Britain's Return to Gold and Impending Entry into the EMS: Expectations, Joining Conditions and Credibility*

Marcus Miller and Alan Sutherland
University of Warwick

July 1990

No. 361

Abstract

In this paper the surprising conclusion of Smith and Smith (1990) that the prospect of Britain's return to Gold in 1925 had the effect of weakening sterling is subjected to critical analysis. It is shown that this conclusion is reversed when the trend in the UK money stock prior to joining the Gold Standard is treated as endogenous; and when non-stationary solutions are considered. It is further suggested that a more realistic interpretation of events must involve the use of a model with price inertia. The final section of the paper considers the major difference between the UK's return to Gold and its impending entry into the EMS, namely the current lack of credibility attached to an exchange rate peg for sterling.

*This paper was prepared for a conference on "Exchange Rate Targets and Currency Bands" held at the University of Warwick sponsored by the CEPR and NBER, July 1990. We are most grateful to Robert Skidelsky and Paul Weller for extensive discussions and we are happy to acknowledge the financial support of the ESRC (grant no. R000231417). Responsibility for errors remains with us. This paper is ciculated for discussion purposes only and its contents should be considered preliminary.

Introduction

In studying changes of monetary regime Flood and Garber (1983) treated them as irreversible switches in the stochastic process determining prices and the exchange rate, and showed how the anticipation of such a regime change could affect the economy *ex ante*. As an application of these ideas they cited the behaviour of the pound sterling in the 1920's, when the return to the Gold Standard was widely anticipated; and in order to highlight the novel aspect of their study, they adopted "the simplest exchange rate model popular in the current literature - the monetary model."

Even with this simple model, the formal analysis was rather forbidding; but subsequent studies have derived closed-form solutions which are much easier to interpret, see Smith (1989) and Froot and Obstfeld (1989). Smith and Smith (1990) have used these solutions to spell out a surprising implication of the analysis, which is that the desire of the authorities to restore sterling back up to its pre-war peg of $4.86 had the effect of weakening sterling relative to what would have emerged from a clean float.

We begin our discussion of the return to gold by arguing that this paradoxical conclusion is probably due to misspecifying the nature of monetary policy. It is shown that treating the trends in money in the 1920's, not as exogenous, but as part and parcel of the planned return to gold radically changes one's interpretation of the effect of the anticipated regime switch. We also note that the stationary solutions proposed by the authors cited give no role to the fixed time limit implied by the expiration of the Gold and Silver (Export Control) Act at the end of 1925. Since its significance was stressed by those centrally involved in the decision to return, we indicate how non-stationary solutions can be obtained for the monetary model which allow a role for such time dependent features.

As the contemporary debate was to a very large extent focussed on the problems of securing the adjustment of British prices necessary to remain internationally competitive as sterling was pushed back to $4.86, it seems distinctly inappropriate to analyse events with a "monetary model" which assumes perfect flexibility of prices and continuous purchasing power parity. As an alternative, we therefore consider the same issues in a model where there is inertia in the price level. Postulating inertia in prices and not in monetary policy offers, we argue, a more convincing interpretation of the state contingent condition for return to gold than does the monetary model; and we note how it can generate endogenous time trends leading sterling towards its planned parity. However, the fact that British prices were widely thought to be <u>uncompetitive</u> (by about 10%) when sterling actually went back on gold in 1925, suggests the relevance of a non-stationary solution, which allows for return by a planned date (without regard to PPP being achieved). This solution, we believe, captures the role of "speculative anticipations" promoted by Sir Charles Addis, a director at the Bank of England, and lamented by Keynes, a vociferous critic of early return.

As the UK is once again in a situation where a change in regime is in prospect, the last part of the paper addresses some issues in the current debate on UK entry into the European Monetary System. We note, for example, that the contrast between state contingent and time dependent conditions has again been a feature.

What we focus on, however, is a key difference between now and then, namely the perceived credibility of the exchange rate peg after the regime switch. The Prime Minister has played an active role in opposing and delaying entry, and has explicitly indicated that she would allow realignments of sterling within the Exchange Rate Mechanism. So we suggest that UK entry in current circumstances can be thought of as a switch to a "peg with a peso problem"! Where there are forward looking labour contracts, we show how a realignment probability can undo some or all of the benefits of "locking" onto a hard currency like the deutschmark; and we note that even when there is a serious commitment to locking currencies, the perceived probability of realignment will raise the output cost of maintaining the peg.

1. The Return to Gold in the Monetary Model - A Reinterpretation.

In this section we spell out three key reservations concerning the existing analysis of the return to gold using the monetary model. The first concerns the role of the time trend in fundamentals assumed by both Flood and Garber and Smith and Smith. We show that if this trend is viewed as policy action implemented to speed the return to gold then, contrary to Smith and Smith's assertion, the appropriate interpretation of their results is that sterling was strengthened, not weakened. The second criticism is of the interpretation Flood and Garber place on their choice of state contingent joining condition. We dispute their suggestion that it represents a return to gold "when purchasing power parity is achieved" but show that it arises from an implicit assumption that the money supply does not make discrete adjustments - an assumption which is given no justification. Our third reservation concerning the existing analysis results from the emphasis put on state contingent joining conditions. We suggest that, in fact, expectations in 1925 were strongly affected by events fixed in calender time which were reckoned to set a time limit on floating. We use the monetary model to show how this kind of joining condition tends to pull sterling towards its known future value.

The two country model used by Flood and Garber to analyse the effect of a state-contingent commitment to stabilise sterling at $4.86 (listed in Annex 1) implies a linear "structural semi-reduced form" relationship between the current exchange rate (s(t), measured in logs), its own expected rate of change and economic fundamentals k(t). This takes the form

$$s(t) = k(t) + \lambda E_t \frac{[ds(t)]}{dt} \qquad (1)$$

where fundamentals are represented by

$$k(t) \equiv m(t) - m^*(t) + v(t) - v^*(t) - \phi[y(t) - y^*(t)]$$

λ is the interest semi-elasticity of demand for money, and $E_t[ds(t)]/dt$ is the expected rate of change of the exchange rate conditioned on the time t information set containing the structure of the model and all variables dated t or earlier. (For simplicity, structural parameters are assumed to be the same in the US and the UK.)

If fundamentals follow a Brownian motion process with instantaneous variance σ^2 and drift η, then, as Froot and Obstfeld (1989) show, the general stationary solution for the exchange rate is

$$s(t) = f[k(t)] = k(t) + \lambda\eta + A_1 e^{\rho_1 k(t)} + A_2 e^{\rho_2 k(t)} \qquad (2)$$

where $\rho_1>0$ and $\rho_2<0$ are the roots of

$$\rho^2\lambda\frac{\sigma^2}{2} + \rho\lambda\eta - 1 = 0$$

and where A_1 and A_2 are constants to be determined by boundary conditions.

The "free float" solution with no bubbles (A_1=A_2=0)

$$s(t) = k(t) + \lambda\eta \qquad (3)$$

is shown by the line FF in Figure 1 for the case where the trend is positive (due, for example, to the faster growth rate of velocity adjusted money, m+v, in the US).

