bmatrix} \hat{p} \\ \\ \hat{e} \end{bmatrix} \tag{14c}$$

$$b_{11} = 2\sigma\lambda_1 + \pi_1\delta(1-\pi_2)^2 + \delta\pi_1\{\psi_{22}\pi_2\lambda_2\xi - \psi_{12}(1-\pi_2)\} \quad (> 0)$$

$$b_{12} = 2\sigma\lambda_1 + \pi_1\pi_2\delta \ \{\xi\lambda_2-(1-\pi_2)\} + \pi_1\delta\{\psi_2\pi_2\lambda_2\xi-\psi_1(1-\pi_2)\} \quad (> 0)$$

$$b_{21} = (1-\pi_2)\theta - 2\sigma\varphi - \theta\psi_{12} - \xi(\theta\lambda+\pi_1\varphi\delta)\psi_{22} \gtrless 0$$

$$b_{22} = 2\sigma\varphi + \theta\pi_2 + \xi(\lambda\theta+\delta\varphi\pi_1) + \theta\psi_1 + \xi(\lambda\theta+\delta\varphi\pi_1)\psi_2 \quad > 0$$

where

$\theta_1 = 1 - (\gamma+v\delta)$ (> 0), $\lambda_1 = \lambda+\pi_2\varphi_2$, $\lambda_2 = \lambda+\varphi_2$, $\varphi = \varphi_1-v\varphi_2(1-\pi_2)$ (>0)

$\theta = \theta_1 + (1-\pi_1)(\gamma+v\delta) + v\delta\pi_1\pi_2$, $\Delta = \theta\lambda_1+\delta\varphi\pi_1(1-\pi_2)$

$\pi_1 = 1-2\sigma_1$, $\pi_2 = 2(1-\alpha_1)$, $\psi_1 = \psi_{11}+\psi_{12}$, $\psi_2 = \psi_{21}+\psi_{22}$

The determinant of the state matrix of (14c) (which equals $-v/\Delta^2[b_{22}b_{11}+b_{12}b_{21}]$) can be shown from the definition of the b_{ij}'s to be almost certainly negative, implying that (14c) will in general have one positive root and one negative root. Accordingly, the system will be saddle-point stable. Notting that the solution to the system is of the form,

$$\hat{e} = A_1 \ e^{\rho_1 t} + A_2 \ e^{\rho_2 t} \tag{15c$_1$}$$

$$\hat{p}_1 = A_1\frac{(\rho_1\Delta-b_{22})}{b_{21}} e^{\rho_1 t} + A_2 \frac{(\rho_2\Delta-b_{22})}{b_{21}} e^{\rho_2 t} \qquad \begin{matrix}\rho_1 < 0 \\ \rho_2 > 0\end{matrix}$$

an expression for the unique stable-path can be derived from (14c) and (15c$_1$) as

$$\hat{e} = -\frac{b_{21}}{(b_{22}-\Delta\rho_1)}\hat{p}_1 \tag{15c$_2$}$$

Using ($15c_2$) to eliminate the exchange rate variable from ($1c_1$)-($1c_2$) and ($13c_1$), and solving these equations for y_1 as a function of p_1, we obtain

$$\hat{y}_1 = -\ell_1\hat{p}_1 \tag{16c}$$

where

$$\ell_1 = \ell_2(b_{22}-\rho_1\Delta)^{-1} > 0$$

$$\ell_2 = [\ell_3 - b_{11}\rho_1] > 0$$

$$\begin{aligned}\ell_3 &= (b_{11}b_{22} + b_{12}b_{21}) \\ &= (1+\psi_{11})(2\sigma+\delta\xi\pi_1\psi_{22})+ \xi(1+\psi_{21})[2\sigma\lambda+\delta\pi_1(1-\pi_2-\psi_{12})] \ (> 0)\end{aligned}$$

The evolution over time of $\hat{p}_1$ is determined by

$$\dot{\hat{p}}_1 = v\hat{y}_1 \tag{17c}$$

(16c)-(17c) constitute a system of two equations in two endogenous variables y_1 and p_1, and they are plotted in Figure (1). The GMB schedule (equation (16c)) describes the combinations of the relative level of national outputs and of the relative price of national outputs which are consistent with equilibrium in the goods, money and bond markets. The slope of the GMB schedule (given by $d\hat{y}_1/d\hat{p}_1 = -\ell_1$) is negative. Equation (17c) is shown in the figure as the PP schedule. Above the PP schedule, the price of domestic output will be rising relative to the price of foreign output and, hence, $\dot{p}_1 > 0$. Below the PP schedule, $\dot{p}_1 < 0$. Along the PP

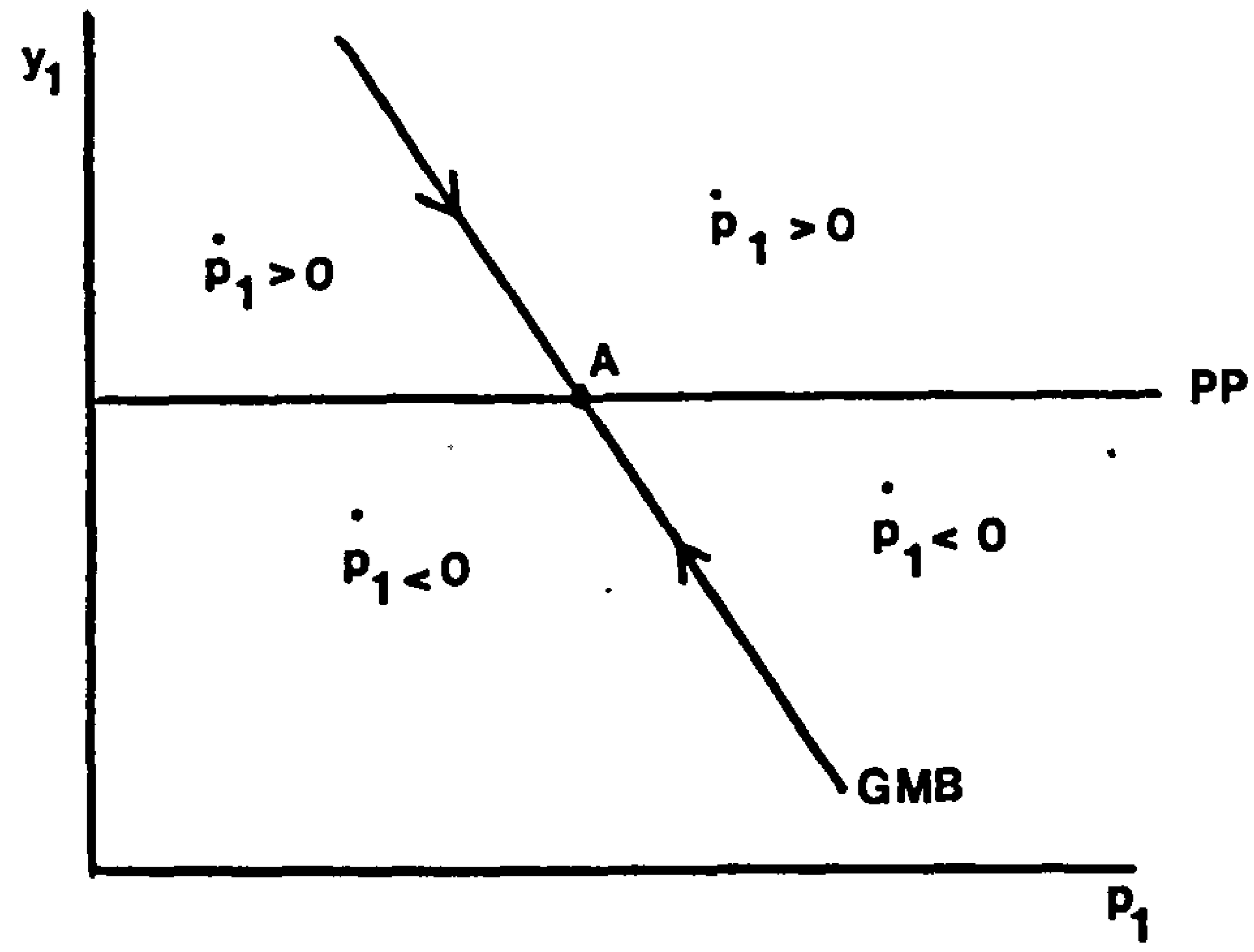


Figure 1

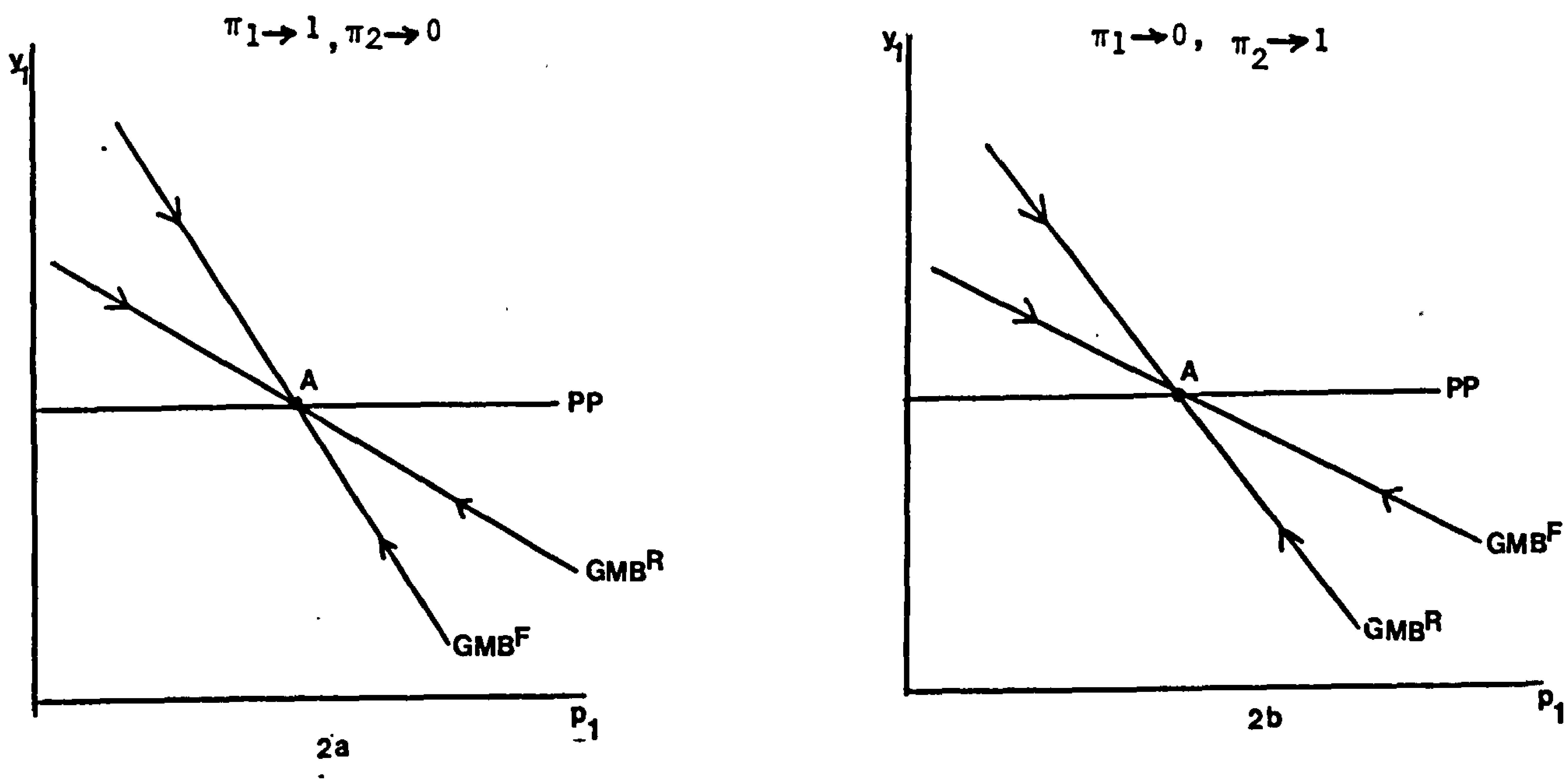


Figure 2

schedule, $\dot{p}_1 = 0$.

From (1c.1)-(1c.3) it is evident that the values of the x_i's and υ_i's will have no effect on the steady-state levels of y_1 and p_1. However the exchange rate rules of equations (1c.1)-(1c.3) will influence the behaviour of real outputs and of prices between steady-states, through ℓ_1 - the slope of the GMB schedule. From (16c) and (14c) it can be seen that the absolute slope of the GMB schedule depends on the size of the b_i's, which, in turn, depend on the size of the π_i's. As we pointed out in Chapter 4, the parameters π_1 and π_2 can be taken to measure the degree of openness of the home and the foreign economy (DOFO): π_2 will be positively related to DOFO, while π_1 will be inveresly related to DOFO. Accordingly, the effects of the exchange rate rules (1c.1)-(1c.3) on the system will not be independent of how open they two economies are. To establish how the degree of openness of the two economies will influence the impact of these rules on the system, one can consider two cases: a case in which DOFO is very low and hence $\pi_2 \to 0$, $\pi_1 \to 1$; and, a case in which DOFO is very high and hence $\pi_2 \to 1$, $\pi_1 \to 0$.

Nominal exchange rate rules

Suppose that the monetary authorities follow the nominal exchange rate rules (NERs) specified in equations $(1c_1)$-$(1c_2)$ - i.e. assume that $\psi_{12} = 0$, $\psi_{22} = 0$. Also, suppose that the degree of openness of the domestic and the foreign economy is low. Letting $\pi_2 \to 0$, $\pi_1 \to 1$, and differentiating the expression for ℓ_1 with respect to ψ_{11} and ψ_{21}, we obtain [5]

$$\frac{d\ell_1}{d\psi_{11}}\bigg|_{\substack{\pi_1\to 1\\ \pi_2\to 0}} = -\,\eta\{\delta(b_{22}-\Delta\rho_1) + 2\sigma\lambda(2\sigma v+\theta_1\rho_2)(\rho_2-\rho_1)^{-1}\} < 0 \qquad (18a_1)$$

$$\frac{d\ell_1}{d\psi_{21}}\Bigg|_{\substack{\pi_1\to 1\\ \pi_2\to 0}} = -\eta\{2\sigma\lambda[v(2\sigma\lambda+\delta)+\Delta\rho_2](\rho_2-\rho_1)^{-1}\} < 0 \tag{18a$_2$}$$

where

$\eta = b_{21}[\Delta(b_{22}-\Delta\rho_1)^2]^{-1}$ (> 0)

$b_{21} = \theta_1 + 2v\sigma\varphi_2 - 2\sigma\varphi_1$ (>0)

$b_{22} = 2\sigma(\varphi_1-v\varphi_1) + \xi\Delta > 0$

$\Delta = \theta_1\lambda + \delta(\varphi_1-v\varphi_2) > 0$

Given the definition of the b_i's, the coefficient η is most likely to be positive. Equations $(18a_1)$-$(18a_2)$ then suggest that as the value of the ψ_{i1}'s varies between 0 (representing the case of floating exchange rates) and ∞, the GMB schedule becomes less steep. This is illustrated in Figure (2a), where two GMB schedules are shown passing through an initial equilibrium point A: GMB^R corresponding to the case with NERs and GMB^F corresponding to that without NERs.

Suppose, however, that the degree of openness of the two economies is relatively high. Letting $\pi_2 \to 1$, $\pi_1 \to 0$, and differentiating ℓ_1 with respect to ψ_{11} and ψ_{21}, we obtain

$$\frac{d\ell_1}{d\psi_{11}}\Bigg|_{\substack{\pi_2\to 1\\ \pi_1\to 0}} = -\eta[2\sigma(2\sigma v+\rho_2)](\rho_2-\rho_1)^{-1} > 0 \tag{18b$_1$}$$

$$\frac{d\ell_1}{d\psi_{21}}\Bigg|_{\substack{\pi_2\to 1\\ \pi_1\to 0}} = -\eta\xi\lambda[2\sigma(2\sigma v+\rho_2)](\rho_2-\rho_1)^{-1} > 0 \tag{18b$_2$}$$

where

$\eta = b_{21}[(b_{22}-\Delta\rho_1)^2]^{-1} < 0$

$b_{21} = -2\sigma\varphi_1 < 0$

$b_{22} = 2\sigma\varphi_1 + (1+\xi\lambda) > 0$

$\Delta = \lambda+\varphi_2 > 0$

Equations $(18b_1)$-$(18b_2)$ indicate that as the value of the ψ_{i1}'s increases, the GMB schedule now becomes more steep.

The explanation for the above results is to be found in the implication of the degree of openness of national economies for the relationship between changes over time in the relative prices of goods $\hat{p}_1$ and changes in the nominal exchange rate $\hat{e}$. As noted in Chapter 4, when DOFO is relatively low and the exchange rate is floating, this relationship is most likely to be negative. For example, a given *rise* in $\hat{p}_1$ will be accompanied by a *fall* in $\hat{e}$ - i.e. a nominal exchange rate *appreciation*. Since the nominal exchange rate rules of equations $(1c_1)$-$(1c_2)$ will reduce the size of any change in $\hat{e}$, they will also reduce the size of the real appreciation (brought about by the rise in $\hat{p}_1$) and, hence, the size of the change in the relative level of national outputs $\hat{y}_1$. This point can also be seen formally from $(18a_3)$,

$$\hat{e}^R\Big|_{\substack{\pi_1\to 1\\ \pi_2\to 0}} = \frac{\omega_{11}}{\omega_{21}}\ \hat{e} \tag{18a$_3$}$$

$$\omega_{11} = \theta_1 + \xi[\lambda\theta_1+\delta(\varphi_1-v\varphi_2)] - \Delta\rho_1 \quad > 0$$

$$\omega_{21} = \{\theta_1 + 2v\sigma\varphi_2-2\sigma\varphi_1\} \ (> 0)$$

$$\Delta \ = \theta_1\lambda + \delta(\varphi_1-v\varphi_2) \quad > 0$$

which shows the relationship between the real and the nominal exchange rate when $\psi_1 = \psi_2 = 0$. (It is obtained by adding and subtracting p_1 to and from the left hand-side of $(15c_2)$ and by using the definition of e^R). Equation $(18a_3)$ indicates that this relationship is most likely to be positive.

When the degree of openness of the two economies is relatively high and the exchange rate is floating, however, changes over time in the relative prices of goods $\hat{p}_1$ and changes in the nominal exchange rate $\hat{e}$ are most likely to be positively related. For example, a *rise* in $\hat{p}_1$ will lead to a

Effects of demand disturbances under nominal exchange rate rules: the role of "openness"

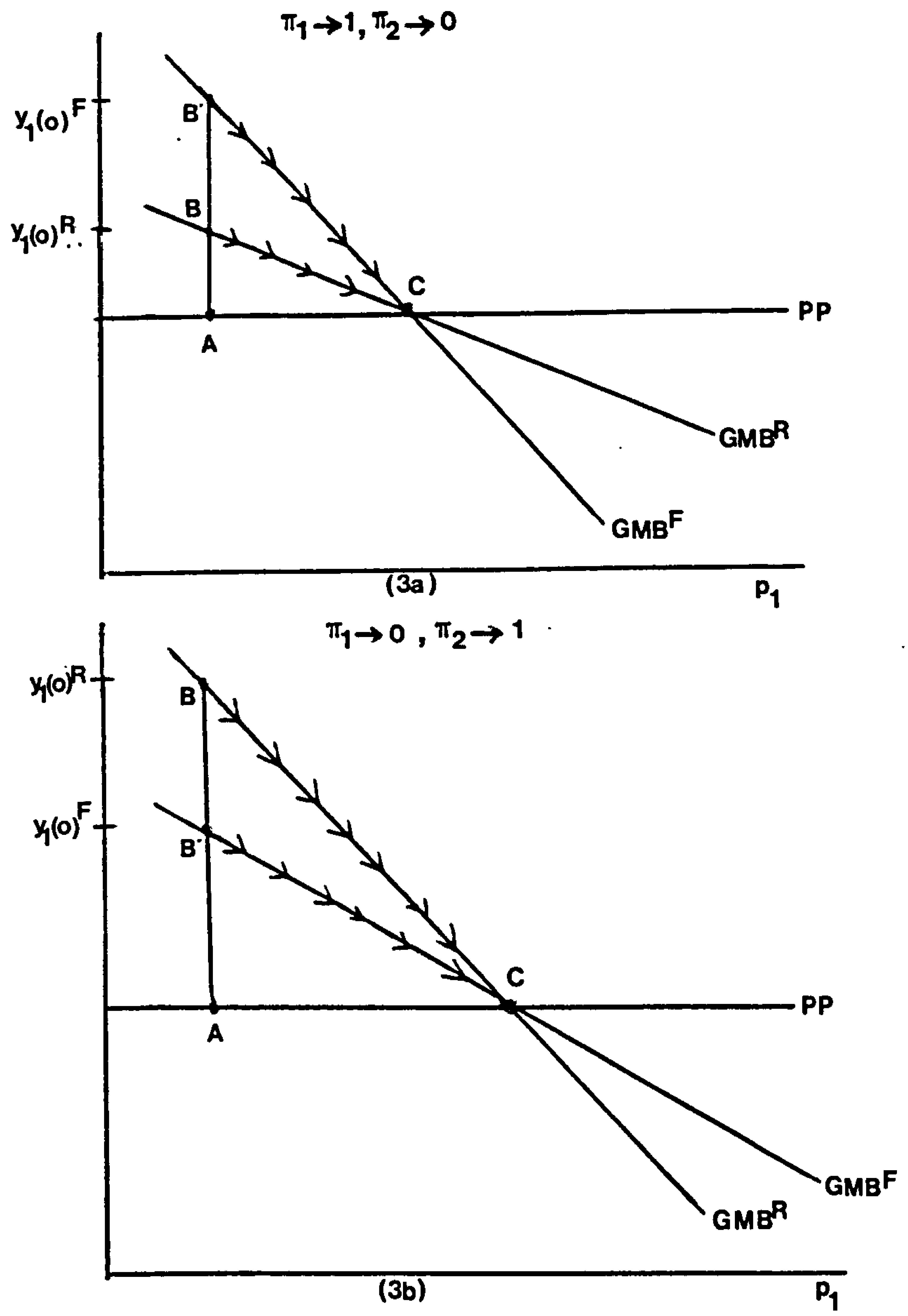


Figure 3

TABLE (1)

Steady-state effects of permanent disturbances

$$\frac{d\bar{p}_1}{ds_1} = (\lambda\xi + \pi_2)H^{-1} > 0$$

$$\frac{d\bar{p}_1}{ds_2} = -(2\sigma\lambda - \delta\pi_1\pi_2)H^{-1} \ (< 0)$$

$$\frac{d\bar{p}_1}{ds_3} = \frac{1}{v}[(2\sigma+\delta\xi\pi_1)\varphi_1+(\lambda\xi+\pi_2)]H^{-1} > 0, \qquad \frac{d\bar{y}_1}{ds_3} = -{}^1/_v < 0$$

$$\frac{d\bar{p}_1}{ds_4} = -(2\sigma + \delta\xi\pi_1)H^{-1} < 0$$

where $H = 2\sigma(1+\lambda\xi)+ \delta\xi\pi_1(1-\pi_2) > 0$

rise in $\hat{e}$ - to a nominal exchange rate *depreciation*. Since the nominal exchange rate rules of equations ($1c_1$)-($1c_2$) will reduce the size of any change in $\hat{e}$, they will increase the size of the real appreciation (brought about by the rise in $\hat{p}_1$) and, hence, the size of the change in the relative level of national outputs $\hat{y}_1$. In fact, if DOFO is high, the relationship between the real exchange rate and the nominal exchange rate will be negative:

$$\hat{e}^R\Big|_{\substack{\pi_2\to 1\\ \pi_1\to 0}} = \frac{\omega_{11}}{\omega_{21}}\,\hat{e} \tag{18b$_3$}$$

$$\omega_{11} = (1+\xi\lambda) - \Delta\rho_1 > 0$$

$$\omega_{21} = -\,2\sigma\varphi_1 < 0$$

$$\Delta \;= \lambda + \varphi_2 > 0$$

In this case, then, the GMB^R schedule will be steeper than the GMB^F schedule as shown in Figure (2b).

The implications of these results for the response of the system to unanticipated disturbances can be seen from Figures (3)-(6).

Consider Figures (3)-(5), which illustrate, respectively, the effects of an exogenous increase in: (a) the relative demand for domestic goods ($s_1 >$ 0, (b) the relative demand for home-government bonds ($s_2 > 0$), and (c) the relative (real) demand for home money ($s_4 > 0$). From Table (1), it is apparent that the qualitative characteristics of the long-run will be unaffected by the size of the π_i's. In particular, the disturbances s_2 and s_4 will always cause the GMB curve to shift to the left of its initial position at A, while the change in s_1 will always cause GMB to move up and to the right of A. However, it is evident from Figures (3)-(5) that the characteristics of the short-run and of the intermediate-run will be

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THE SPINE

Effects of disturbances to the relative demand for domestic and foreign bonds under NERs

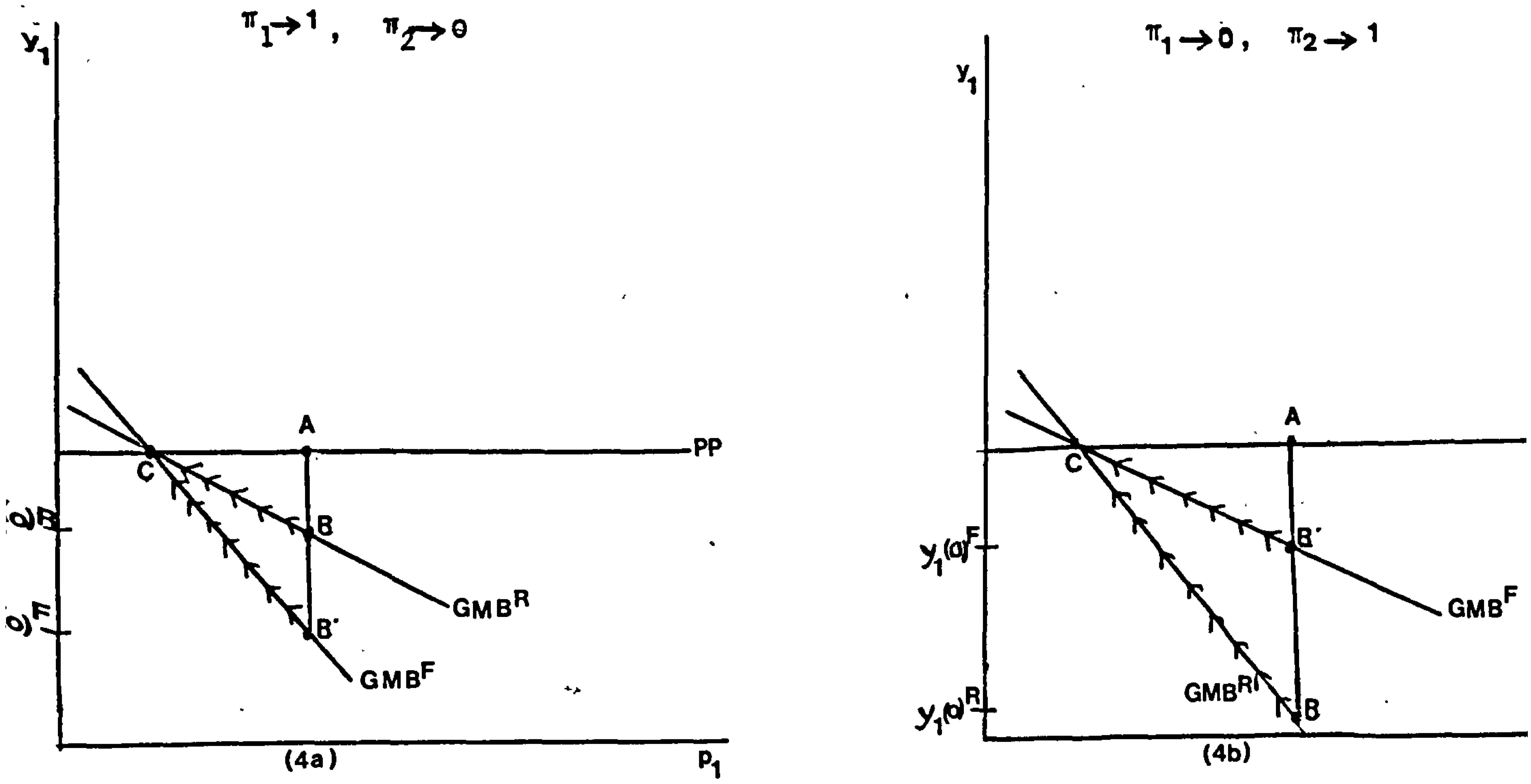


Figure 4

Monetary Disturbances and Nominal Exchange Rate Rules

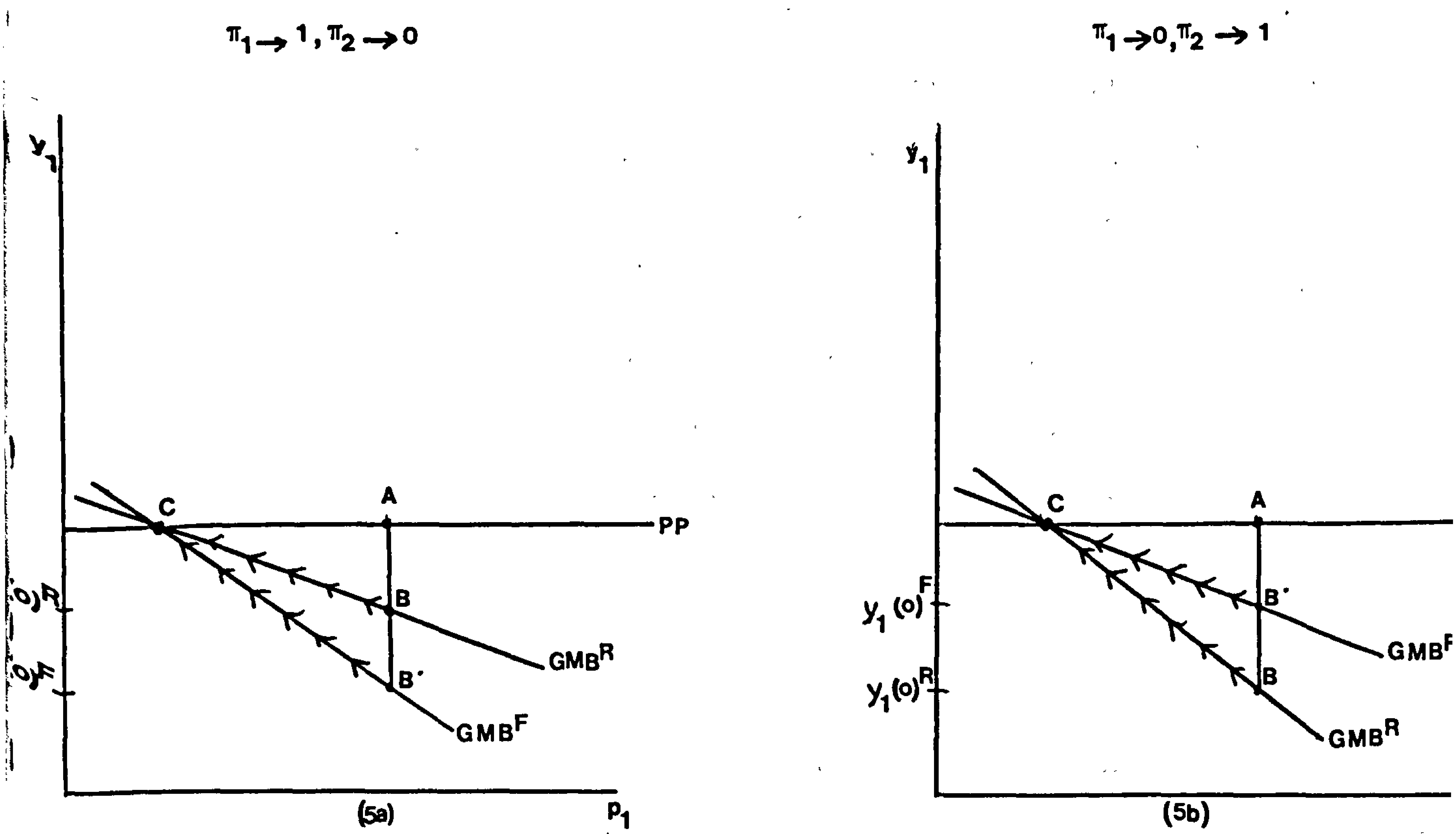


Figure 5

significantly affected: the size of the π_i's will influence both the speed of adjustment to equilibrium and the impact effects of the disturbances under nominal exchange rate rules. *Firstly*, if the degree of openness of the two economies is relatively high, the adjustment to equilibrium will be more rapid under the NERs of equations ($1c_1$)-($1c_2$) than under a floating rate regime. However, the opposite will be true if DOFO is relatively low. *Secondly*, if DOFO is low, the impact effect of the disturbances on real activity levels and inflation rates will be less pronounced when nominal exchange-rate rules are followed than when the exchange-rate is floating. But if DOFO is high, these impact effects will be more pronounced under the nominal exchange rate rules of equations (1c.1)-(1c.3) than under a floating-rate regime.

Consider next Figure (6), which illustrates the effects of a decline in the home country's capacity-output combined with an increase in foreign-capacity output ($s_3 > 0$). This disturbance in general leads to a rise in the steady-state level of p_1 and to a fall in the steady-state value of y_1. Hence it causes both the GMB schedule and the PP schedule to shift to the right of their initial position at A. But the short-run and the intermediate-run behaviour of the system differs, depending on the size of the π_i's. As can be seen from the figure, when DOFO is low, the change in real outputs on impact will be smaller and the adjustment to long-run equilibrium more rapid under the nominal exchange-rate rules of equations ($1c_1$)-($1c_2$) than under a floating-rate regime. When DOFO is relatively high, however, the change in y_1 on impact will be larger and y_1 will stay away from equilibrium for a longer period under NERs than under floating exchange rates.

Real exchange-rate rules

Setting $\psi_{11} = \psi_{21} = 0$ and differentiating the expression for ℓ_1 in equation (16c) with respect to ψ_{12} and ψ_{22}, we obtain ($19a_1$)-($19a_2$) and ($19b_1$)-(19

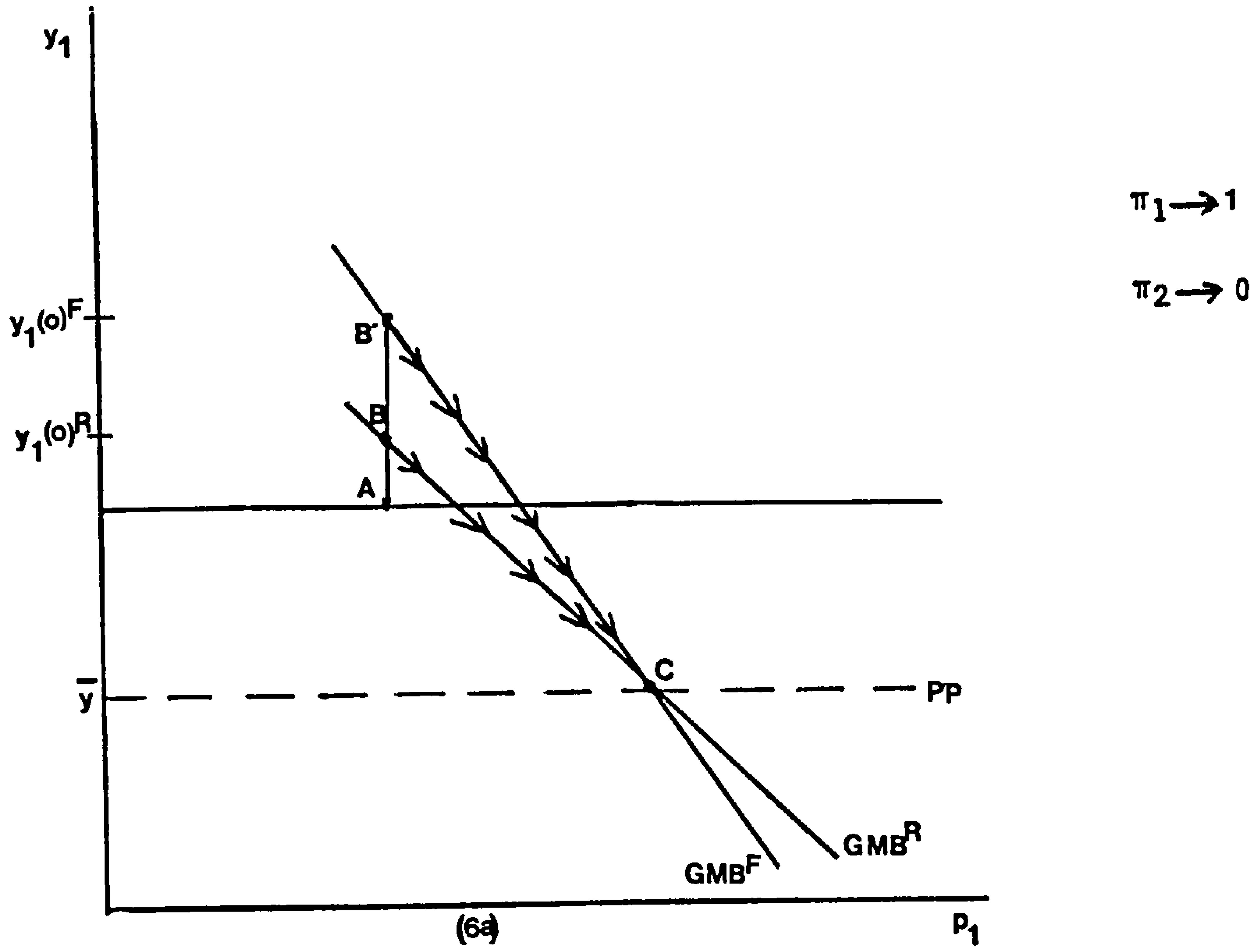
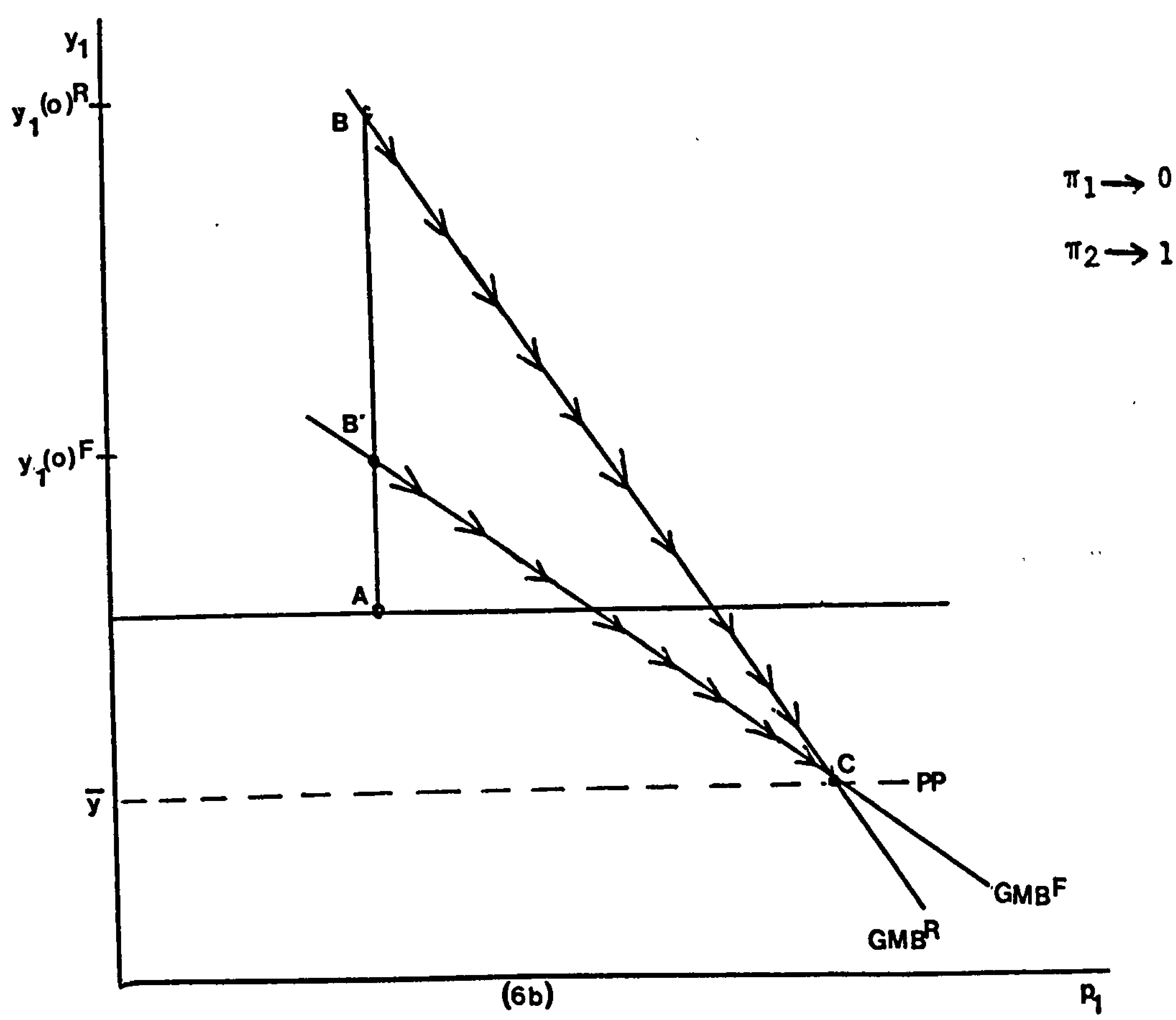

y_1
$y_1(o)^F$
$y_1(o)^R$
B'
B
A
C
$\bar{y}$
PP
GMB^R
GMB^F
(6a)
p_1
$\pi_1 \rightarrow 1$
$\pi_2 \rightarrow 0$

Figure 6


y_1
$y_1(o)^R$
B
B'
$y_1(o)^F$
A
C
$\bar{y}$
PP
GMB^F
GMB^R
(6b)
p_1
$\pi_1 \rightarrow 0$
$\pi_2 \rightarrow 1$

$$\frac{d\ell_1}{d\psi_{12}}\bigg|_{\substack{\pi_2\to 0\\ \pi_1\to 1}} = -\tau_1\{\delta(b_{22}-\Delta\rho_1) + 2\sigma\lambda\tau_3(\rho_2-\rho_1)^{-1}\} < 0 \tag{19a$_1$}$$

$$\frac{d\ell_1}{d\psi_{22}}\bigg|_{\substack{\pi_2\to 0\\ \pi_1\to 1}} = -\xi\tau_1\{2\sigma\lambda\tau_2(\rho_2-\rho_1)^{-1}\} < 0 \tag{19a$_2$}$$

where

$$\tau_1 = (\theta_1 + \xi\Delta - \Delta\rho_1)[\Delta(b_{22}-\Delta\rho_1)^2]^{-1} > 0$$

$$\tau_2 = \Delta\rho_2 - \Delta\rho_1(b_{22}-\Delta\rho_1)\tau_1^{-1} + vb_{21}(2\sigma\lambda+\delta)\tau_1^{-1} > 0$$

$$\tau_3 = \theta_1\rho_2 - \theta_1\rho_1(b_{22}-\Delta\rho_1)\tau_1^{-1} - v\delta b_{21}(\xi-\rho_1)\tau_1^{-1} \quad (>0)$$

$$b_{21} = \theta_1 + 2v\sigma\varphi_2 - 2\sigma\varphi_1 \quad (>0)$$

$$b_{22} = 2\sigma(\varphi_1 - v\varphi_1) + \xi\Delta > 0$$

$$\Delta = \theta_1\lambda + \delta(\varphi_1 - v\varphi_2) > 0$$

and

$$\frac{d\ell_1}{d\psi_{22}}\bigg|_{\substack{\pi_2\to 1\\ \pi_1\to 0}} = -\tau_4[2\sigma\tau_5(\rho_2-\rho_1)^{-1}] < 0 \tag{19b$_1$}$$

$$\frac{d\ell_1}{d\psi_{12}}\bigg|_{\substack{\pi_2\to 1\\ \pi_1\to 0}} = -\xi\lambda\tau_4[2\sigma\tau_5(\rho_2-\rho_1)^{-1}] < 0 \tag{19b$_2$}$$

where

$$\tau_4 = [1+\xi\lambda-\Delta\rho_1](b_{22}-\Delta\rho_1)^{-1} > 0$$

$$\tau_5 = \rho_2 - \rho_1(b_{22}-\Delta\rho_1)\tau_1^{-1} > 0$$

$$b_{22} = 2\sigma\varphi_1 + (1+\xi\lambda) > 0$$

$$\Delta = \lambda + \varphi_2 > 0$$

Equations ($19a_1$)-($19a_2$) and ($19b_1$)-($19b_2$) indicate that, unlike the nominal exchange rate rules, the real exchange rate rules (RERs) described by ($1c_1$)-($1c_2$) will in general reduce the steepness of the GMB schedule. Nevertheless, they suggest that the influence of the RERs on the behaviour of the system will not be completely independent of the size of the π_i's.

