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Exchange Rate and Stock Market Interaction: An Empirical Investigation

by
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A Doctoral Thesis
Submitted in Partial Fulfilment
of the Requirements for the Award of
Doctor of Philosophy

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Loughborough University
January 1997

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Abstract

The aim of this thesis is to analyse the relationship between the exchange rate and stock market, in the UK, USA, Germany, Japan, Canada and the Netherlands over the period 1974 to 1994. It is motivated by recent changes in the international financial environment, particularly the gradual removal of exchange restrictions and the consequent rise in capital flows between the main economies. A further motivation has been the increasing use of stock market variables in macroeconomic models.

The theoretical literature indicates that for a variety of different exchange rate models, it is possible for the exchange rate and stock market to interact in a number of different ways, following an exogenous shock. It is therefore primarily an empirical question as to the specific signs on the variables in the models analysed. This thesis predominantly uses cointegration and error correction models, so that both the long run relationship and short run dynamics can be examined separately.

The thesis shows that stock prices and exchange rates do not have common trends, but do have common cycles. In general exchange rates and stock prices are found to be inversely related. In addition the foreign exchange market risk premium is shown to be directly linked to the differential between the domestic and foreign equity risk premiums. It is also found that the expected change in the exchange rate is more closely linked to risk rather than return differentials.

Key Words:

Asset, Capital, Co-dependence, Cointegration, Exchange rate, Money Supply, Stock price.

ACKNOWLEDGEMENT

I am particularly indebted to my supervisors Dr Eric J. Pentecost and Dr Lawrence Leger for their constant advice and encouragement throughout the time spent on this thesis. Without their help this thesis would not have reached its present state, however I am responsible for any remaining errors. I also wish to thank my external and internal examiners Professor Nicholas Sarantis and Dr Mark Holmes respectively, for their constructive comments on an earlier draft of this thesis, although the usual disclaimer applies.

I would also like to thank members of my family for their support, both financial and physical. In addition I would like to express my gratitude to all the members of the Economics Department at Loughborough University for both their assistance and friendship, as well as the companionship of my fellow students.

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Chapter 1

Introduction

Since the early 1970's, international financial economics has experienced an era of rapid change, in particular there has been a pronounced movement towards globalisation of the worlds' financial markets. This has been facilitated by a gradual relaxation of the myriad restrictions on capital flows across countries, as well as by the process of financial innovation, technological progress and the rising tendency of investors to purchase foreign capital. These changes have been well documented, with a wide variety of empirical tests that show national money, bond and equity markets are increasingly highly integrated, particularly in the G-7 countries (Holmes and Pentecost 1992, Pentecost and Holmes 1995).

In addition to the general influences over the last twenty years, a number of specific factors have had a more transient effect on both capital markets and the exchange rate. In particular, the relationship between macroeconomic policy and the exchange rate as well as the effects of deregulation and liberalisation of stock markets. In the UK the capital markets were deregulated in the mid 1980's, which initially produced a rise in the amounts of business conducted in London . In many cases the removal of capital controls did not initially dramatically affect the capital markets or exchange rate , although over the longer term the effect has been significant as political risk (Aliber 1973) has gradually reduced.

In the context of exchange rate arrangements, the most important economic occurrence over the last thirty years has been the breakdown of the 'Bretton-Woods' system of fixed exchange rates. The 'Bretton-Woods' system was introduced following the Second World War in an attempt to bring stability to the worlds' exchange rates and international monetary system. Under this system central banks were required to peg their currencies to within one per cent of a par value, expressed predominantly against the US dollar. International reserves were held so they could be used to intervene in the markets to support a particular currency. The USA held no reserves, but maintained the value of the dollar in terms of gold at $35 an ounce.