If $\bar{s}$ is the desired parity then fixing the exchange rate at this level implies stabilising the fundamental at $\bar{k}$, where $\bar{k} = \bar{s}$. If discrete jumps in the money stock are ruled out (a point discussed below) then one obtains the boundary condition that a currently floating rate must pass through the point $\bar{s}, \bar{k}$. A second boundary condition is provided by the requirement that the solution should asymptotically approach the free float line as k diverges progressively below $\bar{k}$. So the following solution is obtained for the behaviour of the sterling/dollar rate in the period before the return to the gold standard,

$$s(t) = f[k(t)] = k(t) + \lambda\eta\left(1 - e^{\rho_1(k(t)-\bar{k})}\right) \qquad (4)$$

where $\rho_1 > 0$ (see Froot and Obstfeld (1989) and Smith (1989)). This appears as the curved line NG in Figure 1.

a) The interpretation of the trend.

The reason for Smith and Smith's assertion, that the value of sterling must be lower given the expectation of the peg than it otherwise would have been, is apparent from the picture. The line FF represents what Smith and Smith refer to as a "naive econometric forecast" (which ignores the peg) and the gap between FF and NG is a measure of the "misspecification" so caused. Comparison of (2) and (3) shows that this gap is measured by $-\lambda\eta e^{\rho_1(k(t)-\bar{k})}$: and some of the parameter estimates used by Smith and Smith in their figure imply that, in March 1925 when sterling was at $4.78, the commitment to achieve parity would have been <u>pulling it down</u> from a free float rate above $5.00!

Smith and Smith's paradoxical conclusion - that "contrary to the views of some Treasury advisors and of Keynes, the anticipated regime change had a negative effect on sterling" - can (as they admit) be criticised for treating as exogenous aspects of monetary policy which were in fact directly attributable to the exchange rate objective. What if, as is only too likely, the trend in fundamentals reflected a progressive tightening of UK monetary policy designed to push sterling towards its pre-war parity?[1]

The importance to their conclusions of the assumption that the trend in fundamentals is exogenous can be made most clearly by assuming the opposite - by treating it as entirely endogenous, due to a policy of pushing sterling back to $4.86. As we will show, this essentially reverses their interpretation of events: for in these circumstances the monetary model implies that sterling would have jump-appreciated much earlier (when it was realised what the policy was) and would only be sustained by the perceived culmination of the policy.

The easiest way to demonstrate this is to forget the noise in fundamentals and also to assume that, prior to the decision to go back to $4.86, the composite fundamental k had no trend. In the absence of actual or expected policy changes the solution for the exchange rate would be the 45^0 line passing through the origin (see equation (3), setting $\eta=0$). In these circumstances let the UK monetary authorities announce at time t_0 their intention to introduce a trend reduction in the UK money stock (relative to the US money stock) for as long as necessary to get sterling back to its pre-war parity - and no further. Under present assumptions, this would imply a predictable trend increase in k from $k(t_0)$ to $\overline{k}$, where it would stop.

[1] The authors appear to accept the relevance of this point (p170); and in their conclusion they go so far as to divide the causes of the appreciation of sterling into two categories (i) contemporary policy and other fundamentals, and (ii) the anticipation of the return to gold. While they claim to have shown the latter to be negative, they conclude that "fruitful empirical extensions of the story would involve abandoning our agnosticism about the identity of the fundamentals (in k(t))... monetary policy is one possibility".

What about sterling? Happily the solution is available from equations (1) and (2) by setting $\sigma=0$ ($\rho_1=1/\lambda\eta$) and the result is shown by the curve DG in Figure 1. At time t_0, when the plan is first announced (but before fundamentals have actually changed!) sterling must appreciate onto the line DG (see point J in Figure 1). Note that it does not appreciate as far as FF; that would only be appropriate if the trend were thought to be permanent. The subsequent trajectory (JG) for sterling is the combined result of the steady rise in the fundamental and the progressive unwinding of the jump appreciation as the end of the policy of monetary tightening gets closer.

The economic rationale for these movements is simply that changes in monetary trends lead (via their effects on the rate of interest) to changes in desired real balances. But if discrete jumps in the level of fundamentals are ruled out (see below) then it is the price level, and (by PPP) the exchange rate, which have to adjust. But from time t_0 onwards everything is perfectly predictable, so any jumps in the exchange rate must occur at the beginning.

How does this account depend on the omission of noise? It is obvious that adding back the noise to the evolution of fundamentals makes the date of return endogenous, but it does not change the story in any essential way. The size of the initial appreciation is somewhat reduced, however, as can be seen from Figure 1. Starting again at $k(t_0)$, the rate will only jump to J' on the line NG giving the solution for $\sigma>0$. (The reason why the "noisy" solution NG lies below the deterministic curve DG is because the latter is concave. Adding noise thus imparts a downward bias to the expected value of sterling and arbitrage considerations imply the need for a higher interest rate for sterling; in this model this is achieved by lowering the value of sterling which raises the price level and tightens monetary conditions.)

Treating the trend as policy induced does of course have dramatic effects on one's interpretation of the movements in sterling, as can be seen from Figure 1. Consider, for example, the case when fundamentals have reached the point k_1, quite close to $\bar{k}$ (where all trends and noise are to be "switched-off" by policy adjustment) and where sterling is at B on the path NG leading to \$4.86. For Smith and Smith, the market's recognition that pegging sterling involves "switching off" an exogenous trend is responsible for weakening sterling from A to B. The contrary interpretation is that sterling lies above C only because of the market's perception that the policy induced trend in fundamentals will continue a little longer! (Imagine for example that it were to be ended immediately, leaving fundamentals to "wander" randomly the rest of the way to $\bar{k}$, then the rate would fall to C on the 45^0 line.)

b) The interpretation of the state contingent joining condition.

In deriving their results Flood and Garber assert that "the timing of [sterling's return to the gold standard] depended on achieving purchasing power parity at the pre-war exchange rate". Below, we take issue with this as an accurate interpretation of history. First, however, it is important to point out that, on a purely technical level, such a joining condition is not particularly meaningful in the monetary model. Since in that model PPP holds in all states of the world and at all levels of the exchange rate, "achieving PPP" cannot provide a guide to the selection of a unique solution for the exchange rate!

To see that this is so consider Figure 2 where three possible solutions are illustrated. The Flood and Garber/Smith and Smith solution is, as before, marked NG. The second solution is marked FG' and coincides with the free-float line. The latter solution is sustained by the anticipation of a discrete reduction of the UK money supply by amount $\lambda\eta$ to take place at the moment sterling is restored to gold. Notice that no bending takes place and that, by definition, at the point of joining "purchasing power parity at the pre-war exchange rate has been achieved". This is also true of the third solution marked N'G" which bends up from the free-float line FF and involves a larger discrete reduction of UK money at the point of joining (measured by the distance G"G'). Indeed it can be seen that any solution can be sustained provided there is the anticipation of an appropriately sized discrete monetary adjustment at the time of joining, and all these solutions involve achieving "purchasing power parity at the pre-war exchange rate".

It appears therefore, that PPP considerations themselves are playing no part in the selection of the Flood and Garber/Smith and Smith solution. Instead the crucial assumption being made is the ruling out of discrete adjustments to the money supply. (The role of this assumption in determining the exchange rate behaviour within a currency band is discussed in Flood and Garber (1989).) It is only by assuming this form of "monetary inertia" that they are able to select their unique solution. We feel however, that the important source of inertia in the UK economy at that time was in goods prices, not the money supply! It is for this reason that later we use a model of price inertia to investigate sterling's return to gold.

c) The role of "speculative anticipations".

In their interpretation of events surrounding the return to gold both Flood and Garber and Smith and Smith dispense with the notion that there might have been any fixed "end date" by which the market was certain that return would be achieved, in favour of the idea that the timing was essentially endogenous. This is rather a surprising position to adopt for two reasons. First because there was a natural "end date" for floating, namely the expiry at the end of 1925 of the Gold and Silver (Export Control) Act of 1920. Second because this strict antithesis (between state contingent and time dependent) versions is unnecessary. As in the pricing of dated options, the two factors can be combined - so that the timing may be endogenous but only with a fixed horizon for example.