To establish this point it is convenient to use a numerical example. Accordingly, we consider two "variants" of the model, depending on how open the home and the foreign economy are: one in which $\sigma_1 = .1$, $(1-\alpha_1) = .1$ and hence $\pi_1 = .8$, $\pi_2 = .2$ (Model-L); and another in which $\sigma_1 = (1-\alpha_1) = .4$ and hence $\pi_1 = .2$, $\pi_2 = .8$ (Model-H). For the other parameters of the model we choose the following values:

$$\varphi_1 = \varphi_2 = 1, \ \gamma = .7, \ v = .5, \ \sigma = \delta = .2, \ \lambda = 2, \ \xi = .1$$

Table (2) illustrates the impact effects on real outputs of (unexpected) increases in the s_i's. Although these impact effects are in general less pronounced under RERs than under floating exchange rates, the size of the short-run change in y_1 does depend on the magnitude of the π_i's: the larger is π_1 and the smaller is π_2, the less pronounced are the impact effects of the disturbances s_1, s_2 and s_4 on y_1 when the authorities follow real exchange rate rules.

TABLE (2)

Deviations from initial equilibrium	MODEL-L (1) FERs	MODEL-L (2) RERs RER^m	MODEL-L (2) RERs RER^i	MODEL-H (1) FERs	MODEL-H (2) RERs RER^m	MODEL-H (2) RERs RER^i
Impact effect on y_1 of a unit increase in:						
s_1	1.87	1.16	1.80	1.73	1.08	1.65
s_2	-1.79	-1.11	-1.73	- .66	- .42	- .63
s_3	.76	- .29	.67	.18	- .63	.08
s_4	- .97	- .60	- .94	- .35	- .22	- .33

(1) FERs: $x_1 = x_2 = \upsilon_1 = \upsilon_2 = 0$

(2) RER^m: $x_1 = \upsilon_1 = \upsilon_2 = 0$, $x_2 = .5$

RER^i: $x_1 = x_2 = \upsilon_1 = 0$, $\upsilon_2 = .5$

IV. *Simple Policy Rules and White-Noise Stochastic Disturbances*

In this Section, we consider the following version of equations ($1b_1$) and ($1b_3$) of Section II:

$$m_1 = \bar{m}_1 - [2(x_1 e + x_2 e^R) + x_3 p_{1C} - x_4 y_1{}^n] \qquad (1d_1)$$

$$b_1 p = \bar{b}_1 p - (\upsilon_1 e + \upsilon_2 e^R) \qquad (1d_2)$$

We also assume that the s_i's in ($13b_1$) are stochastic disturbances (which have means of zero and which are distributed independently over time), and we solve numerically the model for the asymptotic[6] (or 'equilibrium') variances of e^R, y_1 and p_{C1}. To obtain the asymtotic variances of the variables, we follow Currie's and Levine's (1982, 1984) methodology for solving continuous-time stochastic models with rational expectations. Describing in Appendix I the steps involved in computing the variances, we report here the results.

Consider the numerical values in Table (3a).

First, the table shows that the performance of all the nominal exchange rate rules is highly sensitive to variations in the size of the parameters π_1 and π_2. For example, in Model-L, the nominal exchange rate rule NER^m performs in general better than a regime of fixed-monetary targets in terms of minimizing fluctuations in real variables. In Model-H, however, real exchange-rate variances and output variances are larger under this rule than under floating exchange rates. And, the same applies to the nominal exchange-rate rule NER^i.

In the context of this stochastic version of the model, the explanation for these results is to be found in the implication of the size of the π_i's

TABLE (3a)

Asymptotic Variances Σ		(1) FERs	(2) NERs: NER^m	(2) NERs: NER^i	(3) RERs: RER^m	(3) RERs: RER^i	(4) PP^m
		MODEL - H					
Disturbance s_1							
	$V^*(y_1)$	56.33	58.72	56.65	35.31	53.70	60.23
	$V^*(e^R)$	258.87	269.50	260.59	164.93	244.74	276.22
s_2							
	$V^*(y_1)$	.0166	.0173	.0166	.0104	.0158	.0177
	$V^*(e^R)$	.0761	.0792	.0766	.0485	.0719	.0812
s_3							
	$V^*(y_1)$	41.94	43.72	42.18	26.29	39.98	44.84
	$V^*(e^R)$	192.74	200.65	194.02	122.79	182.21	205.65
s_4							
	$V^*(y_1)$	.00011	.00012	.00012	.00007	.00011	.00013
	$V^*(e^R)$	.00053	.00055	.00053	.00034	.00050	.00056

Asymptotic Variances Σ		(1) FERs	(2) NERs: NER^m	(2) NERs: NER^i	(3) RERs: RER^m	(3) RERs: RER^i	(4) PP^m
		MODEL - L					
Disturbance s_1							
	$V^*(y_1)$	681.04	666.44	679.63	421.28	657.85	790.33
	$V^*(e^R)$	585.39	577.33	583.48	423.05	554.18	642.23
s_2							
	$V^*(y_1)$	.3242	.3172	.3235	.2005	.3132	.3562
	$V^*(e^R)$	.2787	.2748	.2778	.2014	.2638	.3057
s_3							
	$V^*(y_1)$	169.02	165.40	168.67	104.56	163.27	196.15
	$V^*(e^R)$	145.29	143.28	144.81	104.99	137.54	159.39
s_4							
	$V^*(y_1)$	.5763	.5640	.5751	.3565	.5567	.6688
	$V^*(e^R)$	.4956	.4886	.4938	.3580	.4690	.5435

(1) FERs: $x_1 = x_2 = \upsilon_1 = \upsilon_2 = 0,\ x_3 = x_4 = 0$
(2) NER^m: $x_2 = \upsilon_1 = \upsilon_2 = 0,\ x_3 = x_4 = 0,\ x_1 = .5$
NER^i: $x_1 = x_2 = \upsilon_2 = 0,\ x_3 = x_4 = 0,\ \upsilon_1 = .5$
(3) RER^m: $x_1 = \upsilon_1 = \upsilon_2 = 0,\ x_3 = x_4 = 0,\ x_2 = .5$
RER^i: $x_1 = x_2 = \upsilon_1 = 0,\ x_3 = x_4 = 0,\ \upsilon_2 = .5$
(4) PP^m: $x_1 = x_2 = \upsilon_1 = \upsilon_2 = 0,\ x_4 = 0,\ x_3 = .5$

MODEL L: $\pi_1 = .8,\ \pi_2 = .2$
MODEL H: $\pi_1 = .2,\ \pi_2 = .8$

for the sign of the asymtotic covariance of e and p_1 and of e and e^R. If the degree of openness of the two economies is relatively low, variations in the relative price of national outputs p_1 and variations in the nominal exchange rate around their mean-convergent path will be inversely related. Thus, in the stochastic steady state, the covariance of e and p_1 will be negative, while the covariance of e and e^R will be positive. Accordingly, the authorities will be able to reduce both the long-run volatility of the nominal exchange rate and that of the real exchange rate (and, hence, indirectly the variance of the real interest-rate differential) when they are adjusting the money supply or the relative supplies of bonds according to the NERs described by $(1d_1)$-$(1d_2)$. As a result, in the case of Model-L, NERs will in general perform better than a floating exchange-rate regime in terms of output stabilization. If, on the other hand, the degree of openness of the two economies is relatively high, variations in e and p_1 around their mean-convergent path will be positively related: the asymtotic covariance of e^R and e may be small in absolute size, but its sign will be negative. In this case, then, the authorities will increase the long-run variability of the real exchange rate if they try to stabilize the nominal exchange rate. As a consequence, in Model-H: (i) shocks to the demands for and the supplies of goods (which will directly affect the real exchange rate in the stochastic steady-state) will have a significantly larger impact on real outputs when $x_1 = .5$ or $\upsilon_1 = .5$ than when $x_1 = \upsilon_1 = 0$; and (ii) shocks to the demands for bonds and money (which, in the stochastic steady-state, do not significantly affect the real exchange rate) will have a fractionally larger effect on real outputs when $x_1 = .5$ or $\upsilon_1 = .5$ than when $x_1 = 0$, $\upsilon_1 = 0$.

Second, the real exchange rate rules of equations $(1d_1)$-$(1d_2)$ perform in general better than all the NERs in terms of output stabilization, and they are "robust" to variations in the size of the π_i's. Third, the price rule of equations $(1d_1)$-$(1d_2)$ (PP^m) increases the variance of the real exchange rate (especially in the case where $\pi_1 = .8$ and $\pi_2 = .2$). The PP^m rule also yields, in general, the largest variances for the relative level of national outputs.

The results that appear in Table (3b), however, are very different from those that are presented in Table (3a). First, in Model-L, the variances of the relative level of national price indices are larger under the nominal exchange-rate rules of $(1d_1)$-$(1d_2)$ than under fixed monetary targets. In the case of Model-H, on the other hand, NERs perform better than a floating exchange rate regime, independently of how they are implemented. Second, real exchange rate rules now perform poorly: all the RERs described by $(1d_1)$-$(1d_2)$ yield larger variances for p_{c1} relative to those which occur under the other policy rules, and the real exchange rate rule RER^m is particularly poor when supply-side shocks and shocks to the demands for goods occur. Third, as expected, the variances of national price indices are, in general, larger when $x_i = \upsilon_i = 0$ than when the authorities follow the price rule PP^m.

These results illustrate a problem that one is likely to face in choosing between different policy rules in a stochastic environment: simple policy rules that reduce the variability of real outputs tend to increase the variability of price indices. That feature of simple policy rules is not surprising: in a world of less than perfectly flexible prices, any policy rule that reduces the variability of the relative level of national outputs y_1 has the effect of slowing down the adjustment speed of the relative prices of goods p_1. This, in turn, has the effect of increasing the 'steady-state' or 'aymptotic' variance of national price

TABLE (3b)

Asymptotic Variances Σ	(1) FERs	(2) NERs NER^m	(2) NERs NER^i	(3) RERs RER^m	(3) RERs RER^i	(4) PP^m
			MODEL - H			
Disturbance						
s_1						
$V^*(p_{c_1})$	27.08	20.89	26.11	157.62	35.96	17.51
s_2						
$V^*(p_{c_1})$	.0080	.0061	.0077	.0463	.0106	.0051
s_3						
$V^*(p_{c_1})$	20.16	15.56	19.44	117.35	26.77	13.04
s_4						
$V^*(p_{c_1})$	.00006	.00004	.00005	.00032	.00007	.00004

Asymptotic Variances Σ	(1) FERs	(2) NERs NER^m	(2) NERs NER^i	(3) RERs RER^m	(3) RERs RER^i	(4) PP^m
			MODEL - L			
Disturbance						
s_1						
$V^*(p_{c_1})$	318.82	328.92	319.95	612.15	337.93	255.96
s_2						
$V^*(p_{c_1})$	.1518	.1566	.1523	.2914	.1609	.1218
s_3						
$V^*(p_{c_1})$	79.13	81.63	79.41	151.93	83.87	63.53
s_4						
$V^*(p_{c_1})$	.2698	.2784	.2708	.5180	.2860	.2166

(1) FERs: $x_1 = x_2 = \upsilon_1 = \upsilon_2 = 0,\ x_3 = x_4 = 0$
(2) NER^m: $x_2 = \upsilon_1 = \upsilon_2 = 0,\ x_3 = x_4 = 0,\ x_1 = .5$
NER^i: $x_1 = x_2 = \upsilon_1 = 0,\ x_3 = x_4 = 0,\ \upsilon_1 = .5$
(3) RER^m: $x_1 = \upsilon_1 = \upsilon_2 = 0,\ x_3 = x_4 = 0,\ x_2 = .5$
RER^i: $x_1 = x_2 = \upsilon_1 = 0,\ x_3 = x_4 = 0,\ \upsilon_2 = .5$
(4) PP^m: $x_1 = x_2 = \upsilon_1 = \upsilon_2 = 0,\ x_4 = 0,\ x_3 = .5$

MODEL L: $\pi_1 = .8,\ \pi_2 = .2$
MODEL H: $\pi_1 = .2,\ \pi_2 = .8$

indices (particularly in the case where DOFO is low, when variations in p_1 have a significant influence on p_{c1}). In a stochastic set-up, therefore, the relative performance of simple policy rules cannot be assessed independently of both the degree of openness of national economies and the nature of the 'loss function' that the authorities wish to minimize. Suppose, for example, that the authorities are mainly concerned with price stabilization. Then, RERs will in general lead to unsatisfactory outcomes. However, NERs will lead to better outcomes than a floating exchange rate regime when DOFO is relatively high. If, on the other hand, the primary objective of the authorities is to minimize output fluctuations, the adoption of RERs will be the best policy irrespective of how open national economies are. And, the adoption of NERs will lead to particularly poor outcomes when the degree of openness of individual economies is relatively high.

A frequently advocated policy regime is that of targeting the nominal GDP. From Table (4) it can be seen that the nominal GDP rule of equations $(1d_1)$-$(1d_2)$ performs rather poorly overall. First, in the case of shocks to the demands for goods, bonds, and money, the variances of the relative level of national price indices are in general larger under this rule than under all the nominal exchange-rate rules. (They are, though, smaller than those which occur under the real exchange-rate rule RER^m). In the case of the supply-side shock s_3, it also yields a large price variance (relative to all the nominal exchange rate rules) when DOFO is relatively high.

Second, the impact of nominal GDP rules on the variances of the relative level of national outputs depends crucially on the size of the parameters π_1 and π_2. For example, in Model-H, both demand shocks and supply shocks have a smaller effect on real outputs under that rule than under a regime of fixed-monetary targets. However, the opposite is true in the case of

	TABLE (4)		TABLE (5)			
Asymptotic Variances	Nominal GDP Rule (5)		'Joint Rules' (6a) RER^i-PP^m		(6b) NER^i-PP^m	
z	MODEL-L	MODEL-H	MODEL-L	MODEL-H	MODEL-L	MODEL-H
Disturbance s_1						
$V^*(y_1)$	823.72	44.56	769.03	58.02	786.78	60.34
$V^*(e^R)$	696.89	206.35	611.86	263.78	737.61	294.89
$V^*(p_{c1})$	346.71	79.19	269.28	23.21	258.12	17.25
s_2						
$V^*(y_1)$	.3921	.0131	.3661	.0171	.3745	.0177
$V^*(e^R)$	.3317	.0606	.2913	.0775	.3511	.0867
$V^*(p_{c1})$	.1650	.0233	.1282	.0068	.1229	.0051
s_3						
$V^*(y_1)$	181.26	33.07	190.86	43.19	195.27	44.92
$V^*(e^R)$	153.35	153.12	151.85	196.39	183.06	219.55
$V^*(p_{c1})$	76.29	58.76	66.83	17.28	64.06	12.84
s_4						
$V^*(y_1)$	.6971	.0001	.6508	.00012	.6658	.00014
$V^*(e^R)$	.5898	.0004	.5178	.00054	.6442	.00060
$V^*(p_{c1})$	.2934	.0002	.2279	.00005	.2184	.00004

(5) Nominal GDP Rule: $x_1 = x_2 = x_3 = \upsilon_1 = \upsilon_2 = 0$, $x_4 = .5$

(6) Joint Rules

RER^i-PP^m: $x_1 = x_2 = x_4 = \upsilon_1 = 0$, $x_3 = \upsilon_2 = .5$

NER^i-PP^m: $x_1 = x_2 = x_4 = \upsilon_2 = 0$, $x_3 = \upsilon_1 = .5$

MODEL L: $\pi_1 = .8$, $\pi_2 = .2$

MODEL H: $\pi_1 = .2$, $\pi_2 = .8$

Model-L. The reason for this result is straightforward: if the degree of openness of the two economies is relatively low, the nominal GDP rule of equations $(1d_1)$-$(1d_2)$ will have the effect of stabilizing the nominal interest-rate differential r_1 and, hence indirectly, the nominal exchange rate. With e being stabilized, variations in the relative prices of goods in the stochastic steady-state will tend to affect the relative level of real outputs y_1 through the real exchange rate e^R. If, on the other hand, the degree of openness of the two economies is relatively high, the nominal GDP rule of equations $(1d_1)$-$(1d_2)$ will increase the variability of the interest rate differential and, hence indirectly, the variance of the nominal exchange rate. In this case, however, variations in e and in e^R will be negatively related in the stochastic steady-state. Thus, nominal GDP rules will tend to reduce the asymtotic variance of the real exchange rate and, thereby, the asymptotic variance of real outputs.

Table (5) shows the effects on the variances of p_{C1}, y_1 and e^R of "joint" policy rules. In column (6a) of Table (5), the authorities are assumed to follow the price rule PP^m *and* the real exchange rate rule RER^i. In column (6b), it is assumed that the authorities change the relative supplies of bonds according to the nominal exchange-rate rule NER^i *and* adjust the money supply according to the price rule PP^m. From Table (5) and Tables (3)-(4), it is apparent that the PP^m-RER^i rule does not provide any significant gains relative to the other policy rules. However, when $\pi_1 = .2$ and $\pi_2 = .8$, the PP^m-NER^i rule yields some benefits in terms of lower price variances.

Given the aim of this chapter, it is worthwhile assessing the effects of the simple policy rules described by $(1d_1)$-$(1d_2)$ in terms of an 'overall performance' measure. For this purpose we combine the solutions for $V^*(p_{C1})$ with the solutions for $V^*(y_1)$, assuming that variations in price levels and fluctuations in real outputs are equally undesirable. Our

TABLE (6): Overall Performance of Simple Policy Rules

Asymptotic Variances	MODEL-L								
Z	(1) FERs	(2) NERs		(3) RERs		(4) P^m	(5) Nominal GDP Rule	(6) Joint Rules	
		NER^m	NER^i	RER^m	RER^i			RER^m-P^m	NER^i-P^m
Disturbance									
s_1	499.93	497.68	499.79	516.71	497.89	523.14	585.22	519.16	522.45
s_2	.23798	.23691	.23791	.24597	.23701	.24903	.27858	.24713	.24870
s_3	124.08	123.52	124.04	128.24	123.57	129.84	128.78	128.85	129.67
s_4	.42308	.42117	.42296	.43729	.42135	.44272	.49525	.43935	.44214

Asymptotic Variances	MODEL- H								
Z	(1) FERs	(2) NERs		(3) RERs		(4) P^m	(5) Nominal GDP Rule	(6) Joint Rules	
		NER^m	NER^i	RER^m	RER^i			RER^m-P^m	NER^i-P^m
Disturbance									
s_1	41.70	39.80	41.38	96.46	44.83	38.87	61.87	40.61	39.79
s_2	.01226	.01170	.01216	.02835	.01318	.01142	.01818	.01194	.01140
s_3	31.05	29.64	30.81	71.82	33.38	28.94	45.91	30.24	28.88
s_-	.00009	.000081	.000084	.000197	.000091	.000079	.000126	.000083	.00009

results are presented in Table (6). From Table (6) it is apparent that the ranking of the policy rules in terms of this 'overall performance measure' depends crucially on the size of the π_i's and hence on the degree of "openness" of the two economies. In Model-H: (i) the price rule PP^m-NER^i is the best policy for shocks to the relative demand for bonds and to the demands for and the supplies of goods; and (ii) the simple price rule PP^m is the best policy for shocks to money demands. In Model-L, however, the overall performance of all the price rules is poor when compared with the performance of the other policy rules. In this model, the nominal exchange rate rule NER^m turns out to be the best policy.

V. *Extentions-Additions to the Model.*

The model examined in this chapter has been very simple. The desirable extentions-additions to the model are therefore numerous. However, we propose two worthy modifications-extentions. An extended model should allow for the possibility that the random disturbances of Section IV may be more persistent than we have assumed in the chapter. An extended model should also allow for the possibility that the Authorities might be unable to respond instantaneously to innovations in the current information set (due to delays in collecting and interpreting aggregate information). To take this possibility into account, (1b.1)-(1b.3) can be re-defined in terms of lagged policy responses.

An objection to our analysis may focus on the specification of (1b.1)-(1b.3): i.e. on the fact that the policy rules (1b.1)-(1b.3) have not been obtained from explicit minimization of a "loss function". However, as e.g. Currie has (1985) emphasized, fully optimal policy rules are usually too complex to be fully understood by the public and too complicated to be actually implemented [7]. In fact, Mckinnon (1984,1986), Roosa (1984), Williamson (1985b,1986b,1987) and Edison, Miller and Williamson (1987), among others, propose reforms of the International Monetary System which are based on the adoption by individual countries of simple policy rules of the kind described by (1b.1)-(1b.3). Thus our analysis can be seen as an attempt to examine whether the degree of openness of national economies has any impact on the effectiveness of this type of policy rules.

Appendix I

The model can be expressed in the following form:

$$\begin{bmatrix} dp_1 \\ de^e \end{bmatrix} = B' \begin{bmatrix} p_1(t) \\ e(t) \end{bmatrix} dt + \underline{dv} \tag{A.1}$$

where

$$\underline{dv} = \begin{bmatrix} dv_1 \\ dv_2 \end{bmatrix} = C\underline{s}dt, \qquad \underline{s} = \begin{bmatrix} s_1 \\ s_2 \\ s_3 \\ s_4 \end{bmatrix} \tag{A.2}$$

$$B' = \begin{bmatrix} b_{11}' & b_{12}' \\ b_{21}' & b_{22}' \end{bmatrix}, \qquad C = \begin{bmatrix} c_{11} & c_{12} & c_{13} & c_{14} \\ c_{21} & c_{22} & c_{23} & c_{24} \end{bmatrix} \tag{A.3}$$

In (A.1)-(A.3), $\underline{dv}$ is a vector of white-noise random disturbances and B' and C are coefficient matrices.

Following Currie and Levine (1982, 1984), we denote the diagonal matrix of the eigenvalues of B' by R and the associated matrix of left eigenvectors by M. Noting that

$$MB' = RM \tag{A.4}$$

we can write

$$\begin{bmatrix} M_1 \\ M_2 \end{bmatrix} \begin{bmatrix} b_{11}' & b_{12}' \\ b_{21}' & b_{22}' \end{bmatrix} = \begin{bmatrix} \rho_1 & 0 \\ 0 & \rho_2 \end{bmatrix} \begin{bmatrix} M_1 \\ M_2 \end{bmatrix} \qquad \begin{matrix} \rho_1 < 0 \\ \rho_2 > 0 \end{matrix} \tag{A.5}$$

where

$$M_1 = [\mu_{11}\ \mu_{12}]\ ,\ M_2 = [\mu_{21}\ \mu_{22}]$$

Let

$$\underline{u}(t) = \begin{bmatrix} u_1(t) \\ u_2(t) \end{bmatrix} = M \begin{bmatrix} p_1(t) \\ e(t) \end{bmatrix} \tag{A.6}$$

Then,

$$d\underline{u}^e = \underline{u}^e(t+dt,t)-\underline{u}^e(t,t)$$

where $\underline{u}^e(t+dt,t)$ is the rational expectation of $\underline{u}(t+dt)$ held at time t. Accordingly,

$$d\underline{u}^e = \underline{u}^e(t+dt,t)-\underline{u}^e(t,t)$$

$$= M \begin{bmatrix} dp_1{}^e \\ de^e \end{bmatrix} \tag{A.7}$$

Since $dv_1{}^e(t+dt,t) = 0$, we can write (A.7) as follows:

$$d\underline{u}^e = \underline{u}^e(t+dt,t) - \underline{u}^e(t,t)$$

$$= M \begin{bmatrix} dp_1 - dv_1 \\ de^e \end{bmatrix} \tag{A.8}$$

$$= MB \begin{bmatrix} p_1(t) \\ e(t) \end{bmatrix} dt + \begin{bmatrix} \mu_{12} \\ \mu_{22} \end{bmatrix} dv_2$$

$$= RM \begin{bmatrix} p_1(t) \\ e(t) \end{bmatrix} dt + \begin{bmatrix} 0 & \mu_{12} \\ 0 & \mu_{22} \end{bmatrix} \begin{bmatrix} dv_1 \\ dv_2 \end{bmatrix}$$

$$= \begin{bmatrix} \rho_1 & 0 \\ 0 & \rho_2 \end{bmatrix} \begin{bmatrix} u_1(t) \\ u_2(t) \end{bmatrix} dt + \begin{bmatrix} 0 & \mu_{12} \\ 0 & \mu_{22} \end{bmatrix} \begin{bmatrix} dv_1 \\ dv_2 \end{bmatrix} \tag{A.8}$$

Thus,

$$\begin{aligned} du_2{}^e &= u_2{}^e(t+dt,t) - u_2{}^e(t,t) \\ &= \rho_2 u_2(t)dt + \mu_{22}dv_2 \end{aligned} \tag{A.9}$$

Replacing t by $\tau+d\tau$ and taking expectations at time $t \leq \tau$ we have from (A.9) that

$$du_2^e(\tau+d\tau,t) = u_2^e[\tau+2d\tau+d(d\tau),t] - u_2^e(\tau+d\tau,t)$$

$$= \rho_2 u_2^e(\tau+d\tau,t)dt + \mu_{22} dv_2^e(\tau+d\tau,t) \qquad (A.10)$$

Since $dv_2^e(\tau+d\tau,t) = 0$, we can write (A.10) as follows

$$du_2^e(\tau+d\tau,t) = \rho_2 u_2^e(\tau+d\tau,t)dt \qquad (A.11)$$

For given t and variable τ, (A.11) represents a differential equation for the expectation formed at time t of future values of u_2. A non-explosive solution for u_2 requires a non-explosive solution for $u_2^e(\tau,t)$ when $\tau \geqq t$. Since $\rho_2 > 0$, the only non-explosive solution to (A.11) is $u_2^e(\tau+d\tau,t) = 0$ for each $\tau \geqq t$. It follows that we must also have $u_2^e(t+dt,t) = 0$. Hence, from (A.9), we obtain

$$- u_2^e(t,t) = \rho_2 u_2(t)dt + [0 \quad \mu_{22}] \underline{dv} \qquad (A.12')$$

Given the assumption of rational expectations, $u_2^e(t,t) = u_2(t)$. Accordingly, we can write (A.12') as

$$- u_2(t) = \rho_2 u_2(t)dt + [0 \quad \mu_{22}] \underline{dv} \qquad (A.12)$$

Letting $dt \to o$, it follows from (A.12) and (A.2) that $u_2(t) \to 0$ since $\underline{dv} = C\underline{s}dt$. Since from (A.6) $u_2(t) = \mu_{21}p_1(t) + \mu_{22}e(t)$, we have that [8]

$$e = - \mu_{21}(\mu_{22})^{-1}p_1 \qquad (A.13)$$

Adding and subtracting p_1 to and from the left-hand side of (A.13), and using the definition of the real exchange rate e^R, we obtain

$$e^R = -[1 + \mu_{21}(\mu_{22})^{-1}]p_1 \qquad (A.14)$$

Using (A.13) and the definition of p_{C1} we can write

$$p_{C1} = [(1-\pi_2) - \pi_2\mu_{21}(\mu_{22})^{-1}]p_1 \qquad (A.15)$$

Substituting (A.13) into the first equation in (A.1), we obtain

$$dp_1 = [b_{11}' - b_{12}'\mu_{21}(\mu_{22})^{-1}]p_1dt + dv_1$$
$$= \rho_1 p_1 dt + dv_1 \qquad (A.16)$$

Let z_1 and z_2 denote, respectively, the variance of p_1 and the variance-covariance matrix of the disturbances:

$$z_1 = \mathrm{Var}(P_1)$$
$$z_2 = \mathrm{Cov}(\underline{dv})$$

Currie and Levine (1982, 1984) note that, given (A.16), z_1 satisfies

$$\frac{dz_1}{dt} = 2\rho_1 z_1 + z_2{}^1 \qquad (A.17)$$

where $z_2{}^1 = \mathrm{Cov}(dv_1)$. Accordingly, the asymptotic or 'equilibrium' variance of p_1 must satisfy (A.18)

$$2\rho_1 z_1{}^* + z_2{}^{1*} = 0 \qquad (A.18)$$

Let $z_3{}^*$ and $z_4{}^*$ denote, respectively, the asymtotic variance of e^R and of p_{c1}:

$$z_3{}^* = V^*(e^R)$$
$$z_4{}^* = V^*(p_{c1})$$

Using (A.18) we then have from (A.14)-(A.15) that

$$z_3{}^* = \frac{-1}{2\rho_1}[1 + \mu_{21}\ (\mu_{22})^{-1}]^2 z_2{}^{1*} \qquad (A.19)$$

$$z_4{}^* = -\frac{1}{2\rho_1}[(1-\pi_2)\mu_{22} - \pi_2\mu_{21}(\mu_{22})^{-1}]^2 z_2{}^{1*} \qquad (A.20)$$

Also, it follows from (A.16) and from the third equation in ($13b_1$) of Section II that

$$y_1(t)dt = \frac{1}{v}[b_{11}'-b_{12}'\mu_{21}(\mu_{22})^{-1}]p_1(t)dt + [dv_1 - s_3dt]\frac{1}{v}$$

Thus,

$$[y_1(t) - \frac{1}{v}\rho_1 p_1(t)]dt = (dv_1 - s_3dt)\frac{1}{v} \qquad (A.21a)$$

Letting $dt \to o$, we have

$$y_1 = \frac{1}{v} \rho_1 p_1$$

Denoting the asymtotic variance of y_1 by z_5*,

$$z_5* = V*(y_1)$$

we have that $z_5* = [(\rho_1/_v)^2]z_1*$.

Using (A.18), we then have that

$$z_5* = -\frac{\rho_1}{2v^2} z_2{}^1* \tag{A.21}$$

To compute the asymtotic variances of e^R, p_{C1} and y_1 appearing in Tables (3)-(6), we have made use of (A.19), (A.20) and (A.21). Specifically, from (A.2) it follows that

$$z_2{}^1* = Cov*[c_{11}s_1dt + c_{12}s_2dt + c_{13}s_3dt + c_{14}s_4dt]$$

Assuming one type of disturbance at a time, we then have

$$\underline{s_1} \qquad\qquad\qquad \underline{s_2}$$

$$z_2{}^1* = c_{11}{}^2 V*(dv_{11}) \qquad\qquad z_2{}^1* = c_{12}{}^2 V*(dv_{12})$$

$$\underline{s_3} \qquad\qquad\qquad \underline{s_4}$$

$$z_2{}^1* = c_{13}{}^2 V*(dv_{13}) \qquad\qquad z_2{}^1* = c_{14}{}^2 V*(dv_{14})$$

where $V*(dv_{1i}) = V*(s_idt)$ for $i = 1,2,3,4$. In Tables (3)-(6), we have set $V*(dv_{1i}) = 1$.

Notes.

1. See, for example, Currie and Levine (1984, 1985a, 1985b), Sachs and Mckibben (1986), Adams and Gros (1986), Alogoskoufis (1987), and Miller and Williamson (1988).

2. See e.g. Dornbusch (1982); Blundell-Wignall and Masson (1984); Edison, Miller and Williamson (1987); Moutos (1987); PiKoulakis (1988).

3. Wealth effects on spending can be incorporated into the model without changing the main conclusions of the analysis in Sections III and IV.

4. The empirical evidence on the effectiveness of sterilized-intervention is not conclusive. See e.g. the Report of the Working Group on Exchange Market Intervention (1983); and also Obstfeld (1983), Solomon (1983), Rogoff (1984) and Loopesko (1984). However several authors note that although sterilized intervention may be a viable strategy only for the 'short run', this short run may be long enough for practical purposes.

5. In obtaining ($18a_1$)-($18a_3$) from (16c), we have made use of the fact that (a) the trace of the state-matrix of (14c) is equal to the sum of the roots and (b) the determinant of this matrix equals the product of the roots.

6. The 'asymtotic' covariance properties of stochastic systems like the one examined in this chapter provide a convenient measure of the average characteristics of such systems. Currie and Levine (1984, 1985a), Sachs and Mckibbin (1986), and Adams and Gros (1986), among others, evaluate alternative policy regimes in terms of their impact on the asymptotic covariances of several key variables.

7. For surveys of the theoretical literature on optimal intervention and exchange rate regime choice, see e.g. Henderson (1984) and Marston (1985).

8. It should be noted that the "surprise" in the exchange rate is negligibly small in continuous-time stochastic models with rational expectations, since information becomes available almost instantly (see, also Currie and Levine (1982, 1984)).

CHAPTER 6

Effects of Foreign Interest-Rate Changes in a Model of a Debtor Less-Developed Country *

* This Chapter extends ideas that first appeared in Zervoyianni (1984, 1985b).

I. *Introduction.*

A striking feature of recent work on the macroeconomic behaviour of open economies is that, implicitly or explicitly, it refers to the major industrial countries. Most authors, in analysing how changes in foreign interest rates may affect the domestic economy, assume that the home country's net foreign asset position vis-a-vis the rest of the world is positive. Even when the net foreign asset position of the home country is taken to be negative, the analysis is usually based on models that do not incorporate several of the channels through which external financial shocks might be transmitted to the major debtor countries. For example, in the majority of the theoretical studies [1], borrowing decisions in the economy are assumed to be made by "consumers". Thus, the analysis often concentrates on the effects of the external disturbances on aggregate demand, and any likely effects on aggregate supply are ignored or are given little attention. In addition, the foreign residents are usually assumed to perceive no default-risk on loans to domestic residents, so that, in the absence of exchange risk, they regard those claims as perfect substitutes for other assets.

None of these assumptions is relevant when one does not implicitly refer to the industrial countries. First, in the major debtor economies, the bulk of the private external borrowing is, directly or indirectly, done by firms and the principal public-sector borrowers are public enterprises. Also, a large part of the short-term external borrowing is used to finance purchases of foreign intermediate inputs, which, in many cases, are essential for the production of exports [2]. In open economies of this kind, therefore, the level of the foreign interest rate is likely to be among those variables whose behaviour can have a significant influence on domestic production. Second, empirical evidence suggests that the default-risk premiums on loans to the residents of the major debtor countries are large when compared with the premiums on similar loans to residents of the industrial economies [3]. When the claims on the residents of a country are not considered to be free of default-risk, however, any change in their indebtedness is likely to influence the terms of foreign borrowing. This, in turn, may influence the overall response of the economy to external financial shocks.

In this chapter, we attempt to study the response of an open economy to an (unanticipated) increase in foreign interest-rates within a model in which some of the characteristics of the debtor developing-countries (DCs) are incoprorated. Our model draws on the analytical framework developed by: (i) Bruno (1979), Taylor (1981) and Van Wijnbergen (1982, 1983), who concentrate on a closed economy but stress that certain markets in the DC economies differ in their characteristics from those that macroeconomic models usually assume; (ii) Sachs (1984), Cohen and Sachs (1986) and Aizenman (1987), who specify models of foreign lending which incorporate the possibility of debt-default but which abstract from monetary or macroeconomic considerations; and (iii) Henderson and Rogoff (1982), Branson (1983a), Dornbusch (1983b), Frenkel and Mussa (1985) and Obstfeld and Stockman (1985), who focus on dynamic adjustment in open economies.

The purpose of this chapter is therefore twofold. First, it aims to extend the recent theoretical literature on international macroeconomics by exploring how external financial shocks may affect the behaviour of an open DC economy. Second, it aims to complement the literature that focuses on the macroeconomic developments in the debtor countries during the early 1980s [4], and to contribute towards an explanation of some of those developments, by considering the effects of interest-rate changes on a debtor LDC within an analytical framework.

The structure of the chapter is as follows. Section II develops the basic model, and discusses its characteristics. In Sections III and IV we examine the behaviour of the home economy subsequent to an increase in foreign interest rates, using various versions of the basic model. It is shown that an increase in foreign interest rates may cause a short-run deterioration in the competitiveness of the home economy. Also, the degree of substitutability of claims on home residents and other assets in the foreign investors' portfolios has important implications for the dynamic stability of the system: if it is very low, the home country's debt may grow over time at an increasing rate. A brief Section V contains concluding remarks.

II. *The Model*

We consider a semi-small open economy in which the 'general public' may hold its financial wealth in the form of two domestic assets: money M; and interest-bearing inside assets B_d, which we take to be loans to 'firms'. (For simplicity, we shall treat the retained earnings of firms as loans from firms to firms and we shall include them in B_d). As is common in models of DCs, we abstract from the possibility of private holdings of foreign assets and assume that government-debt is only held by the Central Bank. We shall further assume a fixed exchange rate [5], and that the authorities may use foreign borrowing to finance balance of payments deficits. Also, as 'consuming households' in DCs have very little access to foreign credit, we shall postulate that all the private external borrowing is done by firms. Firms may use foreign borrowing to finance payments for current-production inputs as well as to finance domestic investment. To incorporate into the model the fact that production in many DCs depends heavily on imports of primary inputs, we shall take the domestic output Y to be produced by: a foreign variable input N; and two domestic inputs, namely, labour L and fixed-capital K. We also assume, for analytical simplicity, that firms are in perfect competition, that production is characterized by constant returns, and that the production process is completed within the 'short-term'.

The financial sector

The financial sector of this economy can be described by the following equations:

$$B_d = (KP + \psi WL) - EB_{f_1} \qquad 0 \leq \psi \leq 1 \qquad (1.1a)$$

$$EB_{f_1} = F(i - r - \dot{E}/_E)(KP + \psi WL) \qquad F_1 > 0 \qquad (1.1b)$$

$$EB_{f_2} = EP^*N \qquad (1.1c)$$

$$B_d = J(i)(H^n + PK) \quad (1.2a_1) \qquad M = \{1 - J(.)\}(H^n + PK) \quad (1.2a_2)$$
$$J_1 > 0$$

$$\begin{aligned} H^n &= M - EB_f \\ &= [D^g + E(R^a - B_f{}^a)] - EB_f \\ &= D^g - E(B_f + B_f{}^o) \\ &= D^g - EB \end{aligned} \qquad (1.2b)$$

where

P = the price of domestic output

W = the wage rate

E = the exchange rate

P^* = the price of foreign inputs and of foreign goods (assumed to be given)

B_f = private external borrowing

Bf^a = external borrowing by the monetary authorities

H^n = the (net) nominal financial wealth of the private sector

D^g = the home-government debt (held by the Central Bank)

R^a = the foreign exchange reserves

B = the home country's total debt (taken to be positive)

i = the domestic interest rate

r = the interest rate on foreign borrowing (which we assume to be in the form of loans at variable interest rates)

Equation (1.1b) postulates that, at the beginning of each 'short' period, firms will attempt to obtain foreign capital to finance the costs of domestic-inputs (i.e. the purchase of the physical capital and any necessary wage payments) if i exceeds $(r + \dot{E}/E)$. As until recently many DC-governments have sought to encourage firms to borrow abroad to finance purchases of primary imported inputs (so as to relieve pressures on foreign exchange reserves), we shall take the imports of N to be financed primarily by foreign credit. This is indicated by (1.1c). Accordingly, equation (1.1a) specifies the (net) demand for domestic financial capital by firms. Equations $(1.2a_1)$-$(1.2a_2)$ represent a conventional portfolio balance condition: $(1.2a_1)$ assumes that the proportion of the total nominal wealth, $(H^n + PK)$, held by the public in the form of interest-bearing assets, B_d, will depend positively upon the level of the domestic interest rate. The net financial wealth H^n of the private sector is defined in (1.2b). B_d does not appear in this equation, because, being an inside asset, it nets out in the definition of H^n. Hence, H^n is given as the stock of money minus the total private external debt EB_f. Since the monetary base consists of the stock of government-debt and the monetary authorities' net foreign assets, M can be expressed as $M = [D^g+E(R^a-B_f^a)]$. Denoting then the net official borrowing by B_f^o and the net national borrowing by B (so that $B_f^o = B_f^a-R^a$ and $B = B_f + B_f^o$), we can write H^n in the form shown in (1.2b). It should be noted here that while B_f and B_f^o can change instantaneously, B is predetermined at any point in time by past current account deficits. Also, the wealth constraint renders one of the equations $(1.2a_1)$-$(1.2a_2)$ redundant. Accordingly, substituting (1.2b), $(1.2a_1)$ and (1.2b) into (1.1a) yields

$$J(i)(D^g-EB+PK) = \{1 - F(i-r-\dot{E}/E)\}(KP + \psi WL) \qquad (1)$$

$$J_1, F_1 > 0, \quad 0 \leq \psi \leq 1$$

as the equilibrium condition in the domestic financial sector. It may be noted that in the case in which $F_1 \to \infty$, $(i-r-\dot{E}/E) \to 0$. Here this case may arise if domestic firms are allowed to borrow abroad freely (for example, without government permission or government guarantee). In that case, firms may fully respond to any discrepancies between the domestic and the foreign-borrowing rates so that (1) may reduce to the interest rate parity condition, $i = r + \dot{E}/E$.