It was not until the 1960's that the 'Bretton-Woods' system began to suffer problems. In 1967 the UK devalued its currency, something which had not been allowed for

when the system had first been created, except when fundamental disequilibrium occurred. However there was a more serious problem, related to the use of the US dollar as the main reserve currency. The actual cause of the breakdown is open to debate. In the late 1940's it had been predicted that in order for stable growth of the world economy to occur, it was necessary for there to be a growing level of international liquidity, which would be through a rise in dollar holdings. As the external stock of dollars rose relative to US gold reserves, it would become ever more implausible that the dollar was convertible into gold. Following an inevitable collapse in confidence, there would be a deflation similar to that of the 1930's and this was known as Triffin's dilemma (Triffin 1958).

Another view suggested that the problem was merely transient and that the problem of Japan and Europe having less than their required levels of internationally liquid assets would be satisfied by the emerging globalisation of the capital markets. The SDR was introduced to act as an alternative to the US dollar so preventing the sort of problems predicted by Triffin. However it has been argued (Crystal 1970) that this compounded the problem and caused the loss of confidence in the US dollar which lead to the end of the system in 1971, when dollar convertibility was suspended.

Regardless of the causes of its failure, most developed countries have experienced floating exchange rates ever since, with some attempts at managing its movements. The main exception to this has been those members of the DM zone which includes Germany and the Netherlands, which are two of the countries studied in this thesis. Additionally since 1979 and the formation of the EMS, a number of countries in Europe have also operated a target zone. To begin with the system experienced a number of devaluations such as with France and the Netherlands. In the late 1980's there was a period of relative calm until the early 1990's when once again there was a certain amount of turmoil, which culminated in the ERM bands being widened in September 1993 to accommodate a rise in exchange rate volatility

The main changes with regards to the worlds stock markets has been the liberalising of exchange restrictions, which was evident during the late 1970's and early 1980's. This has lead to a greater degree of foreign investment in the main stock markets around the world. For instance in 1992 the fastest growing sector of shareholders in the UK stock market were the overseas investors. By 1993 16.3% of total equity in the UK stock market was owned by overseas investors, whereas in the early 1980's the amount was less than 4%. This trend has mirrored the inexorable rise in the

popularity of unit trusts and particularly pension funds, which now account for about 35% of total equity holdings.

During the 1970's, the worlds' stock markets experienced a certain amount of volatility, due to the sharp changes in commodity prices, especially oil. As a consequence the main market indexes did not rise significantly. It was not really until 1980 that the long term rise began. In the 1980's there was a sharp fall in 1987, and a slightly smaller fall in 1989, both in November. The 1987 fall is interesting as it introduces two aspects which are important in this thesis. Firstly it shows how integrated the worlds stock markets have become. These interrelationships are particularly strong between specific groups of markets (Bertero and Mayer 1990) and the USA market not surprisingly played a leading role. Secondly the impact on the macroeconomy of the crash was alleviated by the response of the monetary authorities.

This thesis examines the nature of the relationship between the stock market and the exchange rate. The inclusion of the stock market into models that determine the exchange rate is important for three main reasons. Firstly it has been shown that the stock market is an important determinant of a variety of macroeconomic variables. For instance Tobin (1969) offers a theoretical motivation for using the stock market as a means of determining levels of investment. Similarly Friedman (1988) gives a theoretical and empirical justification for including the stock market in the money demand function.

There is an alternative view, which was common particularly before the 1960's. Keynes felt that there was very little difference between the interest rate and the return from the stock market. In addition it was felt that the stock market was influenced by irrational waves of exuberance and pessimism, primarily due to a lack of information. Recent evidence however tends not to support this view, as market efficiency is now an accepted theory and the return on the stock market and bonds is widely divergent. Over the ninety year time period 1889-1978, the average real yield on the Standard and Poor 500 index was seven per cent, whilst the average real return on treasury bills was below one per cent (Mehra and Prescott 1985).

The second reason why a systematic study which relates the exchange rate and the stock market is particularly relevant is that over the last twenty years there has been a process of deregulation of financial markets and the gradual removal of exchange restrictions as noted earlier. This has lead to increasing amounts of capital flowing

between the worlds' stock markets, which inevitably will have an effect on the way the exchange rate and stock market interact. In addition this study employs a consistent econometric methodology which analyses the relationship in the short and long run.