On the first point it is worth quoting from a letter (dated July 1924) to Keynes from Sir Charles Addis giving the latter's plan for exploiting the existence of the "end point" to secure an appreciation of sterling.

> "Had I a magician's wand I would cause a definite statement to be made, probably in reply to a question in the House of Commons, that HM Government has no present intention of interfering with the ordinary course of events by which on the expiry of the Prohibition Act the free export of gold would be resumed on the 1st January 1926... The effect of such an announcement if people really believed it would tend to raise the sterling exchange probably sharply at first and later more gradually". (Keynes, XIV, p268.)

It should be said that Keynes himself had been rather dismissive of the importance of the Gold and Silver Act in his evidence to the Bradbury Committee in July 1924. But later he was to argue that, starting in October 1924, "speculative anticipations" played a major role. In The Economic Consequences of Mr Churchill, for example, he wrote

> "The movement away from equilibrium began in October last [1924] and has proceeded, step by step, with the improvement of the exchange, brought about by the anticipation, and then by the fact, of the restoration of gold, and not by an improvement in the intrinsic value of sterling." (Keynes, Vol IX, 1970, pp209-10)

To see formally how this "speculative anticipation" could operate in the monetary model it is simplest to ignore the time trend (i.e. set η=0). Assuming there is an announcement that the authorities are to return to a fixed rate $\bar{s}$ at time T which is taken to be a fully credible expression of intent (and that the currency peg can be successfully defended) then one obtains a non-stationary solution to equation (1) of the form

$$s(t) = k(t)\left(1 - e^{-\frac{1}{\lambda}(T-t)}\right) + \bar{s}e^{-\frac{1}{\lambda}(T-t)} \qquad (5)$$

so the exchange rate over the interval [t,T] is a weighted average of the value under a free float (given simply by k(t)) and of the target value $\bar{s}$ with weights that vary over time (measured backwards from T).

The implied result of a credible announcement, illustrated in Figure 3, is almost exactly as described in Addis's plan. At the time of the announcement the floating rate jumps from the 45^0 line onto the flatter line passing through the point B (where $\bar{s}$ cuts the 45^0 line). Then this sharp movement is followed by a more gradual movement as the line showing the solution swivels until it coincides with $\bar{s}$ at T. (For present purposes we ignore the fact that the spread between the gold points means that the final equilibrium is a narrow band rather than simply a fixed value $\bar{s}$, but we give the solution for the more general case in Ichikawa, Miller and Sutherland (1990))

What has been outlined is a purely time dependent version of events, with the rate fixed for sure at time T, but not before. It implies, however, that if fundamentals were to go above $\bar{k}$ before T, for example, then sterling would be allowed to rise above $4.86. As this seems to rule out the known desire to return sterling to its pre-war parity as soon as reasonably possible, the obvious answer is to combine both the time dependent and state contingent elements; so sterling is assumed to return by a fixed end point for sure, but earlier if fundamentals happen to carry it to $4.86. This compromise can be seen in Figure 3 as the combination of the time dependent solution already discussed to the left of $\bar{k}$, but the fixed value of $\bar{s}$ to the right of $\bar{k}$.

2. A Model with Price Inertia.

We now turn to the fundamental question of price flexibility. The problem of securing price adjustment is stressed in Skidelsky's account of the return to gold; and it was made abundantly clear by Keynes in the following passage from The Economic Consequences of Mr Churchill

> "Our troubles are not due to either world wide recession or to reduced consumption at home. And it is obvious what does cause them. It is a question of relative price here and abroad. The prices of our exports in the international market are too high. About this there is no difference of opinion. Why are they too high? ... We know as a fact that the value of sterling money abroad has been raised by 10%, whilst its purchasing power over British labour in unchanged. This alteration in the exchange value of sterling money has been the deliberate act of the Governor and the Chancellor of the Exchequer, and the present troubles of our export industries are the inevitable and predictable consequences of it."

It is true that the UK Government and its advisers took an optimistic view of the speed of price adjustment at that time, but subsequent events seemed to have proved them wrong[1]. In this section we reconsider the analysis of state contingent and time dependent joining conditions in what we consider to be a more realistic model - where prices are slow to adjust.

Not only do we consider this model to be a more satisfactory representation of reality, it also allows us to give meaning to the idea that state contingent joining takes place "when PPP is achieved". However, after analysing this case we still

[1] There were evidently important differences of view about price flexibility, between the Government and commentators like Keynes, which a complete model of events would have to allow for. However, we do not attempt to do that here. Given that the monetary model - with perfect price flexibility and continuous PPP - is too extreme to capture this debate (just as a fix price model would be, at the other extreme), we believe that a more interesting analysis can be obtained by postulating an intermediate degree of price inertia.

consider the time dependent account to be the more accurate reflection of historical events.

The sluggish price model has a further advantage over the monetary model in that it provides a more reasonable explanation of the trend increase in sterling which Flood and Garber and Smith and Smith attempt to model by an exogenous time trend in the fundamental. It is the dynamics of sluggish price adjustment which generates systematic trends in the exchange rate in the model we use here. The case of "overshooting" exchange rates in the Dornbusch (1976) model illustrates this point; there the response to an (unanticipated) change in the money supply is an initial "jump" followed by an exponential convergence to equilibrium.

The equations of the two county model of price inertia are summarised in Annex 2, but the modifications it involves (relative to Annex 1) may be briefly summarised. The principal change comes from replacing the assumption of price flexibility in favour of a type of Phillips curve relating inflation to the level of output. (A.W. Phillips did after all fit his equations to UK data from 1861 to 1915 and tested it out of sample on the inter-war data being considered here!.) The inflation process is subject to zero mean white noise disturbances which are the only stochastic element in the model. Output is demand determined where demand depends on the real interest rate, the real exchange rate and activity overseas. The equations for international currency arbitrage and money market equilibrium are as for the monetary model - except that the velocity of money is taken as a constant.

As in the monetary model, the impact of state contingent commitments can be determined by comparing the unconstrained "free floating" rate with the solution which is constrained to satisfy the relevant point boundary condition (as well as the fundamental differential equation of the model). Except for special cases, however, there are no closed-form representations of the solutions for models which have inherent dynamics[1]. Numerical results can be obtained for specific parameter values: but as an alternative a qualitative treatment has been developed and this is used in Figure 4(a).

The dollar value of sterling is measured on the vertical axis, while the horizontal axis shows p-p*, the log of the ratio of US to UK prices, measured at an "equilibrium" exchange rate, s_e. The desired parity of $4.86 is shown at $\bar{s}$ which is higher than s_e. In the absence of any commitment to peg at a high level, the equilibrium is shown at E where the price differential is zero and the nominal rate is s_e. Hence the latter quantity represents the equilibrium <u>real</u> exchange rate for this model; and the 45^0 line shows all other combinations of nominal rates and relative prices which give the same real rate. (This 45^0 line is referred to as the "PPP line" in what follows, although, since exports and imports are different goods, it is not strictly a locus of Purchasing Power Parity.)