The goods market

Assuming that firms maximize short-run profits and that they face the production function (2.1a), the aggregate supply function can be described by (2) and the demand functions for the inputs N and L can be specified as in (3.1)-(3.2):

$$Y = Y\{(1+r+\dot{E}/E)EP^*/P,\ (1+i\psi)W/P,\ K\} \qquad Y_1, Y_2 < 0,\ Y_3 > 0 \qquad (2)$$

$$N = N\{Y,\ (1+r+\dot{E}/E)EP^*/P,\ (1+i\psi)W/P\} \qquad N_1, N_3 > 0,\ N_2 < 0 \qquad (3.1)$$

$$L = L\{Y,\ (1+i\psi)W/P,\ (1+r+\dot{E}/E)EP^*/P\} \qquad L_1, L_3 > 0,\ L_2 < 0 \qquad (3.2)$$

$$Y = Q(N,L,K) \qquad Q_1, Q_2, Q_3 > 0 \qquad (2.1a)$$

$$VC = \underbrace{EP^*N(1+r+\dot{E}/E)}_{X_1} + \underbrace{WL(1+i\psi)}_{X_2} \qquad (2.1b)$$

Consider, first, a representative firm. On the basis of the assumptions stated on pp.162, its variable costs, VC, can be expressed as in equation (2.1b). VC consists of two components: (i) the term denoted χ_1 represents the total cost of the foreign inputs N, which includes the cost of the external finance; (ii) the term denoted χ_2 represents the wage bill. In the specification of χ_1 we take explicitly into account the fact that primary inputs from abroad have to be purchased at the beginning of the production process (and, so, prior to output sale) and hence at the beginning of the short period under consideration. The cost of financing the purchase of these inputs must therefore be included in (2.1b). Hence EP*N in χ_1 has been multiplied by the term $(1+r+\dot{E}/E)$. As for the term $(1+\dot{\iota}\psi)$ in χ_2, we follow, for example, Bruno (1979), Taylor (1981) and Van Wijnbergen (1983, 1986) in allowing for the fact that wage payments are sometimes made before final output sale. In such a case (reflected in the possibility that $\psi > 0$), the financial cost of the capital required to finance these 'advance' wage payments must be included in χ_2. (In that case, therefore, ψ in (1) will also be non-zero). It should be noted here that in the specification of χ_2, we have used the nominal wage rate W and the nominal interest rate $\dot{\iota}$. This follows from our implicit assumption that in the short-run the money wage is fixed: as stressed by e.g. Bruno (1979), Taylor (1981) and Diaz-Alejandro (1984), in most of the major debtor countries there are binding wage contracts so that, at least in the short-run, nominal wages can be assumed to be given. We shall maintain this assumption throughout. Using then (2.1a)-(2.1b) and postulating (a) that each firm takes the price of its output as given and maximizes short-run profits and (b) that all firms are identical, we can obtain (2) and (3.1)-(3.2).

A conventional aggregate demand function is given by equation (4):

$$Y = C_1 + P^*/_{EP}(X) + \dot{K} + G$$

$$= C_1(Y_1, H_1, P/_{EP^*}) + P^*/_{EP}X_1(Y^*, P/_{EP^*}) + \dot{K} + G \qquad (4)$$

$$C_{11},\ C_{12},\ X_{11} > 0, \quad C_{13},\ X_{12} < 0$$

where

$$Y_1 = Y_D/P_C,\ H_1 = (H^n + PK)/P_C,\ P_C = P^a\ EP^{*(1-a)} \qquad (4.1)$$

$$H^n + PK = (D^g - EB) + PK \qquad (4.2)$$

$$Y_D = PY - (EP^*)N - EBr - PG \qquad (4.3)$$

$$Y_D = PY - (EP^*)N - EB_fr - PT_x \qquad (4.3_1)$$

$$PT_x = EB_f^o r + PG \qquad (4.3_2)$$

and where

C_1 = domestic consumption of home goods

X = real export demand

$\dot{K}$ = net investment

G = government spending [6]

Y_1 = real private (disposable) income

H_1 = real private wealth

Y_D = nominal private (disposable) income

T_x = tax revenue

In (4), C_1 is shown to be an increasing function of real private disposable income and real private wealth, and a decreasing function of the relative price of home and foreign goods ($P/_{EP^*}$). The price variable used here to deflate nominal disposable income Y_D and nominal wealth (H^n+PK) is the consumer price index P_C (i.e. a weighted average of the prices of domestic goods and imports). Export demand X is taken to be negatively related to ($P/_{EP^*}$), and positively related to foreign output Y^*. Equation (4.3_1) defines Y_D as the domestic value-added (PY-EP*N) minus interest payments on private external debt, (EB_fr), and taxes (PT_x). Equation (4.3_2) specifies the government budget constraint. It is assumed that the interest payments on the foreign loans obtained by the monetary authorities are transferred to the government budget, and that the interest-rate charged on official debt (B_f^o) and on private debt (B_f) is the same. We also introduce the simplifying assumption that the government always balances its budget through endogenous changes in taxes. This in turn implies that D^g in (4.2) and (1) remains invariant over time. Accordingly, using (4.3_1) and (4.3_2), we can express Y_D as in equation (4.3).

The foreign-capital supply function

To complete the static part of the model we introduce equation (5), which reflects our assumption about supply-conditions in the market for foreign capital:

$$B = \zeta(r - r^*)H^* \tag{5.1}$$

Along the lines suggested by e.g Cuddington and Smith (1985), Sachs (1984) and Aizenman (1987), we postulate that foreign investors will allocate a fraction of their wealth H* to holdings of claims on domestic residents B, according to the differential return (r - r*). r* is assumed to be the return on foreign assets, and it is taken to denote the foreign interest rate. By inverting and re-arranging (5.1), we obtain (5) [7]:

$$r = r^* + [1/\zeta(B/H^*)] \tag{5}$$

The parameter ζ can be taken to measure the degree of substitutability between loans to home residents and other assets in the foreign investors' portfolios, while $[1/\zeta(.)]$ can be interpreted as a risk premium on the loans. In the context of models like the present one, there are three main reasons why such loans may be regarded by the foreign residents as 'risky' assets when compared with foreign assets. First, the foreign lenders and the domestic private-sector borrowers may be subject to completely different legal systems regarding the enforceability of loan agreements. Hence, there is the possibility that the foreign lenders may not be able to apply pressures to get full servicing of the debts if the domestic borrowers do not comply fully with the terms on their outstanding liabilities. Second, domestic laws regarding the conditions under which interest-payments can be made to the foreign creditors may change in a way that can reduce the real value of their claims B. Third, there is the possibility that the home government may take over the private debts and suspend debt-servicing, or that it will abandon debt-servicing and repudiate the home country's total debt. Equation (5) can therefore be interpreted in the following way: When the share of foreign wealth held in the form of claims on domestic residents increases, the extent to which the expected return on H* depends upon that on the asset B also increases. Because the asset B is not considered to be free of default risk, its return is regarded by the foreign investors as uncertain relative to the foreign interest rate r*. Hence any change in the rate of return on this asset must exceed the change in r* if it is to induce the foreign investors to hold a greater share of their wealth in B.

The dynamic equations of the system

Three sources of dynamics drive this economy from one equilibrium to another and towards the steady state. The first is the accumulation or decumulation of national debt through CA imbalances:

$$E\dot{B} = - TB + EBr \tag{6}$$

where

$$TB = EP^*X(.) - C_2(.)P - EP^*N(.) \tag{6.1}$$

$$C_2 = C_2(Y_1, H_1, P/EP^*) \qquad C_{21}, C_{22}, C_{23} > 0 \tag{6.2}$$

In (6), (TB) and (EBr) represent, respectively, the trade balance (surplus) and the service balance (deficit). $C_2(.)$ is (real) domestic consumption of foreign goods, and it is specified in a similar way to $C_1(.)$ in (4).

The second source of dynamics is the gradual adjustment of the physical capital stock to changes in investment:

$$\dot{K} = I(K,\ i - \dot{P}/P^e) \qquad I_1,\ I_2 < 0 \qquad (7)$$

Following the Keynes-Wicksell models of investment, we take investment demand to be a decreasing function of the existing stock of capital and of the (expected) real interest rate ($i - \dot{P}^e/P$).

A third source of dynamics is the possibility of wage-rate adjustments over time:

$$\dot{W} = \lambda_1 + \lambda P_C - W \qquad 0 \leq \lambda \leq 1,\ \lambda_1 > 0 \qquad (8)$$

Equation (8) follows e.g. Bruno (1979), Taylor (1981) and Dornbusch (1983b) in postulating that nominal wages may be permitted to rise following previous increases in the consumer price index. For example, the case where $0 < \lambda < 1$ is consistent with an assumption of partial wage indexation (which fits some DCs, especially in Latin America).

The characteristics of the system

Equations (1), (2), (4), (3.1)-(3.2) and (5) (together with an assumption about how price expectations are formed) determine, at any moment, equilibrium values for the endogenous variables i, Y, P, N, L and r as functions of: (i) the predetermined variables B, K and W, whose dynamic behaviour is described by (6), (7) and (8); (ii) the exogenously given foreign interest rate r^*; (iii) the domestic policy variables G, D^g, $\dot{E}/E$, E; and (iv) the foreign variables Y^*, P^*, H^*. In what follows, G, D^g, $\dot{E}/E$, E, H^*, Y^* and P^* will be assumed to remain unchanged and will be dropped [8].

Two features of our model, which differ from those of most of the recent dynamic models of open-economies, are worth noting. First, in this model, a change in the foreign interest-rate will affect the system through (2), via its impact on the cost of the foreign capital which is used to finance purchases of foreign primary inputs. Second, changes in the amount of national borrowing B may affect the cost of borrowing through equation (5).

In the sections that follow, we shall use, for convenience, a linear version of the model. Thus, we take a linear approximation to (1) and to (4.1)-(4.3) as

$$\dot{\iota} = \varphi_1 r + {}^1/_{\varphi}[\psi(\ell + w\bar{L}) + (1-\varphi_2)k + \bar{K}(1-\varphi_2)p + \varphi_2 b] \tag{1a}$$

$$h_1 = k - b + \mu_2 p \tag{4a.1}$$

$$y_1 = y - n - \bar{r}b - \bar{B}r + \mu_1 p \tag{4a.2}$$

where

$$\varphi = F_1(\overline{KP}+\psi\overline{WL}) + J_1(\bar{H}^n+\overline{PK}) > 0,\ \varphi_1 = F_1(\overline{KP}+\psi\overline{WL})\varphi^{-1} > 0$$
$$\varphi_2 = \bar{B}_d(\bar{H}^n+\overline{PK})^{-1} > 0,\ (1-\varphi_2) > 0$$
$$\mu_1 = a(\bar{N} + \overline{Br}) + (1-a)(\bar{Y}-\bar{G}),\ \mu_2 = \bar{K}(1-a) - a\bar{H}^n$$

For notational simplicity, we express all variables (including the interest rates) as deviations from their initial steady-state values (and, we take the initial steady state to be characterized by $\dot{B} = \dot{K} = \dot{P} = \dot{W} = 0$, $\bar{r} = \bar{\iota}$, $\bar{Y} = \bar{W} = \bar{P} = \bar{E} = \bar{P}^* = \bar{H}^* = 1$). We also assume, for simplicity, that the production function (2.1a) is Gobb-Douglas, i.e. $Y = A(N)^{\tau_1}(L)^{\tau_2}(K)^{\tau_3}$ where $\tau_3 = 1-\tau_1-\tau_2$. Accordingly, we can write equations (2) and (3.1)-(3.2) in linearized-form as follows

$$y = \psi_1 p - \psi_2 r - \psi_3 i + \psi_4 k - \psi_5 w \tag{2a}$$

$$n = \eta_1(p + y) - \eta_2 r \tag{3a.1}$$

$$\ell = \ell_1[(p - w) + y] - \ell_2 i \tag{3a.2}$$

where

$$\psi_1 = \tau_1^* + \tau_2^*,\ \psi_2 = \tau_1^*(1+\bar{r})^{-1}$$
$$\psi_3 = \psi\tau_2^*(1+\psi\bar{r})^{-1},\ \psi_4 = (\bar{Y}/\bar{K}),\ \psi_5 = \tau_2^*$$
$$n_1 = \tau_1(1+\bar{r})^{-1},\ n_2 = n_1(1+\bar{r})^{-1}$$
$$\ell_1 = \tau_2(1+\psi\bar{r})^{-1},\ \ell_2 = \psi\ell_1(1+\psi\bar{r})^{-1}$$
$$\tau_1^* = \tau_1(1-\tau_1-\tau_2)^{-1},\ \tau_2^* = \tau_2(1-\tau_1-\tau_2)^{-1}$$

We also consider a linear version of equations (4)-(8):

$$y = c_1 + x + \dot{k} - \bar{X}p \tag{4a}$$

$$c_1 = \gamma_1 y_1 + \kappa_1 h_1 - \sigma p \tag{4a.3}$$

$$x = - x_1 p \tag{4a.4}$$

$$r = r^* + \xi b \tag{5a}$$

$$\dot{b} = - tb + \bar{r}b + \bar{B}r \tag{6a}$$

$$tb = x - n - c_2 - \bar{C}_2 p \tag{6a.1}$$

$$c_2 = \gamma_2 y_1 + k_2 h_1 + \sigma p \tag{6a.2}$$

$$\dot{k} = - \delta_1 k - \delta(i - \dot{p}^e) \tag{7a}$$

$$\dot{w} = \lambda_3 p - w \tag{8a}$$

It should be noted that one can relate the size of ψ_2 in (2a) to the extent to which domestic production depends on imports of foreign inputs (as measured by the elasticity of output with respect to changes in N). For example, one can approximate the case in which the inputs N are relatively unimportant for domestic production by considering a situation where $\tau_1 \to 0$. This, in turn, implies that $\psi_2 \to 0$, $\eta_2 \to 0$ and $\eta_1 \to 0$. Also, the parameter ξ in (5a) can be taken to measure the degree of imperfect substitutability of loans to domestic residents and foreign assets in the foreign investors' portfolios: in the case of perfect substitutability, $\xi \to 0$.

We shall proceed to the analysis of this model in three steps. In Section III, capital accumulation and the possibility of wage adjustments over time [9] will be ignored. In Sections IIIa, IIIb and IIIc we shall focus on the short-run behaviour of the system, on its dynamic behaviour with $\xi \to 0$, and on its dynamic behaviour with $\xi \neq 0$. In Section IVa, capital accumulation will be assumed to be non-zero and the characteristics of this more general model will be studied. In Section IVb, equation (8a) will be re-introduced into the model, and the behaviour of the full system will be examined under alternative assumptions about some of its structural parameters.

III.a *Output and Prices in the Short-run*

With no capital accumulation and wage adjustments, the model reduces to

$$\dot{i} = \varphi_5 r + {}^1/\varphi_3\{\varphi_4 p + \psi\ell_1 y + \varphi_2 b\} \tag{1a}$$

$$y = \psi_1 p - \psi_2 r - \psi_3 \dot{i} \tag{2a}$$

$$n = \eta_1(p + y) - \eta_2 r \tag{3a.1}$$

$$y = \gamma_1 y_1 + \kappa_1 h_1 - \sigma_1 p \tag{4a}$$

$$h_1 = - b + \mu_2 p \tag{4a.1}$$

$$y_1 = y - n - \bar{r}b - \bar{B}r + \mu_1 p \tag{4a.2}$$

$$r = r^* + \xi b \tag{5a}$$

$$\dot{b} = - tb + \bar{r}b + \bar{B}r \tag{6a}$$

$$tb = - \{n + \gamma_2 y_1 + k_2 h_1 + \sigma_2 p\} \tag{6a.3}$$

where

$$\varphi_3 = \varphi\{1 + ({}^1/\varphi)\psi\ell_2\}^{-1}$$
$$\varphi_4 = \bar{K}(1-\varphi_2) + \psi\ell_1$$
$$\varphi_5 = \varphi_1\{1 + ({}^1/\varphi)\psi\ell_2)\}^{-1}$$
$$\sigma_1 = \sigma + x_1 + \bar{X},\ \sigma_2 = \sigma + x_1 + \bar{C}_1$$

Consider the short-run equilibrium of this model. Since the home country's total debt b is given at any point in time, short-run equilibrium requires that output supply equals demand and that the domestic loan market clears.

In Figure (1), the YY_s schedule describes supply. It is positively sloped, because a rise in the price of domestic output will lower the real price of imported intermediate inputs as well as the real wage. Other things being equal, this will lead to an increase in production.

The YY_d schedule describes demand. Its slope depends on the relative magnitude of the following effects of a change in the price of output. First, an exogenous increase in p will result in a deterioration of competitiveness, will cause a fall in the real value of exports, and will lead to a drop of (net) domestic income by raising the demand for imported intermediate imports by firms. Second, the rise in the price level p_c

Output and Prices in the Short-Run

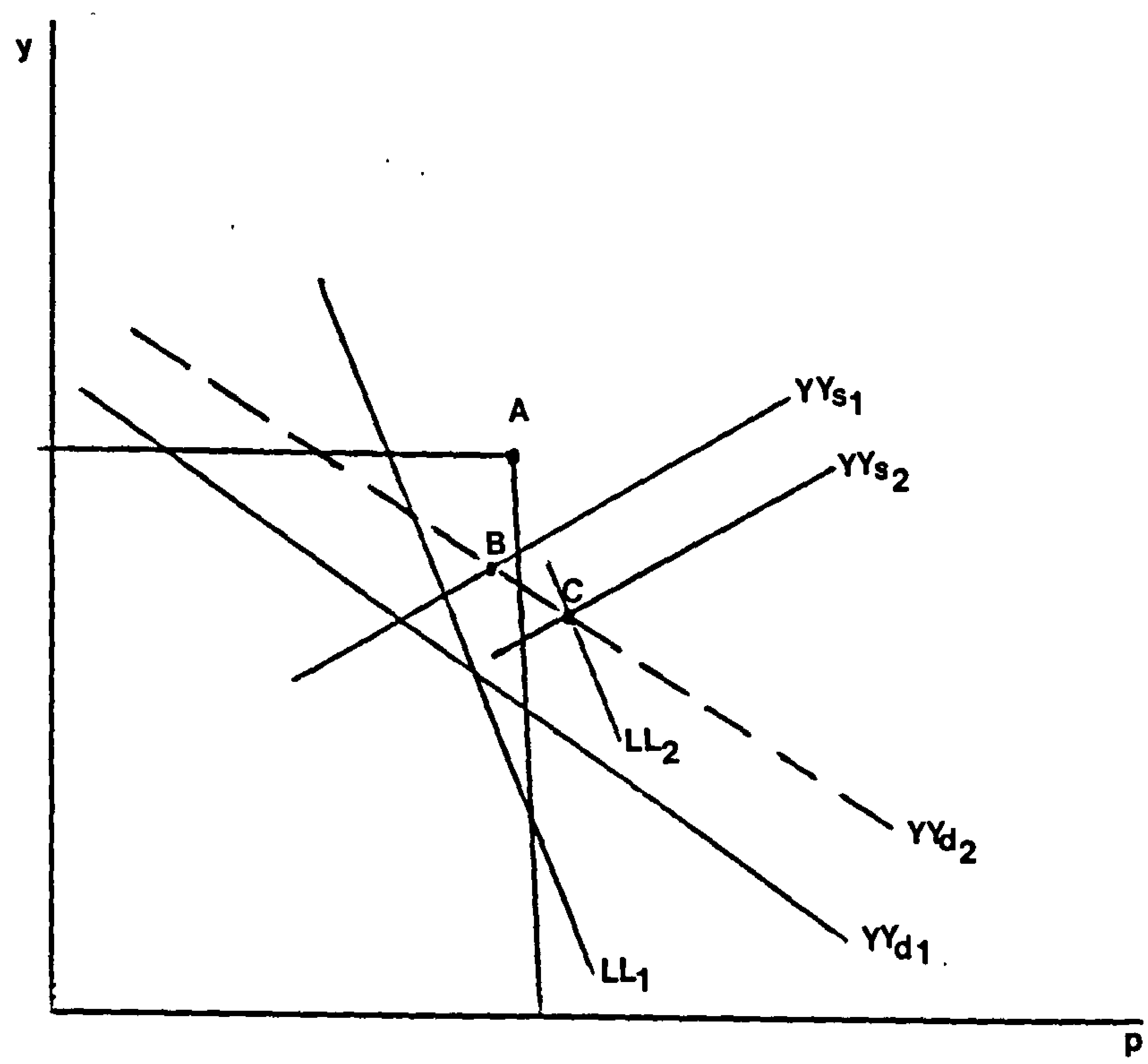


Figure 1a

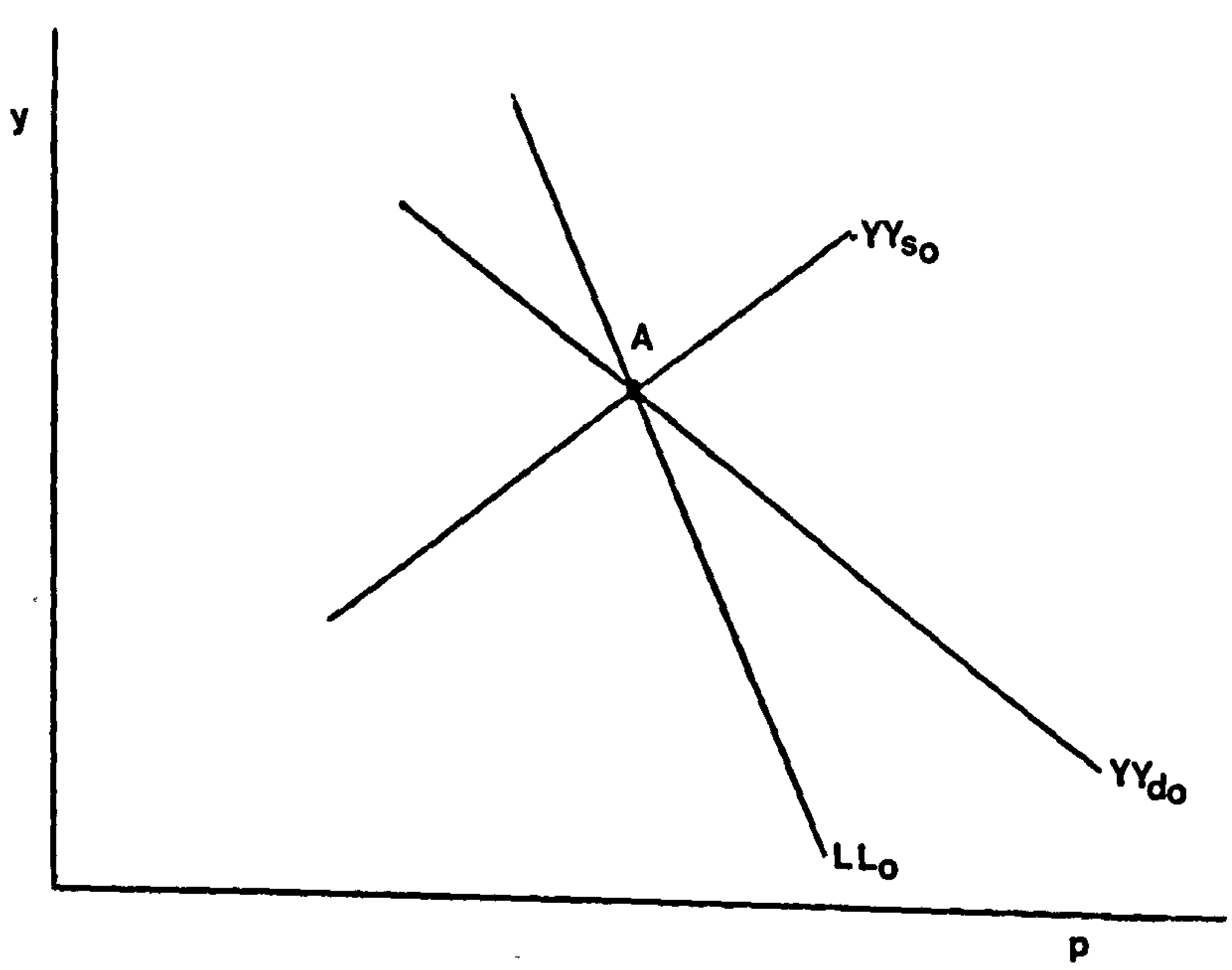


Figure 1

will lead to an increase in private (disposable) income by lowering the real interest payments on the outstanding debt and the real payments for the initial imported inputs. The rise in p_c will also increase real private wealth if, at the initial equilibrium, net domestic financial wealth (H^n) is negative. Third, an increase in p, by improving the terms of trade, will raise the level of real income corresponding to the initial volume of production as well as the level of real wealth corresponding to the (initial) stock of physical capital. More formally, the slope of the YY_d schedule is given by

$$\frac{dY}{dp}\Big|_{YY_d} = -\theta/\epsilon \tag{9a$_1$}$$

where

$$\epsilon = 1 - \gamma_1 + \eta_1\gamma_1 \quad > 0$$

$$\theta = \underbrace{\{\sigma_1 + \gamma_1\eta_1\}}_{\chi_1} - \underbrace{\{[\gamma_1(\bar{N}+\bar{E}\bar{B}r)-\kappa_1\bar{H}^n]a + [\gamma_1(\bar{Y}-\bar{G})+\kappa_1\bar{K}](1-a)\}}_{\chi_2}$$

The coefficient ϵ represents the income multiplier (which we assume to be positive). χ_1 describes the 'demand-reducing' effects of an exogenous increase in p, while χ_2 describes its 'demand-increasing' effects.

It is worth noting that the assumption of CA balance in the initial steady state implies that $\bar{X} = \bar{N} + \overline{Br} + \bar{C}_2$. Using this condition, we can express θ as follows

$$\theta = \underbrace{\{\sigma+x_1+(1-a\gamma_1)\bar{X}+a\gamma_1\bar{C}_2+\gamma_1\eta\}}_{\chi_{11}} - \underbrace{(1-a)\gamma_1(\bar{Y}-\bar{G})}_{\chi_{21}} - \kappa_1\underbrace{[\bar{K}(1-a)-a\bar{H}^n]}_{\chi_{22}} \tag{9a$_2$}$$

The first term in the expression for θ, i.e. χ_{11}, is positive. The second term, $-\chi_{21}$, is negative and reflects a 'Laursen-Meltzer' effect[10] of a change in the price of domestic output. The last term represents the wealth effect on spending on home goods of an increase in p. The 'Laursen-Meltzer' effect is not specific to a debtor developing country. A positive wealth effect, however, is particularly likely in the case of a debtor DC. Firstly, when the home country is a net debtor, $\overline{H}^n$ is possible to be negative. Even if $\overline{H}^n$ is positive, its absolute value is most likely to be small. Secondly, when there are no domestic markets for primary financial assets (such as government bonds), the share of physical capital in total wealth ($\overline{KP} + \overline{H}^n$) is most likely to be high. Combined, these two factors suggest that here a negative sign for $-\chi_{22}$ can be postulated. In the following analysis, we shall follow most of the literature in assuming that the sign of θ is positive (and, hence, that the demand schedule YY_d is downward sloping). However, one should bear in mind that a positive wealth effect will imply a relatively flat YY_d schedule.

The LL schedule shows the combinations of y and of p which, given the level of the borrowing-rate r and the stock of the debt b, are compatible with a constant domestic interest-rate i. An increase in the price level will create excess demand in the domestic loan market, by raising the funds which the firms will need to finance the purchase of the physical capital. As long as $\psi \neq 0$, it will also increase the demand for loans by inducing a rise in labour demand (via the decline in the real wage) and, therefore, a rise in the capital requirements for wage payments. To maintain equilibrium, output will have to fall to reduce labour demand and hence wage payments. Thus, the LL schedule is negatively sloping. All points above LL reflect excess demand, while all points below LL reflect excess supply. Given our earlier discussion about the coefficient θ, and given the definition of the φ_i's in (1a), the LL schedule is taken to be steeper than the YY_d curve.

Consider an initial equilibrium at point A in Figure (1a), and assume an unanticipated increase in the foreign interest-rate r*. As equation (5.1) of Section II shows, the rise in r* will disturb equilibrium in the international money markets by increasing the demand for foreign assets and by reducing the demand for claims on the home residents. Since the home country's external debt b is given in the short run, equilibrium can be maintained only if r adjusts in proportion to r* so as to induce the foreign residents to hold an unchanged share of their wealth in the form of the asset b.

Consider the effects on the home economy of the change in the interest rate r. *First*, interest payments on the outstanding external debt will increase. This will cause a reduction in total private spending by lowering net domestic income. Part of that reduction in spending will fall on home goods, so that the initial YY_{d0} schedule will shift to the left of its position at A. *Second*, if domestic firms are dependent on foreign credit to finance purchases of foreign primary inputs, the rise in r will have a direct effect on their costs. Hence, at the initial level of the price of domestic output p and of the domestic borrowing-rate $\dot{i}$, production will tend to fall causing the YY_{s0} schedule to shift down and to the right of A (to a position occupied, say, by YY_{s1}). At the same time, the rise in the cost of financing the imports of N will lead to input substitution effects. That is, labour use will tend to increase while the use of inputs from abroad will decrease: this, via increased domestic value-added and hence spending, will give rise to a rightward shift of YY_{d1} (to a position occupied by YY_{d2}) which will partially offset the initial leftward shift. How large the rightward shift of YY_{d1} and the downwards shift of YY_{S0} will be, will depend on the relative importance of primary inputs from abroad for domestic production (as measured by the size of ψ_2 and η_2). *Third*, because of the increase in the interest rate r, domestic producers will attempt to finance a larger proportion of the domestic-input costs by borrowing from the domestic loan market. The LL_0 schedule will therefore shift to LL_1, and, as a result, point B will be associated with an excess demand for domestic financial capital. Such excess demand will tend to drive the domestic interest-rate $\dot{i}$ upwards. Hence the LL_1 curve will move up, and the rising $\dot{i}$ will cause YY_{S1} to shift down and to the right of point B (by increasing the cost of financing wage payments).

As far as output is concerned, then, both the 'demand-effect' and the 'supply effect' of the change in r* will be in the same (downward) direction. However, the effect on prices may be in an upward direction. If the direct and indirect (negative) effect of the increase in the foreign interest-rate on supply is strong enough to outweigh the net (negative) effect on demand, the economy will move from point A to a point like C: y will fall, but p will rise in contrast to what most of the existing models of open-economies would suggest. More formally, the impact effect of the change in r* on the price level p is given by

$$dp(o) = \frac{\omega_1}{\omega_2} dr^* \tag{9b}$$

where

$$\omega_1 = \psi_2 + \frac{\gamma_1\eta_2}{\epsilon} + \{\psi_3\varphi_1 + (1/\varphi)\psi\omega_3\} - \frac{\gamma_1\bar{B}}{\epsilon}$$

$$\omega_2 = \theta/_\epsilon + \{1 + (1/\varphi)(\ell_2 + \ell_1\psi_3)\psi\} + \{\psi_1 + (1/_\varphi)\omega_4\} \quad (> 0)$$

$$\omega_3 = \psi_2\ell_2 - \frac{\gamma_1(\bar{B}-\eta_2)}{\epsilon}(\ell_2 + \psi_3\ell_1) \gtrless 0$$

$$\omega_4 = \psi(\ell_2\psi_1 - \psi_3\ell_1) - \psi_3\bar{K}(1-\varphi_2) \gtrless 0$$

Given the definition of the reduced-form coefficients, (9b) indicates that the possibility of a positive sign for dp(o) is positively related to the size of ψ_2 and of η_2 and η_1, and it increases when $\psi_3 \neq 0$. Also, the size of the increase in dp(o) can be expected to be inversely related to (θ/ϵ) and hence to the steepness of the demand schedule YY_d.

Since the characteristics of the short-run that are described by Figure (1a) and by equation (9b) differ from those that 'standard' models of open-economies usually assume, a crucial question is whether such characteristics can indeed be expected in the 'less standard' case of DC-economies. Three factors suggest that, in the context of DCs, an equilibrium position like point C is indeed likely. First, many DCs are highly dependent on imported primary inputs for domestic production, as well as on foreign credit for the financing of the purchase of these inputs. Second, the assumption of advance wage payments seems particularly relevant in the case of developing countries. Cavallo (1977), Lara-Resende (1979) and Van Wijnbergen (1982), for example, note that in many DCs the capital requirements associated with such payments amount to 5-10 percent of industrial sales (as opposed to .5-1 percent in most developed countries). Third, the overall responsiveness of demand to price changes can be expected to be relatively low in debtor developing countries, because of the high probability of a positive wealth effect. All of these factors suggest that, in open economies of this kind, a short-run equilibrium position such as point C is likely.

In fact, these three factors may have been important determinants of the behaviour of several DC-economies during the early 1980s. As mentioned in Chapter 1, in 1980-83, when international interest rates rose sharply, real GDP declined considerably in almost all developing countries. In many DCs, however, inflation and prices in the manufacturing sector did not drop as much as one would have expected according to standard macroeconomics. In the early 1980s, several explanations were offered to account for that phenomenon. Some analysts suggested that the phenomenon might have resulted from the devaluations which occured in a number of DCs during the 1981-1983 period. Others argued that it might have resulted from the fact that some DC-governments financed increases in spending by the issue of money. Our analysis offers another possible explanation: that the unfavourable terms on external credit to DCs in 1980-83 might have had a strong adverse influence on domestic production decisions, so that their aggregate supply may have declined more than the reduction in aggregate demand. Recently, Sachs (1985a) and Diaz-Alejandro (1983, 1984) have pointed to the possibility of 'excess-demand' in DCs during the early 1980s. However, this possibility has been given very little attention and no formal analysis of its likely causes has been attempted.

IIIb. *Foreign Interest-Rate Changes and the Current Account*

To keep our analysis simple, in this section we ignore the possibility of capital requirements for wage payments (by setting $\psi_3 = 0$ in (2a)). We also use the interest-rate parity version of equation (1a) of Section II (by letting $F_1 \to \infty$). As is apparent from our analysis in Section IIIa, these simplifications reduce the complexity of the algebra without changing the essential characteristics of the system. Accordingly, the model can be reduced to

$$p = -\,{}^{1}/\alpha_1\{(\alpha_2 - \xi\alpha_3)b - \alpha_3 r^*\} \qquad (10a_1)$$

$$\dot{b} = \beta_1 p - (\beta_2 - \xi\beta_3)b + \beta_3 r^* \qquad (10a_2)$$

where

$$\alpha_1 = \theta + \epsilon\psi_1 > 0,\quad \alpha_2 = \gamma_1\bar{r} + \kappa_1 > 0,\ \alpha_3 = \epsilon\psi_2 - \gamma_1(\bar{B}-\eta_2) \gtrless 0$$

$$\beta_1 = \sigma_2+\eta_1(1-\gamma_2)+\gamma_2\mu_1+\kappa_2\mu_2+\lambda_1\psi_1 > 0,\ \beta_2 = \kappa_2 - \bar{r}(1-\gamma_2) \gtrless 0,$$

$$\beta_3 = \bar{B}(1-\gamma_2) - \lambda\ (> 0),$$

and

$$\epsilon = 1-\gamma_1+\gamma_1\eta_2,\quad \sigma_2 = \sigma + x_1 + \bar{C}_2$$

$$\lambda_1 = \{(1-\gamma_2)\eta_1 + \gamma_2\},\ \lambda = \psi_2\lambda_1+\eta_2(1-\gamma_2)$$

Equation ($10a_1$) describes a relationship between the price of domestic output p, the stock of the debt b, and the foreign interest rate r*, which is consistent with equilibrium in the goods market. Equation ($10a_2$) describes the current account as a reduced-form function of p, b and r*. It is obtained by combining (6a),(6a.3), (3a.1), (5a) and the aggregate supply function (2a).

The following features of ($10a_1$) and ($10a_2$) are worth noting.

The coefficient α_3 captures the impact effect on domestic prices of an increase in r*. From the analysis in Section IIIa, it follows that this coefficient may be positive if the sensitivity of aggregate supply to changes in foreign interest rates is strong relative to the sensitivity of aggregate demand (i.e. in the context of ($10a_1$)-($10a_2$), if ψ_2 and η_2 are relatively large). The coefficient α_1 captures the net effect of a change in the price of home output on excess demand in the domestic goods market. It is most likely to be positive, independently of the sign of θ (because, in addition to the 'demand-reducing' effects of a rise in p, here supply-side effects will also lead to a drop in the excess demand). Following most of the literature, we shall make the assumption that β_3 is positive; that is, the direct adverse effects of an increase in foreign interest rates on the service balance are not overcompensated by the induced drop in imports. The coefficient β_1, which reflects the effect of an exogenous rise in the price of home goods on the CA deficit, is unambiguously positive. Both in ($10a_2$) and in ($10a_2$), however, the sign of the coefficient of b depends on the size of ξ and hence on the substitutability of loans to domestic residents and other assets in the foreign investors' portfolios. To see more clearly the possible implications of imperfect asset substitutability in the context of this model, we shall assume for the moment that $\xi \to 0$. Accordingly, we can write ($10a_1$) and ($10a_2$) as follows

$$p = - {}^{1}/\alpha_1\{\alpha_2 \; b - \alpha_3 \; r^*\} \qquad (10b_1)$$

$$\dot{b} = \beta_1 p - \beta_2 b + \beta_3 r^* \qquad (10b_2)$$

In ($10b_1$), the coefficient of b is positive. The sign of β_2 in ($10b_2$) indicates whether an exogenous increase in the stock of the debt has a negative or a positive effect on the CA. A rise in b increases interest payments and moves the CA into deficit by worsening the service balance (SB). At the same time, however, it causes a reduction in (net) domestic income. This produces a partially offsetting change in the trade balance (TB), via reduced imports of final goods. Against the adverse SB effect, also stands the TB improvement arising from the drop in imports due to the decline in (net) domestic wealth. β_2 will therefore be positive, as long as the wealth effect and the income effect of an increase in the debt on spending generate a contraction in imports sufficiently large to offset the interest-payment effect. As is well-known, a positive sign for β_2 is an important condition for stability in closed-economy Keynesian models of debt finance. In the context of our model, this condition is sufficient but not necessary to rule out instability. Here stability with $\beta_2 < 0$, requires the drop in domestic prices following an increase in the debt to be large enough to generate an overall CA improvement. More formally, by inserting the goods market equilibrium condition ($10b_1$) into ($10b_2$), we can express the stability condition as

$$\Delta' = \beta_2 + \frac{\beta_1\alpha_2}{\alpha_1} = \frac{1}{\alpha_1} \quad (\beta_1\alpha_2 + \beta_2\alpha_1) > 0 \qquad (10b_3)$$

As noted above, α_1 can be expected to be positive. Thus, ($10b_3$) will always hold if $\beta_2 > 0$. Even if β_2 is negative, Δ' is most likely to be positive, since, from the definition of the reduced-form coefficients, one would expect that $|\beta_1\alpha_2|>|\beta_2\alpha_1|$. Hence, in what follows, Δ' will be taken to be positive and the stability condition ($10b_3$) will be assumed to hold.

To examine the steady-state properties of the system, $\dot{b}$ can be set equal to zero. Imposing the steady-state requirement $\dot{b} = 0$, equations ($10b_1$) and ($10b_2$) yield (10c)

$$\begin{bmatrix} \alpha_1 & \alpha_2 \\ -\beta_1 & \beta_2 \end{bmatrix} \begin{bmatrix} \tilde{p} \\ \tilde{b} \end{bmatrix} = \begin{bmatrix} \alpha_3 \\ \beta_3 \end{bmatrix} r^* \qquad (10c)$$

from which, by differentiation, one can obtain the long-run effects of the change in r* on the stock of the debt and on the domestic price level as follows:

$$d\tilde{b} = \frac{1}{\Delta}\,[\alpha_1\beta_3 + \beta_1\alpha_3]dr^* \quad (10c_1) \qquad d\tilde{p} = \frac{1}{\Delta}\,[\alpha_3\beta_2 - \beta_3\alpha_2]r^* \quad (10c_2)$$

where

$$\Delta = \beta_1\alpha_2 + \alpha_1\beta_2 > 0$$

From the stability condition ($10b_3$), the term Δ is positive. Thus, given our earlier discussion about the probable signs of the α_i's and β_i's, $\tilde{b}$ in ($10c_1$) will increase if $\alpha_3 > 0$. In this case, $\tilde{p}$ in ($10c_2$) may in principle rise or fall depending on the relative size of the parameters values that determine the size of the coefficients in the bracketed expression. On the other hand, a negative sign for α_3 will most probably imply a negative $d\tilde{p}$. To find an explicit expression for $d\tilde{b}$ and $d\tilde{p}$, we can use the definition of the reduced-form coefficients to substitute out the α_i's and β_i's from ($10c_1$)-($10c_2$). To simplify here the algebraic expressions[11], we shall assume that, in the initial steady state, net domestic financial wealth is neither negative nor positive (i.e. $\bar{H}^n \rightarrow 0$). We shall also set $a = 1$ in equations (4a.1)-(4a.2) of Section I. Accordingly, ($10c_1$)-($10c_2$) yield

$$d\tilde{b} = \frac{1}{\Delta}(\alpha_1\beta_3 + \beta_1\alpha_3)\; dr^*$$

$$= \frac{1}{\Delta}\,(1-\gamma)\;[(\bar{B}-\eta_2)q_1 + \psi_2 q_2]dr^* \qquad (10c_1{*})$$

$$d\tilde{p} = \frac{1}{\Delta}(\alpha_3\beta_3 - \beta_3\alpha_2)dr^*$$

$$= -\frac{1}{\Delta}[(\bar{B}-\eta_2)q_3 + \psi_2 q_4]dr^* \qquad (10c_2^*)$$

where
$$q_1 = \psi_1 + (\sigma + x_1) + \bar{X} > 0$$
$$q_2 = \eta_1 + (\sigma + x_1)(1-\eta_1) + (\bar{C}_2-\eta_1\bar{X}) > 0$$
$$q_3 = \gamma_1\kappa_2 + (1-\gamma_2)\kappa_1 > 0$$
$$q_4 = (1-\gamma)(\bar{r}-\kappa_2) - (\eta_1[\kappa_2\gamma_1 + \kappa_1(1-\gamma_2)] + \gamma_2(\kappa_1+\kappa_2)) \gtrless 0$$

It may be noted that the term $(\bar{B}-\eta_2)$ must be positive if, on balance, the short-run shift of the YY_d schedule in Figure (1a) is to be to the left of its initial position - an assumption that seems reasonable, given the definition of η_2. Hence an increase in the foreign interest rate will, in general, lead to a rise in the long-run level of the home country's indebtedness. Its effect on domestic prices (and hence on competitiveness) is ambiguous, although the possibility of drop in the steady-state value of p seems more likely.