The third motivation behind the use of these two variables is the similarities that exist between them. Most of the similarities relate to the nature of these variables, in particular they are both assets traded on markets. For this reason any analysis of either of the variables inevitably involves considering the importance of information and expectations. Also as Macdonald (1992) points out, bilateral exchange rates and stock markets have exhibited similar levels of volatility over the 1970's and 1980's, whereas commodity prices and money supplies have exhibited far lower levels of volatility. The main reason for the similarity in volatility is the substantial amount of short term capital flowing between the worlds capital markets. These speculative funds affect the foreign exchange market through the need to first change the funds into the currency that offers the most attractive risk return profile.

The thesis is arranged in the following order. Chapter 2 is a review of the theoretical literature and discusses the various theories, which relate the stock market and the macroeconomy and then specifically the stock market and exchange rate. The third chapter is a review of the empirical literature and concentrates on a variety of tests of the relationship between the stock market and exchange rate as well as their respective risk premiums. This is the first occasion in which either the empirical or theoretical literature has been systematically reviewed.

The fourth chapter is an overview of the changes that have occurred in the exchange restrictions over the relevant time period. In particular there is a discussion of the lifting of capital controls in all the countries studied. The data is also described and explained. Although there is an annual publication which lists the exchange restrictions for each country, the review in this chapter looks at those changes relating to the removal of capital controls throughout the 1970's and 1980's, concentrating on how throughout the relevant time period, capital has been allowed to move more freely in the countries analysed in the empirical chapters.

Chapter five analyses the direct relationship between nominal stock prices and exchange rates, as well as tests for causality, using the Granger causality test. The main contribution of this chapter is that it applies modern time series techniques to the data set. These include cointegration, which tests for common trends and Co-

dependence, which tests for common cycles between variables. Also unlike the published work on cointegration between the stock market and exchange rate (Bahmani-Oskooee and Sohrabian 1992), there is some evidence of cointegration between some of the countries tested.

The next two chapters concentrate on analysing specific exchange rate models, which are motivated by recent attempts to model the exchange rate in an alternative way to conventional models. The main developments in recent years have been in the use of improved econometric techniques and incorporating other characteristics into the conventional models, such as risk (Dornbusch 1982). The following chapters continue this trend as, in particular, a wider choice of assets need to be included into the conventional models to represent the different choices open to investors and the different risk and return characteristics of these assets.

Chapter six uses an IS/LM type of model to analyse the relationship between the exchange rate and stock market, usually termed the Mundell-Fleming model. The first section developes a model primarily derived from Blanchard's theory (1981), in which the stock market index is incorporated into the model through the aggregate demand function. This model is then tested using cointegration and error correction models.

Chapter seven analyses the relationship between the exchange rate and stock market in the context of the monetary model. The justification for including the stock market index in this model originates from Friedman's (1988) use of a stock market index in the money demand function. This is again the first time in which this type of model has been estimated, as well as the analysis on the theoretical motivation for the inclusion of a stock market variable in this class of model. In addition an alternative specification for Uncovered Interest Parity is incorporated into the model and estimated.

Chapter eight looks specifically at the role risk plays in determining the exchange rate and whether changes in the exchange rate can be affected by differences in the levels of risk between countries. If risk is important, then domestic and foreign bonds are not perfect substitutes, which implies a portfolio balance type of model may be more effective in analysing the exchange rate. However the portfolio balance type of model is not specifically analysed in this thesis, as it has already been studied comprehensively, as discussed in the literature review. The main contribution of this study is applying cointegration to the analysis of the relationship between the risk premiums on the exchange rate and stock market. In addition there has been no

previous attempt to use a stock market based measure of risk to analyse the expected change in the exchange rate.