The upward sloping line labelled FF is the stable eigenvector of the system and represents the (no-bubbles) free floating solution for the currency as a function of the

[1] The principal exception to this is where there is no feedback between the asset price and the evolution of fundamentals (a_{12}=0): in which case the solutions are Confluent Hypergeometric Functions. The attraction of using such solutions is in our view offset by the implausibility of assuming that the exchange rate has no effect of the evolution of prices.

relative prices (assuming all other forcing variables are constant, including in particular the ratio of money stocks m-m*). Movements in p-p* can, therefore, be thought of as movements in fundamentals; but these fundamentals have endogenous stable dynamics. As the slope of FF indicates the parameters are those associated with exchange rate "undershooting": higher US prices are associated with a fall in US interest rates and in the dollar - via what are assumed to be powerful effects of the real exchange rate on output as one moves away from equilibrium at E.

To compare with this free floating solution we seek the solution which satisfies the commitment to adjust monetary policy so as to keep sterling at $4.86 "when PPP is achieved". In the present context we take this to be the point G where sterling is at the desired parity and the real exchange rate is at its equilibrium value[1]. The solution labelled MGM' (which satisfies the fundamental differential equation of the model defined in Annex 2) resembles the noisy solution to the monetary model in that it asymptotically approaches the free float solution as values of the fundamental diverge from those associated with the regime switch point G. The effect of the expected future contingent monetary tightening on the exchange rate is apparent, MGM' lies everywhere above FF. (The kink observed at point G itself signifies that this is seen as an irreversible switch of policy: otherwise stochastic smoothing would be expected.)

Once again it may be instructive to suppress the noise and consider the deterministic equivalent. (For which of course an exact exponential representation is available). To the right of G, this is shown by the line GD". Like the noisy

[1] The case where there are two possible parities at which one may switch to fixed rates was examined in Miller and Weller (1989).

solution this approaches FF asymptotically to the right, but it remains closer to the stable manifold for reasons analogous to those which applied in the monetary model. For points to the left of G, the state-contingent announcement has no effect since in the absence of noise relative prices will never trigger the tightening: so the deterministic solution coincides with the line FF.

Returning to the stochastic case we note that the switch in policy required at G must evidently be a (relative) tightening of monetary policy in the UK. This will be achieved by a flow of gold across the Atlantic as necessary to equalise interest rates in the UK and the US. (The necessary adjustment of relative money stocks is essentially given by the distance EB which shows the movement of prices that needs to be "accommodated".) Note that the flow of money at fixed exchange rates will immediately restore equilibrium in both countries. The anticipation that monetary policy will only be changed when the real exchange rate is in equilibrium means that all the adjustment comes before the exchange rate is pegged!

We have already argued that Smith and Smith's conclusion (about sterling being weakened) could be reversed once it is recognised that monetary tightening was part and parcel of the policy of returning to gold. While this illustration confirms the idea that anticipated tightening of money strengthens the currency (and the boundary condition seems to correspond more closely to what Flood and Garber describe than those that are imposed in a monetary model with constant PPP) we do not advance it as the most plausible reason for sterling's strength just before 1925. The reason essentially is that monetary policy adjustment was not deferred until the rate was pegged. Money was deliberately tightened ahead of time in the UK and eased in the US; to such an extent indeed that to observers like Keynes in 1924 it seemed as though the necessary monetary shift had already been accomplished and it was only a matter of waiting until it achieved the consequential price changes needed to make $4.86 consistent with PPP.

The case where the monetary adjustment comes first and prices follow after seems to us more plausible and it is illustrated in Figure 4(b). The shift of monetary policy required to move the equilibrium from E to G (a relative tightening in the UK) shifts the free-float solution from FF to F'F' (passing through G) and would of course cause an immediate appreciation of sterling. From a point like E for example sterling would "jump appreciate" and then be expected to adjust towards G, (subject of course to stochastic noise). Since, by construction, all the necessary monetary tightening has been done, adding a state contingent commitment "to do what is necessary when the peg is put in" has no impact on market sentiment. Formally the boundary condition (to pass through G) is satisfied by the free floating solution.

The solution described (some might say caricatured) in Figure 4(b) is consistent with the position taken by Keynes in his evidence to the Chamberlain Bradbury Committee in 1924, that one should not hasten things but should wait for sterling to rise to its old parity as a consequence of relative price adjustments in the US and at home. But Sir Charles Addis, "the Bank director on whose advice (Governor) Norman relied and whom he used most in his discussions on international cooperation" with other countries (Clay quoted in Moggridge (1972) p 41), was less prepared to wait. In his evidence to the same committee he argued that

> "the Government should announce that the legislation restricting gold exports would not be renewed after 31 December 1925, and that the Bank would then take the steps necessary to make such an announcement a success, using the Government statement as the reason, and if necessary the excuse, for these steps. He believed that any period longer than the eighteen months to December 1925, such as proposed by the Governor, would not be credible and as such would be dangerous. Eighteen months would also be sufficient, in his opinion, to allow some adjustment in contracts and take some of the sting out of the price falls implicit in the return to parity. The amount of deflation necessary for a successful return to parity was uncertain, for he expected some rise in American prices to reduce the existing gap of 10 per cent between American and British price levels." (Moggridge, 1972, p. 41)

It has already been shown how, in the monetary model, a credible time dependent promise to peg affects the rate. Much the same logic applies even when prices are not perfectly flexible, in that the announcement of the dated commitment causes a jump in the exchange rate towards the announced target. The schedule labelled AA in Figure 4(b) shows how this swivels the schedule F'F' towards $4.86 at the time of announcement. As time passes the schedule AA swivels further until it coincides with the horizontal line passing through parity at the announced time of joining. (The formal solution is given in Annex 2.) The consequence is that for points to the left of G, parity will be reached at a high real exchange rate; and it was largely for this reason that Keynes was to say "the proposals you outline do terrify me considerably" (Letter to Sir Charles Addis, Keynes, XIX, p. 270).

3. Credibility and the EMS.

At the time of writing Britain is, once again, contemplating an exchange rate commitment. On this occasion it is entry into the Exchange Rate Mechanism of the

EMS rather than a return to gold; so it is establishing a fixed rate *vis a vis* the deutschmark rather than the US dollar which is in prospect.

It is tempting to see whether the methods developed earlier might not be applied to current circumstances. To do this properly would require another paper, so what we do in this section is to indicate some of the key points of similarity and difference; and we use a model with a Poisson process to capture the lack of credibility.

As for points of similarity, on this occasion, as in 1924/25, there has been a conflict between "state contingent" conditions for entry and those implied by picking a fixed date. The so-called Madrid Conditions spelled out by Mrs Thatcher were a clear statement of the former - those economic conditions which needed to be satisfied before the UK would join. Since then, the conditions concerning the evolution of the EMS itself have been met (for example, the end of capital controls and moves towards financial liberalisation) but the requirement that UK inflation should have converged to that in Europe is not currently satisfied. Nevertheless the market is convinced that early entry is in prospect and sterling has risen strongly against the deutschemark on this expectation. Evidently the momentum of European monetary integration itself (and the inter-governmental conferences arranged to further this) together with the approach of the next General Election in the UK, have imposed a time-frame on the discussion which is much tighter than the flexible timetable associated with the Madrid Conditions.

The major difference between the 20's and the present lies in the credibility to be attached to the commitment itself. The return to gold was, in City opinion, a return to the normal order of things; and none doubted the sincerity of Montague Norman, the Governor of the Bank of England, in his ambition to achieve this[1]. Even the Chancellor of the Exchequer's doubts about the wisdom of elevating the interests of finance above those of industry were regrets about a *fait accompli,* not suggestions that the commitment was to be broken. And Keynes was to be a lone voice, crying against an irresistible tide of influential opinion.