Utilizing the information provided by $(10c_1^*)$-$(10c_2^*)$, let us consider the response of the system to increased interest rates using Figure (2). Equations $(10b_1)$ and $(10b_2)$ are plotted in this figure as the schedules GG and CA_Y, respectively. The GG schedule describes the combinations of the shock of the external debt and of the domestic price level which preserve goods market equilibrium. GG is negatively sloped. Along the CA_Y schedule the current account is in balance and y is equal to planned output-supply. CA_Y is drawn here as an upward-sloping curve, on the assumption that the coefficient β_2 is positive. The region above CA_Y is characterized by a current account deficit, while the region below CA_Y corresponds to a current account surplus.

Assume an initial equilibrium at point A in Figure $(2a_1)$, and consider

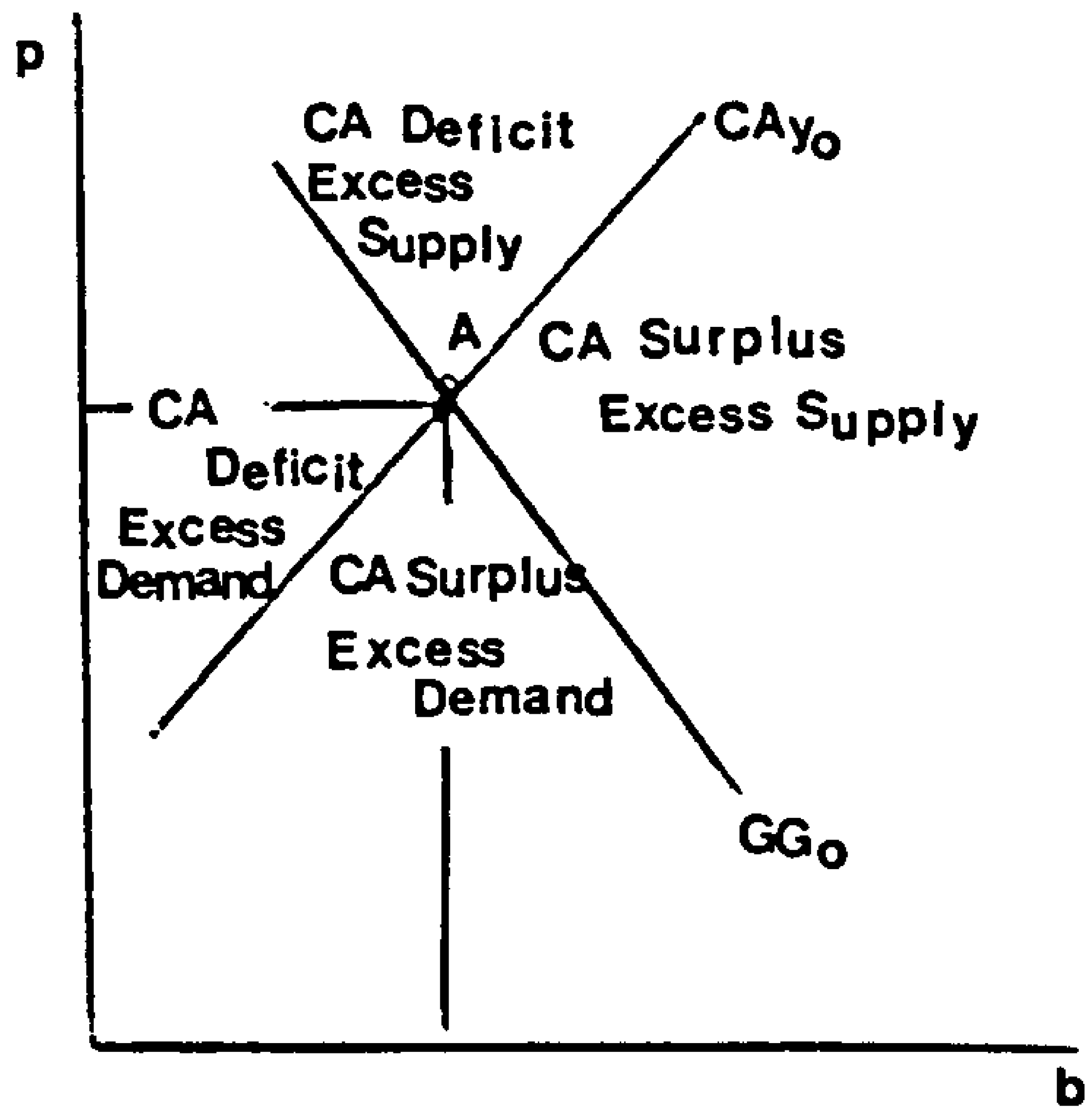


Figure 2

$\alpha_3 > 0$

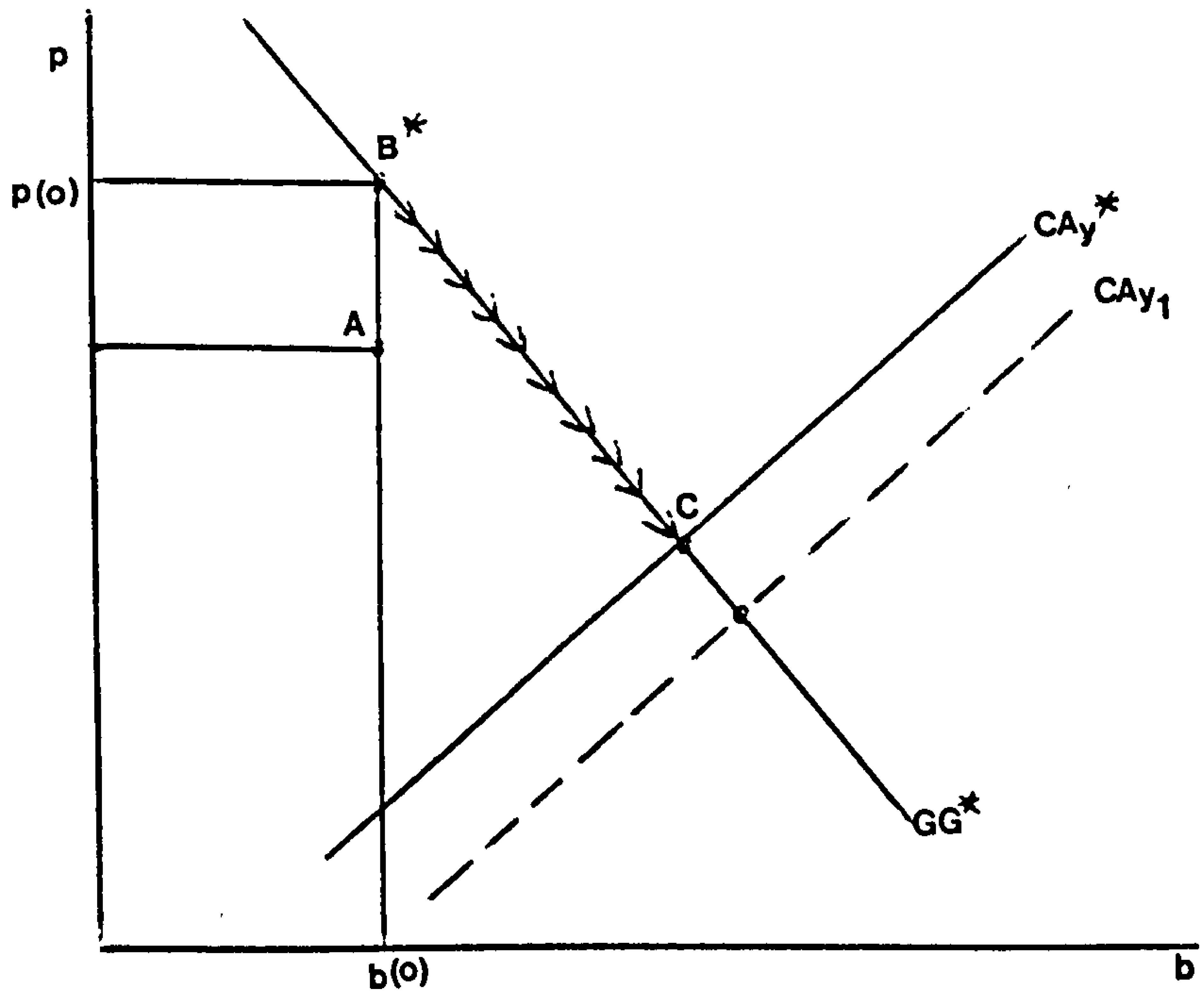


Figure (2a$_1$)

$\alpha_3' < 0$

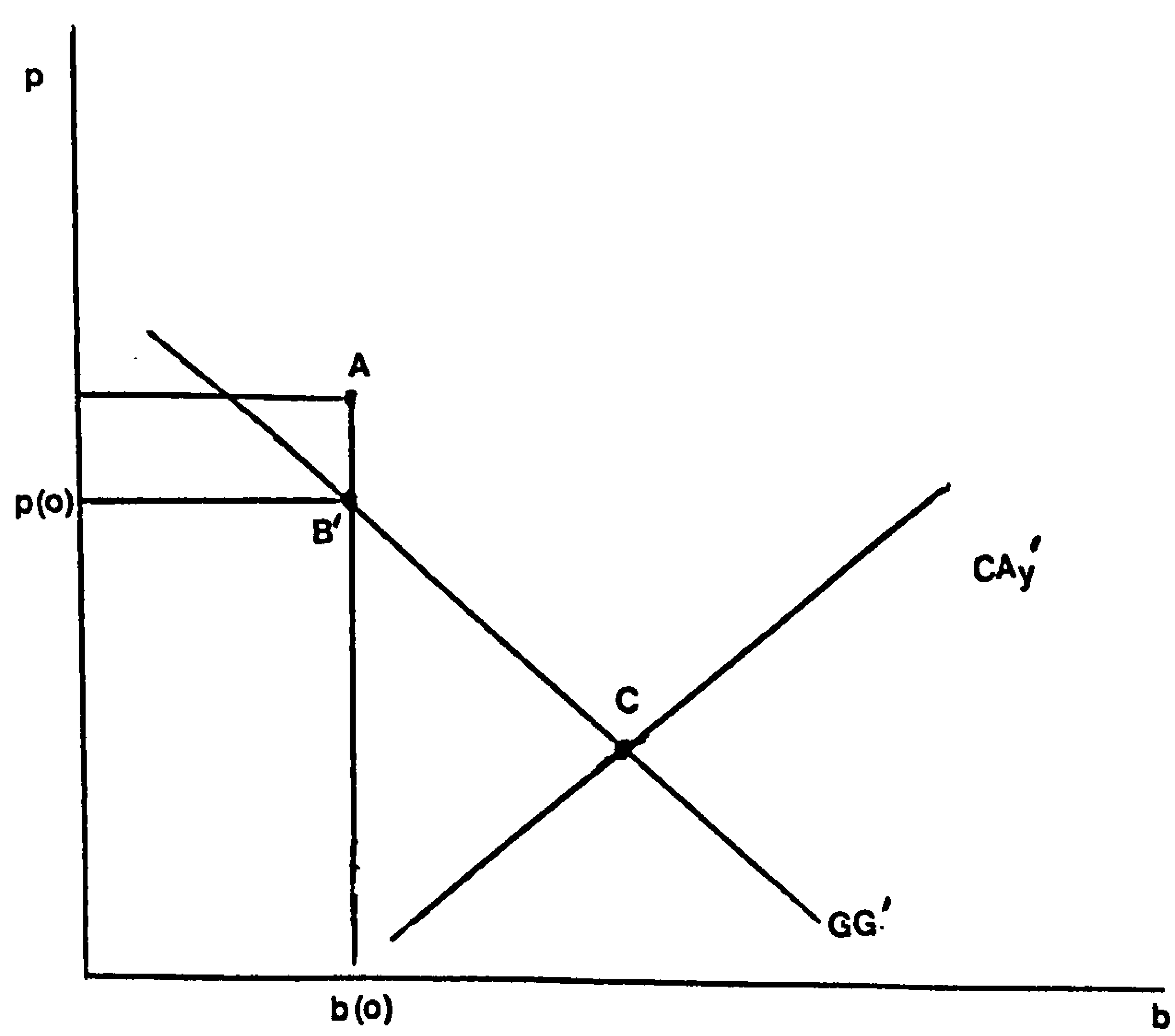


Figure (2a$_2$)

the impact effects of the increase in r*. With $\beta_3 > 0$, the rise in r* will cause the initial CA_Y schedule (not drawn) to shift to the right of point A (to a position occupied by CA_Y*). The initial GG schedule (not drawn) may shift up or down, depending on the sign of α_3. Consider the case where α_3 is positive. In this case, the original GG curve will also shift up and to the right. With the stock of the debt being given in the short-run, equilibrium will occur at a point like B*. In the short-run, the current account will move into deficit and p will increase. Consider, however, the three effects of the change in r* on the CA. First, the increase in r*, by raising the interest-payments on past debt, will cause the initial CA_Y schedule to shift down, by a vertical amount equal to $\bar{B}(1-\gamma_2)$, to a position occupied by CA_{Y_1}. This represents the negative "service balance" effect of the change in r*. Second, the rise in r*, by raising home goods prices, will move the short-run equilibrium combination from point A to point B*: this represents a negative "price competitiveness" effect of the change in r*, which reinforces the service-balance effect in deteriorating the CA. Third, the decrease in the import outlay, which results from the sharp fall in output and imported intermediate inputs due to the increased cost of foreign credit, will cause CA_{Y_1} to shift up by a vertical amount equal to λ. That shift of the CA_Y schedule from CA_{Y_1} to CA_Y* represents the "import-contraction" effect of the change in the foreign interest rate, which actually eliminates a substantial part of the TB deficit generated by the price rise at point B*. As a consequence, the new equilibrium at B* is quite likely to be associated with a relatively small TB deficit, even though domestic prices increase in the short-run. In fact, the sharp drop in production and imports might cause the trade balance to improve at B*, in spite of the short-run deterioration in the home country's competitiveness.

At this point, it may be worth noting that in 1980-81, when international interest-rates started to rise, several DCs achieved remarkable improvement in their TBs, despite the fact that price competitiveness in their manufacturing sector did not substantially improve and domestic inflation did not significantly decelerate. That phenomenon was not consistent with standard macro models of open economies. Standard models would indeed predict a TB improvement following a foreign interest-rate increase, as a result of the reduction in domestic income and hence spending. By the assumptions underlying these models, however, price competitiveness must increase (and inflation must decline) if the trade balance is to improve substantially.

Our analysis suggests that a large TB improvement may be perfectly compatible with price increases following foreign interest-rate increases, because of the possibility of a negative effect of higher foreign interest rates on domestic output-supply and because of a substantial drop in the intermediate import outlay.

To see more clearly this point consider the behaviour of a 'standard' type of open-economy where $\alpha_3 < 0$. That case is illustrated in Figure ($2a_2$).

With $\alpha_3 < 0$, the initial GG schedule in the figure shifts to GG' in response to the increase in r*. The CA_{Y_0} schedule moves down to a position occupied by CA_{Y}'. Short-run equilibrium occurs at point B', characterized by a CA deficit and by a drop in domestic prices. However, whether the CA deficit at B' is smaller than the corresponding to point B* is in principle unclear. It may be smaller because prices have gone down and exports have increased, or it may actually be larger because output and the intermediate import outlay have not substantially dropped. More specifically, the leftward shift of GG_0 to GG' reduces the size of the CA deficit at A, by improving the trade balance (via increased competitivenes). However, the larger shift of CA_Y' (relative to that of CA_Y* in Figure ($2a_1$)) tends to offset that effect: in fact, when α_3 is negative because ψ_2, $\eta_2 \rightarrow 0$, β_3 is small in absolute value because $\lambda \rightarrow 0$. Hence it is perfectly possible for the initial deficit in Figure ($2a_1$) to be the same as, or smaller than, that implied by Figure ($2a_2$), despite the fact that domestic prices increase in the short run.

Consider next the behaviour of the system over time. On the assumption that no further changes in the foreign interest rate occur, the adjustment path will be along the GG curve. Along GG* in Figure ($2a_1$), competitiveness improves (as p is falling) and b rises. The falling p and the rising b will gradually eliminate the initial CA deficit, ensuring convergence to the steady-state (at point C).

IIIc. *The Dynamic Behaviour of the System Under 'Default-Risk'*

Let us now examine the behaviour of the system over time, when loans to domestic residents are not considered to be free of default-risk and hence are regarded by foreign investors as imperfect substitutes for other assets.

From equations (6a) and (2a) of Section II, it can be observed that an non-zero ξ in the foreign-capital supply function (5a) will influence the dynamics of the system through two main channels. Firstly, in addition to raising the debt-service payments at an unchanged interest-rate, a given increase in the home country's debt b will also worsen the service balance by affecting r and thereby raising the unit cost of debt-servicing. Secondly, an exogenous increase in the stock of the debt, by raising r and hence the cost of the foreign capital used to finance primary inputs from abroad, will have an adverse effect on domestic production. Given the level of demand, this will tend to put upward pressures on domestic prices.

In terms of equations ($10a_1$) and ($10a_2$) of Section IIIb, the above observations have two implications: (i) A non-zero value of ξ increases the likelihood that an exogenous rise in b will on balance worsen the CA at the initial level of p. That is, as long as $\beta_3 > 0$, when $\xi \neq 0$, the sign of the coefficient of b in ($10a_2$) is most likely to be positive. (ii) If $\alpha_3 > 0$, a value of ξ sufficiently large is conceivable to give rise to a positive relationship between changes over time in b and changes in p. That is, the sign of the coefficient of b in equation ($10a_1$) is possible to be negative. What (i)-(ii) suggest, in turn, is that, in the context of this model, a low degree of imperfect asset substitutability can lead to dynamic instability.

Figures (3)-(4) can be used to illustrate the potential implications of a non-zero value of ξ in the foreign-capital supply function (5a) for the dynamic behaviour of the home economy.

Both in Figure (3) and in Figure (4), the CA_Y schedule is drawn as a downward-sloping curve. As noted above, when $\xi > 0$, an exogenous increase in the home country's debt is most likely to create a current account deficit. To maintain CA balance it will have to be accompanied by an improvement in competitiveness and, hence, by a drop in the prices of home goods. Thus, all points to the right of CA_{Y_0} correspond to a current account deficit. All points to the left of CA_{Y_0} reflect a current account

Dynamic adjustment with debt-default risk

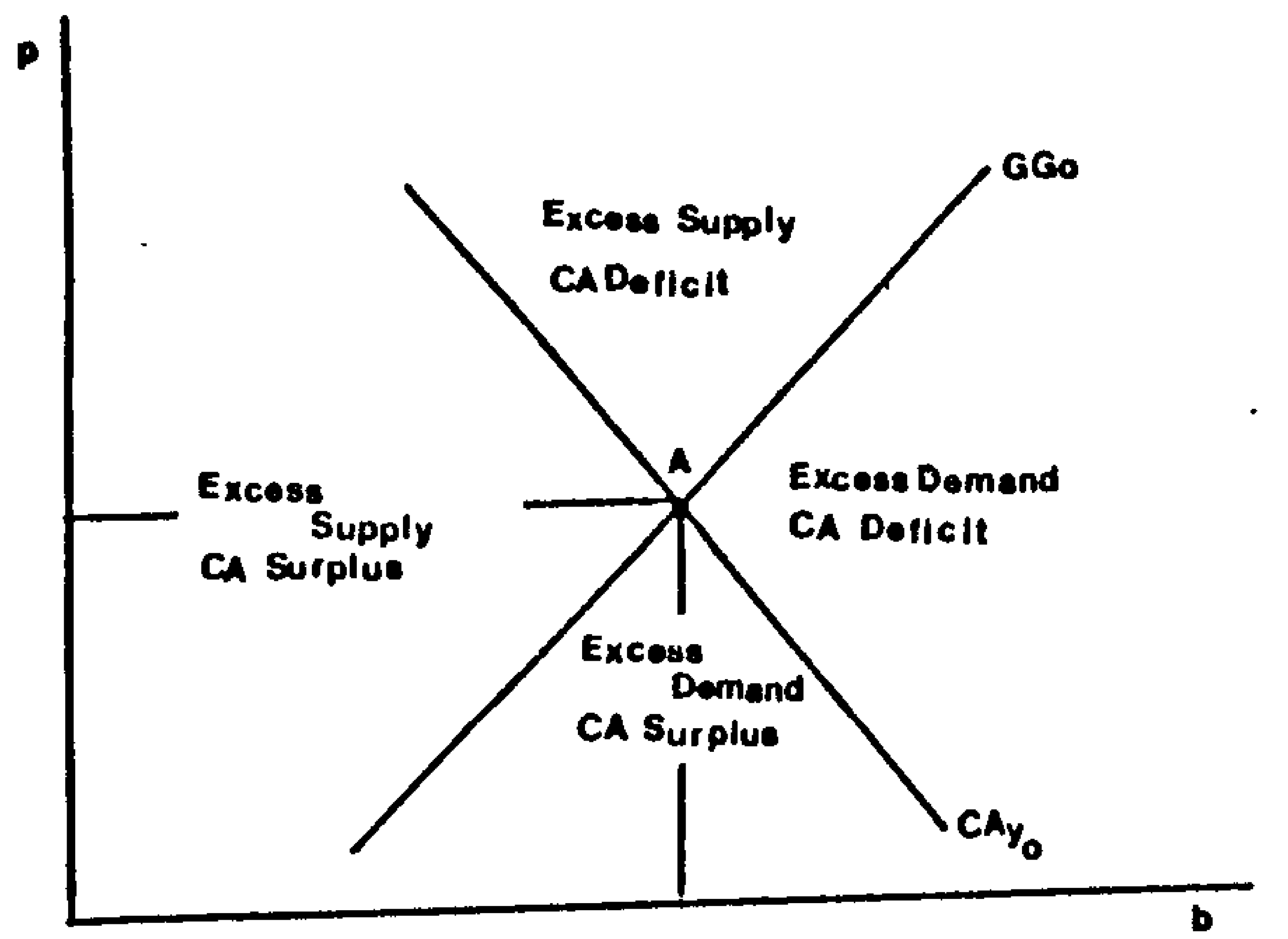


Fig. 3

$(\alpha_2 - \xi\alpha_3) < 0$

$(\beta_2 - \xi\beta_3) < 0$

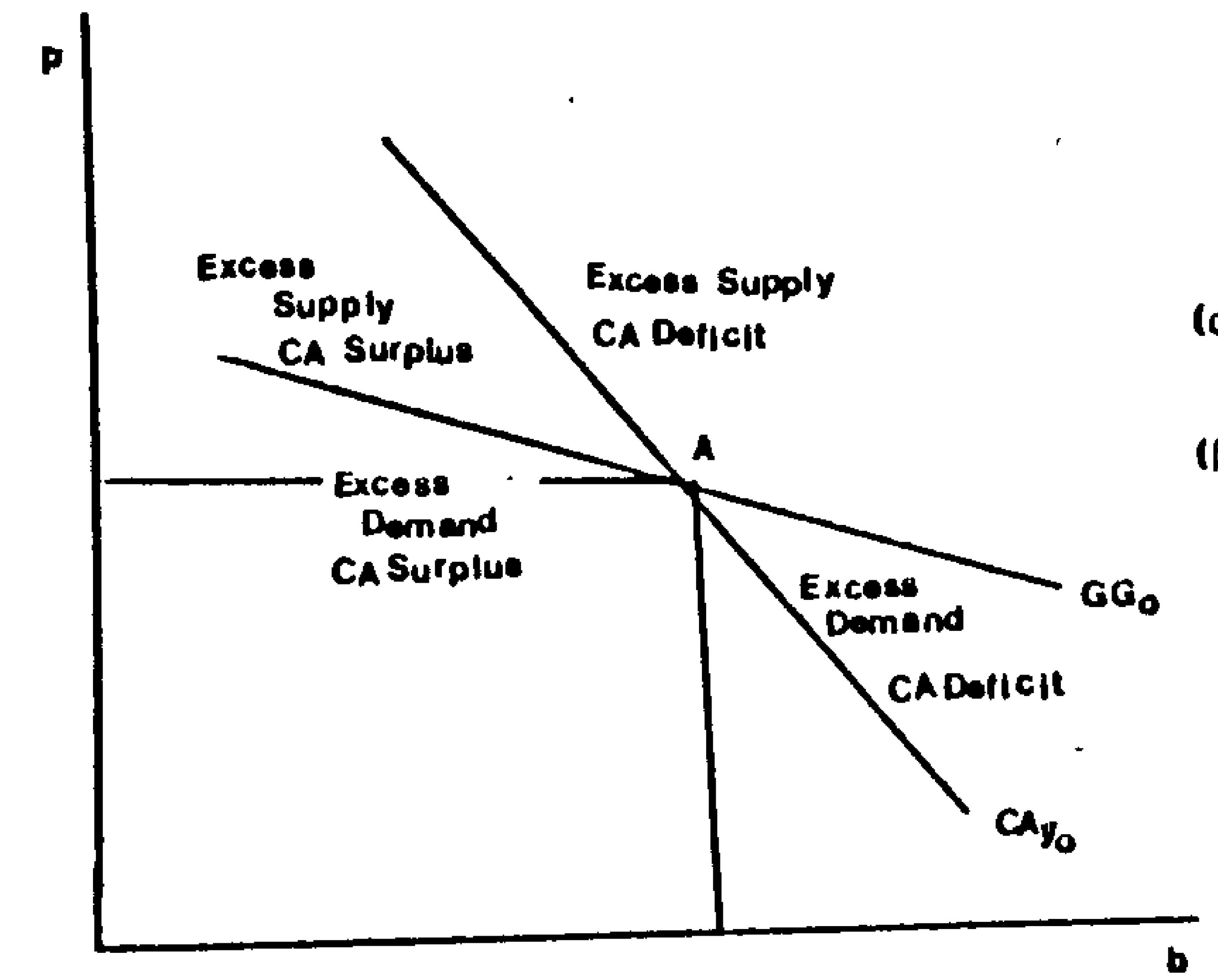


Fig.4

$(\alpha_2 - \xi\alpha_3) > 0$

$(\beta_2 - \xi\beta_3) < 0$

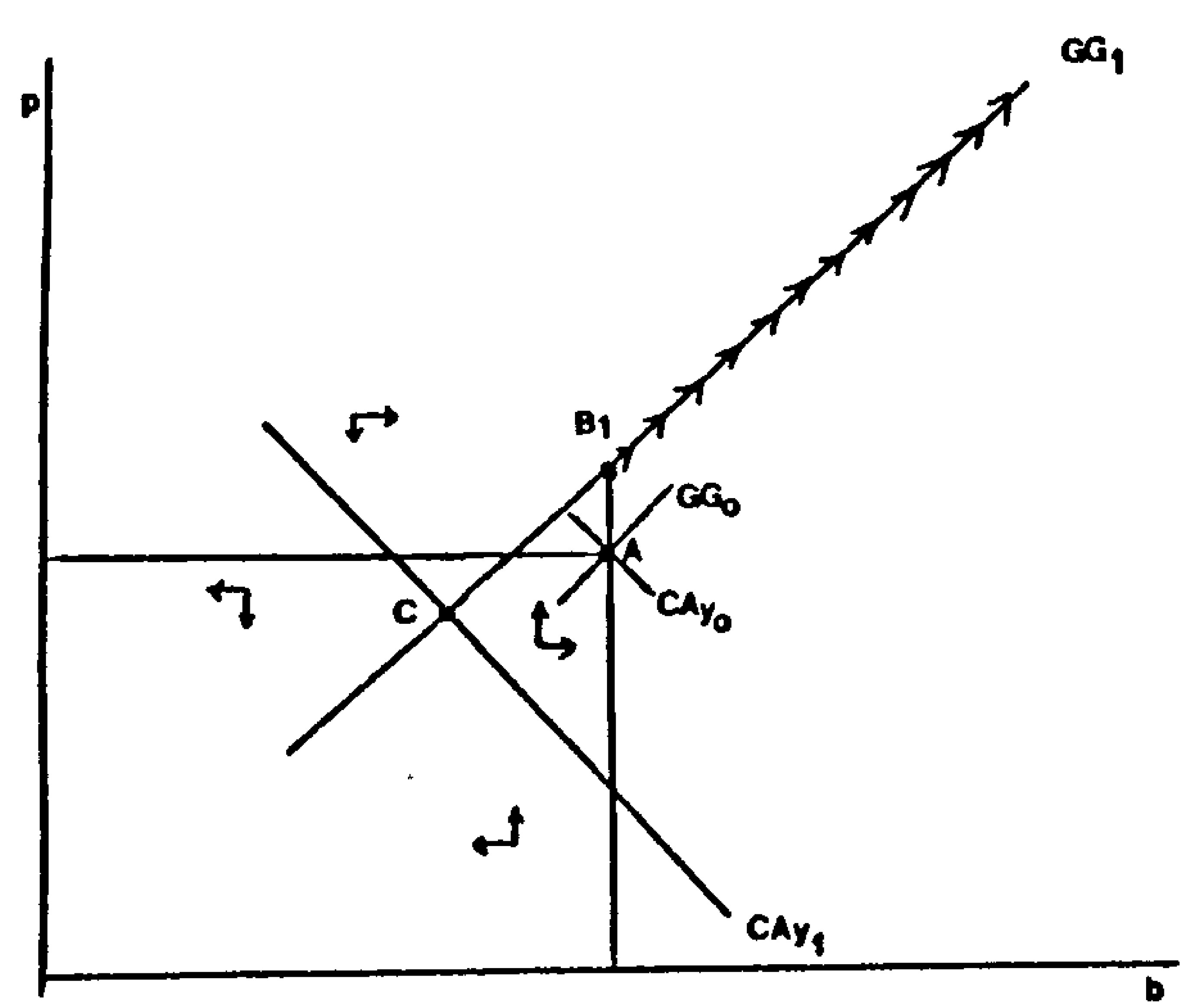


Fig. $3a_1$

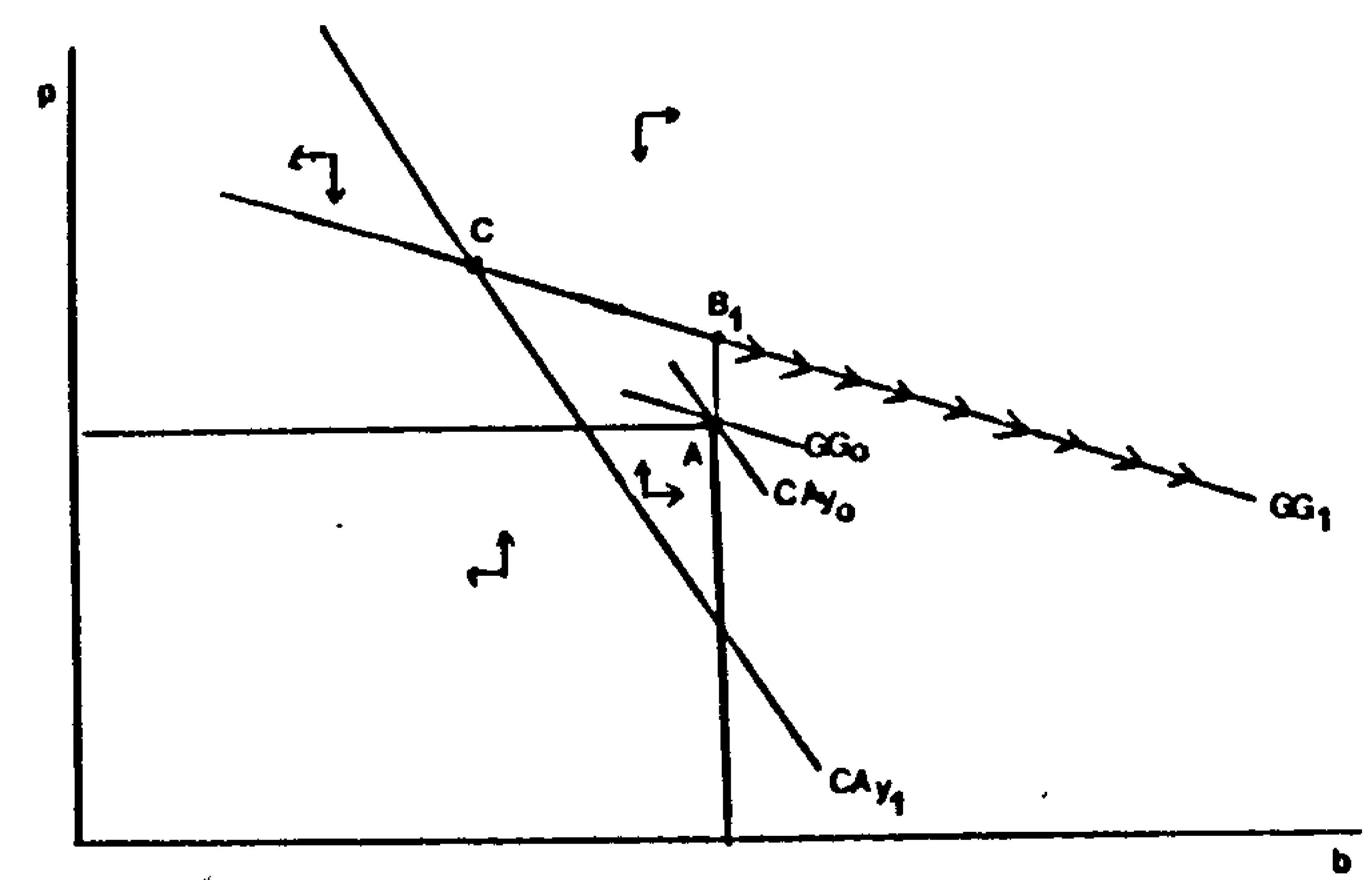


Fig. $4a_1$

surplus.

In Figure (3), the GG schedule is drawn as an upwards-sloping curve. GG_0 illustrates the possibility of a low degree of asset substitutability and of a strong effect of changes in foreign interest-rates on domestic output supply - i.e. the case where $(\alpha_2-\xi\alpha_3) < 0$. In Figure (4), the GG_0 curve is assumed to be negatively sloped but is taken to be flatter than the CAy_0 schedule. Here the relative positions of the schedules GG_0 and CAy_0 reflect the possibility of a large (positive) value of $-(\beta_2-\xi\beta_3)$, i.e. the case when an exogenous increase in the stock of the debt creates a large CA deficit. In that case, the drop in domestic prices required to maintain CA balance following an increase in b may exceed the drop required to preserve goods market equilibrium.

Consider an initial equilibrium at point A in Figures $(3a_1)$-$(4a_1)$, and assume an unanticipated increase in the foreign interest rate r*. The schedules that are drawn correspond to the new (higher) value of r*, and their position follows from our assumptions about the signs and sizes of β_3 and α_3 in Figure $(2a_1)$ of Section IIIb. Hence short-run equilibrium can be described by point B_1. Consider the dynamic behaviour of the system in Figures $(3a_1)$-$(4a_1)$. Along the GG_1 schedule in Figure $(3a_1)$, both b and p are rising. As a result, over time the CA deteriorates. Along the GG_1 schedule in Figure $(4a_1)$, p is falling. However the deficit is growing, because the effect of the improvement in competitiveness on the TB is more than offset by the effect of the rising debt-service payments on the SB. In both figures, the home country's debt grows over time at an increasing rate, and this causes the system to move further away from equilibrium at C: in effect, with a low degree of substitutability of loans to domestic residents and other assets in the foreign investors' portfolios, an initial rise in r* can lead to rising debt-service obligations for the home country and to a debt accumulation process.

More formally, when $\xi \neq 0$, the dynamics of the model can be described by

$$\dot{b} = - \{(\beta_2-\xi\beta_3)+(\alpha_2-\xi\alpha_3)(\beta_1/\alpha_1)\}b + (\alpha_1\beta_3+ \beta_1\alpha_3)r^*$$

Dynamic stability requires that

$$\Delta'' = (\alpha_2\beta_1+\alpha_1\beta_2) - \underbrace{\xi(\alpha_1\beta_3+\alpha_3\beta_1)}_{\xi\Delta^o} > 0 \qquad (10d_1)$$

The first term in ($10d_1$) can be expected to be positive as it corresponds to the stability condition ($10b_3$). When $\xi \neq 0$, however, an important component of the stability condition ($10d_1$) is the second term i.e. the term denoted $\xi\Delta^o$. Since from equation ($10c_1$*) Δ^o is positive, it follows that, in the context of this model, a low degree of asset substitutability can, in general, cause dynamic instability.

At this point, it should be noted that when U.S. interest rates started to rise in 1981-83, interest rate spreads and fees on rescheduled and new bank loans to DCs increased considerably. For example, the spread above LIBOR charged on new debts was 2 and $^7/_8$ percentage points in 1983 - that is, 1.7 percentage points higher than the typical spread in 1978-80. The banks justified these interest-rate increases on the grounds of increased risks (associated with their already substantial exposure to developing countries and with the fact that the willingness and ability of some DCs to service their past (bank) debts was in doubt). However, in mid-1984, spreads on rescheduled and new loans to heavily indebted DCs (including Brazil, Venezuela and Mexico) were reduced to a range of $^7/_8$ to 1 percentage points. The banks also reduced or eliminated their fees.

Our analysis suggests that the banks soon realize the potential implications of high spreads and risk-premiums on loans to DCs under circumstances of rising international interest-rates: given that under such circustances high risk premiums can lead to growing debts and hence growing debt-service payments, they are likely to reinforce the borrowers' incentives to stop servicing their debts. As a result, they can make the debts poorer assets and hence can be self-defeating.

IV. *Effects of Foreign Interest-Rate Increases With Capital Accumulation*

IVa.

To what extent might the behaviour of the system change if investment is non-zero? To this question we now turn by re-considering the model with $\dot{k} \neq 0$. As in Section IIIb, we ignore the possibility of capital requirements for wage payments and assume the interest parity variant of equation (1a).

With $\dot{k} \neq 0$, the reduced form model is given by

$$r = r^* + \xi b \tag{5a}$$

$$\dot{k} = - \delta_1 k - \delta(r - \dot{p}^e) \tag{7a$_1$}$$

$$p = - \frac{1}{\alpha_1} \{\alpha_2 b + \alpha_4 k - \delta \dot{p}^e - (\alpha_3 - \delta) r\} \tag{11a}$$

$$\dot{b} = \beta_1 p - \beta_2 b + \beta_4 k + \beta_3 r \tag{12a}$$

where

$\alpha_4 = \upsilon + \delta_1$ (>0)

$\beta_4 = \kappa_2 + \psi_4 \lambda_1 > 0$

$\upsilon = \psi_4 \epsilon - \kappa_1$ (>0)

Consider equations (11a) and (12a). The coefficients α_1, α_2, α_3, β_1, β_2 and β_3 are identical to those appearing in equations ($10a_1$)-($10a_2$) of Section IIIb. The assumption that α_4 is positive corresponds to the proposition that an exogenous increase in physical capital will reduce the amount of excess demand in the goods market and, as a result, will lower prices. As can be seen from equations (2a) and (4a) of Section II, higher capital leads to an increase in production and to a drop in investment and, hence, creates an excess supply of home goods. At the same time, it leads to an increase in real wealth which tends to raise demand. Given the existing empirical evidence about the probable values of the individual terms in υ [12], a positive sign for α_4 can be postulated. The coefficient β_4 reflects the effect of an exogenous change in the capital stock on the CA. Other things being equal, an increase in fixed-capital will raise the demand for imports by increasing wealth and output. This will worsen the CA. Thus, $\beta_4 > 0$.

Consider the properties of the steady state. The steady-state is here attained when $\dot{k} = 0$, when the CA is in balance ($\dot{b} = 0$), and when the goods market is in equilibrium with $\dot{p}^e = 0$. Imposing these conditions, (5a), ($7a_1$) (11a) and (12a) yield

$$\begin{bmatrix} \delta_1 & 0 & 0 & \delta \\ \alpha_4 & \alpha_1 & \alpha_2 & -(\alpha_3-\delta) \\ -\beta_4 & -\beta_1 & \beta_2 & -\beta_3 \\ 0 & 0 & -\xi & 1 \end{bmatrix} \begin{bmatrix} \tilde{k} \\ \tilde{p} \\ \tilde{b} \\ \tilde{r} \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ \tilde{r}^* \end{bmatrix} \tag{13}$$

(13) gives a solution for the steady-state change in the stock of capital, the stock of the debt and the domestic price level as follows

$$d\tilde{k} = -\frac{\delta}{\delta_1\Delta_1}\{\beta_2\alpha_1 + \alpha_2\beta_1\}dr^* < 0 \qquad (13a_1^*)$$

$$d\tilde{b} = \frac{1}{\Delta_1}[(\beta_3\alpha_1 + \alpha_3\beta_1) + \pi_1]dr^* \ (>0) \qquad (13a_2^*)$$

$$d\tilde{p} = \frac{1}{\Delta_1}[\alpha_3\beta_2 - \alpha_2\beta_3) + \pi_2]dr^* \ (>0) \qquad (13a_3^*)$$

where

$$\pi_1 = \frac{\delta}{\delta_1}\{\upsilon\beta_1 - \alpha_1\beta_4\} \gtrless 0$$

$$\pi_2 = \frac{\delta}{\delta_1}\{\alpha_2\beta_4 + \beta_2\upsilon\} \ (>0)$$

The term Δ_1 represents the determinant of the coefficient matrix of (13). As we show below, Δ_1 must be positive if the system is to be dynamically stable. Accordingly, equation ($13a_1^*$) indicates that the capital stock will fall in the new steady state. Equation ($13a_3^*$) implies that, with endogenous capital, the effect of the rise in the foreign interest-rate on the long-run level of domestic prices is most likely to be positive. This is so because the price-increasing effects of a higher value of r*, which are reflected in the possibility of a positive coefficient α_3, are now reinforced by the reduction in the supply of output that results from the lower steady-state capital stock - i.e. the new term π_2 is almost certainly positive. In ($13a_2^*$), the increase in the stock of the debt will in fact exceed that implied by equation ($10c_1^*$) of Section IIIb if π_1 is positive. This expression reflects the effect of the long-run change in the capital stock on the CA. As in the steady-state $\dot{k} = 0$, a unit decrease in the stock of capital will raise the prices of home goods by υ/α_1 units and, hence, will worsen the CA by $\beta_1(\upsilon/\alpha_1)$ units. At the same time, it will cause a reduction in domestic wealth and output which, through a fall in imports, will improve the CA by β_4 units. If the former effect dominates (so that $\{\beta_1(\upsilon/\alpha_1) - \beta_4\} > 0$), π_1 will be positive. In this case, then, the rise in the long-run level of the home country's indebtedness will have to be larger than that implied by ($10c_1$*) of Section IIIb to weaken private spending sufficiently to restore CA equilibrium in the long run.