In all the empirical tests, specific trends should become apparent. As the UK and USA have the largest stock markets, in terms of turnover, these two countries should produce the closest relationship between the exchange rate and stock market. In contrast Germany, where the stock market is subordinate to the banking sector in providing finance, should produce a less significant relationship. The Netherlands, which has a significantly smaller stock market than the other countries studied, is included in the analysis, to determine if the relationship holds for a smaller economy as well as the main economies.

Chapter 2

Exchange Rate and Stock Market Interdependence: A Review of the Theoretical Literature

2.1 Introduction

Before the mid 1960's there is very little literature linking the stock market and other macroeconomic variables, mainly because the prevailing view was that the return on bonds and equities could be regarded in the long term as being the same. An alternative view expounded by Friedman (1956) is that they need to be modeled separately, especially in relation to the money demand function. The motivation for this view is that equities have fundamentally different levels of yield (Prescott and Mehra 1985), accessability to the public and variations in risk profiles compared with bonds. A similar concept of using the stock market to model the investment function was also developed in the 1960's by Tobin (1969), who developed the q theory. In this case the stock market is not represented as a return, but as the market value of capital. The third major theoretical relationship between the stock market and macroeconomy is through the inclusion of a stock market variable in the aggregate demand function as suggested by Blanchard (1981) and Gavin (1989).

In general the interaction between the exchange rate and stock market are analysed in terms of their reaction to changes in monetary and fiscal policy. In some cases the analysis is based on a variety of monetary policies (Aoki 1986), and then viewed in terms of which is most effective. A common feature throughout the literature is that both the stock market and in turn, the exchange rate react in more than one way to an exogenous change, depending on the interaction between the stock market and other endogenous variables, particularly output. So that in general there is no single theory to explain how the exchange rate reacts following a move in stock prices. The various reactions of the exchange rate, following changes in the exogenous variables are summarised in a table at the end of this chapter.

The aim of this chapter is to analyse some of the theoretical literature which has attempted to link the exchange rate and the stock market price index both directly and indirectly. To explore the indirect relationship it is also necessary to analyse the relationship between the stock market and other macroeconomic variables, such as output and interest rates. In particular the analysis concentrates on the dynamic reaction of the exchange rate following exogenous shocks, and how these reactions are affected by including the stock market in the analysis.

Throughout the review, the aim is to relate the models to each other, when particular models have something in common. An important point about these models is that in many cases there are a variety of consequences following an exogenous disturbance, such that the stock market, exchange rate and output react differently according to the circumstances of the disturbance. In general the most likely scenario is described, but as with the literature the choice of the most appropriate scenario is often ad hoc.

As Gavin (1979) suggests, stock prices and exchange rates have traditionally been viewed as endogenous, although as Merton and Fischer (1985) argue, all variables are to some degree endogenous, including the weather. Because of this, in most theoretical papers, no causal relationship is advocated, although in the papers reviewed here, the emphasis is on the causality running from the stock market to the exchange rate. For instance in the Gavin paper (1989), the main result of the analysis is that under certain circumstances the exchange rate appreciates following a monetary expansion.

There is another section of the exchange rate and stock market literature in which the emphasis is on the exchange rate effects on the stock market, as in Ma and Kao (1992). In this thesis the emphasis is on causality running from the stock market to the exchange rate, as most empirical tests indicate this is the predominant effect (Bahmani-Oskooee and Sohrabian 1992). Also as Chiang (1992) indicates, the stock market is relatively more efficient than the the foreign exchange market and also more sensitive to exogenous shocks, due to the greater number of traders in the stock market.

The following analysis is split into three basic sections. The first section reviews the IS\LM based models which relate the stock market to certain macroeconomic variables and the exchange rate. In the latter case the relationship is often classified as

a Mundell-Fleming model. The second section concentrates on monetary type models and the third section assumes that the exchange rate contains a risk premium, which are broadly termed theoretical portfolio balance models.

2.2 IS/LM Models

The models of Tobin (1969) and Blanchard (1981) have in common the relationship between the stock market, or return from the stock market, and an important macroeconomic variable. In the Tobin model the stock market is represented by q, which is defined as the value of capital, as measured by the stock market, relative to its replacement cost, as measured by the price of new capital goods[1] . If q exceeds unity then new investment is profitable, but if it is below unity then it would be unprofitable.