At the present time there is also a flood tide leading Britain towards an exchange rate commitment. The City and the CBI are keen to stabilise the currency against those of European partners; the Governor signed the Delors Report and both the Treasury and the Foreign Office are believed to be in favour of UK membership of the EMS. But the lone voice on this occasion has been none other than that of the Prime Minister herself. Because she wishes to retain national sovereignty over the conduct of monetary policy, and because the EMS has until recently relied heavily on exchange controls, she has opposed membership. When Mr Lawson, an erstwhile proponent of free floating, became converted to managed exchange rates and tried to shadow the deutschmark, it was known to be against the wishes of his superior; and ultimately he was forced to resign over the issue.

Even now when entry into the ERM seems to be a matter of months away, the Prime Minister insists that entry involves no "locking of currencies". At the Dublin Summit she said "should you come up against the upper limit it is also possible, or

[1] The subtitle of Moggridge's book on the topic is "The Norman Conquest of $4.86"!

the lower limit for that matter, to have one of those weekend sessions when you alter the valuation of the currency. So there is no locking at all and it would not work if there were." (Financial Times, 2 July 1990)

In analysing the effects of entry one must surely take account of such a lack of commitment, and its effects on both interest rates and wages[1]. For nominal interest rates the risk of "realignments" will show up in interest differentials, but to capture adequately the effect on wages one needs an explicit model of wage setting. To allow for the direct impact of future events on current wages while retaining the notion of nominal inertia we have adopted the continuous time model proposed by Calvo (1983). The lack of commitment to a currency peg affects current forecasts of future prices and demand pressure, and current contracts which embody these forecasts.

Formally the Calvo model with a fixed exchange rate consists of the following equations

$$Dp = \delta(x - p) \qquad \text{or} \qquad p(t) = \delta \int_{-\infty}^{t} x(\tau) e^{-\delta(t-\tau)} d\tau \tag{6}$$

$$Dx = \delta(x - p - \beta y) \qquad \text{or} \qquad x(t) = \delta E_t \int_{t}^{\infty} [p(\tau) + \beta y(\tau)] e^{-\delta(\tau - t)} d\tau \tag{7}$$

$$E_t[Ds] = (i - i^*) = 0 \tag{8}$$

$$y = -\gamma(i - E_t[Dp]) + \eta(\bar{s} - p + p^*) \tag{9}$$

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[1] See, for example, the comment by S. Brittan "joining the EMS amid talk of realignments would undo much of the benefit of membership. For which wage negotiators are going to be influenced by a currency peg which Mrs Thatcher insists can readily be withdrawn?" (Financial Times 2 July 1990)

In equation (6) the current price level is given as an average of all outstanding contracts. The current new contract, denoted x, is a forward looking integral of expected future prices and demand pressure as shown in equation (7). Equation (8) is the usual international arbitrage equation while equation (9) is the IS relationship. The exchange rate is fixed at $\bar{s}$.

The model can be reduced to the following set of two dynamic equations

$$\begin{bmatrix} Dp \\ Dx \end{bmatrix} = A \begin{bmatrix} p \\ x \end{bmatrix} + \begin{bmatrix} 0 \\ -\beta\delta\eta \end{bmatrix} \bar{s}, \qquad A = \begin{bmatrix} -\delta & \delta \\ -\delta[1-\beta(\delta\gamma+\eta)] & \delta[1-\beta\delta\gamma] \end{bmatrix} \tag{10}$$

where it is assumed that $i^*=p^*=0$.

Figure 5 illustrates the solution for $\bar{s}=0$ where the forward looking contract lies on the stable manifold marked CC (given by the stable eigenvector of A). The stable manifold may be either upward or downward sloping depending on the parameters of the model. CC passes through the point of equilibrium at E.

Before considering realignments, consider the effect of a fully credible peg in this model. Assume that prior to pegging there is an inflationary equilibrium with constant money growth at rate μ. In Figure 5 this is represented by a steady crawl up the 45^0 line marked NN. (NN is given by the expression $Dp=\mu=\delta(x-p)$.) If the government imposes an unanticipated but permanent and fully credible peg at $\bar{s}=0$ (at the time prices reach point E) the immediate effect is a drop in the contract to point E and a fall in inflation to zero.

We represent the lack of full credibility in this model by assuming that there is a constant probability, denoted π, per unit time that the exchange rate will be devalued to a new parity which is J% from the current parity; which is why it may be referred to as a peg with a "peso problem". This approach has recently been applied in connection with currency bands (see for example Miller and Weller (1989) and Svensson (1989)) but in neither case are the effects on labour contracts considered[1].

In the currency market the arbitrage equation becomes

$$\pi J = (i - i^*) \tag{11}$$

so the domestic nominal interest rate must stand above the foreign rate by πJ. In the labour market the forward looking contract defined in integral (7) also picks up the effect of the possible realignments so that taking the derivative of this integral now yields

$$Dx = \delta(x - p - \beta y) - (1 - \theta_s)\pi J \tag{12}$$

where θ_s is the slope of the stable eigenvector of A. The model with stochastic realignments therefore reduces to the following set of two differential equations

$$\begin{bmatrix} Dp \\ Dx \end{bmatrix} = A \begin{bmatrix} p \\ x \end{bmatrix} + \begin{bmatrix} 0 \\ (\beta\delta\gamma - 1 + \theta_s)\pi J - \beta\delta\eta\bar{s} \end{bmatrix} \tag{13}$$

[1] The formal methods we adopt here were used in an earlier paper where a Poisson process is embodied in a model of forward looking exchange rates, see Miller and Sutherland (1989).

where A is as for equation (10) and $\bar{s}$ is the current parity.

The effect of the expected realignments is to shift the "equilibrium" of the model to the north-east along the 45^0 line. In Figure 5 the new equilibrium is market E' with associated manifold C'C' which has the same slope as CC. When a realignment does occur the equilibrium shifts again to E" and so on.

What the model brings out is the way in which the peso problem erodes the expectational benefits of the currency peg on wage setting. To illustrate this suppose the government chooses the devaluation size, J, and the probability, π, such that $\mu=\pi J$, i.e. such that the average rate of devaluation is the same as under floating. In this case there is no immediate fall in inflation as the contract will be given by the displaced manifold C'C' at point A.

It is true that as time passes competitiveness will be eroded in the absence of a realignment and inflation will slow as point E' is approached - but when the realignment comes the contract will jump onto C"C" and inflation is likely to rise above μ.

The fact that there is no immediate fall in inflation caused by pegging in this case is due to the choice of average devaluation at the same rate as past money growth. If a lower rate of devaluation is chosen, which is credible, then there will be some immediate fall in inflation to the new average.

An interesting feature of this model is that a peg which is in fact fixed can loose some of its benefits if doubts exist about its permanence. Specifically the idea that it might be adjusted encourages wage claims which lead to unemployment as the higher domestic price level reduces competitiveness. In terms of Figure 5 the economy converges on E'. This unemployment will only be permanent if there is no learning. But even if people ultimately learn (that there is to be no realignment) the lack of credibility in the meantime means that the cost of reducing inflation is higher than need be.

The model can perhaps also be applied to analyse the issues raised by a split between the DM bloc (now including France?) and the other EMS members. If one treats the second group as those whose pegs are subject to stochastic realignment one may obtain a characterisation of a "two-speed Europe" with no capital controls[1] where (on average) the rate of inflation in the weak countries remains stubbornly above that in the DM bloc.