To examine the stability properties of the system, it is convenient to write the model in matrix form:

$$\begin{bmatrix} \dot{b} \\ \dot{k} \\ \dot{p}^e \end{bmatrix} = \begin{bmatrix} -\beta_2' & \beta_4 & \beta_1 \\ \alpha_2' & \upsilon & \alpha_1 \\ (\delta\xi+\alpha_2')\delta^{-1} & \alpha_4\delta^{-1} & \alpha_1\delta^{-1} \end{bmatrix} + \begin{bmatrix} \beta_3 \\ -\alpha_3 \\ -(\alpha_3-\delta)\delta^{-1} \end{bmatrix} r^* \quad (14)$$

where

$$\beta_2' = \beta_2 - \xi\beta_3$$

$$\alpha_2' = \alpha_2 - \xi\alpha_3$$

Suppose, for example, that expectations about prices are forward looking. If p is forward-looking, unique convergence will require the equilibrium to be a saddle-point. That is, (14) must have one positive root (associated with p) and two negative roots (associated with b and k). A necessary condition for (saddle-point) stability is the determinant of the state matrix of (14) to be positive. This is the case when:

$$\Delta_1 = (\alpha_2\beta_1+\beta_2\alpha_1) - \xi[(\beta_3\alpha_1+\alpha_3\beta_1) + \pi_1] > 0 \qquad (14a)$$

The stability condition ($10b_3$) of Section IIIb implies that the first term in (14a) will be positive. Given our earlier discussion of the long-run properties of the system, the second term in the bracketed expression can also be expected to be positive. Thus, even when $\dot{k} \neq 0$, in the context of this model, a low degree of substitutability of claims on home residents and other assets in the foreign investors' portfolios can cause dynamic instability (by introducing the possibility that $\Delta_1 < 0$).

Let us now consider the characteristics of the short run and of the dynamic adjustment path, ignoring imperfect substitutability (by setting $\xi = 0$). Also, let us assume long-run foresight expectations, that is

$$\dot{p}^e = v(\tilde{p} - p) \tag{15a}$$

where $\tilde{p}$ is the long-run equilibrium price level (assumed to be known by private agents) and v is the expectations adjustment coefficient.

Using (15a), we can obtain from (14) the following expression for the initial change in domestic prices:

$$dp(o) = \frac{1}{(\alpha_1+\delta v)} \{(\alpha_3-\delta)dr^* + \delta v d\tilde{p}\} \tag{15b}$$

Equation (15b) suggests that even when $\dot{k} \neq 0$, prices may increase in the short-run. The drop in investment expenditure (which results from the rise in the nominal borrowing rate r) reinforces the demand-reducing effects of the increase in the foreign interest rate, thus lowering p(o) by an amount proportional to δ. But the expectation of future price increases (due to the future decline of the capital stock and, hence, the higher level of prices in the longer-run) lowers the real borrowing rate $(r - \dot{p}^e)$. This tends to reduce the drop in demand, raising p(o) by an amount proportional to $v\delta d\tilde{p}$. Thus, the introduction of capital accumulation in the model may affect the size of the initial price change. However, as long as $\alpha_3 > 0$, it cannot rule out the possibility that $dp(o) > 0$.

Using (15a), the model can be described by a system of two differential equations in b and k:

$$\begin{bmatrix} \dot{b} \\ \dot{k} \end{bmatrix} = \frac{1}{(\alpha_1+v\delta)} \begin{bmatrix} -\omega_{11} & -\omega_{12} \\ \omega_{21} & -\omega_{22} \end{bmatrix} \begin{bmatrix} b \\ k \end{bmatrix} + \begin{bmatrix} \omega_{13} \\ -\omega_{23} \end{bmatrix} \tag{16}$$

where

$$\begin{aligned}
\omega_{11} &= \{\beta_1\alpha_2 + \beta_2(\alpha_1+\delta v)\} > 0 \\
\omega_{12} &= \{\beta_1\alpha_4 - \beta_4(\alpha_1+\delta v)\} \ (> 0) \\
\omega_{21} &= v\delta\alpha_2 > 0 \\
\omega_{22} &= [\delta_1(\alpha_1+v\delta) - v\delta\alpha_4] \ (>0) \\
\omega_{13} &= \{[\beta_3\alpha_1 + \beta_1(\alpha_3-\delta)]\tilde{r}^* + v\delta(\tilde{p} + \beta_3\tilde{r}^*)\} \gtrless 0 \\
\omega_{23} &= \delta\{\alpha_1\tilde{r}^* + v(\alpha_3\tilde{r}^* - \alpha_1\tilde{p})\} \ (> 0)
\end{aligned} \tag{16a}$$

The two equations in (16) are plotted in Figure (5). The KK schedule shows the combinations of the capital stock and the stock of the debt which are consistent with $\dot{k} = 0$. An increase in the capital stock is most likely to lower capital accumulation (via reduced investment) and must be accompanied by a drop in the real cost of borrowing to maintain $\dot{k} = 0$. Given the price expectations scheme (15a), this can be achieved through a reduction in the current level of prices relative to their steady-state level and, hence, through a drop in spending and an increase in indebtedness. Thus, the slope of the KK schedule (given by $db/dk = \omega_{22}/\omega_{21}$) is positive.

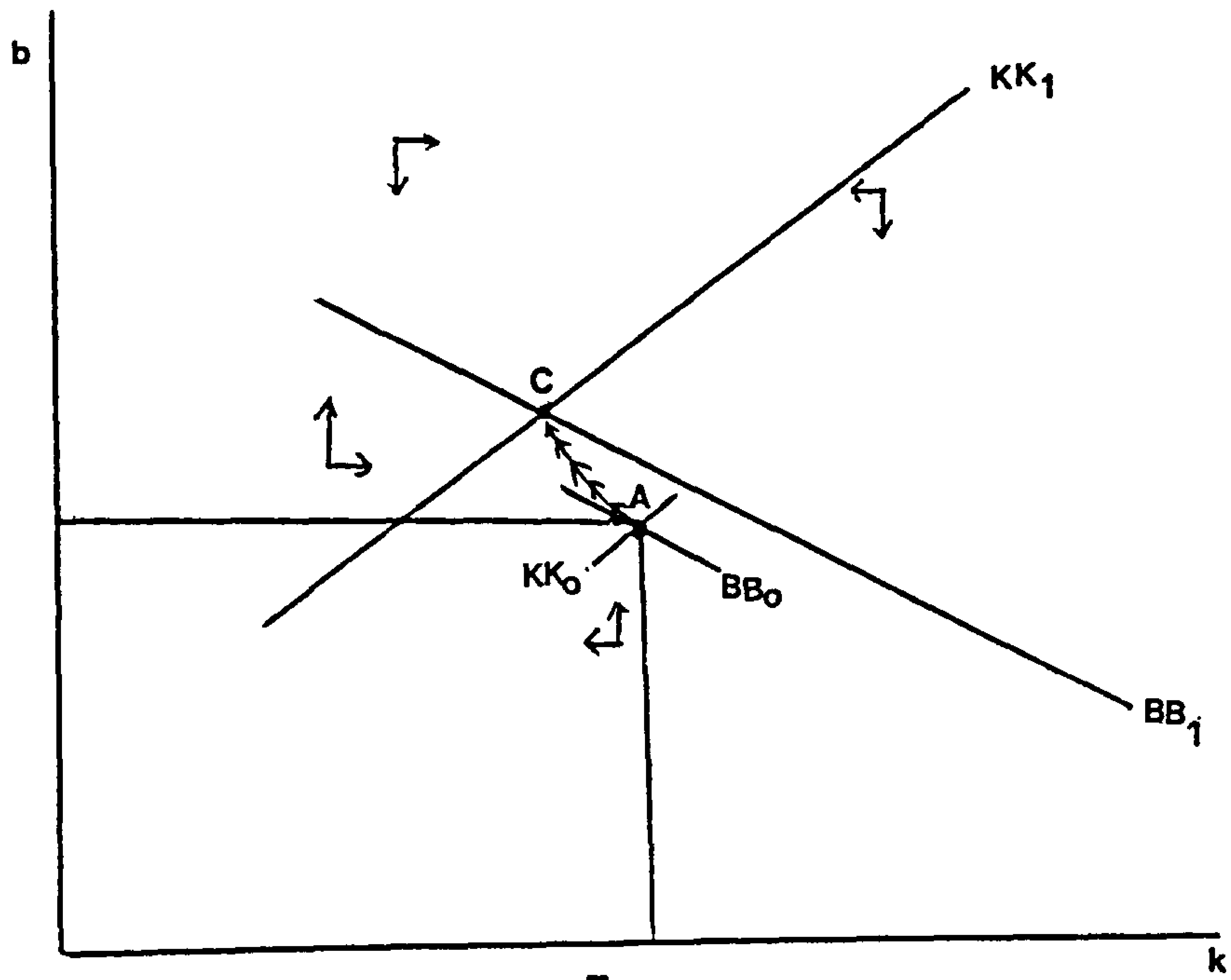


Fig.5a1

$\omega_{13} > 0$

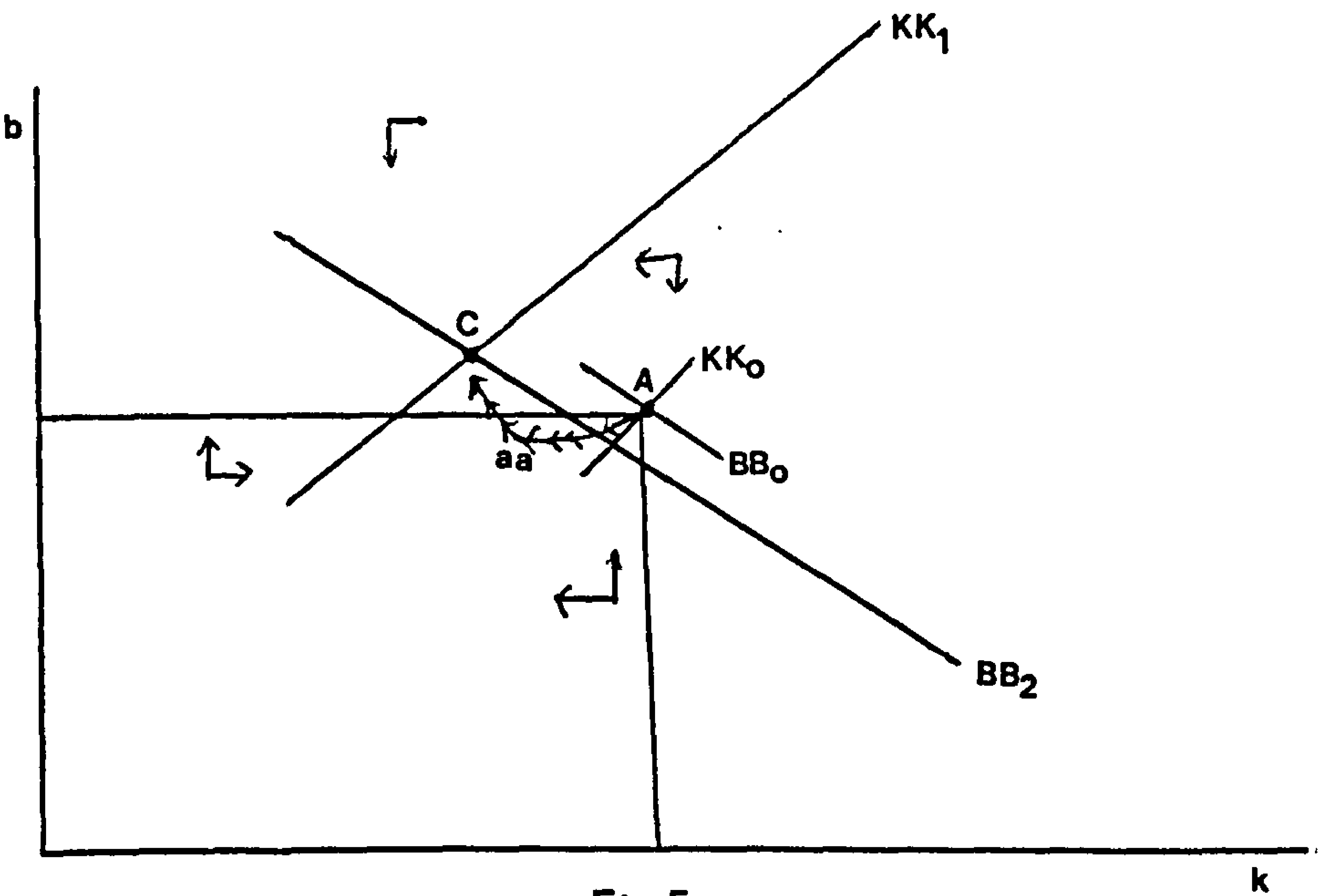


Fig.5a2

$\omega_{13} < 0$

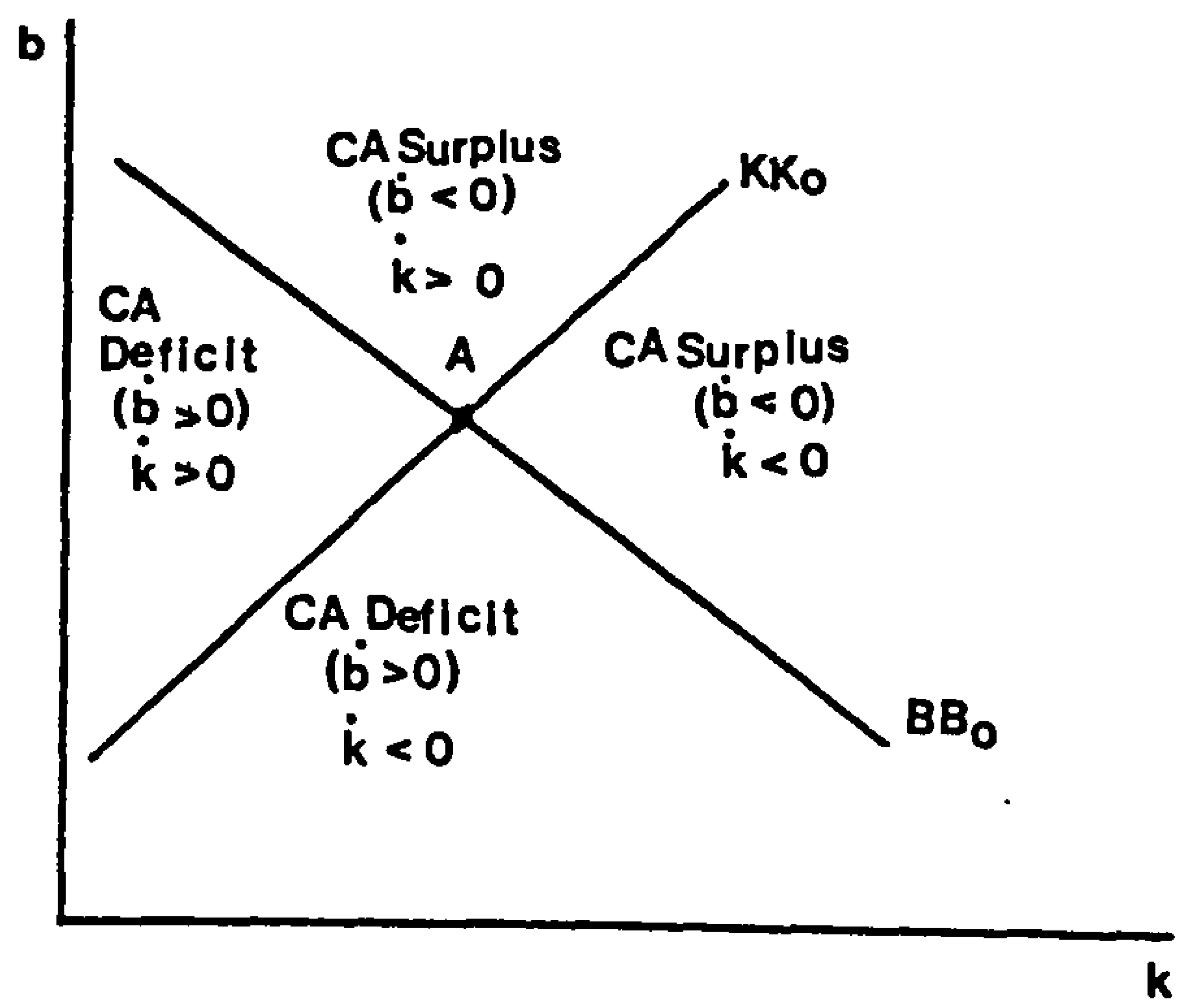


Figure 5

The BB locus describes the combinations of the capital stock and external debt that preserve CA balance and maintain goods market equilibrium. As can be seen from (16), the slope of this locus is $db/dk = -\omega_{12}/\omega_{11}$. It will be negative when $\omega_{12} > 0$ - i.e. when an increase in the capital stock (via increased production, reduced investment expenditure,and hence lower prices of home goods) leads to more additional exports than imports and, therefore, improves the CA. Such is the situation shown in Figure (5), where the BB schedule is drawn as a downward-sloping curve. The region above BB is characterized by a CA surplus, while the region below BB corresponds to a CA deficit.

Let us consider the effects of an unanticipated once-and-for-all increase in the foreign interest r*, using Figure (5a). Given the positive relationship between the sign of α_3 and the sign of $\tilde{p}$, the coefficient ω_{23} can in general be taken to be positive. Accordingly, the rise in r* will cause the KK_0 schedule to shift up and to the left (to a position occupied by KK_1). The BB_0 schedule may in principle shift either way, depending on whether ω_{13} in (16 a) is positive or negative. In the case shown in panel (a_1), where $\omega_{13} > 0$, the BB_0 schedule will shift up and to the right, to a position such as that described by BB_1. In this case, the increase in r* will on impact lead to a CA deficit as well as to a fall in the rate of capital accumulation. In the case shown in panel (a_2), where $\omega_{13} < 0$, the BB_0 locus will shift to the left of its position at A. Hence, the CA will initially move into surplus. As in panel (a_1), however, there will be drop in the rate of investment.

Two features of Figure (5a) are worth noting. First, in the case shown in panel (a_2), the initial drop in the rate of debt accumulation will soon be reserved as the decline in the capital stock will drive up domestic prices (by lowering domestic production): i.e. the adjustment path is most likely to be along aa, from point A to point C. Second, despite the fact that here prices may increase in the short-run, the CA will initially be affected by the change in the foreign interest-rate as in a 'standard' model: because the size of β_3 will be relatively small and $\tilde{p}$ relatively large if the coefficient α_3 is positive, the sign of ω_{13} is unlikely to differ from that of standard open-economy models.

VI.b.

To illustrate the similarities and the differences between the behaviour of this economy and the behaviour of what can be regarded as a 'stardard' open economy, in this final section we solve numerically the model under alternative assumptions about some of its parameter values.

The assumed values for the parameters of the system are given in Table (1):

TABLE (1)

Parameter Values and Initial Conditions

$\delta = \delta_1 = .2/.25/.3/.5$

$\gamma_1 = .6,\ \gamma_2 = .2,\ \kappa_1 = .06,\ \kappa_2 = .02$

$a = .8,\ \sigma + x_1 = .1,\ \tau_3 = (1-\tau_1-\tau_2) = .45$

$\lambda_3 = .5,\ \psi = 0,\ F^{-1} = \infty$

$\overline{Y} = \overline{P} = \overline{E} = \overline{W} = 1,\ \overline{K} = 1.5,\ \overline{H}^n = 0,\ \overline{C}_2 = .1$

$\overline{B} = .3,\ \xi = 0,\ \overline{r}* = .04$

Model-1	Model-2	Model-3
$\tau_1 = \overline{N} = .25$	$\tau_1 = \overline{N} = .15$	$\tau_1 = \overline{N} = .05$

We have considered three variants of the model, depending on how important the foreign inputs N are for domestic production: in Model-1, we have assumed that $\tau_1 = .25$, $\bar{N} = .25$; (ii) in Model-2, we have set $\tau_1 = .15$, $\bar{N} = .15$; and (iii) in Model-3, we have assumed that $\tau_1 = .05$, $\bar{N} = .05$. The elasticity of output with respect to changes in fixed-capital is taken to be 45 percent, in all the variants of the model. Hence the requirement that τ_1, τ_2 and τ_3 must sum to unity is met by adjusting τ_2 - the elasticity of output with respect to the factor L. The initial outstanding debt of the home country is taken to be 30 percent of its initial GDP, while the initial value of the foreign interest-rate r* is set equal to 4 percent. Forward-looking expectations have been assumed in all the solutions, and equation (8a) has been included in the model.

Table (2) shows the short-run response of prices, of output and of the CA to an (unanticipated) increase in r* by 5 percent.

It is clear from the table that the size of τ_1 is crucial in determining the impact effect of the increase in the foreign interest-rate on domestic prices. A large value of τ_1 either leads to a positive initial change in domestic prices or reduces substantially the size of the short-run decrease in p. In Model-1, for example, prices initially rise when $\delta = .2$ or when $\delta = .25$; they remain roughly unchanged when $\delta = .3$; and they fall only slightly when $\delta = .5$. In Model-3, on the other hand, there is a sharp initial fall in prices irrespective of the sensitivity of investment expenditure to changes in interest rates. Although the size of the short-run decrease in output is negatively related to the value of τ_1, the influence of this parameter on the output response is minor when compared with that on the price response.

However, even when prices rise in the short-run, the current account

TABLE (2)

*Impact effects of a 5% increase in r**
(Percentage deviations from initial equilibrium values)

	Price Level p	Real GDP y	Current Account CA
δ = .2			
Model-1	.34	-2.26	.45
Model-2	- .74	-2.50	.42
Model-3	-2.28	-3.17	.43
δ = .25			
Model-1	.15	-2.48	.63
Model-2	- .97	-2.79	.60
Model-3	-2.59	-3.69	.61
δ = .3			
Model-1	- .02	-2.70	.79
Model-2	-1.18	-3.05	.76
Model-3	-2.86	-4.04	.77
δ = .5			
Model-1	- .59	-3.39	1.33
Model-2	-1.85	-3.87	1.28
Model-3	-3.72	-5.08	1.26

initially moves into surplus. Also, the size of the surplus is very little affected by the extent to which domestic production depends on foreign inputs. In the case where $\delta = .2$, $\delta = .25$ or $\delta = .3$, the surplus is only fractionally smaller in Model-2 than in Model-3; and it is only marginally larger in Model-1 than in Model-3. In the case where $\delta = .5$, the size of the surplus increases only slightly as τ_1, $\overline{N}$ rise.

Tables $(3a_1)$-$(3a_3)$ illustrate the dynamic adjustment of the system to the shock, when $\tau_1 = \overline{N} = .05$ and when $\tau_1 = \overline{N} = .25$.

When $\tau_1 = \overline{N} = .05$ adjustment occurs as follows:

(a) Because of the initial CA surplus, there is a reduction in the net borrowing in 'year' 1. This, by raising income and wealth, leads to an increase in spending and output. However the decrease in the capital stock reduces domestic production and, hence, aggregate supply. Thus, in year 1, prices increase (relative to year 0) and the current account moves into deficit. *(b)* Between years 2 and 4, the domestic price level continues to rise, the capital stock decreases and the debt grows. As a result, output falls further. *(c)* By the fourth year, the increase in the debt has substantially weakened aggregate demand. Thus, after that year, p and w start to fall. However, output continues to decline. *(d)* In the long run, output will be lower than its initial steady-state value (due to the lower capital stock). Prices and wages will also be slightly below their initial steady-state levels.

When $\tau_1 = \overline{N} = .25$, the pattern of adjustment can be described as follows:

(a) The initial CA surplus again leads to a fall in the amount of the new borrowing in year 1. But, in this year, output declines and prices increase substantially. As prices rise, the CA moves into deficit. *(b)* In the case where $\delta = .25$ or $\delta = .3$, prices and wages also rise between years 2

TABLE ($3a_1$)- *Dynamic adjustment to an increase in r* by 5%*
(Percentage deviations from initial equilibrium values)
$\delta = \delta_1 = .25$

Time elapsed ('Years')	Price Level p	Real GDP y	Capital Stock k	External Debt b	Current Account CA	Wages w
			Model-3: $\tau_1 = \bar{N} = .05$			
0	-2.59	-3.7	0	0	.61	0
1/2	-1.71	-2.8	-1.8	- .79	.20	-.89
1	- .77	-2.7	-2.9	- .90	-.07	-.59
1 1/2	- .10	-2.8	-3.6	- .57	-.24	-.21
2	.32	-2.9	-4.1	.01	-.33	.05
4	.65	-3.3	-4.9	2.92	-.34	.33
6	.39	-3.6	-5.0	5.17	-.22	.21
8	.17	-3.8	-5.0	6.40	-.14	.10
∞	- .20	-4.0	-5.0	8.16	0	-.10
			Model-1: $\tau_1 = \bar{N} = .25$			
0	.15	-2.5	0	0	.63	0
1/2	1.24	-2.6	-1.8	- .78	.19	.39
1	1.97	-2.7	-2.9	- .88	-.07	.81
1 1/2	2.42	-2.9	-3.6	- .59	-.21	1.10
2	2.68	-3.0	-4.1	- .08	-.29	1.27
4	2.92	-3.3	-4.9	2.40	-.29	1.46
6	2.82	-3.5	-5.0	4.28	-.19	1.42
8	2.70	-3.6	-5.0	5.30	-.12	1.40
∞	2.55	-3.7	-5.0	7.03	0	1.28

TABLE ($3a_2$)- *Dynamic adjustment to an increase in r* by 5%*
(Percentage deviations from initial equilibrium values)
$\delta = \delta_1 = .3$

Time elapsed ('Years')	Price Level p	Real GDP y	Capital Stock k	External Debt b	Current Account CA	Wages w
			Model-3: $\tau_1 = \bar{N} = .05$			
0	-2.86	-4.0	0	0	.77	0
1/2	-1.73	-2.9	-2.0	- .96	.23	- .93
1	- .65	-2.8	-3.1	-1.08	-.09	- .56
1 1/2	.06	-2.8	-3.8	- .69	-.27	- .14
2	.47	-2.9	-4.3	- .05	-.36	.13
4	.70	-3.4	-4.9	3.03	-.35	.36
6	.39	-3.6	-5.0	5.29	-.22	.21
8	.15	-3.8	-5.0	6.50	-.13	.09
∞	- .20	-4.0	-5.0	8.16	0	- .10
			Model-1: $\tau_1 = \bar{N} = .25$			
0	- .02	-2.7	0	0	.79	0
1/2	1.27	-2.7	-2.0	- .97	.23	.37
1	2.08	-2.8	-3.2	-1.09	-.08	.84
1 1/2	2.54	-2.9	-3.9	- .75	-.24	1.15
2	2.80	-3.0	-4.3	- .18	-.32	1.33
4	2.96	-3.3	-4.9	2.45	-.29	1.48
6	2.82	-3.5	-5.0	4.35	-.18	1.40
8	2.70	-3.6	-5.0	5.40	-.11	1.10
∞	2.55	-3.7	-5.0	7.03	0	1.28

TABLE ($3a_3$)- *Dynamic adjustment to an increase in r* by 5%*
(Percentage deviations from initial equilibrium values)
$\delta = \delta_1 = .5$

Time elapsed ('Years')	Price Level p	Real GDP y	Capital Stock k	External Debt b	Current Account CA	Wages w
			Model-3: $\tau_1 = \bar{N} = .05$			
0	-3.72	-5.1	0	0	1.30	0
1/2	-1.68	-3.1	-2.5	-1.41	.28	-1.01
1	- .30	-2.8	-3.7	-1.47	-.16	- .45
1 1/2	.46	-2.9	-4.3	- .92	-.36	.04
2	.81	-2.9	-4.6	.10	-.44	.31
4	.76	-3.4	-5.0	3.30	-.36	.40
6	.36	-3.7	-5.0	5.52	-.21	.20
8	.24	-3.8	-5.0	6.60	-.12	.08
∞	- .20	-4.0	-5.0	8.16	0	- .10
			Model-1: $\tau_1 = \bar{N} = .25$			
0	- .59	-3.4	0	0	1.33	0
1/2	1.37	-2.9	-2.6	-1.49	.30	.34
1	2.38	-2.9	-3.8	-1.58	-.15	.95
1 1/2	2.84	-3.0	-4.4	-1.07	-.34	1.30
2	3.04	-3.1	-4.7	- .32	-.40	1.47
4	2.99	-3.4	-5.0	2.61	-.30	1.51
6	2.82	-3.5	-5.0	4.49	-.18	1.42
8	2.70	-3.6	-5.0	5.50	-.11	1.40
∞	2.55	-3.7	-5.0	7.03	0	1.28

and 4, and then they fall slightly. As in Model-3, however, output continues to fall, the debt grows and the capital stock decreases over time. *(c)* In the long-run, the stock of the debt will be larger than in the initial steady-state, while output will be below its initial steady-state value. But prices and wages will now be above their previous steady-state levels.

V. *Concluding remarks.*

The purpose of this chapter was to exprore the likely differences between the macroeconomic behaviour of a debtor developing country subsequent to disturbances and the behaviour of what is considered in the literature to be a 'standard' open economy. Although the model presented in the chapter was kept as simple as possible, it suggested some plausible explanations for some of the developments in the economies of the DCs and in the international lending markets during the early 1980s.

Notes.

1. Most of the existing papers on the behaviour of an open-economy, in which the home residents' net foreign asset position is negative, are based on the explicit or implicit assumption that external borrowing is undertaken by "consumers": See e.g. Henderson and Rogoff (1982), Dornbusch (1983c) and Kharas and Shishido (1987).

2. The intermediate import share of GDP typically amounts to 15-25 percent in semi-industrialized (debtor) developing countries: See e.g. Taylor (1981), and Bergsten, Williamson and Cline (1985).

3. See, for example, Dooley and Isard (1980), Edwards (1986) and Frankel and MacArthur (1988).

4. Several studies, and Brookings and World Bank reports, have concentrated on the impact of the industrial countries' macroeconomic policies during the early 1980s on the economies of the DCs. These studies include Cline (1983, 1984), Sachs (1985a, 1986), Dornbusch (1985), Diaz-Alejandro (1983, 1984) and Camdessus (1986).

5. As is well-known, few DCs have large external assets, and most of them peg their currencies to a basket of major international currencies.

6. Government expentidure and investment expenditure are assumed, for simplicity, to fall entirely on home goods.

7. Equation (5) is consistent with a number of recent models of optimal lending which suggest that "default risks" can lead to an upward sloping supply of funds to borrowing countries. Sachs (1984, Ch.II), for example, derives a foreign-capital-supply function of the form we assume here from utility maximizing behaviour of risk-averse banks. Also, Aizenman (1987) and Sachs (1984, Ch.IV) obtain a supply of credit of the form $r = F(r^*,B)$ where $F_2 > 0$, from an optimizing model in which: (i) the borrowing country's incentive to default increases as the size of its debt grows, and (ii) the participants in the lending markets have incomplete information about the likely costs to the

borrowing country of repudiating debts. Moreover, financial models of foreign investment, such as those of Eaton and Turnovsky (1981) and of Dooley and Isard (1980), suggest that default-risks and risk-aversion among rational, fully informed investors will create a risk-premium, thereby causing r in (5) to deviate from r*. For a survey of the theoretical literature on debt-default, see Eaton, Gersovitz and Stiglitz (1986). For empirical evidence on the positive relationship between high debt ratios and large risk premiums on loans to developing countries, see e.g. Edwards (1986).

8. It should be noted that the assumption of a fixed exchange rate and a balanced budget, together with our implicit assumption of no foreign inflation, implies no ongoing domestic inflation. Our model also assumes a non-growing economy. We have made these assumptions to keep the model as simple as possible and to concentrate on foreign borrowing and on the dynamics of debt accumulation.

9. The inclusion of equation (8a) in the model does not alter any of its qualitative characteristics.

10. For a discussion of the 'Laursen-Metzler' effect, see e.g. Svenson and Rasin (1983).

11. With $(1-a) \neq 0$ and $\bar{H}^n \neq 0$, the solution for $d\tilde{b}$ is given by

$$d\tilde{b} = \frac{1}{\Delta}\{(1-\gamma)[(\bar{B}-\eta_2)q_1 + \psi_2 q_2] + q_{11}{}^*\}\, dr^* \quad > 0$$

where
$$q_{11}{}^* = (1-a)[\bar{C}_1+\bar{C}_2]q_{12}{}^* + q_{13}{}^*\mu_2 \gtrless 0$$
$$q_{12}{}^* = \psi_2[\gamma_2+\eta_1\gamma_1] - (\bar{B}-\eta_2)\gamma_1$$
$$q_{13}{}^* = \psi_2[\epsilon\kappa_2+\kappa_1(1-\gamma_2)+\kappa_1\gamma_2] - (\bar{B}-\eta_2)[\kappa_1(1-\gamma_2)+\gamma_1\kappa_2]$$

The solution for $d\tilde{p}$ is the same as that described by $(10c_2{}^*)$.

12. See, for example, the estimates appearing in Haas and Masson (1986) and in Masson and Knight (1986).

CHAPTER 7

"Variable-Priced" Debt, "Fixed-Priced" Debt and Macroeconomic Adjustment to External Financial Shocks *

* This Chapter extends ideas and findings that first appeared in Zervoyianni (1985a). An earlier version of its present form has been presented at a Staff-Seminar at Edinburgh University.

I. *Introduction.*

Since the large rise in short-term U.S interest rates and the sharp deterioration in the economic performance of the debtor countries (DCs) in 1980-84, several proposals have been made for a reform of the present lending arrangements.

In the crisis period of 1981-83, most of these proposals focused on possible modification in the terms of past bank loans to DCs [1]. More recently, emphasis has been placed on possible changes in the nature of the future lending to the debtor countries. Sachs (1986), for example, has suggested that the (net) capital inflow to DCs may be increased if any new lending is made on the basis of marketable securities purchased by banks, asset funds and private wealth-holders. Williamson (1980) notes that debt in the form of issues of long-term securities may reduce the fluctuations in the DCs' interest payments. Bergsten, Cline and Williamson (1985), on the other hand, point out that measures encouraging new nonbank forms of private long-term lending to DCs may promote the stability of the international financial system. In several other studies, such as Guttentag and Herring (1985) and World Bank (1985), there are also strong suggestions for longer-term finance to DCs, for an increased role of nonbank private institutions in the lending process and for a greater 'securitization' of the lending.

In this chapter, we attempt to investigate formally the macroeconomic implications of these recent lending proposals for the borrowing countries. For this purpose we examine the effects of changes in foreign interest rates on the economy of a DC, under two assumptions about the nature of its external debt: "variable-priced" debt (VPD) - i.e. debt in the form of long-term bond issues; and "fixed-priced debt" (FPD) - i.e. debt in the form of loans at floating short-term interest rates. In the literature, to date, there is no study analysing formally the likely implications of VPD for the macroeconomic behaviour of the DCs subsequent to external shocks. In evaluating any alternative lending options, however, one must explicitly consider how the economies of the debtor countries might be affected by any change in the nature of the instrument through which lending takes place. This issue is considered in the chapter.

The structure of the chapter is as follows. In Section II we modify the model presented in Chapter 6 to incorporate the possibility of VPD as a source of external finance. In Sections IIIa and IIIb, we examine the characteristics of this model. It is shown that 'variable-priced' debt is, in general, associated with three effects: an "expectation" effect, a "wealth- revaluation" effect" and an "asset-revaluation" effect. In Section IV, we proceed to investigate how these three effects might influence the response of the home economy to external shocks. Section IVa demonstrates that VPD may reduce or increase the short-run sensitivity of domestic output, of prices and of the current account to changes in foreign interest-rates, depending on the 'initial conditions' of the home country (i.e. the initial size of its overall indebtedness and its initial VPD/FPD ratio). In Section IVb the behaviour of the model is analysed numerically, under alternative assumptions about the initial conditions of the domestic economy and the nature of the foreign disturbances. Our results suggest: (a) that the various stages in the process of greater 'securitization' of the lending to DCs are likely to have sharply different implications for the behaviour of their economies subsequent to external financial shocks; and (b) that both the macroeconomic and the "welfare" effects of variable-priced debt can be expected to be highly sensitive to the particular characteristics of the external disturbances. Section V contains concluding comments.

II. *Setting Out the Model: Wealth, Income, Borrowing Rates and the Current Account With 'Variable-Priced' Debt.*

Instead of assuming that all lending to the home country is in the form of foreign loans which are offered at a short-term rate r, we shall postulate that external borrowing by domestic residents can also be undertaken through the issue of long-term bonds. For simplicity, we shall take the bonds to be perpetuities, paying a constant flow of dividends equal to one unit of foreign currency [2]. Thus, we can express the price of each bond, P_b, and the total issues of bonds, B_2, as follows:

$$P_b = 1/R$$

$$B_2 = AP_b = A/R$$

where R denotes the interest rate associated with the bonds and A denotes the number of bond issues.

Accordingly, equations (4.2) and (4.3) of the model specified in Chapter 6 will be replaced by (4.2') and (4.3'):

$$H_1 = (H^n + PK)/P_c, \quad Y_1 = (PY_D)/P_c, \quad P_c = P^a EP^{(1-a)} \tag{4.1}$$

$$\begin{aligned} H^n + PK &= D^g - EB + PK \\ &= D^g - E(B_1 + B_2) + PK \\ &= D^g - E(B_1 + AP_b) + PK \\ &= D^g - E(B_1 + A/R) + PK \end{aligned} \tag{4.2'}$$

$$Y_D = PY - EP^*N - E(B_1r + A) \tag{4.3'}$$

where

H_1 = real wealth

Y_1 = real (disposable) income

$H^n + PK$ = total nominal wealth

H^n = net financial wealth

K = the domestic capital stock

P = the price of domestic output

D^g = the home-government debt (held by the Monetary Authorities)

Y_D = nominal disposable income

Y = real domestic output

N = the quantity of imported intermediate inputs

P^* = the (exogenously given) foreign price level

E = the exchange rate (taken to be fixed)

P_c = the domestic price index

Equations (4.2') and (4.3') define, respectively, the nominal wealth and the nominal (disposable) income of the domestic residents. B is the total (nominal) debt of the home country, B_1 is the nominal value of the foreign loans, while B_2 is the nominal value of the bond issues. Hence, B_1 and B_2 can be taken to represent, respectively, the "fixed-priced" debt (FPD) and the "variable-priced" debt (VPD) of the home country.

Similarly, the current-account equation (6) of Chapter 6, will be replaced by (6')

$$E(\dot{B}_1 + \dot{A}P_b) = E(\dot{B}_1 + \dot{A}_{/R}) = -TB + E(B_1r + A) \tag{6'}$$

where TB denotes the trade balance (surplus).

Our assumption about asset choices in the rest of the world will be very simple. We shall postulate that foreign residents can allocate their wealth between claims (B_1) and (B_2) on domestic residents, and holdings of a foreign asset that yields a return equal to the foreign short-term rate r* (which we treat as exogenous). One can easily introduce into the model both short-term and long-term foreign assets separately. There is however little gain from doing so, provided that the expected return on these two assets is equated through perfect arbitrage (an assumption we make [3]). For simplicity, we shall therefore ignore the possibility of long-term foreign assets. Since claims on domestic residents may be assumed to bear risks (for the reasons analysed in Chapter 6) independently of their form, we shall also postulate that (B_1) and (B_2) are regarded by the foreign investors as equally risky assets when compared with foreign assets. Accordingly, we shall take the assets B_1 and B_2 to be perfect substitutes in their portfolios. Thus, their total return will be matched:

$$r = R + \dot{P}_b{}^e / P_b \qquad (9.1)$$

where ($\dot{P}_b{}^e / P_b$) is the rate of expected capital gains on the asset B_2. Since $\dot{P}_b{}^e / P_b = - \dot{R}^e / R$, (9.1) can be expressed as follows:

$$r = R - \dot{R}^e / R \qquad (9)$$

As perfect substitutability between the assets B_1 and B_2 is assumed, equation (5) of the model presented in Chapter 6 can be maintained. In fact, by combining that equation and equation (9) we obtain

$$r^* + [1/\zeta(B/H^*)] = R - (\dot{R}^e/R) \tag{9.2}$$

where

$$B = B_1 + B_2$$
$$= B_1 + A/R$$

Equation (9.2) indicates that speculation will bring the expected return on the asset B_2 into equality with the foreign interest rate plus a risk premium on that asset. The risk premiun will be a function of the share of the foreign wealth (H^*) held in the form of claims on domestic residents, and, hence, a function of the home country's overall indebtedness. The parameter ζ in (9.2) can be taken as a measure of the substitutability of such claims and alternative assets in the foreign investors' portfolios. ζ is positively related to the degree of the substitutability, with $\zeta \to \infty$ in the case of perfect substitutability.

Linearizing equations (4.1), (4.2')-(4.3') and (6') around the initial steady state (taken to be characterized by $\dot{A} = \dot{B}_1 = \dot{R}^e = 0$, $\bar{Y} = \bar{P} = \bar{E} = 1$, $\bar{P}^* = 1$), we can write

$$h_1 = -(b_1 + \bar{P}_b a - \bar{B}_2\bar{P}_b R) + \mu_2 p + k \qquad \mu_2 > 0 \tag{4b$_1$.1}$$

$$y_1 = y - n - (\bar{r}b_1 + \bar{B}_1 r + a) + \mu_1 p \qquad \mu_1 > 0 \tag{4b$_1$.2}$$

$$\dot{b}_1 + \dot{a}\,\bar{P}_b = -tb + (\bar{r}b_1 + \bar{B}_1 r + a) \tag{6b$_1$}$$

where h_1 is real domestic wealth, y_1 is real (private) disposable income, and (tb) represents the trade-balance surplus. For simplicity of notation, all variables (including the interest rates) are here expressed as deviations from their initial steady-state values. Bars refer to the initial steady-state values, so that $\bar{B} = \bar{B}_1 + \bar{B}_2$. (The μ_i's are defined as in Ch.6).

Let b denote the total 'stock' of the home country's external debt (i.e. the deviations of total debt from its initial steady-state value, excluding any revaluations associated with changes in its market price):

$$b = b_1 + a\,\bar{P}_b$$

The rate of change in the total 'stock' of the debt is therefore

$$\dot{b} = \dot{b}_1 + \dot{a}\,\bar{P}_b$$

Using the above equations and noting that $\bar{r} = \bar{R}$, we can express $(4b_1.1)$, $(4b_1.2)$ and $(6b_1)$ as follows

$$h_1 = -(b - i\bar{B}_2R) + \mu_2 p + k \tag{4b.1}$$

$$y_1 = y - n - \bar{r}b - \bar{B}_1 r + \mu_1 p \tag{4b.2}$$

$$\dot{b} = -tb + \bar{r}b + \bar{B}_1 r \tag{6b}$$

where

$$\bar{P}_b = i, \qquad \bar{B}_1 + \bar{B}_2 = \bar{B}$$

Also, linearizing and re-arranging (9) yields

$$\dot{R}^e = \bar{r}(R - r) \tag{9b}$$

Similarly, linearizing equation (5) of Chapter 6 we can write

$$r = r^* + \xi(b - i\bar{B}_2R) \qquad \xi = 1/\zeta \tag{5b}$$

In obtaining equation (5b) from (5) of Ch.6 we have made use of the fact that $\bar{B} = \bar{B}_1 + \bar{A}/\bar{R}$ and we have set $H^* = 1$. In this equation, the parameter ξ is inversely related to the substitutability of claims on home residents and foreign assets in the foreign investors' portfolios.