The Blanchard and Tobin models have a further important common feature, in that both can be represented by the IS\LM framework (Hicks 1937). The Blanchard model is in effect a dynamic version of Hick's IS\LM model rather than the static model used by Tobin. The Blanchard model, although based in output and stock market space, is "one step" removed from the standard IS\LM framework in contrast to Tobin's model because in this case the stock market variable represents the value of the stock market, rather than a rate of return as in Tobin's q. The IS and LM schedules are replaced by the steady-state stock market and steady-state output schedules. There is also a post-monetary expansion schedule,which represents the stable saddle path of the system, given expectations are assumed to be formed by perfect foresight.

As Blanchard uses the Tobin model as a motivation for incorporating the stock market variable into the aggregate demand function, the Tobin model is described first, followed by the Blanchard model. The basic model used by Tobin, termed the money-capital model consists of a wealth relationship, portfolio balance equations for the return on capital and money and two further identities. In a developement of this basic model, Tobins q is analysed in the context of an open economy, whereby the portfolio includes foreign assets as well as the equities, money and bonds (Buiter and Tobin 1981). However the analysis is restricted to the basic model in this chapter as

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[1] A further analysis of the importance of Tobins q on investment is contained in Hayashi (1982) and Yoshikawa (1980).

their are many versions of this model, but all formed from this original model. Wealth is defined as the market worth of capital and the real stock of money. The portfolio balance equations for the rates of return on capital and money are identical, as both stipulate that the market worth of capital is a function of the return on money, capital and income relative to total wealth.

In addition both portfolio balance equations are homogenous in wealth, such that the proportions of the two assets held are independent of the absolute scale of wealth. It is assumed in this case that all else being equal, the transactions demand for money rises with income, so that the demand for capital falls proportionately. Assuming the demand for money is related to the rate of return on holding money, then Tobin includes in his money demand function, the return on capital and ratio of income to wealth.

In addition to the above relationships, there is an inverse relationship between the market value of equity capital and the market rate of return on it. Furthermore it is assumed that the return on money is equal to the nominal rate of interest on money (assumed to be zero) and the expected rate of change in commodity prices. It is assumed that a rise in the money supply increases the value of existing capital so increasing investment.

Tobin looks on the financial and what he terms real sides of the economy as being interrelated, and in equilibrium. Asset prices and interest rates affect the levels of capital accumulation, which in turn determines the capital stock. This then impinges on commodity prices and the labour market, which in turn affects income and the asset markets. So the linkage can be in both directions. Thus equilibrium in asset markets is dependent on the real economy in the form of output and income, and the real economy in terms of output and spending depends on the asset markets, implying a simultaneous relationship exists between the two sectors of the economy.

The optimal level of investment occurs when q is equal to the marginal effective cost of investment, which is directly determined by the costs of adjustment. So given the adjustment cost function, which is assumed to be convex, investment increases with q. The motivation for increasing investment stems from a short-run divergence between the price of goods and their valuation in the market. The above conclusion assumes a homogenous production function, in which output is determined by labour, and an

index of fixed capital. A further assumption is that there are no fixed costs associated with raising the level of investment, such as a larger administrative department. Excluding this assumption means the critical value for q would be above unity.

In the context of Tobins q, it is necessary to choose between average and marginal q, depending on its use. Tobin stipulated that marginal q determined investment, although in general average q has been used as an empirical proxy for it. Marginal q is defined as the ratio between the market value of an extra item of capital, and its cost of replacement, which is why it is of more practical use than average q. In some circumstances average and marginal q are equal, although it requires the rather strong assumption of the firm acting as a price-taker and the need for constant returns to scale. The neo-classical view fails to take into account adjustment costs, unlike marginal q , but marginal q fails to include the affects of taxes and depreciation of the capital stock. Both factors have an important influence on the decision- making process on changes in investment.