Conclusion

The convenience of using the monetary model to analyse the anticipatory effects of a regime switch is not to be denied, particularly now that explicit exponential solutions are available (solutions which encompass both temporary switches at the edge of currency bands (c.f. Krugman (1988)) as well as the "irreversible" switches which Flood and Garber first discussed). In defence of this

[1] The simple "peso problem" approach described here is one in which there is essentially no convergence in the speeds - but in research currently in progress at Warwick Luisa Lambertini is using more realistic partial realignment rules such as described by Giavazzi and Spaventa (1990) to obtain convergence.

model we have argued that the implausible result noted by Smith and Smith (that sterling was weakened by the commitment of the British government to return to the Gold Standard) is not an essential feature; it can be reversed by reinterpreting the role of the trend in monetary data, and also by allowing for discrete changes in monetary policy or by nonstationarity in the solution.

But the appeal of such explicit solutions must not be pushed too far. Reference to issues under debate in the 1920's suggests that, at a minimum, some attention should be paid to the dynamics of adjusting prices; and models with endogenous dynamics do not (except in special cases) have explicit solutions. A qualitative treatment is nevertheless possible (at least for low order systems) and generalised regime switching conditions are also available (see Whittle (1982)). So the approach pioneered by Flood and Garber may in fact be applied to models with inherent dynamics as we have shown in the paper. We are inclined however to ascribe a greater role to explicit time dependent features than are the other contributors we discuss.

Prospective UK entry into the EMS cries out for some way of describing a less-than-fully-credible commitment; and for the effects of this on labour markets to be taken into account. The approach taken here is to include a Poisson process to cover realignment of the peg and forward looking labour contracts to endogenise expectations. The potential for temporary discrepancy between the true Poisson process and what is perceived in financial and labour suggests a role for learning (see Lewis (1988)).

Evidence of short term interest differentials in Europe implies that Britain would not be alone in having a less than fully credible peg *vis a vis* the deutschmark. So the issues discussed here surely have relevance to the operation of a two-speed EMS, as well.

Annex 1: The Monetary Model.

The model used by Flood and Garber (1983) is as follows

$$m(t) - p(t) = \phi y(t) - \lambda i(t) - v(t) \qquad \text{(i)}$$

$$m^*(t) - p^*(t) = \phi y^*(t) - \lambda i^*(t) - v^*(t) \qquad \text{(ii)}$$

$$s(t) = p(t) - p^*(t) \qquad \text{(iii)}$$

$$\frac{E_t[ds(t)]}{dt} = i(t) - i^*(t) \qquad \text{(iv)}$$

Lower case letters denote logarithms (except for i and i*) and the asterisk indicates a UK variable, others being US variables. The first two equations specify equilibrium in the money market, where m denotes the money supply, p the price level, y is full employment GNP and i is the nominal interest rate. Equation (3) states that purchasing power parity always holds, where s denotes the exchange rate (here the US dollar cost of sterling). Equation (3) is (approximately) a risk neutral arbitrage condition, in which the expected depreciation is set equal to the interest differential.

By substitution one obtains equation (1) in the text, namely

$$s(t) = k(t) + \lambda \frac{E_t[ds(t)]}{dt} \qquad \text{(v)}$$

In the absence of efforts to fix the exchange rate, the forcing function k is assumed to be a Brownian motion process with drift

$$dk(t) = \eta dt + \sigma dz \qquad \text{(vi)}$$

where z is trend free Brownian motion with unit variance.

Application of Ito's lemma establishes that a stationary solution for the exchange rate as a function of fundamentals, s=f(k), must satisfy the second order differential equation

$$f(k) = k + \lambda\eta f'(k) + \lambda\frac{\sigma^2}{2}f''(k) \qquad \text{(vii)}$$

which has a general solution of the form

$$f(k) = k + \lambda\eta + A_1 e^{\rho_1 k} + A_2 e^{\rho_2 k} \qquad \text{(viii)}$$

Froot and Obstfeld (1989) who show how different boundary conditions expressed in terms of the fundamental k determine the parameters A_1 and A_2.

Note that the requirement that s be a stationary function of fundamentals precludes direct effects of time on the exchange rate, though the latter can nevertheless reflect the trend in fundamentals.

Boundary conditions involving time itself, call for a nonstationary solution of the form s=g(k,t). This leads to the replacement of the ordinary differential equation above with the following partial differential equation

$$g(k,t) = k + g_t(k,t) + \lambda\eta g_k(k,t) + \lambda\frac{\sigma^2}{2}g_{kk}(k,t) \qquad \text{(ix).}$$

Equation (5) in the text is obtained by solving this PDE (with η=0) subject the boundary condition that the exchange rate coincide with the target rate ($\bar{s}$) at the time of joining (T) for all levels of the fundamental, formally

$$g(k,T) = \bar{s}, \quad -\infty < k < +\infty.$$

The solution is obtained using the method of separation of variables.

Annex 2: The Model with Price Inertia.

The sticky price model used in Section 2 is a two-country version of that described in Miller and Weller (1990) and consists of the following equations

$$m - p = \phi y - \lambda i - v$$

$$m^* - p^* = \phi y^* - \lambda i^* - v^*$$

$$y = -\gamma(i - E_t[dp]) + \eta(s - p + p^*) + \delta y^*$$

$$y^* = -\gamma(i^* - E_t[dp^*]) - \eta(s - p + p^*) + \delta y$$

$$dp = \psi y dt + \sigma dz$$

$$dp^* = \psi y^* dt + \sigma dz^*$$

$$E_t[ds(t)] = (i - i^*)dt$$

The assumption that structural parameters are identical in both countries allows the model to be split into two independent sets of equations, one describing global averages and the other describing intercountry differences. Only the differences system involves the exchange rate and it can be reduced to the following set of two stochastic differential equations

$$\begin{bmatrix} d(p-p^*) \\ E_t[ds] \end{bmatrix} = A\begin{bmatrix} (p-p^*) \\ s \end{bmatrix}dt + B(m-m^*)dt + \begin{bmatrix} \sigma \\ 0 \end{bmatrix}dz$$

where $A = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} = \frac{1}{\Delta}\begin{bmatrix} -\psi(\gamma+\eta) & 2\eta\lambda\psi \\ (1+\delta-\gamma\psi-2\eta\phi) & 2\eta\phi \end{bmatrix}$, $B = \frac{1}{\Delta}\begin{bmatrix} \psi\gamma \\ -1-\delta+\gamma\psi \end{bmatrix}$

and $\Delta = \gamma\phi + 1 + \delta - \gamma\psi$.

As in Miller and Weller (1990), a solution to the exchange rate for non-time-dependent boundary conditions must be a function f(p-p*) which satisfies the following ordinary differential equation

$$a_{21}(p-p^*) + a_{22}f = [a_{11}(p-p^*) + a_{12}f]f' + \sigma^2 f''.$$

When the boundary conditions do involve time, however, the exchange rate is a time-varying solution, g(p-p*,t), and the fundamental differential equation becomes the following partial differential equation

$$a_{21}(p-p^*) + a_{22}g = [a_{11}(p-p^*) + a_{12}g]g_1 + g_2 + \sigma^2 g_{11}$$

(where g_i is the partial derivative of function g with respect to argument i). The time dependent solution discussed in Section 2 is obtained by solving this equation subject to the boundary condition

$$g(p-p^*,T)=\bar{s}, \quad -\infty < p-p^* < +\infty.$$

Using the method of separation of variables the following solution is obtained

$$s=g(p-p^*,t)=\bar{s}[1-h(t)]+(p-p^*)h(t)$$

where $h(t)=\left[\dfrac{1-e^{(\rho_s-\rho_u)(T-t)}}{\theta_u-\theta_s e^{(\rho_s-\rho_u)(T-t)}}\right]\theta_s\theta_u$, and ρ_s and ρ_u are the stable and unstable eigenvectors of A and θ_s and θ_u are the slopes of the corresponding eigenvectors.