Equation ($7a_1$) of Chapter 6 will be modified to incorporate the possibility that domestic investment is financed through the issue of long-term bonds as well as by foreign loans:

$$\dot{k} = -\delta_1 k - \delta u(r - \dot{p}^e) - \delta(1-u)(R - \dot{p}^e) \qquad 0 \leq u \leq 1 \tag{7b}$$

where

$$\dot{p}^e = \dot{P}^e/P$$

The aggregate supply function, aggregate demand function, consumption and export demand functions of the model specified in Section IV of Ch.6 will be maintained:

$$y = \psi_1 p - \psi_2 r + \psi_4 k - \psi_5 w \tag{2b}$$

$$y = c_1 + x + \dot{k} - \bar{X}p \tag{4b}$$

$$c_1 = \gamma_1 y_1 + \kappa_1 h_1 - \sigma p \tag{4b.3}$$

$$x = -x_1 p \tag{4b.4}$$

where

w = the wage rate

c_1 = real domestic consumption of home goods

x = foreign demand for home goods

It should be noted that only r is assumed to enter into the supply equation (2b), reflecting the shorter-term nature of external borrowing to finance purchases of imported intermediate inputs.

The following equations of the model in Chapter 6 will also be maintained:

$$n = \eta_1(y + p) - \eta_2 r \tag{4b}$$

$$tb = x - n - c_2 - \bar{C}_2 p \tag{6b.1}$$

$$c_2 = \gamma_2 y_1 + \kappa_2 h_1 + \sigma p \tag{6b.2}$$

$$\dot{w} = \lambda_3 p - w \tag{8b}$$

where

n = the quantity of imported intermediate inputs

c_2 = real domestic demand for foreign goods

Accordingly, the full model consists of equations (2b)-(9b), (4b.1)-(4b.4) and (6b.1)-(6b.2). Equations (2b), (4b), (5b) and (9b) (together with an assumption about how expectations are formed and with (3b), (4b.1)-(4b.4) and (6b.1)-(6b.2)) can determine, at any moment, values of y, p, r and R as functions of: (i) the predetermined variables b, k and w, whose dynamic behaviour is described by equations (6b)-(8b); and (ii) the foreign interest-rate r*.

It may be noted that when $\bar{B}_1 = \bar{B}$ and $\bar{B}_2 = (1-u) = 0$, (9b) becomes redundant and the model reduces in essence to the one examined in Chapter 6. In fact, the formulation of our model enables one to consider any of the following four cases: <u>(i)</u> The entire outstanding debt of the home country as well as its entire new debt is FPD, in which case $\overline{B}_1 \rightarrow \overline{B}$ and $\overline{B}_2 \rightarrow 0$, $u \rightarrow 1$. (ii) There is no pre-existing VPD, but the new borrowing (except that used to finance purchases of imported intermediate inputs) is undertaken through the issue of VPD. In this case, $\overline{B}_1 \rightarrow \overline{B}$, $\overline{B}_2 \rightarrow 0$ and $(1-u) \rightarrow 1$. (iii) The entire outstanding debt and new borrowing (except that used to finance purchases of imported intermediate inputs) is in the form of VPD, in which case $\overline{B}_2 \rightarrow \overline{B}$, $\overline{B}_1 \rightarrow 0$ and $(1-u) \rightarrow 1$. (iv) Intermediate cases in which only a fraction of the initial outstanding debt is VPD ($\overline{B}_2 < \overline{B}$, $\overline{B}_1 \neq 0$) and in which domestic fixed-capital formation is financed both through the issue of VPD and by foreign loans ($0 < u < 1$).

Since (i)-(iv) are special cases of equations (4b.1)-(4b.2), (5b), (6b)-(7b) and (9b), our model provides a convenient framework within which the effects of "variable-priced" debt and "fixed-priced" debt can be analysed and compared.

In the following two setions the possibility of wage adjustments over time will be ignored, as it has no substantive bearing upon the issues we shall focus upon [4]. However, equation (8b) will be re-introduced into the model in Section IVb.

IIIa. *The Steady-State Properties of the Model.*

Consider the steady-state properties of the model. In the steady state, portfolio balance in the rest of the world requires no expected capital gains or losses on claims on the domestic residents. Accordingly, $\dot{R}^e = 0$, and so, from (9b), the (long) borrowing-rate R will equal the (short) borrowing-rate r. Also, the condition $\dot{b} = \dot{k} = 0$ will apply and, given our simplifying assumption of no ongoing domestic inflation, $\dot{p}^e = 0$.[5]

Imposing these conditions, equations (5b), (9b), (6b), (6b.1)-(6b.2) and (7b) yield

$$\tilde{r} = \tilde{R} = \tilde{r}^* + \xi\{\tilde{b} - i\bar{B}_2\tilde{R}\}$$

$$\tilde{x} - \tilde{n} - \tilde{c}_2 - \bar{C}_2\tilde{p} = \bar{B}_1\tilde{r} + \bar{r}\,\tilde{b}$$

$$\delta u\tilde{r} + \delta(1-u)\tilde{R} + \delta_1\tilde{k} = 0$$

Equations (4b.1)-(4b.2) become

$$\tilde{h}_1 = -(\tilde{b} - i\bar{B}_2\tilde{R}) + \mu_2\tilde{p} + \tilde{k}$$

$$\tilde{y}_1 = \tilde{y} - \tilde{n} - \bar{r}\tilde{b} - \bar{B}_1\tilde{r} + \mu_1\tilde{p}$$

Combining the above equations with the steady-state of the rest of the model, and ignoring for the moment the possibility of wage adjustments, we obtain the following solutions for the capital stock, the stock of the external debt, and the domestic price level:

$$d\tilde{k} = -\frac{\delta}{\Delta_2\delta_1}(\alpha_2\beta_1 + \alpha_1\beta_2)d\tilde{r}^* < 0 \qquad (10b_1)$$

$$d\tilde{b} = \frac{1}{\Delta_2}[(\alpha_1\beta_3' + \beta_1\alpha_3') + i\bar{B}_2(\beta_1\kappa_1 + \alpha_1\kappa_2) + \pi_1]d\tilde{r}^* > 0 \qquad (10b_2)$$

$$d\tilde{p} = \frac{1}{\Delta_2}[(\alpha_3'\beta_2 - \alpha_2\beta_3') + i\bar{B}_2(\beta_2\kappa_1 - \alpha_2\kappa_2) + \pi_2]d\tilde{r}^* \gtrless 0 \qquad (10b_3)$$

where

$$\alpha_3' = \epsilon\psi_2 - \gamma_1(\bar{B}_1 - \eta_2), \quad \beta_3' = \bar{B}_1(1-\gamma_2) - \lambda$$

The term Δ_2 in $(10b_1)$-$(10b_3)$ represents the determinant of the steady-state coefficient matrix of the model. As will be seen shortly, Δ_2 must be positive if the system is to be dynamically stable. The first term in the bracketed expression of $(10b_2)$ is essentially the same as that appearing in equation $(13a_2*)$ of Chapter 6, except that here the coefficients β_3' and α_3' are appropriately defined to account for the fact that $\bar{B} = \bar{B}_1 + \bar{B}_2$. The same also applies to the first term in $(10b_3)$. Hence, an explicit expression for these two terms can be obtained from equations $(10c_1*)$-$(10c_2*)$ of Ch.6 by replacing $\bar{B}$ with $\bar{B}_1$. The coefficients α_1, α_2, β_1 and β_2 are defined exactly as in the previous chapter. Also, the π_i's in $(10b_2)$-$(10b_3)$ are identical to the π_i's of equations $(13a_2*)$-$(13a_3*)$ in Chapter 6.

Thus, the solution for the stock of the debt in the new steady state does not seem to differ fundamentaly from the solution described by the model of Ch.6. For example, if $\bar{B}_1$ is only a fraction of the total initial debt ($\bar{B}_1 < \bar{B}$, $\bar{B}_2 \neq 0$), the first term in the bracketed expression of $(10b_2)$ will decrease in size. This will reduce the size of the change in the long-run level of indebtedness $\tilde{b}$. However, if $\bar{B}_2$ is non-zero, the size of the long-run change in the stock of the debt will increase because of the second (positive) term in $(10b_2)$. The presence of VPD, therefore, does not seem to affect the sign of $d\tilde{b}$. Similarly, the sign of the steady-state change in the domestic price level $\tilde{p}$ appears, in general, to be unaffected by the size of $\bar{B}_2$ or by any other parameter associated with "variable-priced" debt.

The fact that the steady-state properties of this model are not very dissimilar to those of the model analysed in Ch.6 implies that foreign interest-rate disturbances will ultimately be transmitted to the home country irrespective of the nature of its external debt. Nevertheless, the impact and the dynamic effects of disturbances may be very different depending on whether its debt is VPD or FPD. To establish this point we proceed to examine the characteristics of the system outside steady states.

IIIb. *The Characteristics of the System Outside Steady-States.*

Consider equation (9.2), which describes the behaviour of the interest-rate R. One of the important features of this equation is that, unless participants in the international money markets have static expectations, the term $\dot{R}^e/R$ will contain information about the future behaviour of the system which, in turn, will be reflected in the current value of R. Suppose, for example, that the long rate, R, is forward looking. Setting $\dot{R}^e = \dot{R}$ and $H^* = 1$, (9.2) can be integrated to give a solution for R as

$$R(t) = \underbrace{\int_t^\infty e^{\int_t^x r^*(t')dt'} dx}_{\chi_1} + \underbrace{\int_t^\infty e^{1/\zeta \int_t^x B(t')dt'} dx}_{\chi_2} \qquad (9.2a)$$

In (9.2a), R(t) can be viewed as being the sum of two components. The first of these two components, the term denoted χ_1, incorporates information about the current and (expected) future movements in the foreign (short) rate r*. Its implication for the short-run behaviour of the (long) rate R is analogous to that established by the recent literature on the term structure of interest rates [e.g. Blanchard (1981), Miller

(1982), Turnovsky and Miller (1984), and Turnovsky (1986)]. Hence this component requires no particular comment. Consider, however, the second component, i.e. the term denoted χ_2. That term results from imperfect sustitutability of claims on domestic residents and foreign assets in the foreign investors' portfolios, and reflects their expectations about the current and the future level of the home country's indebtedness.

To see more clearly the implication of that term, let us assume that any change in r* is a once-and-for-all change and let us consider the linearized version of (9.2). Accordingly, by substituting (5b) into (9b) we obtain equation (9b.1)

$$\dot{R}^e = \bar{r}\{R - r^* - \xi(b - i\bar{B}_2R)\} \tag{9b.1}$$

which, upon integration, gives

$$R(t) = \{\, r^* + \int_t^{\infty} e^{\xi\int_t^x (b(t')dt'} dx \,\}\, (1 + \xi i\bar{B}_2)^{-1} \tag{9b.2}$$

Let us also assume that there is no initial outstanding VPD. Letting $\bar{B}_2 \to 0$, we can write (9b.2) as follows

$$R(t) = \{\, r^* + \int_t^{\infty} e^{\xi\int_t^x (b(t')dt'} dx \,\} \tag{9b.3}$$

Equation (5b), which describes the behaviour of the borrowing-rate r, can analogously be expressed as

$$r(t) = \{r^* + \xi b(t)\} \qquad (5b.3)$$

Equation (9b.3) indicates that, as long as $\xi \neq 0$, the current value of R, unlike that of r, will depend on future changes in the stock of the home country's debt (which, at any point in time, is predetermined) as well as on current movements in the foreign interest rate.

This result can be understood as follows. The indebtedness of the home country may increase in the future and, because of (default) risk considerations on the part of the foreign creditors, the market value of its debt may in the longer-run fall below its original value. The long rate R, being forward-looking, will incorporate this information and will react to current changes in foreign interest-rates as well as to any anticipated future changes in the home country's indebtedness (and, hence, to any future movements in the market value of its debt). We refer to this characteristic of the model as the "*expectation*" *effect* of variable-priced debt.

To see a second important feature of (9b) and (5b) let us now assume that participants in the international money markets have static expectations, but that the home country's pre-existing debt in long-term bonds is non-zero. Accordingly, letting $\dot{R}^e \to 0$, we can obtain from (9b.1) an expression for R(t) as

$$R(t) = \{r^* + \xi b(t)\}(1 + i\xi_1)^{-1} \qquad (9b.4)$$

where

$$\xi_1 = \xi \bar{B}_2$$

Consider the coefficient ξ_1. This coefficient is the product of two factors: $\overline{B}_2$ - the size of the home country's (initial) outstanding VPD; and ξ - the degree of imperfect substitutability of claims on home residents and other assets in the foreign investors' portfolios. It implies that, for any given b and for any given non-zero value of ξ, the larger is $\overline{B}_2$ the smaller will be the change in the interest rate R following a change in r*.

The explanation for this result is to be found in an "*asset-revaluation*" effect. When the outstanding VPD of the home country is non-zero, in addition to raising the rate of return on claims on domestic residents, a given rise in R will also reduce the nominal value of these pre-existing claims in the foreign investors' porfolios. When the substitutability between such claims and foreign assets is imperfect, this will increase the equilibrating impact on the international money markets of any given change in R (induced by a change in foreign interest-rates).

Consider next the rest of the equations of the model. Through appropriate substitutions, (4b) and (2b) can be expressed as functions of the borrowing-rates r and R and of b,k, $\dot{p}^e$:

$$\begin{bmatrix} \epsilon \\ 1 \end{bmatrix} y = \begin{bmatrix} -\theta \\ \psi_1 \end{bmatrix} p - \begin{bmatrix} [\delta u + \gamma_1(B_1 - \eta_2)] & [\delta(1-u) - iB_2\kappa_1] & \alpha_2 & (\delta_1 - \kappa_1) & -\delta \\ \psi_2 & 0 & 0 & -\psi_4 & 0 \end{bmatrix} \begin{bmatrix} r \\ R \\ b \\ k \\ \dot{p}e \end{bmatrix} \qquad (11b_1)$$

where

$$\epsilon = (1 - \gamma_1 + \gamma_1\eta_1) > 0$$
$$\theta = \sigma_1 + \gamma_1\eta_1 - \gamma_1\mu_1 - \kappa_1\mu_2 \ (> 0)$$
$$\sigma_1 = \sigma + \overline{X} + x_1 > 0$$
$$\alpha_2 = \gamma_1\overline{r} + \kappa_1 > 0$$

The equations in $(11b_1)$ represent the equilibrium condition in the home goods market, and the coefficients ϵ and θ are defined exactly as in Chapter 6.

Similarly, the current-account equation (6b) and the capital accumulation equation (7b) can be written in the form

$$\begin{bmatrix} \dot{b} \\ \dot{k} \end{bmatrix} = \begin{bmatrix} -\beta_2 & \beta_4 \\ 0 & -\delta_1 \end{bmatrix} \begin{bmatrix} b \\ k \end{bmatrix} + \begin{bmatrix} \beta_3' & \beta_5 & 0 & \beta_1 \\ -\delta u & -\delta(1-u) & \delta & 0 \end{bmatrix} \begin{bmatrix} r \\ R \\ \dot{p}^e \\ p \end{bmatrix} \tag{12b}$$

where

$$\beta_1 = \sigma_2 + (1-\gamma_2)\eta_1 + \gamma_2\mu_1 + \kappa_2\mu_2 + \lambda_1\psi_1 \quad > 0$$
$$\beta_2 = \kappa_2 - \bar{r}(1-\gamma_2) \gtrless 0, \ \beta_3' = \bar{B}_1(1-\gamma_2) - \lambda \ (>0)$$
$$\beta_4 = \kappa_2 + \psi_4\lambda_1 > 0, \ \beta_5 = i\bar{B}_2\kappa_2 > 0$$
$$\sigma_2 = x_1 + \sigma + \bar{C}_2 > 0, \ \lambda_1 = (1-\gamma_2)\eta_1 + \gamma_2 > 0$$
$$\lambda = \psi_2\lambda_1 + \eta_2(1-\gamma_2) > 0$$

From $(11b_1)$ it is apparent that, unless no intermediate imported inputs are assumed (i.e. η_1, $\eta_2 \rightarrow 0$ and hence $\psi_2 \rightarrow 0$), a change in the short borrowing-rate r will affect the behaviour of the home economy through the supply-side, just as in the model of Ch.6. A notable feature of $(11b_1)$, however, is that a given increase in r will have a larger contractionary effect on demand than an increase in R of the same magnitude. This is due to two factors. Firstly, debt-service payments, and hence net domestic income, will be independent of changes in R. Secondly, if the pre-existing VPD is non-zero, any increase in R will lower, from equation (4.2'), the nominal value of the home residents' outstanding liabilities. For a given level of prices, this will raise real domestic wealth and, hence, will increase spending on home goods. We refer to that effect of variable-priced debt as the "*wealth-revaluation*" effect.

From (12b) and the definition of β_3' and of β_5, it can also be seen that the size of the service-balance deficit that will result from proportional increases in r and R will be inversely related to the value of $\bar{B}_2/\bar{B}_1$ (and, therefore, to the share of VPD in the total (initial) debt $\bar{B}$). When $\bar{B}_2 \neq 0$, however, the wealth effect on spending of the increase in R will raise imports. Other things being equal, this will lead to a deterioration of the trade balance.

Finally, consider the stability properties of the system. Solving ($11b_1$) for p we can express the goods market equilibrium condition as

$$p = \frac{1}{\alpha_1}[-\alpha_5 \quad (\alpha_3'-\delta u)]\begin{bmatrix} R \\ r \end{bmatrix} - \frac{1}{\alpha_1}[\alpha_2 \quad \alpha_4 \quad -\delta]\begin{bmatrix} b \\ k \\ \dot{p}^e \end{bmatrix} \qquad (11b)$$

where

$\alpha_1 = \theta + \epsilon\psi_1 > 0$, $\alpha_3' = \epsilon\psi_2 - \gamma_1(\bar{B}_1 - \eta_2) \gtrless 0$

$\alpha_4 = \delta_1 + \upsilon > 0$, $\alpha_5 = \delta(1-u) - i\bar{B}_2\kappa_1 \gtrless 0$

$\upsilon = \epsilon\psi_4 - \kappa_1$ (> 0)

Using equation (5b) to eliminate r from (9b), (11b) and (12b), we can write the model (in deviation-form) as follows:

$$\begin{bmatrix} \dot{R} \\ \dot{b} \\ \dot{k} \\ \dot{p}^e \end{bmatrix} = \begin{bmatrix} \bar{r}(1+i\xi_1) & -\bar{r}\xi & 0 & 0 \\ \beta_5'' & -\beta_2'' & \beta_4 & \beta_1 \\ [-\delta(1-u)+\alpha_5''] & \alpha_2'' & \upsilon & \alpha_1 \\ \frac{[\alpha_5''-\delta u i\xi_1]}{\delta} & \frac{(\alpha_2''+\xi\delta u)}{\delta} & \frac{\alpha_4}{\delta} & \frac{\alpha_1}{\delta} \end{bmatrix}\begin{bmatrix} R-\tilde{R} \\ b-\tilde{b} \\ k-\tilde{k} \\ p-\tilde{p} \end{bmatrix} \qquad (13b)$$

where $\alpha_2'' = \alpha_2 - \xi\alpha_3'$, $\alpha_5'' = \alpha_5 + \alpha_3' i\xi_1$

$\beta_2'' = \beta_2 - \xi\beta_3'$, $\beta_5'' = \beta_5 - \beta_3' i\xi_1$

In terms of the stability of the system, the implication of a low degree of substitutability of claims on domestic residents and other assets in the foreign investors' portfolios is analogous to that discussed in Chapter 6. If, for example, forward-looking behaviour in both the international money markets and the domestic goods market is assumed, (13b) will involve two non-predetermined variables (R and p) and two predetermined variables (b and k). In this case, there will exist a (unique) stable path converging to the steady state provided there exist two negative and two positive characteristic roots. When $\xi \to 0$, the characteristic equation of (13b) is

$$(\bar{r} - \rho)\{\rho^3 - v_3\rho^2 - v_2\rho - v_1\} = 0 \tag{14b$_1$}$$

where

$$v_1 = \frac{\delta_1}{\delta}(\alpha_2\beta_1 + \beta_2\alpha_1) > 0$$

$$v_2 = \frac{1}{\delta}[(\alpha_2\beta_1+\beta_2\alpha_1) + \alpha_1\delta_1] + (\alpha_2\beta_4+\upsilon\beta_2) > 0$$

$$v_3 = (\upsilon + \frac{\alpha_1}{\delta} - \beta_2) \gtrless 0$$

From the definition of the α_i's and β_i's it can be confirmed that both v_1 and v_2 are almost certainly positive. Accordingly, the third-order differential equation in curly brackets will have one positive root($\rho_3 < 0$) and two negative roots (ρ_1, $\rho_2 < 0$). The remaining root (which is equal to $\rho_4 = \bar{r}$) is positive. In this case, then, (13b) will satisfy the saddle-point stability property. A low degree of asset substitutability (i.e. a large ξ) may cause dynamic instability by introducing the possibility of three positive roots. Specifically, when $\xi \neq 0$, the constant term of the characteristic equation of (13b) (which equals

$-\rho_1\rho_2\rho_3\rho_4)$ is

$$-(\delta_1/\delta)\Delta_2 \tag{$14b_2$}$$

where $\Delta_2 = v_1(\delta/\delta_1)-\xi\Delta_3$

$$\Delta_3 = (\alpha_1\beta_3'+ \beta_1\alpha_3') + \pi_1+ \overline{B}_2[\alpha_1(1-\gamma_2)-\beta_1\gamma_1] \ (> 0)$$

Hence Δ_2, which also appears in equations ($10b_1$)-($10b_3$), must be positive if the system is to be (saddle-point) stable. In what follows, we shall assume that the value of ξ is such that the stability property of the system is preserved.

IV. The Behaviour of the System Between Steady-States

What we have established in the previous section is that variable-priced debt may, in general, influence the behaviour of the system outside steady states through an *"expectation"* effect, an *"asset-revaluation"* effect and a *"wealth-revaluation"* effect. Having established this point, we shall now proceed to study explicitly the adjustment of the economy between steady states. As the system (13b) is not amenable to a simple diagrammatic or algebraic solution, we shall proceed to that analysis in two steps. In Section IVa, which follows, we shall describe graphically the impact effects of an unanticipated once-and-for-all increase in r*, by introducing some simplifying assumptions (which reduce the number of the differential equations that need to be considered). Also, we shall consider only three of the possible cases discussed in Section II. That is: (i) the case where $\overline{B}_1 = \overline{B}$ and $\overline{B}_2 = (1-u) = 0$ (i.e. both the past and the new debt of the home country is the form of FPD); (ii) the case where $\overline{B}_1 = \overline{B}$ and $\overline{B}_2 = u = 0$ (i.e. the entire initial outstanding debt is FPD, but the new borrowing, except that used to finace purchases of imported intermediate inputs, is undertaken through the issue of VPD); and (iii) the case where $\overline{B}_2 = \overline{B}$ and $\overline{B}_1 = u = 0$ (i.e. the entire outstanding debt and the new borrowing - except that used to finance purchases of imported intermediate inputs - is in the form of VPD). Then, in Section IVb, we will solve numerically the full model, under a variety of assumptions about the 'initial' conditions of the home country and the 'nature' of the foreign interest-rate disturbances.

Our purpose in the analysis of Section IVa is to show how VPD might influence the short-run response of the domestic variables to changes in foreign interest-rates. Our purpose in the analysis of Section Vb is to illustrate the possible implications of VPD for the home country under different circumstances.

IVa. Effects of a Permanent Increase in Foreign Interest Rates With 'Variable-Priced' Debt: A Diagrammatic Exposition

In this Section, we shall assume away the complication arising from the presence of $\dot{p}^e$ in (11b) by making the assumption that expectations in the domestic goods market are static. However, we shall maintain the assumption of forward-looking expectations in the international money markets. Accordingly, we assume that $\dot{R}^e = \dot{R}$ (except at the moment when unanticipated changes in the foreign interest-rate occur), but we set $\dot{p}^e = 0$. Although this 'set-up' is to some extent restrictive, one may accept it on the grounds that, unlike other markets, asset markets are dominated by forward-looking behaviour. Also, in this section, we shall overlook the fact that the dynamics associated with capital accumulation may influence the short-run behaviour of R indirectly (through the impact of the future changes in the capital stock on the CA, and, through the CA, on the level of indebtedness). These two simplifications allow us to describe graphically the 'short run' (by letting $\dot{p}^e \to 0$ in ($11b_1$), (11b) and by ignoring the second equation in (12b)). We will eliminate the simplifications in Section IVb.

IV.a$_1$ Impact Effects of a Once-and-for-all Unanticipated Increase in the Foreign Interest Rate when there is No Initial Outstanding VPD ($\bar{B}_2 \to 0$).

In Figure (1a), equation (5b) is plotted as the rr^F schedule. The RR^V schedule in Figure (2a) plots (9b.1). RR^V describes the combinations of the (long) borrowing-rate R and of the stock of the home country's debt b, which are compatible with portfolio balance in the rest of the world when $\dot{R}^e = 0$. With imperfect asset substitutability ($\xi \neq 0$), the schedules RR^V and rr^F are both upward sloping: an increase in the indebtedness of home residents will increase the foreign investors' perception of risk on their overall portfolio. Any given rise in b must therefore be accompanied by a rise in the rate of return on b in order to maintain equilibrium in the international money markets. Also, the position of these two schedules is the same since (5b) and (9b) imply that, in the long run, R will equal r when $\bar{B}_2 \to 0$.

The CA^F schedule in Figure (1a) shows the combinations of the stock of the debt b and of the borrowing-rate r, which preserve *both* CA balance *and* goods market equilibrium when $\bar{B}_1 = \bar{B}$ and $(1-u) = 0$ (i.e. CA^F plots the

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Fixed-Priced Debt, Variable-Priced Debt and ...
to Changes in Foreign Interest-Rates

$(\bar{B}_2 \to 0)$

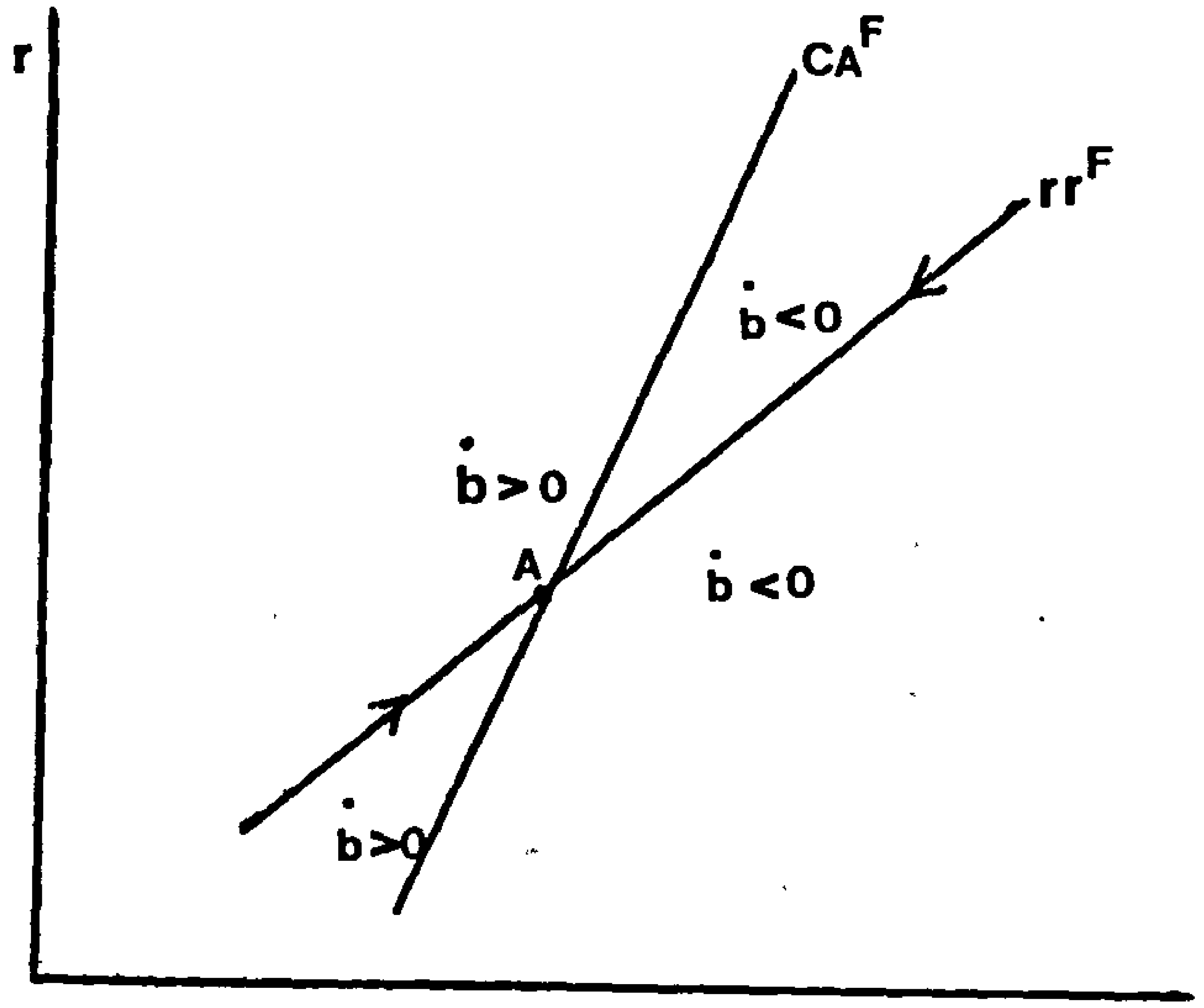

Figure 1a

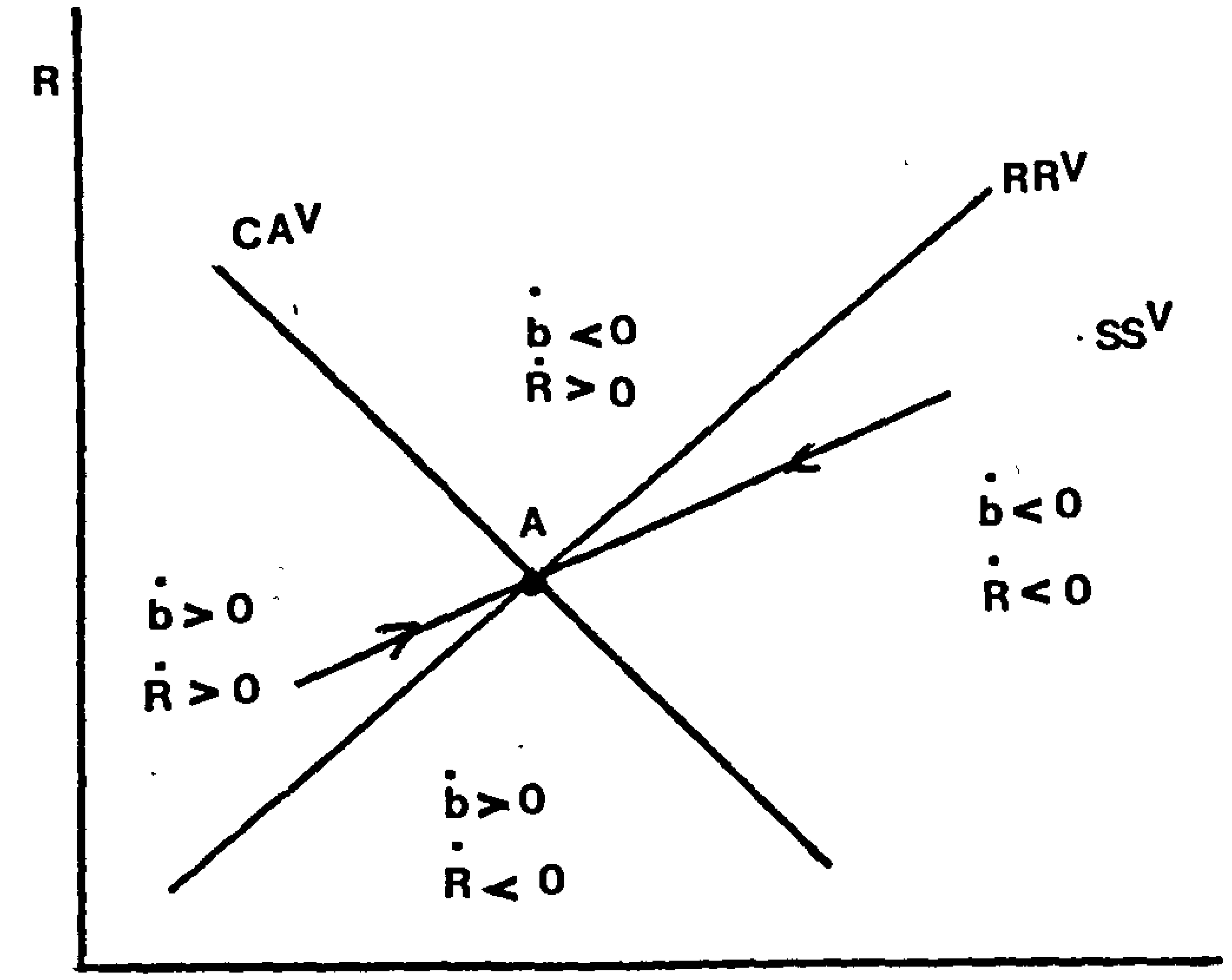

Figure 2a

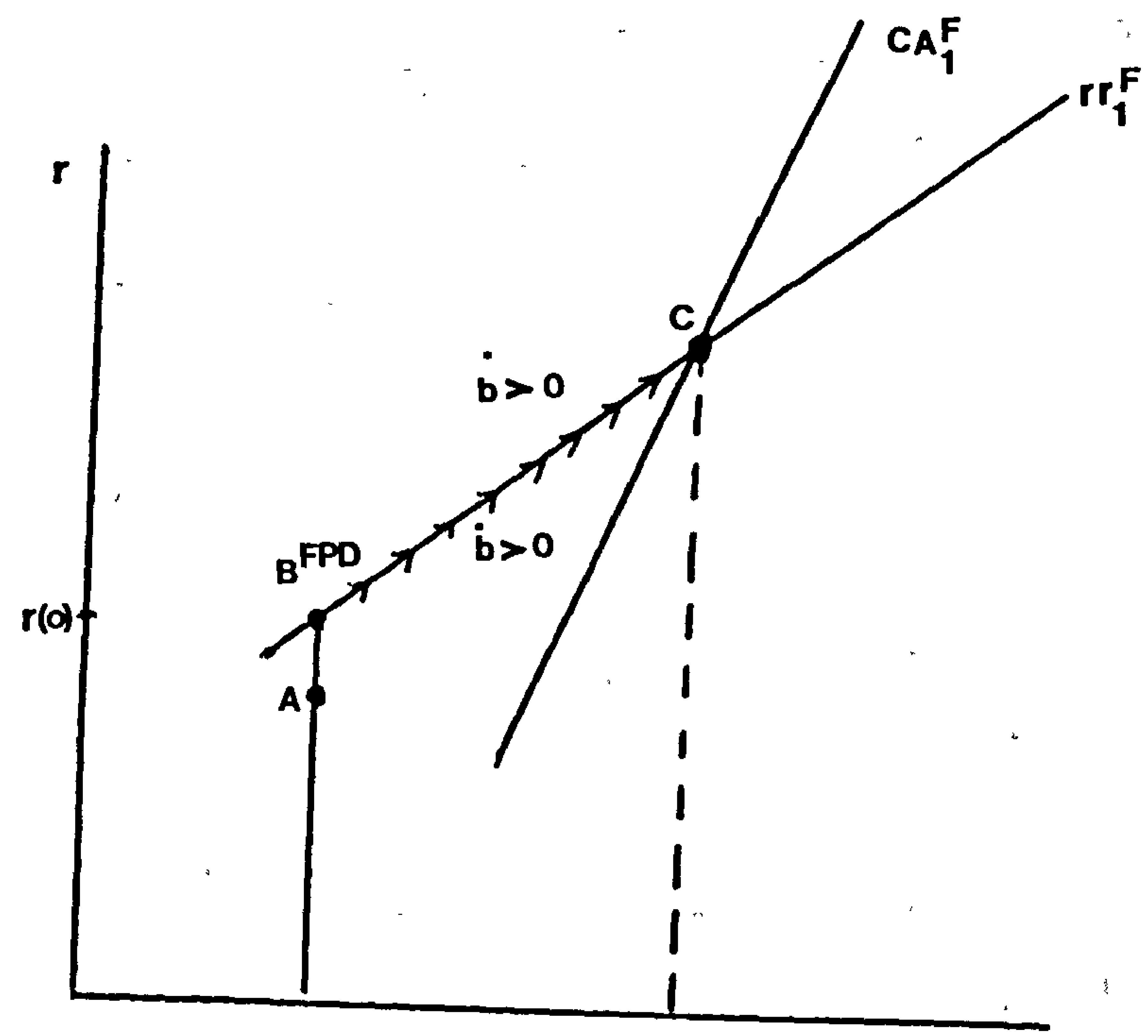

Figure $1a_1$

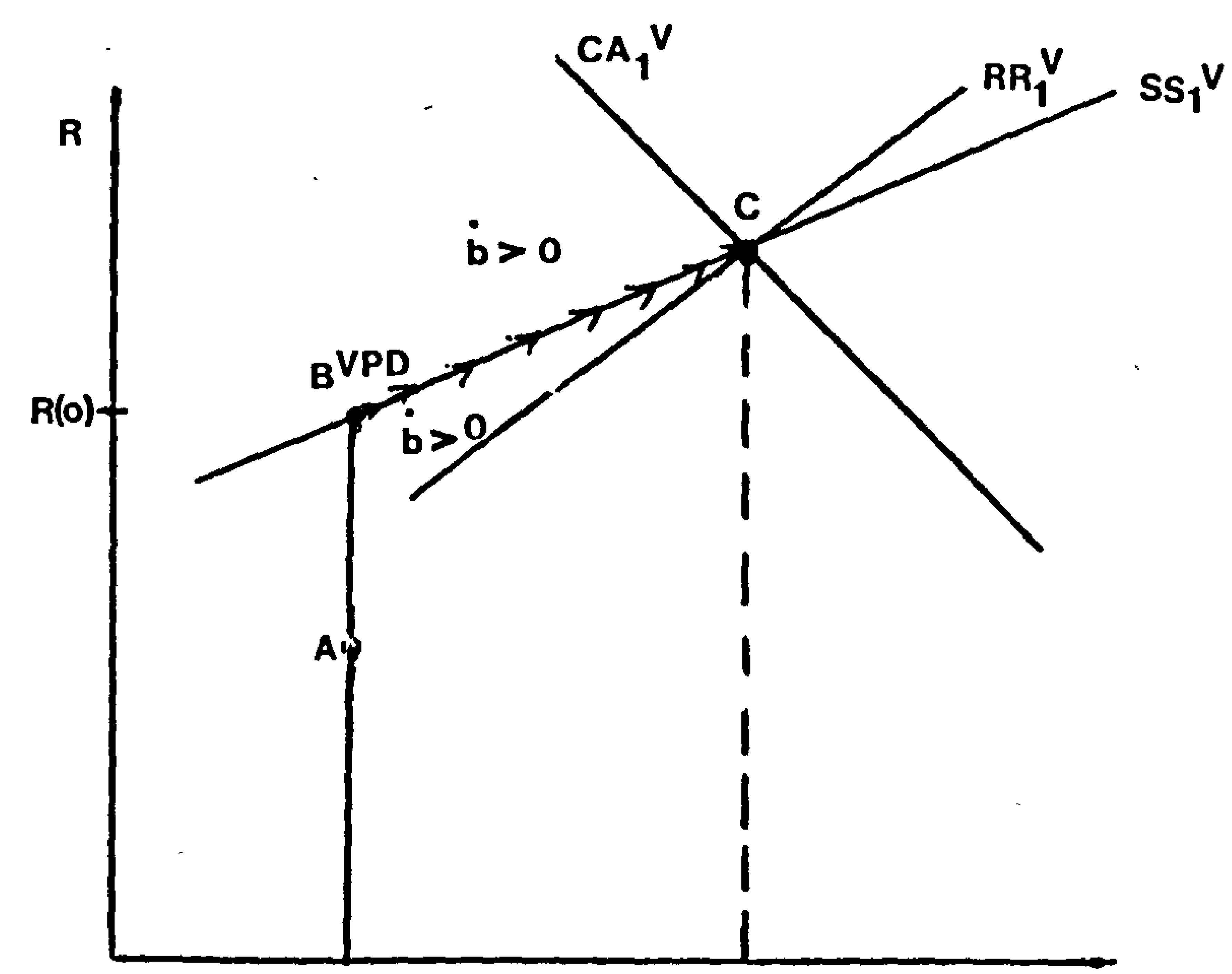

Figure $2a_1$

current account equation in (12b) together with equation (11b)). On the assumption then that an increase in r creates a deficit by worsening the service balance (SB), the trade balance (TB) must improve to maintain equilibrium. Accordingly, domestic wealth and income must decrease to reduce spending on foreign goods and to lower the prices of home goods (by weakening domestic demand). That drop in wealth and income required to restore CA equilibrium can be brought about by a rise in the level of the external indebtedness b. Thus, the CA^F schedule is upward sloping. It may be noted that CA^F is taken to be steeper than the rr^F curve. This assumption follows from the stability requirement. It effectively corresponds to the assumption that the TB-improving effects of an increased level of debt more than offset the adverse SB-effects that result from the rise in the borrowing-rate r due to the increased risk premium on the new foreign loans.

The CA^V schedule in Figure (2a) describes the combinations of the borrowing rate R and of the stock of the debt b which clear the goods markets and which maintain CA balance, when $\bar{B}_1 = \bar{B}$ and $\bar{B}_2 = u = 0$. Here the short borrowing-rate r has been solved out. Starting then from current account balance, an exogenous increase in R, by depressing investment demand, lowers domestic prices and therefore moves the CA into surplus. Provided that the wealth effect and income effect of a drop in the debt on the trade balance (through increased spending on foreign goods, and through higher domestic spending and hence increased prices of home goods) is large enough to more than offset the debt-service payment effect, CA equilibrium can be restored by a reduction of b. Thus, the CA^V schedule is negatively sloped. Also, as the (long) rate R is forward looking while b is predetermined, the equilibrium here is a saddle-point. As can be seen from the figure, the unique convergent path (shown as the schedule SS) is upward sloping. However, it is flatter than RR^V and rr^F.