Tobin emphasises that it is possible to view the q theory in terms of the IS\LM framework. The LM schedule represents stocks of financial assets in their equilibrium, relative to real income, and the commodity price level. As in the standard case the interest rate at this equilibrium point clears both money and goods markets. The difference with the standard IS\LM analysis however is that instead of the conventional interest rate on long term consoles being on the vertical axis, a return on shares is used.

The Tobin version of the LM curve is located by the position in income and return on capital space, where the asset market is in equilibrium as in Figure 2.1. As in the standard model, a rise in the money supply moves the LM curve to the right. The IS curve can then be added, where the goods market or real sector represents the equilibrium for income and the return on capital. So return on shares is represented by the marginal efficiency on the capital already in use, and this takes place at the long run equilibrium level of income. This occurs where income is just enough to raise the level of capital at the "natural growth rate" of the economy. At this level, investment will ensure the equilibrium level of share return is constant, and so q takes a unitary value.

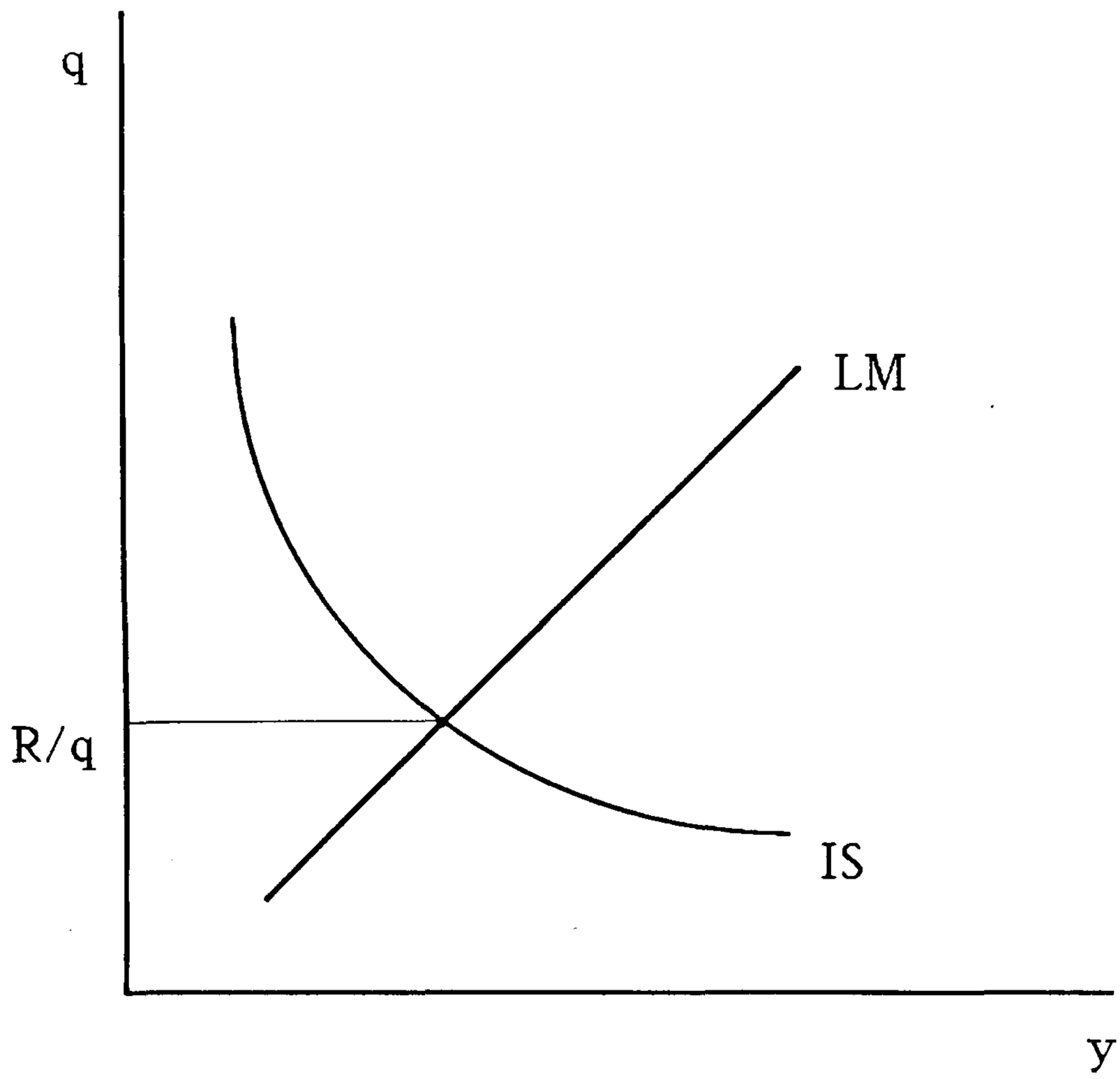

Figure 2.1. An IS/LM representation of the Tobin model.

The IS\LM framework used by Tobin, is relevant in the short-term to demonstrate the dynamics of the adjustments in interest rates, rates of return on assets and income. In the long run, equilibrium will occur when Tobins q equals unity. This requires that equilibrium in the goods market and asset market coincides with the point where the marginal efficiency of the capital stock equates with the standard real income level.(i.e. savings are enough to increase investment at the economy's natural growth rate).

The initial analysis in Tobins' theory is restricted to a simple money-capital model, and the only way in which monetary policy can be varied is through changes in the interest rate on money, which is controlled institutionally. Monetary policy is introduced by including government securities in the model. The main distinguishing feature being that their value is determined endogenously, whilst the rate of return on money is an exogenous variable. If money balances are increased at the expense of

securities, then the LM curve shifts to the right, as in the standard IS\LM framework, producing an expansionary affect on the economy.