(This solution can also be obtained by treating the model as deterministic and solving for the level of the exchange rate for each level of the fundamental and at each point in time given an anticipated regime change at time T.)

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Figure 1

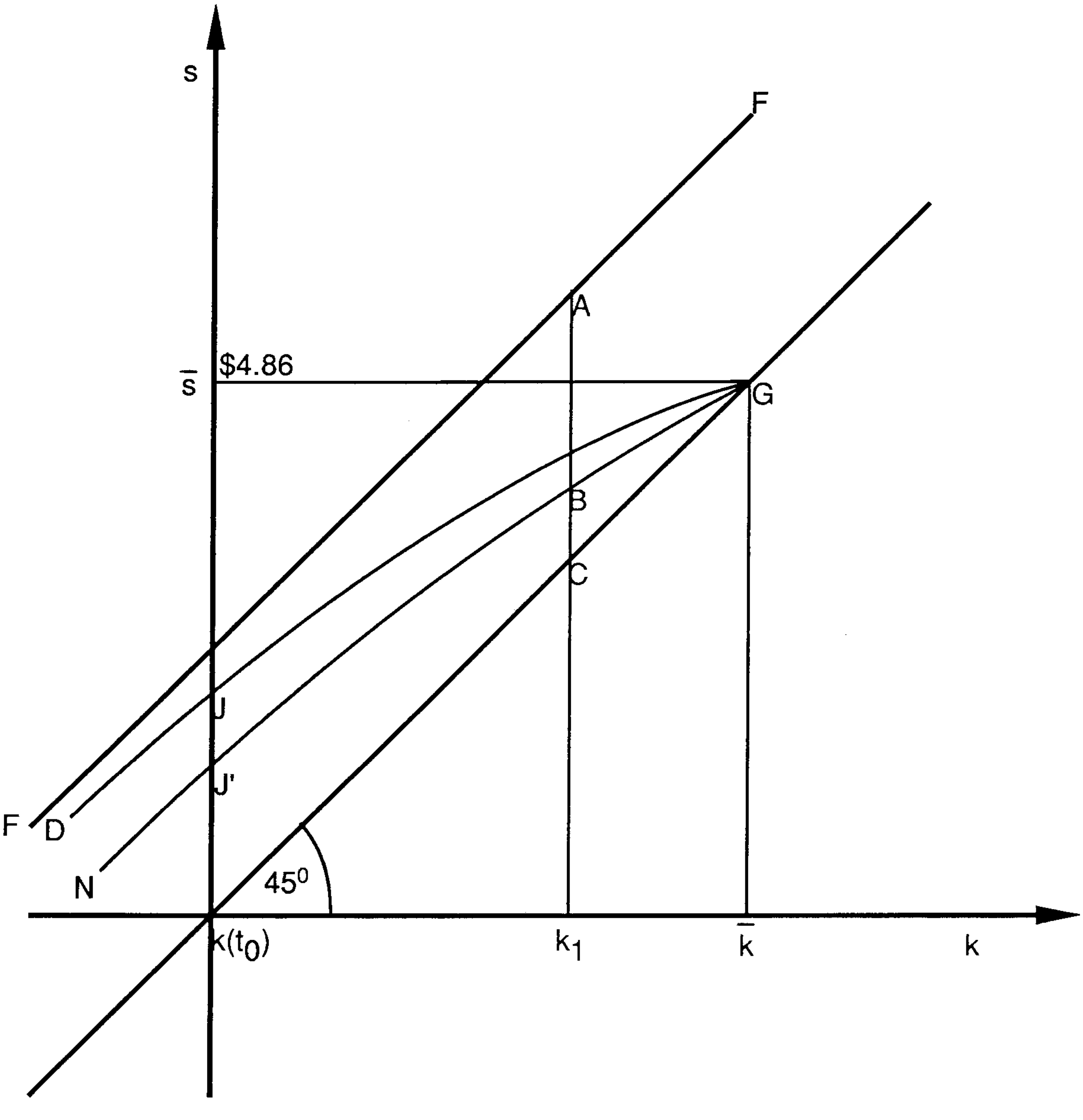

Figure 2

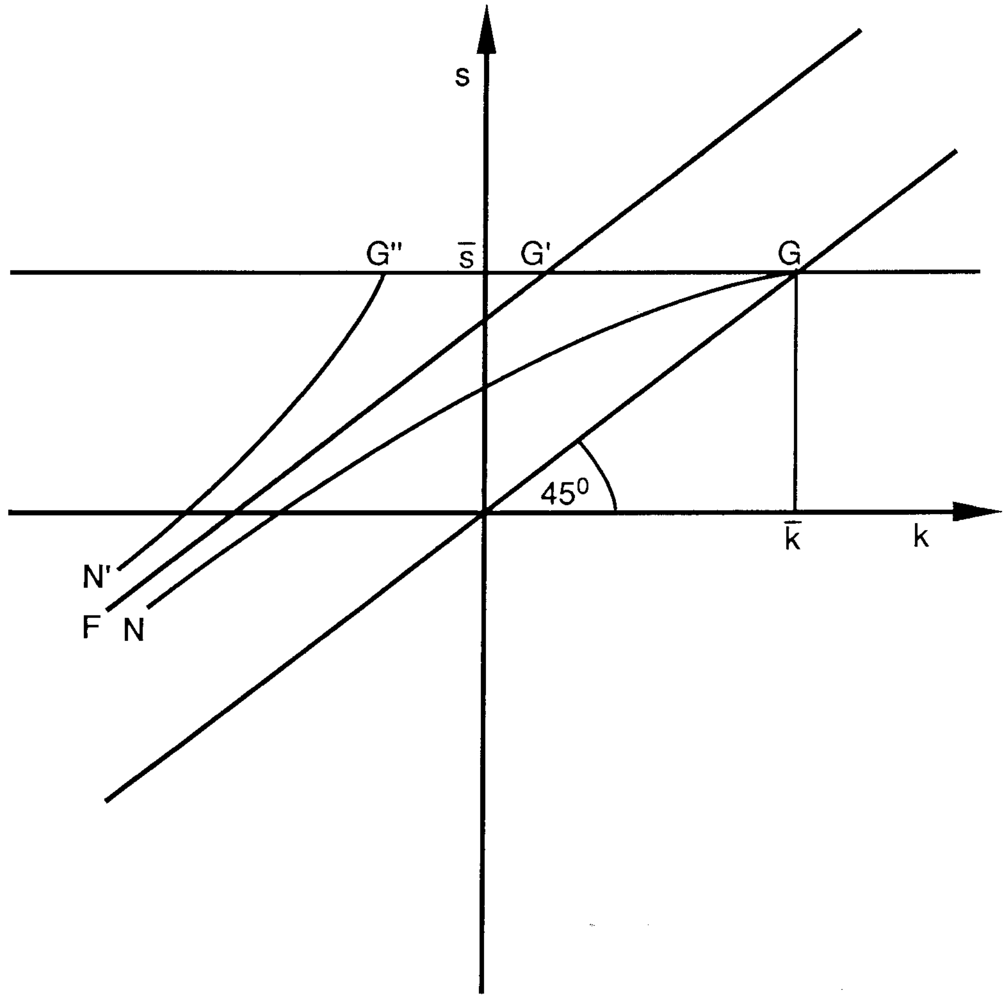

Figure 3

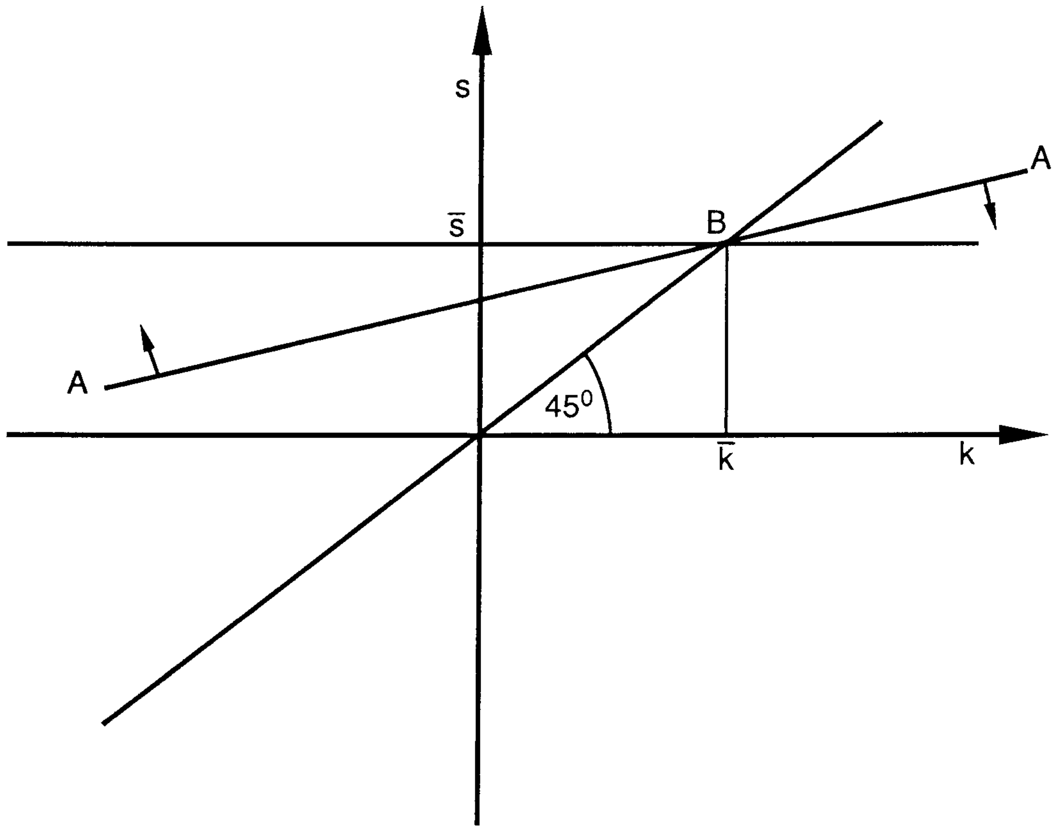

Figure 4(a)

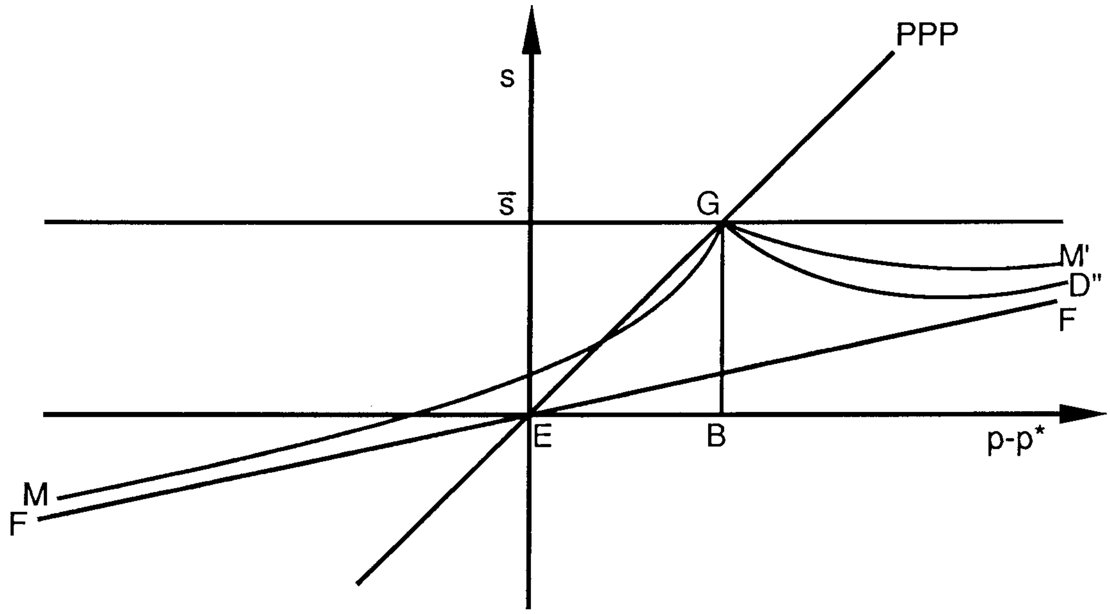

Figure 4(b)

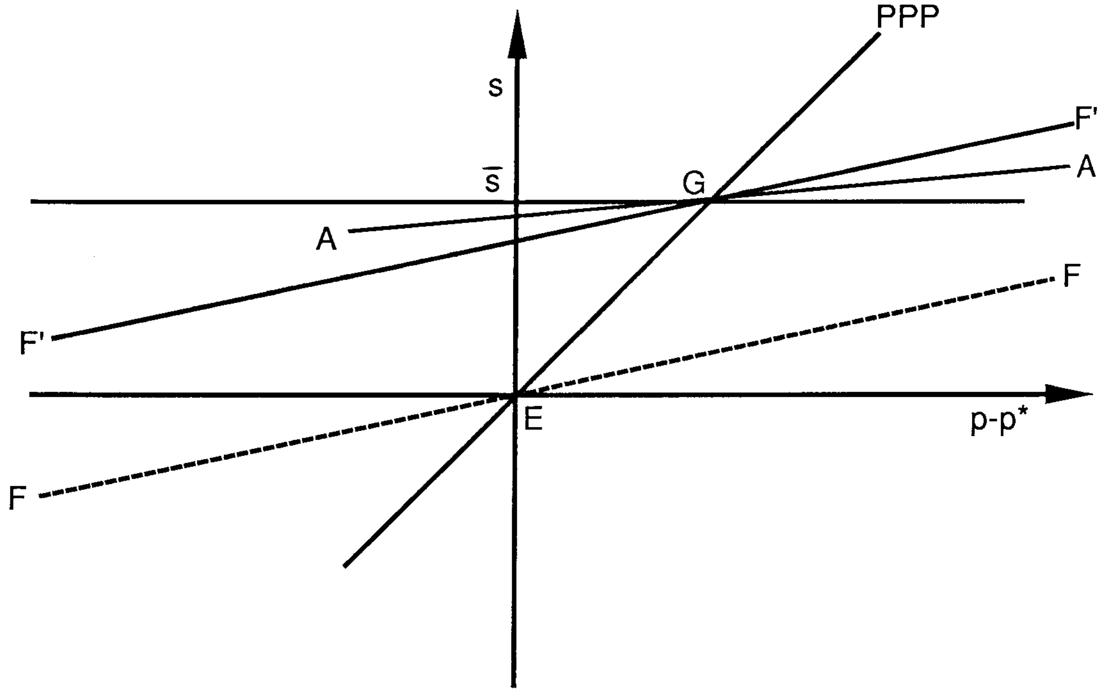

Figure 5