Consider the effects of an (unanticipated) increase in the foreign interest rate in the case described by Fig.($1a_1$) and in the case described by Fig.($2a_1$). As can be seen from equation ($10b_2$), when $\overline{B}_2 = 0$, the long-run stock of the debt will be the same in both cases. Suppose, therefore, that, in both figures, initial equilibrium is at point A and the new steady-state is at point C (characterized by a larger external debt and by higher borrowing rates). Consider the impact effects. In Figure ($1a_1$), the increase in the foreign interest rate shifts upwards the initial rr^F curve. With the stock of the debt being given in the short-run, equilibrium occurs at B^{FPD} on the $rr_1{}^F$ schedule. In the short-run, the (short) borrowing-rate r adjusts in proportion to r*, and the CA moves into deficit. In Figure ($2a_1$), the initial RR^V schedule moves upwards to $RR_1{}^V$ and, given our assumptions stated on pp.229,the initial stable locus shifts up to the position occupied by SS_1. Here the change in the foreign interest rate causes the borrowing-rate R to jump to R_0. R_0 exceeds r_0 by an amount which is positively related to the steepness of $RR_1{}^V$ and hence of SS_1 (and, therefore, to the degree of imperfect substitutability of claims on domestic residents and foreign assets in the foreign investors' portfolios).

The explanation for this result is to be found in the "*expectation*" effect of VPD. Both in Figure ($1a_1$) and in Figure ($2a_1$), the increase in the foreign interest rate worsens the CA of the home country by raising its interest payments on past debt: after the foreign interest-rate change, the home country's external debt will grow and this rise in its indebtedness will increase the foreign lenders' perceived exposure to risks. As the long-rate R is forward looking, the foreign lenders anticipate the deterioration in the home country's CA and hence the subsequent growth in its external indebtedness. Accordingly, they require a larger rise in the rate of return on the asset B_2 than the current rise in the foreign interest-rate in order to be currently convinced to lend more to domestic residents. This discrepancy between the short-run value of R and that of r_o may be viewed as representing a 'premium' that compensates the foreign investors for the perceived future increase in risks on their overall portfolio (which result from the subsequent rise in the indebtedness of the home country) and the future fall in the market value of their assets B_2.

Utilizing the information provided by Figs.($1a_1$)-($2a_1$), let us consider the effect of the change in r* on the domestic real sector. In Figures (1b)-(2b), the two equations in ($11b_1$) are plotted as the schedules YY_d and YY_s: YY_d and YY_s represent, respectively, the aggregate demand function and the aggregate supply function. Starting then from an initial steady state at point A in Figs.($1b_1$)-($2b_1$), the rise in the foreign interest rate, through its impact on the short borrowing-rate r, causes the schedules YY_s^V and YY_s^F to shift up by the same amount (to a position occupied, say, by YYs_1). It also moves down both $YY_{d_o}^F$ and $YY_{d_o}^V$ by an amount equal to the decline in consumption that results from the fall in domestic income due to the increased interest-payments on the past 'fixed-priced' debt. However, the rise in the foreign interest rate causes a greater than proportional short-run response in the borrowing-rate R. As a consequence, there is a larger drop in investment with VPD, an instantaneous $YY_{d_1}{}^V$ curve that lies below $YY_{d_1}{}^F$, and a more profound recession at point B^{VPD} than at B^{FPD}. In effect, our model suggest a sense in which "variable-priced" debt destabilizes the home economy: this is in the sense of increasing the

'Fixed-Priced' Debt, 'Variable-Priced' Debt and Macroeconomic Adjustment to Changes in Foreign Interest-Rates

($B_2 \rightarrow 0$)

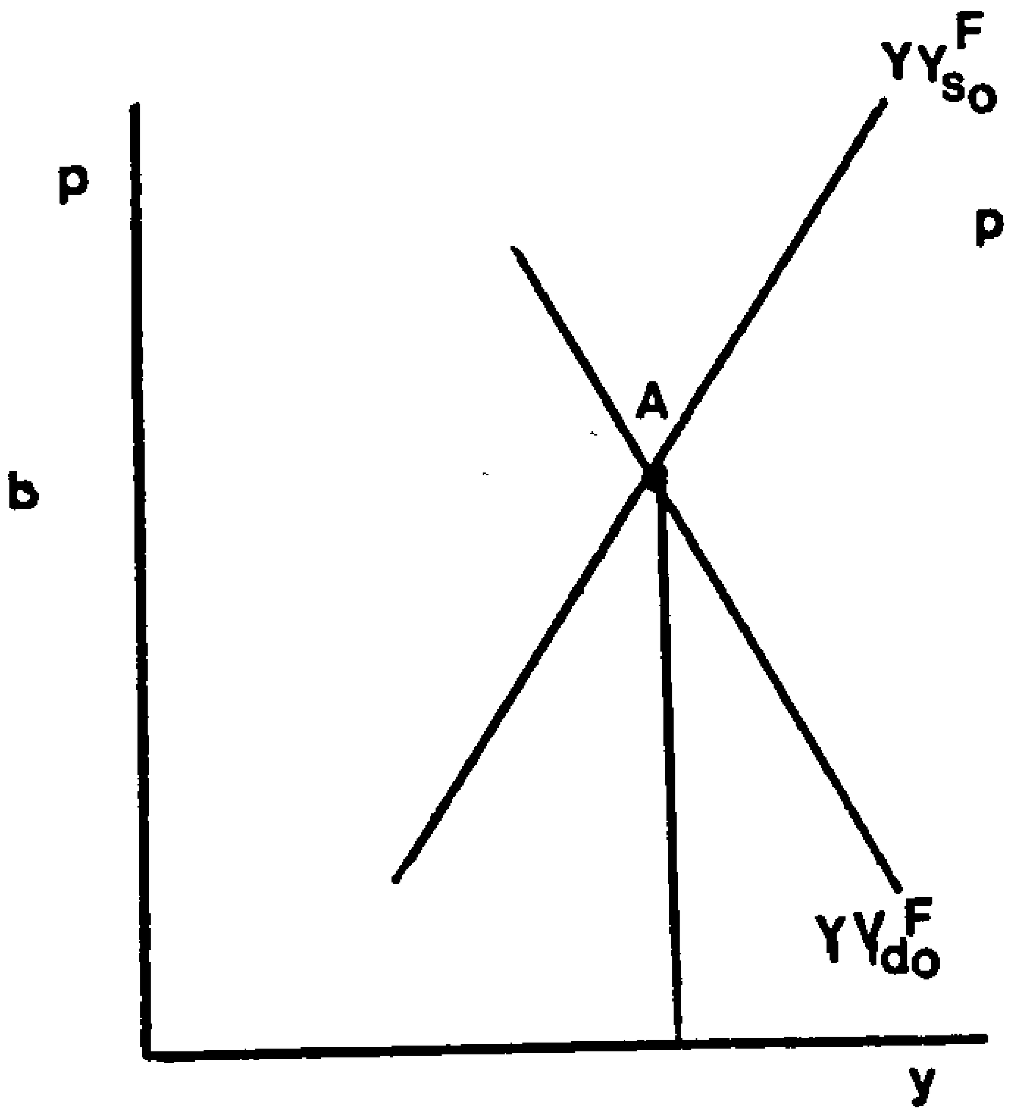

Fig. 1b

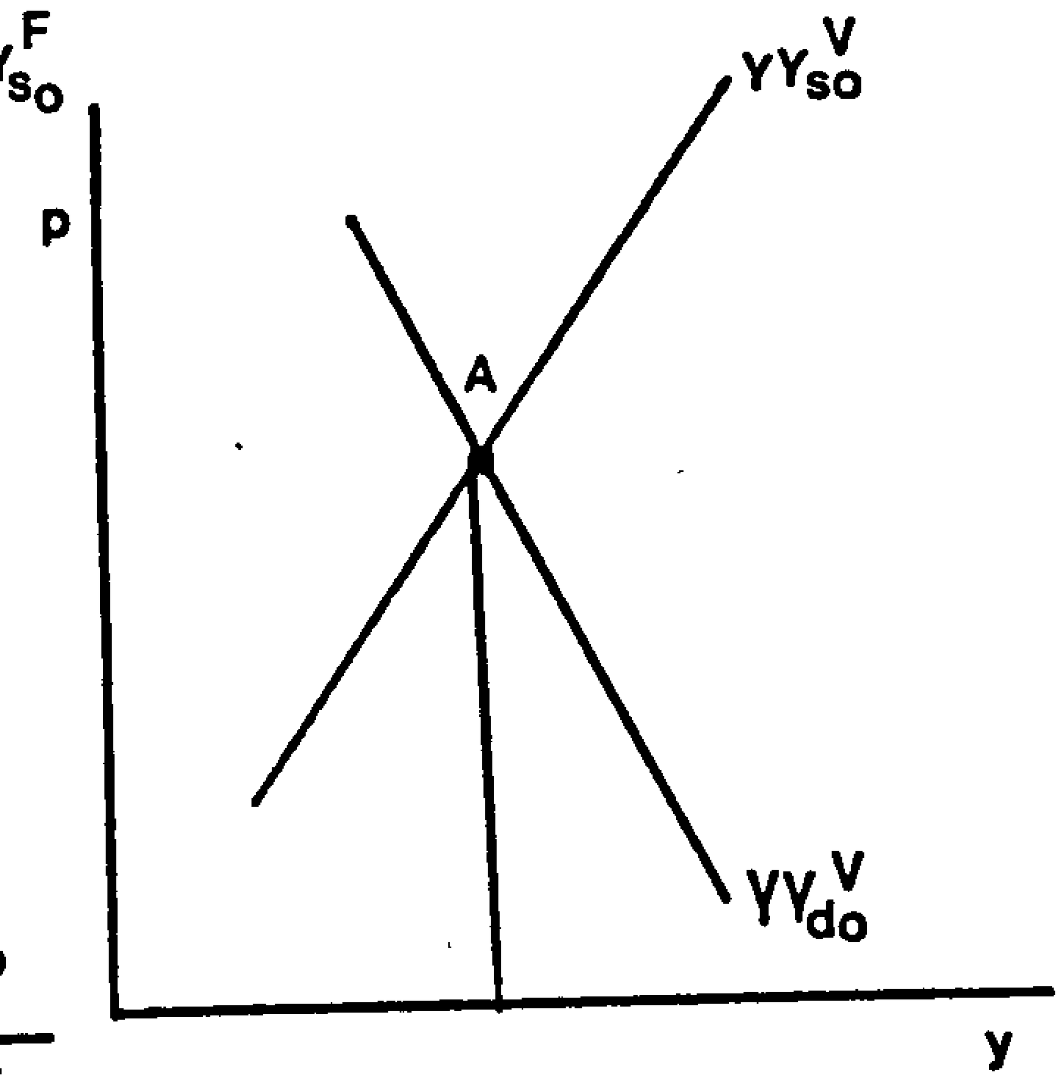

Fig. 2b

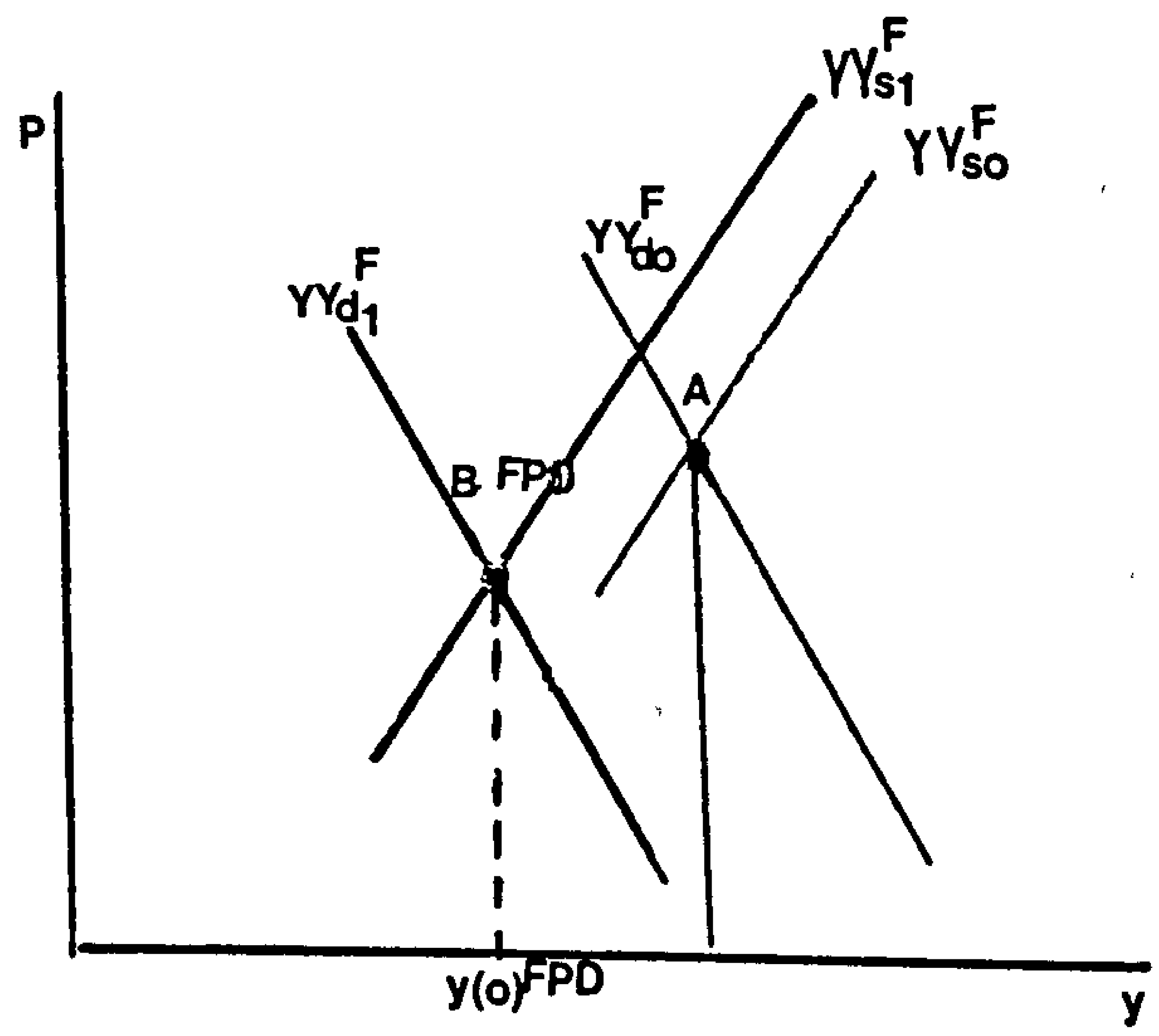

Figure $1b_1$

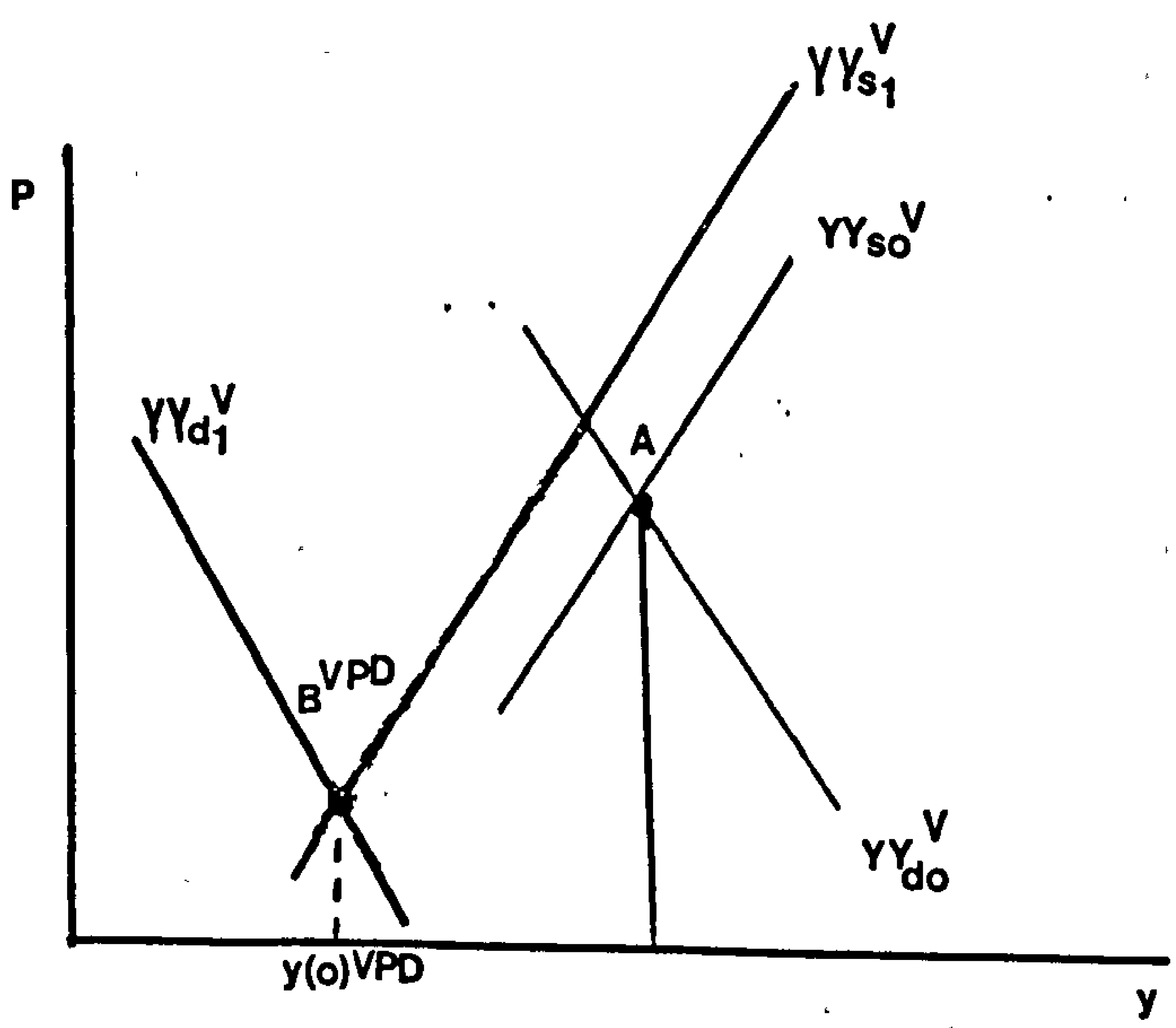

Figure $2b_1$

short-run sensitivity of borrowing-rates and of output to changes in foreign interest-rates.

IV.a_2 Impact Effects of a Once-and-for-all Unanticipated Increase in the Foreign Interest Rate when All Pre-exising Debt is VPD ($\bar{B}_2 \rightarrow \bar{B}$).

We shall now focus on the situation described by Figures (3a) and ($3a_1$)-($3b_1$). These figures illustrate the case where $\bar{B}_2 = \bar{B}$ and $\bar{B}_1 = u = 0$ Consider the RR^V schedule in Fig.(3a). When the home country's initial outstanding debt in long-term bonds is non-zero, the RR^V schedule becomes flatter due to the "*asset-revaluation*" effect of VPD. When $\bar{B}_2 > 0$, any increase in the interest rate R will raise the rate of return on home debt and will also lower the nominal value of the foreign holdings of this pre-existing debt. Equilibrium in the international money markets will, therefore, require a relatively small rise in R following a given rise in b. Consider the CA^V schedule in the figure. Under the assumption that an increase in the stock of the debt lowers the rate of debt accumulation, the sign of the slope of this locus will depend on whether, on balance, a rise in the borrowing-rate R improves or worsens the CA. This, in turn, depends on the relative magnitude of three effects. First is the CA-improving effect of an exogenous increase in R that arises from the drop in domestic prices due to the reduction in investment expenditure. Second is the wealth effect of an increased value of R, which worsens the CA by raising the prices of home goods. Third is the wealth effect of a higher R on import demand, which also results in a deterioration of the CA. For a relatively large (initial) outstanding debt, the two latter effects may dominate and hence the CA^V schedule may be upwards sloping. Such is the situation shown in Figure (3a). It should be noted that the CA^V curve is

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"Variable-Priced" Debt and Macroeconomic Adjustment to Changes in Foreign Interest Rates

$(\bar{B}_2 \rightarrow \bar{B})$

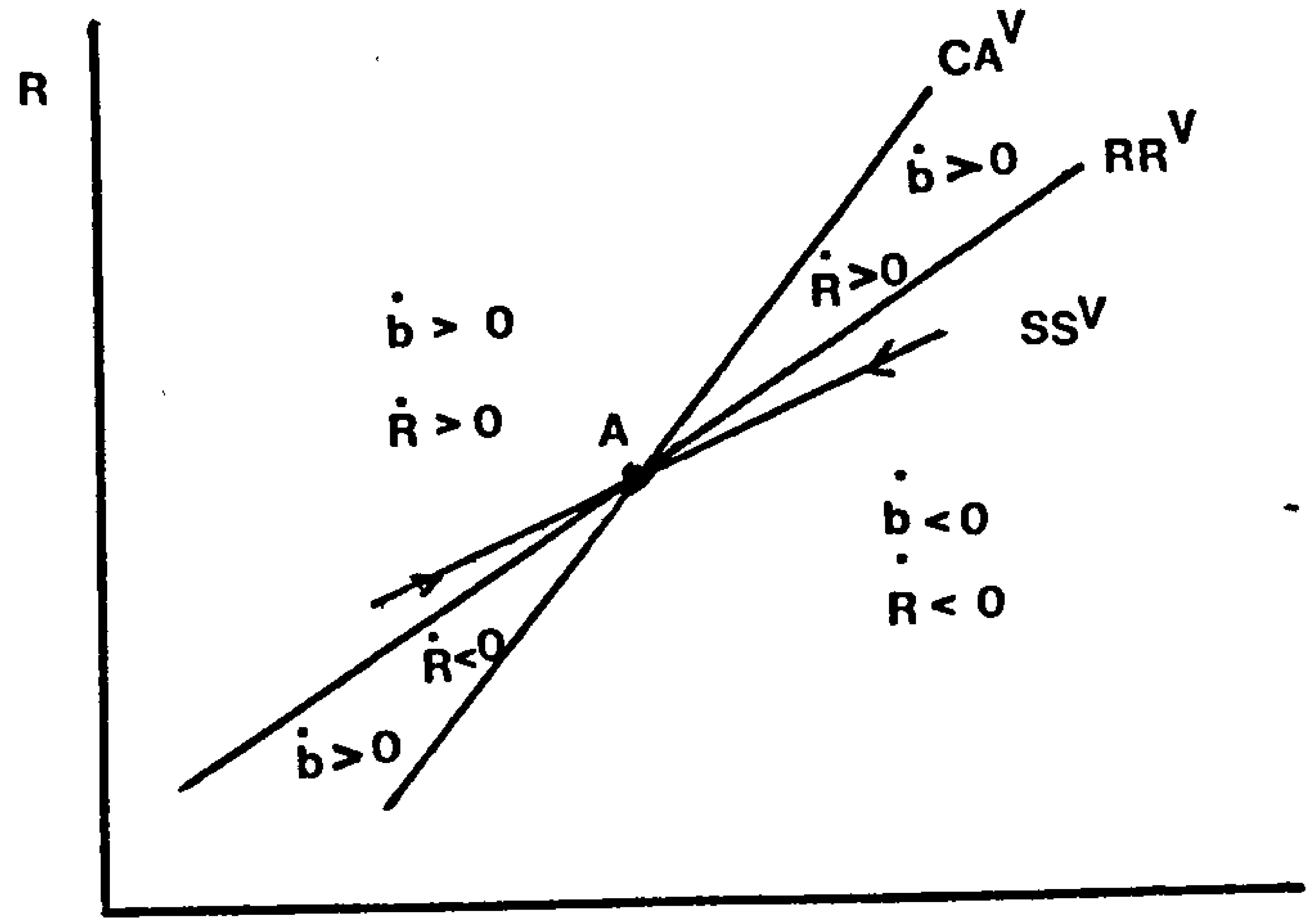

Figure 3a

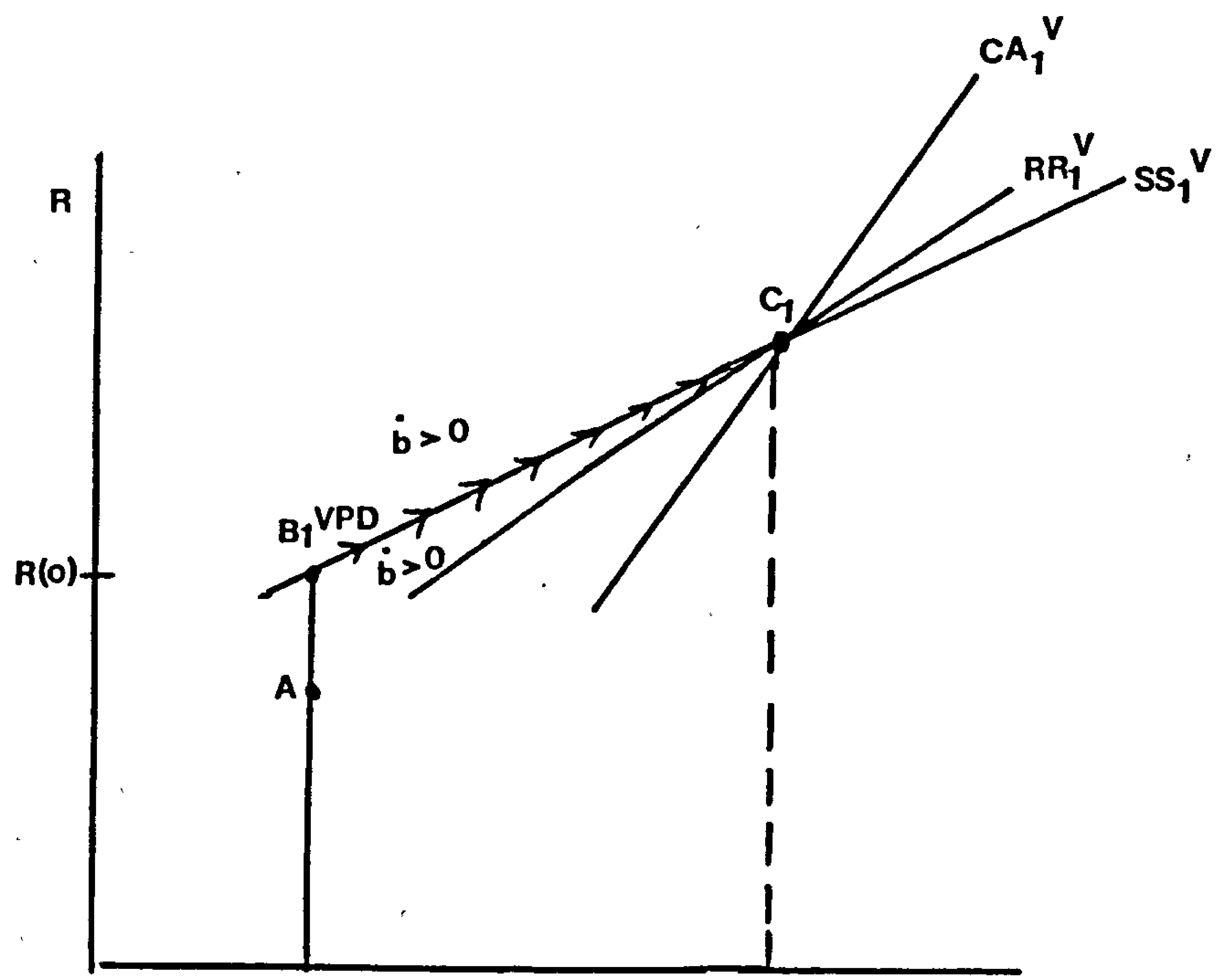

Figure $3a_1$

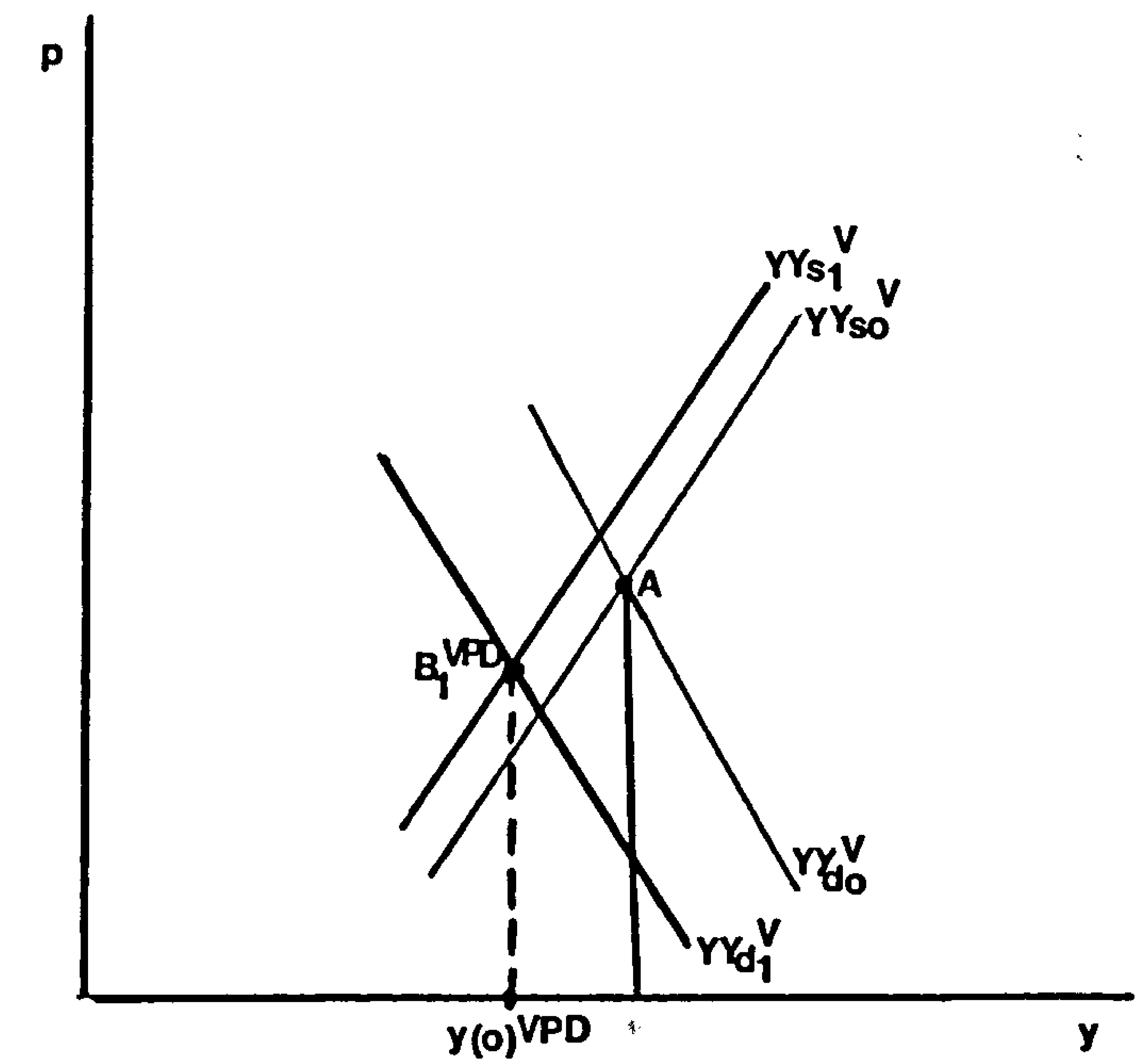

Figure $3b_1$

taken to be steeper than the RR^V schedule on the assumption that the (saddle-point) stability requirement is satisfied. Given this assumption, the positions of the schedules RR^V and CA^V give rise to an upward-sloping stable locus SS. This locus is flatter than the SS locus of Fig.(2a), because of the asset-revaluation effect which reduces the steepness of RR^V. The stock of the debt in the new steady state may however be larger here than in Fig.($2a_1$), as the asset-revaluation effect can accomodate a larger long-run change in b.

Consider then an initial equilibrium at point A in Fig.($3a_1$), and suppose that final equilibrium is at point C_1. In the figure, the increase in the foreign interest rate causes the initial RR^V curve to shift to $RR_1{}^V$, and moves SS to a position occupied by the SS_1 schedule. Short-run equilibrium occurs at $B_1{}^{VPD}$, again characterized by a higher borrowing-rate R and by a CA deficit.

Consider, however, Figure ($3b_1$) (which corresponds to Figure ($2b_1$)). Here three factors will determine how the change in the foreign interest rate will affect domestic output. Firstly, the rise in r*, by inducing an instantaneous rise in R, will cause investment to decrease but will cause consumption to increase through the "*wealth revaluation*" effect of VPD. If this latter effect is strong enough that the increase in consumption outweighs the drop in investment (i.e. $(\delta - i\bar{B}_2\kappa_1) < 0$), the initial $YY_d{}^V$ curve in Fig.($3b_1$) will shift to the right of point A. In this case, domestic output might actually increase in the short run. If, on the other hand, $(\delta - i\bar{B}_2\kappa_2) > 0$, the $YY_{d_0}^V$ curve will move down (as is assumed in Fig. ($3b_1$)) and short-run equilibrium will be associated with a reduction of output. Hence the *first* of the three factors is the *sign* of the change in aggregate demand, which will depend on how strong the wealth-revaluation effect is. The *second* factor is the *size* of the change in aggregate demand, which will depend on the size of the initial change in the interest rate R. As can be seen from Fig.($3a_1$), the size of the change in R will depend both on the initial shift of the stable path SS and on the steepness of this path. Since the steepness of SS will be inversely related to the "asset-revaluation" effect of VPD, the extent of the instantaneous change in R may, in principle, be smaller at point B_1^{VPD} of Fig.($3a_1$) than at point B^{VPD} of Fig.($2a_1$). The *third* factor is the *size* of the change in aggregate supply. The increase in the foreign interest rate, by raising R and thereby reducing the nominal value of the home residents' total outstanding liabilities, will lead to a reduction in the risk-premium on the foreign loans. As a result, it will cause a smaller than proportional short-run change in the short borrowing-rate r and, hence, a smaller shift of the YY_S curve of Figure ($3b_1$) (relative to that of YY_S in Fig.($2b_1$)). These *three* factors suggest that VPD will now produce a different outcome: it will in general reduce the impact effect of the increase in the foreign interest-rate on domestic output, but it may actually imply a larger (initial) CA deficit. Also, it is worth recalling that crucial to the asset-revaluation effect is the assumption that $\bar{B}_2 \neq 0$ combined with the assumption that $\xi \neq 0$. Whereas Fig.($2b_1$) suggests that the initial loss in output will be positively related to the value of ξ, in Fig.($3b_1$) this may not be so. If the home country's initial outstanding debt $\bar{B}_2 = \bar{B}$ is relatively large, "the asset-revaluation" effect may be strong enough to more than offset the impact of the "expectation" effect of VPD on the short-run response of R. In this case, imperfect substitutability of claims on domestic residents and other assets in the foreign investors' portfolios will in fact reduce the size of the immediate decline of domestic output, even if aggregate supply is independent of interest rates.

IVb. *Effects of Foreign Interest-rate Disturbances With 'Variable-Priced' Debt: A Numerical Illustration.*

The results of our analysis in the previous section can be broadly stated as follows:

a) The influence of variable-priced debt on the adjustment of the system between steady states depends crucially of 'initial conditions' - i.e. the initial size of VPD relative to FPD and the initial size of the total stock of debt. Accordingly, the role of VPD in the response of a particular economy to the same foreign disturbance may differ over time, depending on its pre-existing debt structure. Also, two individual countries with an identical (pre-existing) VPD/FPD ratio may be affected differently by external financial developments if they differ in their overall level of indebtedness. In terms of the recent proposals for a greater 'securitization' of the lending to the debtor countries, these results have two important implications. First, the DCs differ in their initial conditions, especially in respect to overall indebtedness. Hence it is difficult to predict how a greater securitization of the lending will affect the economies of all of them. Second, the various stages in the process of greater securitization of the lending will inevitably be associated with different VPD/FPD ratios. These different stages, therefore, are likely to have sharply different implications for the behaviour of the DC's economies subsequent to external financial shocks.

b) For any given set of 'initial' conditions, the response of individual (domestic) variables to disturbances is likely to be influenced in different ways by VPD. In the case described by Fig.($3b_1$), for example, VPD may be considered preferable to FPD to the extent that it reduces the short-run sensitivity of domestic output to changes in foreign interest rates. But VPD may have undesirable short-run effects on other economic variables, including the CA. There is therefore the issue of how the overall implications of VPD for the DCs should be "evaluated".

c) In section IVa, the interest-rate disturbance has been assumed to be permanent and to continue at a uniform level. However, the external financial shocks may themselves differ over time. As in 1980-85, for example, foreign interest-rates may continue rising for a given period before falling back to their equilibrium level. As can be seen from equation (9.2a) of Section IIIb, the nature of the interest rate disturbance may influence the outcomes through the term denoted χ_1. This, in turn, suggests that, for any given set of 'initial conditions', the effects of VPD are also likely to be sensitive to the precise characteristics of the external financial shocks.

Having made these general points we now proceed to solve numerically the full model to illustrate the possible implications of VPD for the home economy under different circumstances.

IV.b_1. 'Variable-Priced' Debt: Initial Conditions, Permanent and Temporary Shocks

The parameter values that we have used in the solutions are the same as those assumed in Section IV of Ch.6. To minimize the effects of interest rate changes on aggregate supply, and hence to make our analysis more general, however, we have set here the elasticity of output with respect to changes in foreign inputs equal to .05. Also, we have considered variations in the parameter ξ in order to see how the degree of asset substitutability might affect the outcomes.

We have solved the model under a variety of assumptions about the home country's initial debt structure and overall indebtedness: (*i*) In the solutions presented in Tables ($1a_1$)-($1a_2$) we have taken the initial level of its overall indebtedness to be 20 percent of its initial output $\overline{Y}$, while in the solutions appearing in Tables ($1b_1$)-($1b_2$) we have set $\overline{B}$ equal to 30 percent of $\overline{Y}$. (*ii*) In the solutions VPD_1, VPD_2, VPD_3, VPD_4 and VPD_5, we have assumed that its pre-existing variable-priced debt is, respectively, 0, .5, 5, 25 and 75 percent of its total outstanding debt (and that $u = 0$). (*iii*) In the solutions FPD, we have set $\overline{B}_2 = 0$ (and $u = 1$).

As for the nature of the interest-rate disturbances, we have examined three cases. The results presented in Tables ($1a_1$)-($1a_2$) and ($1b_1$)-($1b_2$) have been obtained under the assumption that the interest-rate disturbance is expected to be permanent. Hence, in these tables, r* is assumed to rise by 5 percent in 'year' zero and to remain at this level in the subsequent years. The numerical values in Tables ($2a_1$)-($2a_2$) and ($2b_1$)-($2b_2$) have been obtained under the assumption that the disturbance is expected to be temporary. Thus, in Tables ($2a_1$)-($2a_2$), r* is assumed to rise by 5 percent in year 0 and to revert to its original level after two years. In Tables ($2b_1$)-($2b_2$), r* is assumed to rise from 4 percent to 9 percent in years 0 to 5 and then to revert to 4 percent.

The third case we have considered is described by Table ($3a_1$), and our results are reported in Tables ($3a_2$)-($3a_3$). Here we have first chosen a set of values describing the 'initial' conditions of the home country and the behaviour over time of r* so as to approximate: (a) the characteristics of the DCs in terms of debt structure, overall level of indebtedness, and borrowing rates in the late 1970s; and (b) the interest rate developments of the early 1980s. For instance, the value of $\overline{B}_2$ shown in Table ($3a_1$)can be taken as a measure of the outstanding VPD of DCs in 1979. Also, the values describing the behaviour over time of r* approximate the developments in U.S short-term rates during 1979-1985. Then, using the values appearing in Table ($3a_1$), we have solved the model for the time path of a set of key variables under two assumptions: (i) in the solution FPD*, we have set $u = 1$; and (ii) in the solution VPD*, we have assumed that $(1-u) = 1$. Thus, this example attempts to illustrate what could have happened in DCs in 1980-85 if the had used VPD to finance domestic investment. It may be noted that the changes over time in r* have been taken to be "anticipated" shocks. This is consistent with the widely held view that, while the initial sharp rise in U.S interest rates was presumably unanticipated, the additional interest rate increases of 1982-1985 were not unforeseen (as the stance of U.S. fiscal policy over that period was clearly expansionary).

Finally, Tables (4a)-(4c) represent our attempt to evaluate in "welfare terms" the implications of VPD for the home country. Following, Dornbusch (1985) and Kharas and Shishido (1987), we have used a simple "welfare criterion", namely, the discounted value of the total consumption forgone due to the shocks.

IV.b_2 *Permanent* shocks

A. Impact effects

When both the past and the new debt of the home country is in the form of FPD, the characteristics of the short-run are as follows. Output falls, partly due to the decline in investment expenditure and partly due to the drop in consumption (caused by the higher interest-payments on the outstanding debt and the reduction in income). Prices also fall, and the CA initially moves into surplus. As can be seen from Tables ($1a_1$)-($1a_2$) and ($1b_1$)-($1b_2$), 'initial conditions' have very little influence on the characteristics of the short-run.

The numerical values in these tables, however, illustrate that the effects of VPD are highly sensitive to the initial conditions of the home country. Consider first the results appearing in Table ($1a_1$).

TABLE ($1a_1$) - *Impact effects of a 5% permanent increase in* r^*.
(Percentage deviations from initial equilibrium values)
$\bar{B}/\bar{Y}$ = .2, ξ = .3

	FPD	VPD_1	VPD_2	VPD_3	VPD_4	VPD_5
Real GDP	-4.33	-5.12	-5.07	-4.66	-3.14	-.88
y						
Interest rates						
R		5.98	5.96	5.77	5.08	3.56
r	5.00	5.00	4.93	4.57	3.13	1.00
Price level						
p	-3.11	-3.75	-3.72	-3.42	-2.30	- .63
Consumption						
c_1	-3.13	-3.62	-3.58	-3.19	-1.76	.26
c_2	-1.25	-1.46	-1.44	-1.29	- .74	.04
(c_1+ c_2)	-4.38	-5.08	-5.02	-4.48	-2.50	.30
Investment						
i_n	-1.85	-2.28	-2.27	-2.19	-1.86	-1.27
Current account						
CA	1.31	1.68	1.66	1.53	1.02	.12

(*a*) In the case of VPD_1, VPD_2, VPD_3 and VPD_4, the "expectation" effect of VPD dominates the "asset-revaluation" effect and, hence, the long-rate R initially rises by more than the rise in r*. As a result, the immediate decline in investment expenditure is greater than that which occurs when both the past and the new debt is FPD. In the case of VPD_1, VPD_2 and VPD_3, the immediate decline in output is also more pronounced than in the FPD-case.

(*b*) Both the "wealth-revaluation" effect and the "asset-revaluation" effect of variable-priced debt, however, become increasingly important as the pre-existing VPD rises. Partly because of the relatively large wealth effect and partly because of the relatively small increase in the interest payments on the outstanding FPD (which results from the small initial rise in the short rate r, due to the asset-revaluation effect), consumption in the VPD_4-case is well above that in the FPD-case. Hence the short-run decrease in output is smaller in the former case, despite the fact that the decrease in investment is slightly larger.

(*c*) In the VPD_5-case, consumption actually rises in the short-run. Also, the "expectation" effect of VPD is now dominated by the "asset-revaluation" effect. Thus, the long-rate R initially rises by 3.56 percent and investment expenditure falls by only 1.27 percent. As a consequence, the short-run level of output in the VPD_5-case is substantially higher than that in the FPD-case.

(d) Irrespective of the pre-existing $VPD/_{FPD}$ ratio, however, the CA initially moves into surplus and domestic prices fall.

Consider next Table ($1b_1$), where $\bar{B}/\bar{Y}$ has been set equal to .3. The table shows that the outcomes with VPD are sensitive to the size of the *total* pre-existing debt:

TABLE ($1b_1$) - *Impact effects of a 5% permanent increase in r*.*
(Percentage deviations from initial equilibrium values)
$\bar{B}/\bar{Y} = .3$, $\xi = .3$

	FPD	VPD_1	VPD_2	VPD_3	VPD_4	VPD_5
Real GDP	-4.95	-5.98	-5.90	-5.17	-2.76	-.06
y						
Interest rates						
R		6.36	6.32	6.00	4.76	2.86
r	5.00	5.00	4.93	4.33	2.32	.18
Price level						
p	-3.61	-4.46	-4.39	-3.85	-2.05	- .03
Consumption						
c_1	-3.82	-4.47	-4.39	-3.69	-1.42	.93
c_2	-1.52	-1.79	-1.76	-1.49	- .61	.31
(c_1+c_2)	-5.34	-6.26	-6.14	-5.18	-2.03	1.23
Investment						
i_n	-1.89	-2.96	-2.44	-2.30	-1.77	- .99
Current account						
CA	1.20	1.69	1.67	1.47	.73	- .30

(*a*) For any given VPD/FPD ratio, the significance of the wealth effect and asset-revaluation effect of VPD increases as the value of $\bar{B}$ rises. Thus, when $\bar{B}/\bar{Y} = .3$, consumption in the VPD_3-case is slightly above that in the FPD-case. Also, in the VPD_4-case, the asset-revaluation effect now more than offsets the impact of the expectation effect of VPD on the long rate R. Hence, R is initially below the foreign interest rate. With the drop in consumption and investment being relatively small, output falls in this case by only 2.76 percent. For the same reasons, the short-run increase in consumption is greater, and the decline in investment is smaller, in the VPD_5-case of Table ($1b_1$) than in the corresponding case of Table ($1a_1$). As a result, in the former case, output is only slightly below its value in the initial steady state. However, the CA now moves into deficit.

(*b*) In the case of VPD_1, VPD_2 and VPD_3, on the other hand, a large total initial debt leads to a relatively more pronounced drop in output. For instance, the fall in output in the VPD_2-case of Table ($1b_1$) exceeds that in the VPD_2-case of Table ($1a_1$) by almost 1 percent. The decline in output is also greater in the VPD_3-case of Table ($1b_1$) than in the corresponding case of Table ($1a_1$).

Moreover, the numerical values in Tables ($1a_2$) and ($1b_2$) show that the initial conditions of the home economy can significantly influence the role of the substitutability between claims on home residents and other assets in foreign investors' portfolios in the outcomes. Consider, for example, the results in Table ($1b_2$), which have been obtained under the assumption that $\xi = .5$ (and $\overline{B}/\overline{Y} = .3$):

(*a*) When the pre-existing VPD is relatively small, imperfect asset substitutability has a destabilizing impact on the domestic economy in the sense that it increases the short-run sensitivity of aggregate demand and of output to the foreign interest-rate disturbance. In the VPD_1-case of Table ($1b_2$), for instance, output is 7 percent below its initial steady-state value and 2.16 percent below its value in the FPD-case. The short-run level of output is also lower in the case of VPD_2 and of VPD_3 of that table than both in the case of FPD and in the cases of VPD_2 and VPD_3 of Table ($1a_2$).

(*b*) When, however, the pre-existing VPD is large, a relatively low

TABLE ($1a_2$) - *Impact effects of a 5% permanent increase in $r*$.*
(Percentage deviations from initial equilibrium values)
$\bar{B}/\bar{Y} = .2,\ \xi = .5$

	FPD	VPD_1	VPD_2	VPD_3	VPD_4	VPD_5
Real GDP	-4.26	-5.80	-5.72	-5.03	-2.86	-.64
y						
Interest rates						
R		6.98	6.93	6.44	4.76	2.60
r	5.00	5.00	4.91	4.20	2.03	.12
Price level						
p	-3.04	-4.31	-4.25	-3.75	-2.16	- .52
Consumption						
c_1	-3.08	-4.05	-3.98	-3.38	-1.54	.19
c_2	-1.23	-1.64	-1.61	-1.38	- .66	.03
(c_1+c_2)	-4.31	-5.68	-5.58	-4.75	-2.20	.21
Investment						
i_n	-1.81	-2.65	-2.63	-2.44	-1.77	- .94
Current account						
CA	1.30	2.00	1.98	1.76	1.01	.11

TABLE ($1b_2$)- *Impact effects of a 5% permanent increase in $r*$.*
(Percentage deviations from initial equilibrium values)
$\bar{B}/\bar{Y} = .3,\ \xi = .5$

	FPD	VPD_1	VPD_2	VPD_3	VPD_4	VPD_5
Real GDP	-4.87	-7.03	-6.86	-5.51	-2.18	-.02
y						
Interest rates						
R		7.95	7.83	6.86	4.17	1.87
r	5.00	5.00	4.85	3.71	1.10	- .25
Price level						
p	-3.55	-5.32	-5.19	-4.19	-1.69	- .04
Consumption						
c_1	-3.78	-5.12	-4.97	-3.80	-1.01	.62
c_2	-1.50	-2.06	-2.00	-1.55	- .45	.20
(c_1+c_2)	-5.28	-7.18	-6.97	-5.35	-1.46	.82
Investment						
i_n	-1.85	-3.04	-2.99	-2.60	-1.54	- .65
Current account						
CA	1.16	2.19	2.14	1.75	.69	- .19

degree of asset substitutability has the effect of reducing the immediate drop of output. Thus, output in the VPD_4-case of Table ($1b_2$) is above that in the VPD_4-case of Table ($1b_1$). Given our analysis in Section IVa, the explanation for this result is straightforward: with a large pre-existing variable-priced debt, the "asset-revaluation" effect dominates the "expectation" effect. Hence the size of the short-run change in R decreases as the value of ξ rises. In fact, in the VPD_5-case of Table ($1b_2$), the short-run increase in the long rate R is only 1.87 percent. Moreover, because of the strong asset-revaluation effect, the initial change in the short-rate r is actually negative. As a result, output initially falls by only .02 percent.

B. Dynamic adjustment

Tables ($1a_1$*) and ($1b_1$*) in Appendix I show the evolution over time of several key variables: output, prices, wages, interest rates, the capital stock and the current account.

(*a*) When all the past and the new debt is FPD, adjustment occurs as follows. Because of the initial CA surplus and the reduction in the new borrowing, the interest-rate r temporarily falls below r*. As both b and r fall, consumption recovers and output rises. Soon, however, the CA moves into deficit, because the decrease in the capital stock drives up the prices of home goods by lowering domestic production. The debt therefore starts to grow after year 1, and this leads to a rise in the borrowing-rate r (through an increased risk-premium on the new loans). As the debt grows and the interest rate r rises, consumption, investment and output fall. After year 4, prices and wages also start to decline so that the CA deficit is gradually reduced. In the long-run, output decreases due to the lower

TABLE $(2a_1)^{(+)}$ - *Impact effects of a 5% transitory increase in $r*$* (++)

$\overline{B}/\overline{Y} = .3,\ \xi = 0$

	FPD	VPD_1	VPD_2	VPD_3	VPD_4	VPD_5
Real GDP	-5.08	-2.75	-2.74	-2.59	-1.93	-.27
y						
Interest rates						
R		1.65	1.65	1.65	1.65	1.65
r	5.00	5.00	5.00	5.00	5.00	5.00
Price level						
p	-3.72	-1.82	-1.80	-1.68	-1.14	- .21
Consumption						
c_1	-3.91	-2.45	-2.43	-2.27	-1.53	.33
c_2	-1.55	- .94	- .93	- .87	- .58	.12
(c_1+c_2)	-5.46	-3.39	-3.36	-3.04	-2.11	.45
Investment						
i_n	-1.97	- .69	- .69	- .68	- .64	- .56
Current account						
CA	1.26	.16	.16	.13	.01	- .30

TABLE $(2a_2)$ (+) - *Impact effects of a 5% transitory increase in $r*$* (++)

$\overline{B}/\overline{Y} = .3,\ \xi = .6$

	FPD	VPD_1	VPD_2	VPD_3	VPD_4	VPD_5
Real GDP	-4.84	-3.48	-3.42	-2.95	-1.55	-.07
y						
Interest rates						
R		2.73	2.70	2.50	1.89	1.17
r	5.00	5.00	4.94	4.44	2.88	1.06
Price level						
p	-3.52	-2.41	-2.37	-2.03	-1.02	- .04
Consumption						
c_1	-3.75	-2.90	-2.85	-2.40	-1.05	.34
c_2	-1.49	-1.13	-1.11	- .94	- .42	.12
(c_1+c_2)	-5.24	-4.03	-3.96	-3.34	-1.47	.46
Investment						
i_n	-1.83	-1.09	-1.07	- .99	- .72	- .40
Current account						
CA	1.15	.50	.50	.42	.18	- .15

(+) Duration of disturbance: Two 'Years'

(++) Percentage deviations from initial steady-state values capital stock. Prices and wages rise when $\overline{B}/\overline{Y} = .2$, and they fall slightly when $\overline{B}/\overline{Y} = .3$. Irrespective of the value of $\overline{B}$, however, the stock of the debt increases in the long-run.

(*b*) In the case of VPD_1, VPD_2 and VPD_3, the initial CA surplus also causes the short-rate r to fall temporarily below the foreign interest rate. As the drop in r reduces the interest payments on the pre-existing FPD, consumption is increased. The increase in consumption outweighs the decline in investment (caused by the rise in the long-rate R). Thus, between years 0 and 1, output expands. After year 1, both R and r rise while y falls. But the long-rate R is always above the short-rate r. As a result, investment, the capital stock and output decrease over time faster than in the FPD-case.

(*c*) In the case of VPD_4 and VPD_5, the long-rate R again rises over time, and it exceeds the short-rate r throughout the simulation. In the early years of the adjustment period, however, R is below the foreign interest rate. Thus, in year 10, the decrease in output (relative to its initial steady-state value) is smaller than that in the FPD-case. Relative to the FPD-case, therefore, the adjustment to the shock is slower.

IV.b_3 Temporary shocks

A. Impact effects

The numerical values in Tables ($2a_1$),($2a_2$), ($2b_1$) and ($2b_2$) illustrate several important points:

(*a*) With $\xi = 0$, the impact effects on domestic variables of a purely transitory increase in r* are, in general, less pronounced with VPD than

TABLE (2b_1) (+) - *Impact effects of a 5% transitory increase in $r*$* (++)
$\bar{B}/\bar{Y} = .3,\ \xi = 0$

	FPD	VPD_1	VPD_2	VPD_3	VPD_4	VPD_5
Real GDP	-5.08	-3.75	-3.73	-3.52	-2.60	-.30
y						
Interest rates						
R		3.09	3.09	3.09	3.09	3.09
r	5.00	5.00	5.00	5.00	5.00	5.00
Price level						
p	-3.72	-2.63	-2.61	-2.44	-1.69	.20
Consumption						
c_1	-3.91	-3.98	-3.05	-2.82	-1.78	.80
c_2	-1.55	-1.20	-1.19	-1.10	- .71	.28
(c_1+c_2)	-5.46	-5.18	-4.24	-3.92	-2.49	1.08
Investment						
i_n	-1.97	-1.24	-1.23	-1.22	-1.17	-1.05
Current account						
CA	1.26	.63	.63	.56	.27	- .45

TABLE (2b_2) (+) - *Impact effects of a 5% transitory increase in $r*$* (++)
(Percentage deviations from initial equilibrium values)
$\bar{B}/\bar{Y} = .3,\ \xi = .6$

	FPD	VPD_1	VPD_2	VPD_3	VPD_4	VPD_5
Real GDP	-4.84	-5.19	-5.08	-4.16	-1.78	-.02
y						
Interest rates						
R		5.26	5.19	4.64	3.06	1.50
r	5.00	5.00	4.88	3.96	1.56	- .07
Price level						
p	-3.52	-3.81	-3.73	-3.06	-1.32	- .03
Consumption						
c_1	-3.75	-3.98	-3.87	-3.04	- .92	.49
c_2	-1.49	-1.58	-1.54	-1.22	- .40	.16
(c_1+c_2)	-5.24	-5.56	-5.41	-4.26	-1.32	.65
Investment						
i_n	-1.83	-2.03	-2.00	-1.77	-1.13	- .52
Current account						
CA	1.15	1.32	1.29	1.08	.46	- .16

(+) Duration of disturbance: Six 'Years'

(++) Percentage deviations from initial steady-state values with FPD (see Tables ($2a_1$)-($2b_1$)). This is due to two factors. First is the anticipation that the foreign interest rate will eventually revert back to its original level, which causes the long-rate R to rise in the short-run by less than 5 percent. Second is the wealth effect of VPD, which has a stabilizing impact on domestic output through consumption.

(*b*) When the substitutability of claims on home residents and other assets in the foreign investors' portfolios is less than perfect, however, the outcomes depend on both the duration of the disturbance and the initial conditions of the home economy. Consider, first, the case where the disturbance is expected to persist for only two years. As Table ($2a_2$) shows, in this case, the short-run reduction in output is smaller with variable-priced debt than with fixed-priced debt, regardless of the initial $VPD_{/FPD}$ ratio. Consider, however, the results presented in Table ($2b_2$), where the disturbance is assumed to persist for six years. Here the effects of variable-priced debt depend on the size of $\dot{\bar{B}}_2$. *First*, in the VPD_2-case (as well as in the VPD_1-case), even a purely transitory increase in the foreign interest rate leads to a greater than proportional short-run increase in the borrowing-rate R. This is because the "expectation" effect of VPD dominates both the "asset-revaluation" effect and the anticipation that r* will eventually revert back to its original level. As a consequence, the short-run drop in investment, output and consumption is greater than the drop which occurs when all the past debt and the new borrowing is in the form of FPD. *Second*, in the VPD_3-case of Table ($2b_2$) the long-rate R exceeds its level in the corresponding case of Table ($2b_1$). This indicates that the "expectation" effect of VPD is still relatively strong. But R is slightly below the foreign interest rate r^*. Also, domestic consumption falls by only 3.04 percent (due to the wealth effect of VPD and the impact of the asset-revaluation effect on the short rate r). Thus, output in the VPD_3-case of Table ($2b_2$) is higher relative to its level in the FPD-case, althought it is lower relative to its level in the VPD_3-case of Table ($2b_1$). *Third*, in the VPD_4-case of the table, the value of R is only fractionally smaller, and the level of investment only marginally higher, than those in the corresponding case of Table ($2b_1$). Investment is also not significantly above its value in the FPD-case. However, the level of output in the VPD_4-case of Table ($2b_2$) exceeds that in the VPD_4-case of Table ($2b_1$) and in the FPD-case by .82 and 3.02 percent respectively. The fact that output drops by less in the VPD_4-case of Table ($2b_2$) than in the VPD_4-case of Table ($2b_1$) is mainly due to the impact of the asset-revaluation effect of VPD on consumption through the short rate r: because of the asset- revaluation effect, r initially rises by 1.56 percent and hence the interest payments on the outstanding fixed-priced increase only slightly. Relative to the FPD-case, the decrease in output is even smaller due to the wealth effect of VPD. *Finally*, the long rate R in the VPD_5-case of Table ($2b_2$) is significantly below its level in the VPD_5-case of Table ($2b_1$). As a result, in the former case, investment falls by .52 percent and output is only .02 percent lower than in the initial steady state.

B. Dynamic Adjustment

Consider now the dynamic adjustment of the home economy to the purely temporary shock of Table ($2b_2$). Table ($2b_2$*) show the time-path of output, of the short-rate r, of the long-rate R, and of the CA:

(*a*) When all the past and the new borrowing is in the form of FPD, TABLE ($2b_2$*)

(a) *FPD: Dynamic adjustment to a transitory increase in r* by 5 percent. (Percentage deviations from initial equilibrium values)*

Time elapsed ('Years')	Real GDP	Interest Rates		Current account
	y	R	r	CA
0	-4.8		5.0	1.10
1	-2.5		4.3	- .12
2	-3.0		4.9	- .32
3	-3.7		5.7	- .35
4	-4.4		6.5	- .36
5	-5.1		7.4	- .36
6	-2.7		3.0	.75
7	-1.7		2.1	.14
8	-1.5		1.1	.01
∞	0		0	0

TABLE ($2b_2$*)

(b) *VPD_1: Dynamic adjustment to a transitory increase in r* by 5 percent. (Percentage deviations from initial equilibrium values)*

Time elapsed ('Years')	Real GDP	Interest Rates		Current account
	y	R	r	CA
0	-5.2	5.3	5.0	1.30
1	-2.7	5.4	3.9	- .05
2	-3.0	5.7	4.5	- .42
3	-3.6	5.8	5.7	- .53
4	-4.2	5.7	7.0	- .56
5	-4.7	5.4	8.3	- .55
6	-1.0	1.5	3.0	.79
7	-1.3	1.4	1.9	.26
8	-1.1	1.3	1.4	.04
∞	0	0	0	0

until year 5 the pattern of adjustment is very similar to that which occurs if the shock is believed to be permanent. Thus r falls below the foreign interest rate in year 1, and then it rises continually until year 6 when r* reverts back to its original value. In this year, r drops (relative to its level in year 5) by 4.4 percent; output increases (relative to its level in year 5) by 2.4 percent; and the CA moves into surplus. After year 6, the borrowing rate r falls further, y rises and the CA surplus is reduced.

(*b*) In the case of VPD_1, VPD_2, and VPD_3, the long-rate rate R initially continues to increase. Over time, however, the future horizon over which high foreign interest-rates are expected to prevail is shortened. Thus, two years before r falls again, the forward-looking rate R starts to fall. On the other hand, the short-rate r falls between year 0 and year 1 (due to the initial CA surplus and the reduction in the new borrowing), and then it rises continually until the reversal of the shock. As a result, in year 5, the long-rate R is significantly below the short-rate r. Although output decreases between years 2 and 5 (due to the impact of the rise in r on consumption through the cost of servicing the oustanding fixed-priced debt), the rate at which it decreases is slower than that in the FPD-case. This is because the fall in the long rate R leads to higher investment.

(*c*) The characteristics of the adjustment path in the case of VPD_4 and of VPD_5 are in general similar to those in the other VPD-cases. Because in the VPD_5-case R initially rises by only 1.5 percent, however, in year 5 (one year before the reversal of the shock) and in year 7 (one year after the reversal of the shock) the level of output is substantially higher than in the FPD-case.

TABLE ($2b_2$*)

(c)VPD_2: Dynamic adjustment to a transitory increase in r by 5 percent.*
(Percentage deviations from initial equilibrium values)

Time elapsed ('Years')	Real GDP y	Interest Rates R	Interest Rates r	Current account CA
0	-5.1	5.2	4.9	1.30
1	-2.6	5.4	3.8	- .05
2	-3.0	5.6	4.4	- .42
3	-3.6	5.7	5.6	- .53
4	-4.2	5.7	6.9	- .56
5	-4.7	5.3	8.3	- .55
6	-2.2	1.5	3.0	.79
7	-1.3	1.4	1.9	.25
8	-1.1	1.2	1.4	.04
∞	0	0	0	0

TABLE ($2b_2$*)

(d)VPD_3: Dynamic adjustment to a transitory increase in r by 5 percent.*
(Percentage deviations from initial equilibrium values)

Time elapsed ('Years')	Real GDP y	Interest Rates R	Interest Rates r	Current account CA
0	-4.2	4.6	4.0	1.10
1	-2.1	4.9	3.1	- .12
2	-2.5	5.1	3.8	- .45
3	-3.1	5.3	5.0	- .54
4	-3.7	5.3	6.3	- .60
5	-4.2	4.9	7.7	- .55
6	-2.0	1.4	2.7	.73
7	-1.2	1.2	1.7	.23
8	-1.0	1.2	1.3	.04
∞	0	0	0	0

TABLE ($2b_2$*)

(e) VPD_4: Dynamic adjustment to a transitory increase in r by 5 percent.*
(Percentage deviations from initial equilibrium values)

Time elapsed ('Years')	Real GDP y	Interest Rates R	Interest Rates r	Current account CA
0	-1.8	3.1	1.6	.46
1	- .9	3.4	1.3	- .32
2	-1.3	3.7	2.0	- .53
3	-1.8	3.9	3.1	- .58
4	-2.4	3.9	4.5	- .57
5	-2.9	3.7	6.1	- .52
6	-1.2	.9	1.7	.46
7	- .8	.9	1.1	.15
8	- .7	.8	.9	.09
∞	0	0	0	0

TABLE ($2b_2$*)

(f) VPD_5: Dynamic adjustment to a transitory increase in r by 5 percent.*
(Percentage deviations from initial equilibrium values)

Time elapsed ('Years')	Real GDP y	Interest Rates R	Interest Rates r	Current account CA
0	- .02	1.5	- .07	- .16
1	.08	1.8	.09	- .55
2	- .20	2.1	.39	- .64
3	- .53	2.3	1.20	- .64
4	- .89	2.4	2.30	- .59
5	-1.30	2.3	4.00	- .49
6	- .26	.5	.27	.12
7	- .38	.5	.43	.05
8	- .40	.5	.50	.00
∞	0	0	0	0

IV.b_4. <u>Foreign Interest-Rate Increases During 1980-1985.</u>

Tables ($3a_2$) and ($3a_3$) illustrate, respectively, the short-run and dynamic adjustment of the system to the shock described by Table ($3a_1$):

(*a*) In general, the impact effects of the shock are more pronounced with "variable-priced" debt than with "fixed-priced" debt. Firstly, in the VPD*-case, there is a larger immediate decline in investment as the expectation of additional foreign interest-rate increases in the future causes the long rate R to rise in the short run by more than the initial rise in r*. As a result, output falls by 3.51 percent in the former case and by 2.67 percent in the latter case. Secondly, given that the decline of output is greater with VPD than with FPD, the decline in consumption is also larger: aggregate consumption falls by 3.53 percent in the case of VPD* and by 2.82 percent in the case of FPD*. Thirdly, in both cases, prices fall and the CA moves into surplus. The size of the surplus, however, is larger in the VPD*-case (due to the larger drop in domestic prices).

(*b*) Between years 0 and 1, in both cases, output increases as the initial CA surplus leads to a reduction in the short-rate r and hence to a revival of consumption. In the VPD*-case, however, the long-rate R continues to rise (and, therefore, investment falls).

(*c*) When r* rises again in year 1, r increases and output declines in the FPD*-case. In the VPD*-case, the long rate R also increases. But the magnitude of the change in R is small: relative to its level in 'year 1/2', R rises by only .2 percent. Thus output remains roughly unchanged. However, the long-rate R is still above the foreign interest rate. As a result, in year 1, the level of output is lower in the VPD*-case than in the FPD*-case.

TABLE $(3a_2)$

Impact effects of the foreign interest-rate increases of 1980-85 (+)	FPD*	VPD*
Real GDP	-2.67	-3.51
y		
Interest rates		
R		4.01
r	2.95	2.95
Price level		
p	-1.95	-2.61
Consumption		
c_1	-2.02	-2.52
c_2	- .80	-1.01
(c_1+c_2)	-2.82	-3.53
Investment		
i_n	-1.09	-1.53
Current account		
CA	.72	1.10

TABLE $(3a_1)$

A. Foreign Interest rate Changes(+) r* (t)	Time ('Years')
7.0	0
8.0	1
11.0	2
8.0	3
5.0	4
6.0	5
6.0	∞

B. Initial Conditions

$\bar{B}/\bar{Y}$ = 25%
$\bar{B}_2/\bar{B}$ = .48%
$\bar{r}$ = 4%

C.

ξ = .4

TABLE $(3a_3)$-*Dynamic adjustment to the interest rate increases of 1980-85*(+)

Time elapsed ('Years')	Real GDP y (FPD*)	Interest Rates R (FPD*)	Interest Rates r (FPD*)	Current account CA (FPD*)	Real GDP y (VPD*)	Interest Rates R (VPD*)	Interest Rates r (VPD*)	Current account CA (VPD*)
0	-2.7		3.0	.72	-3.5	4.0	3.0	1.10
1/2	-1.5		2.6	.16	-1.96	4.1	2.4	.37
1	-1.7		3.4	-.18	-1.97	4.3	3.2	- .12
1 1/2	-1.9		3.5	-.23	-2.0	4.4	3.4	- .27
2	-3.1		6.1	-.81	-2.6	4.6	6.4	- .91
2 1/2	-3.7		6.7	-.67	-3.0	4.4	7.1	- .81
3	-2.9		4.6	-.01	-2.7	3.9	4.8	- .13
3 1/2	-2.8		4.7	-.18	-2.6	3.8	4.9	- .24
4	-1.6		2.0	.35	-2.0	3.3	2.0	.32
4 1/2	-1.3		1.9	.14	-1.8	3.5	1.8	.14
5	-1.8		2.8	-.14	-2.1	3.8	2.8	- .15
6	-2.0		3.0	-.11	-2.3	3.9	3.1	- .15
8	-2.2		3.3	-.09	-2.7	4.2	3.5	- .12
10	-2.5		3.6	-.08	-2.9	4.4	3.8	- .10
∞	-3.7		5.0	0	-3.7	5.0	5.0	0

(+) *Percentage deviations from initial equilibrium values* (*d*) When r* increases to 11 percent in year 2, the borrowing-rate r rises sharply in the FPD*-case: this causes output to fall (relative to its level in year 1) by 1.4 percent. Output also decreases in the VPD*-case, as both R and r rise. Because of the expected future fall in the foreign interest rate, however, the rise in the long-rate R is relatively small. Hence, in the VPD*-case, ouput drops (relative to its level in year 1) by only .63 percent.

(*e*) In year 3, when the foreign interest rate falls by 3 percent, r in the FPD*-case drops (relative to its level in year 2 $^1/_2$) by 2.1 percent. Hence, consumption and investment recover and output expands. In the VPD*-case, the long-rate R drops only slightly and, as a result, the output increase (relative to year 2 $^1/_2$) is only .3 percent. But the level of output in the VPD*-case is now slightly above that in the FPD*-case.

(*f*) In year 4, when r* drops again, the borrowing-rate r in the FPD*-case decreases significantly: in this year, r is only 2 percent higher than its initial steady-state value. As a consequence, output is only 1.6 percent lower than in the initial steady state. Moreover, the CA is in surplus. In the VPD*-case, the CA also moves into surplus. But the long-rate R falls (relative to its level in year 3 $^1/2$) by only .5 percent. Thus, output in the VPD*-case is now below that in the FPD*-case.

(*g*) Due to the CA surplus in year 4, there is a drop in the short-rate r and a revival of consumption in year 4 $^1/2$. Thus, both in the FPD*-case and in the VPD*-case, output expands. However the CA surplus is reversed in year 5, when r* rises to 6 percent. Also, in this year, R is above the foreign interest rate. This is because participants in the international money markets anticipate that no further reductions in r* will take place in the future and that the home country's debt will eventually grow: i.e.

the forward-looking rate R incorporates the required risk-premium on the new lending. As a result, in that year, the decrease in output is 2.1 percent in the VPD*-case and 1.8 percent in the FPD*-case.

(g) After year 5, in both cases, borrowing-rates rise and output falls. However, even after ten years of simulation, the output decrease relative to the initial steady state is larger in the VPD*-case than in the FPD*-case. Hence, the system adjusts to the long-run change in r* more gradually with FPD than with VPD.

IV.b_5 "Welfare Effects" of Variable-Priced Debt

Tables (4a), (4b) and (4c) below show, respectively, the "welfare effects" of a permanent increase in r*, of a purely temporary rise in r*, and of shock described by Table ($3a_1$). These "welfare effects" are measured in terms of the discounted-value of the total consumption forgone due to the shocks. Twenty-years of simulation have been used to calculate the "welfare loss", and the discount factor has been set equal to .8 (For comparison purposes, we have set ξ = .4 in all the cases examined).

'WELFARE EFFECTS' (%)

TABLE (4a): *Permanent Increase in r* by 5 percent*

(a) FPD	(b) VPD_2	(c) VPD_5
-26.5	-30.9	-2.8

TABLE (4b)(+): *Transitory Increase in r* by 5 percent*

(a) FPD	(b) VPD_2	(c) VPD_5
-17.9	-16.2	+.11

TABLE (4c): *Foreign Interest Rate Increases of 1980-85*

(a) FPD*	(b) VPD*
-13.4	-14.7

(+) Duration of disturbance: Six 'Years'

The numerical values in Tables (4a)-(4c) illustrate two main points: first, for any given set of 'initial' conditions the welfare effects of VPD are highly sensitive to the nature of the shock; and, second, whether the shock is permanent or purely transitory, the direction and the size of such welfare effects depend crucially on the initial conditions of the home economy.

Consider first the case where the pre-existing VPD is relatively small (column (b) of Tables (4a)-(4c)). In terms of our welfare criterion: (i) the welfare loss that results from a permanent increase in the foreign interest rate is greater with VPD than with FPD; (ii) the welfare loss caused by a purely transitory rise in r* is less pronounced with VPD than with FPD, but the magnitude of the difference is small; and (iii) the loss that results from the shock described by Table ($3a_1$) is larger in the VPD*-case than in the FPD*-case.

Consider now the case where the pre-existing variable-priced debt is relatively large (column (c) of Tables (4a)-(4b)). In terms of our welfare criterion: (i) when the shock is permanent, the loss is smaller with VPD than with FPD; and (ii) when the shock is purely transitory, VPD actually leads to a welfare gain.

V. *Concluding Comments.*

In many recent proposals for changing the nature and terms of international lending to the debtor countries, there are strong suggestions for longer-term finance to DCs, for an increased role of nonbank private institutions in the lending process, and for a greater 'securitization' of the lending. In the literature, to date, however, there has been no attempt to investigate formally the implications of these proposals for the borrowing countries.

Our results can be summarized as follows: first, whether or not "variable-priced" debt can be considered preferable to "fixed-priced" debt depends crucially on the initial conditions of the domestic economy and on the nature of the external financial shocks; and, second, both the macroeconomic and the welfare implications of VPD are likely to differ among countries and over time.

Notes.

1. In the period 1981-83, when the ability and willingness of the DCs to continue to service their debts was in doubt, most of these proposals concentrated on possible modifications in the terms and conditions of bank lending (for example, lower interest-rate spreads over LIBOR, interest capitalization for countries with poor economic performance, and multi-year re-schedulings). For these proposals, see Lessard and Williamson (1985), Cline (1983, 1984), Williamson (1986), Camdessus (1986) and Bergsten, Cline and Williamson (1985).

2. We implicitly assume that all the liabilities of the domestic residents are denominated in foreign currency. One could alternatively assume that domestic borrowers issue long-term bonds denominated in domestic currency. Introducing this assumption will have virtually no effect on our results, given that the exchange rate is taken to be fixed (as is indeed the case in most of the DCs).

3. This is equivalent to assuming perfect substitutability between short-term and long-term foreign assets. In fact, in the case of the industrial countries, there is no strong empirical evidence against this assumption: See e.g. Begg (1983), Ch. 5.

4. The inlcusion of equation (8b) in the model does not essentially alter any of its qualitative characteristics.

5. As in Chapter 6, the specification of the model is based on the simplifying assumption that the world is not characterized by conditions of secular inflation.

Appendix IA.

TABLE ($2a_1$*)- FPD:Dynamic adjustment to a 5% Permanent Increase in r* (++)

Time elapsed ('Years')	Real GDP y	Price Level p	Interest Rates r	R	Capital Stock k	Current Account CA	b	Wages w
0	-4.3	-3.1	5.0		0	1.30		0
1/2	-2.3	-.9	4.6		-2.3	.32		-.7
1	-2.1	.4	4.5		-3.3	-.08		-.1
1 1/2	-2.2	1.1	4.6		-3.9	-.25		.4
2	-2.4	1.4	4.8		-4.3	-.32		.6
4	-3.1	1.6	5.6		-5.4	-.31		.8
6	-3.7	1.5	6.3		-6.1	-.25		.8
8	-4.2	1.5	6.8		-6.7	-.19		.7
∞	-7.1	1.2	8.6		-8.6	0	11.91	.6

TABLE ($2a_1$*)- VPD_1:Dynamic adjustment to a 5% Permanent Increase in r* (++)

Time elapsed ('Years')	Real GDP y	Price Level p	Interest Rates r	R	Capital Stock k	Current Account CA	b	Wages w
0	-5.1	-3.8	5.0	6.0	0	1.70		0
1/2	-2.9	-1.1	4.4	6.1	-3.0	.55		-.9
1	-2.5	.7	4.2	6.2	-4.5	.01		-.1
1 1/2	-2.6	1.7	4.3	6.4	-5.3	-.26		.6
2	-2.8	2.2	4.5	6.6	-5.9	-.39		1.0
4	-3.6	2.5	5.6	7.2	-7.0	-.43		1.3
6	-4.3	2.2	6.5	7.6	-7.5	-.32		1.1
8	-4.7	1.9	7.1	7.9	-7.9	-.22		1.0
∞	-7.1	1.2	8.6	8.6	-8.6	0	11.91	.6

TABLE ($2a_1$*)- VPD_2:Dynamic adjustment to a 5% Permanent Increase in r* (++)

Time elapsed ('Years')	Real GDP y	Price Level p	Interest Rates r	R	Capital Stock k	Current Account CA	b	Wages w
0	-5.1	-3.7	5.0	6.0	0	1.70		0
1/2	-2.8	-1.1	4.4	6.1	-3.0	.54		-.8
1	-2.5	.7	4.2	6.2	-4.5	.01		-.05
1 1/2	-2.6	1.2	4.3	6.4	-5.3	-.27		.6
2	-2.8	2.2	4.5	6.6	-5.9	-.40		1.0
4	-3.6	2.5	5.6	7.1	-7.0	-.43		1.3
6	-4.3	2.2	6.5	7.6	-7.5	-.32		1.1
8	-4.7	1.9	7.1	7.9	-7.8	-.22		1.0
∞	-7.1	1.2	8.6	8.6	-8.6	0	12.13	.6

TABLE ($2a_1$*)- VPD_3:Dynamic adjustment to a 5% Permanent Increase in r* (++)

Time elapsed ('Years')	Real GDP y	Price Level p	Interest Rates r	R	Capital Stock k	Current Account CA	b	Wages w
0	-4.7	-3.4	4.6	5.8	0	1.50		0
1/2	-2.6	-.9	4.0	5.9	-2.9	.45		-.7
1	-2.3	.9	3.9	6.1	-4.3	-.07		-.05
1 1/2	-2.4	1.8	4.0	6.2	-5.2	-.32		.7
2	-2.6	2.3	4.2	6.4	-5.8	-.45		1.0
4	-3.5	2.6	5.4	7.0	-6.9	-.47		1.3
6	-4.1	2.3	6.3	7.5	-7.4	-.35		1.2
8	-4.6	2.0	7.0	7.8	-7.8	-.24		1.0
∞	-7.1	1.2	8.6	8.6	-8.6	0	14.05	.6

TABLE ($2a_1$*)- VPD_4:Dynamic adjustment to a 5% Permanent Increase in r* (++)

Time elapsed ('Years')	Real GDP y	Price Level p	Interest Rates r	R	Capital Stock k	Current Account CA	b	Wages w
0	-3.1	-2.3	3.1	5.0	0	1.00		0
1/2	-1.6	-.0	2.8	5.2	-2.5	.10		-.3
1	-1.5	1.4	2.8	5.4	-3.8	-.33		.4
1 1/2	-1.7	2.3	3.0	5.6	-4.6	-.54		.9
2	-1.9	2.7	3.2	5.8	-5.2	-.64		1.2
4	-2.9	2.8	4.5	6.5	-6.4	-.61		1.4
6	-3.7	2.4	5.6	7.1	-7.0	-.46		1.2
8	-4.2	2.1	6.1	7.5	-7.2	-.39		1.2
∞	-7.1	1.2	8.6	8.6	-8.6	0	22.63	.6

TABLE ($2a_1$*)- VPD_5:Dynamic adjustment to a 5% Permanent Increase in r* (++)

Time elapsed ('Years')	Real GDP y	Price Level p	Interest Rates r	R	Capital Stock k	Current Account CA	b	Wages w
0	-.9	-.6	1.0	3.6	0	.12		0
1/2	-.2	1.1	.9	3.8	-1.0	-.51		-.2
1	-.3	2.1	1.0	4.0	-2.8	-.80		.8
1 1/2	-.5	2.7	1.3	4.3	-3.5	-.94		1.2
2	-.8	3.0	1.6	4.5	-4.0	-.99		1.4
4	-1.8	3.0	3.0	5.3	-5.1	-.89		1.5
6	-2.6	2.7	4.1	6.0	-5.9	-.72		1.3
8	-3.3	2.4	4.8	6.5	-6.4	-.60		1.2
∞	-7.1	1.2	8.6	8.6	-8.6	0	44.06	.6

(++) Percentage Deviations from Initial Equilibrium Values

Appendix IB

TABLE ($2b_1$*)- FPD:Dynamic adjustment to a 5% Permanent Increase in r* (++)

Time elapsed ('Years')	Real GDP y	Price Level p	Interest Rates r	R	Capital Stock k	Current Account CA	b	Wages w
0	-5.0	-3.60	5.0		0	1.20		0
1/2	-2.9	-1.50	4.6		-2.3	.24		-.94
1	-2.6	-.28	4.6		-3.4	-.14		-.41
1 1/2	-2.8	.34	4.7		-4.0	-.30		.01
2	-3.0	.62	4.9		-4.5	-.37		.24
4	-3.9	.68	5.9		-5.6	-.37		.35
6	-4.7	.48	6.7		-6.5	-.30		.25
8	-5.4	.30	7.3		-7.2	-.24		.16
∞	-7.8	-.40	9.8		-9.8	0	15.99	-.20

TABLE ($2b_1$*)- VPD_1:Dynamic adjustment to a 5% Permanent Increase in r* (++)

Time elapsed ('Years')	Real GDP y	Price Level p	Interest Rates r	R	Capital Stock k	Current Account CA	b	Wages w
0	-6.0	-4.5	5.0	6.4	0	1.70		0
1/2	-3.5	-1.7	4.4	6.5	-3.2	.52		-1.10
1	-3.1	.1	4.3	6.7	-4.8	-.03		-.34
1 1/2	-3.2	1.2	4.4	6.7	-5.8	-.31		.33
2	-3.5	1.7	4.6	7.1	-6.4	-.45		.71
4	-4.5	1.8	5.8	7.8	-7.7	-.50		.93
6	-5.4	1.3	6.9	8.3	-8.3	-.39		.68
8	-6.1	.8	7.7	8.8	-8.7	-.28		.44
∞	-7.8	-.4	9.8	9.8	-9.8	0	15.99	-.20

TABLE ($2b_1$*)- VPD_2:Dynamic adjustment to a 5% Permanent Increase in r* (++)

Time elapsed ('Years')	Real GDP y	Price Level p	Interest Rates r	R	Capital Stock k	Current Account CA	b	Wages w
0	-5.9	-4.4	4.9	6.3	0	1.70		0
1/2	-3.4	-1.7	4.3	6.5	-3.2	.51		-1.10
1	-3.1	.2	4.2	6.7	-4.8	-.04		-.32
1 1/2	-3.2	1.2	4.3	6.9	-5.7	-.32		.34
2	-3.4	1.7	4.6	7.1	-6.4	-.46		.73
4	-4.5	1.8	5.8	7.8	-7.6	-.51		.94
6	-5.4	1.3	8.3	8.3	-8.3	-.39		.69
8	-6.1	.8	8.7	8.7	-8.7	-.28		.49
∞	-7.8	-.4	9.8	9.8	-9.8	0	16.36	-.20

TABLE ($2b_1$*)- VPD_3:Dynamic adjustment to a 5% Permanent Increase in r* (++)

Time elapsed ('Years')	Real GDP y	Price Level p	Interest Rates r	R	Capital Stock k	Current Account CA	b	Wages w
0	-5.2	-3.9	4.3	6.0	0	1.50		0
1/2	-3.0	-1.3	3.8	6.2	-3.0	.37		-.91
1	-2.7	.5	3.7	6.4	-4.6	-.14		-.14
1 1/2	-2.8	1.5	3.9	6.6	-5.5	-.31		.49
2	-3.1	1.9	4.1	6.8	-6.1	-.43		.84
4	-4.2	2.0	5.4	7.6	-7.0	-.56		1.00
6	-5.2	1.4	6.6	8.1	-8.1	-.43		.75
8	-5.9	1.0	7.4	8.6	-8.5	-.32		.50
∞	-7.8	-.4	9.8	9.8	-9.8	0	19.66	-.20

TABLE ($2b_1$*)- VPD_4:Dynamic adjustment to a 5% Permanent Increase in r* (++)

Time elapsed ('Years')	Real GDP y	Price Level p	Interest Rates r	R	Capital Stock k	Current Account CA	b	Wages w
0	-2.8	-2.1	2.3	4.8	0	.73		0
1/2	-1.4	.1	2.0	5.0	-2.4	-.11		-.25
1	-1.4	1.5	2.1	5.2	-3.7	-.52		.42
1 1/2	-1.6	2.2	2.4	5.5	-4.5	-.71		.91
2	-1.9	2.5	2.7	5.7	-5.1	-.80		1.20
4	-3.1	2.4	4.1	6.6	-6.4	-.76		1.20
6	-4.2	1.9	5.4	7.3	-7.2	-.61		.97
8	-5.0	1.4	6.4	7.9	-7.8	-.47		.71
∞	-7.8	-.4	9.8	9.8	-9.8	0	34.36	-.20

TABLE ($2b_1$*)- VPD_5:Dynamic adjustment to a 5% Permanent Increase in r* (++)

Time elapsed ('Years')	Real GDP y	Price Level p	Interest Rates r	R	Capital Stock k	Current Account CA	b	Wages w
0	-.1	-.0	.2	2.9	0	-.3		0
1/2	.3	1.4	.2	3.1	-1.5	-.8		.4
1	.1	2.2	.3	3.3	-2.3	-1.0		.9
1 1/2	-.1	2.6	.5	3.6	-2.9	-1.1		1.2
2	-.4	2.8	.8	3.8	-3.4	-1.2		1.4
4	-1.5	2.7	2.1	4.7	-4.5	-1.1		1.4
6	-2.4	2.2	3.3	5.5	-5.3	.9		1.1
8	-3.3	1.8	4.2	6.1	-6.0	.8		1.0
∞	-7.8	-.4	9.8	9.8	-9.8	0	71.10	-.2

(++) Percentage Deviations from Initial Equilibrium Values

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