In an economy with n assets, there should be no more than n-1 rates of return. As it is assumed that the rate of return on money is exogenous, then the rate of return on capital must be endogenous and so determinable by the model. This means the monetary authorities can determine the rate of return on capital, and thus the price of capital and q. Following an expansionary monetary policy, the return on capital falls, as the cost of capital rises and the value of q increases. This means the market price of capital rises in proportion to its replacement cost, so investment increases, which raises aggregate demand. Blanchard's analysis of the effects of monetary policy changes are very similar .

The basis of the Blanchard model is an alternative version of the conventional aggregate demand schedule. Rather than including consumption and investment, Blanchard uses a stock market price index as a proxy for both, assuming a rise in the stock market produces a similar rise in aggregate demand. In addition a fiscal measure is also incorporated into the aggregate demand function. Changes in output are determined by the difference between aggregate demand and output, also a conventional money demand function is used in which real money balances are determined by the nominal interest rate and income. The stock market and bond market are connected by the returns on both markets. This suggests the real interest rate is equal to the capital gain on holding equities and a measure of company profits.

Like Tobin, an increase in the stock of money leads to a fall in the real interest rate, and cost of capital, i.e. q increases. This leads to higher investment and profits, so output rises, which also leads to a rise in the stock market. Within the context of the IS\LM framework, Blanchard distinguishes between the "good news" and "bad news" case, when considering the effects of monetary policy changes, he also considers the different effects of anticipated and unanticipated changes on the dynamic relationships, which arise because of the assumption of rational expectations. A policy change is unanticipated when it is implemented immediately it is announced. It is anticipated when there is a lag between announcement and implementation. The length of the lag plays an important role in determining the dynamics of the system, and the effectiveness of any particular policy.

The IS/LM representation of the Blanchard model contasts with the Tobin model in that it is essentially a dynamic model, this is illustrated in Figure 2.2. The Blanchard model produces a relationship between the stock market (q) and income (y), which gives a stable solution on the saddle path The steady state income schedule is upward sloping, because an increase in the stock market leads to a rise in income, and vice versa. This assumes that output is determined by aggregate demand.

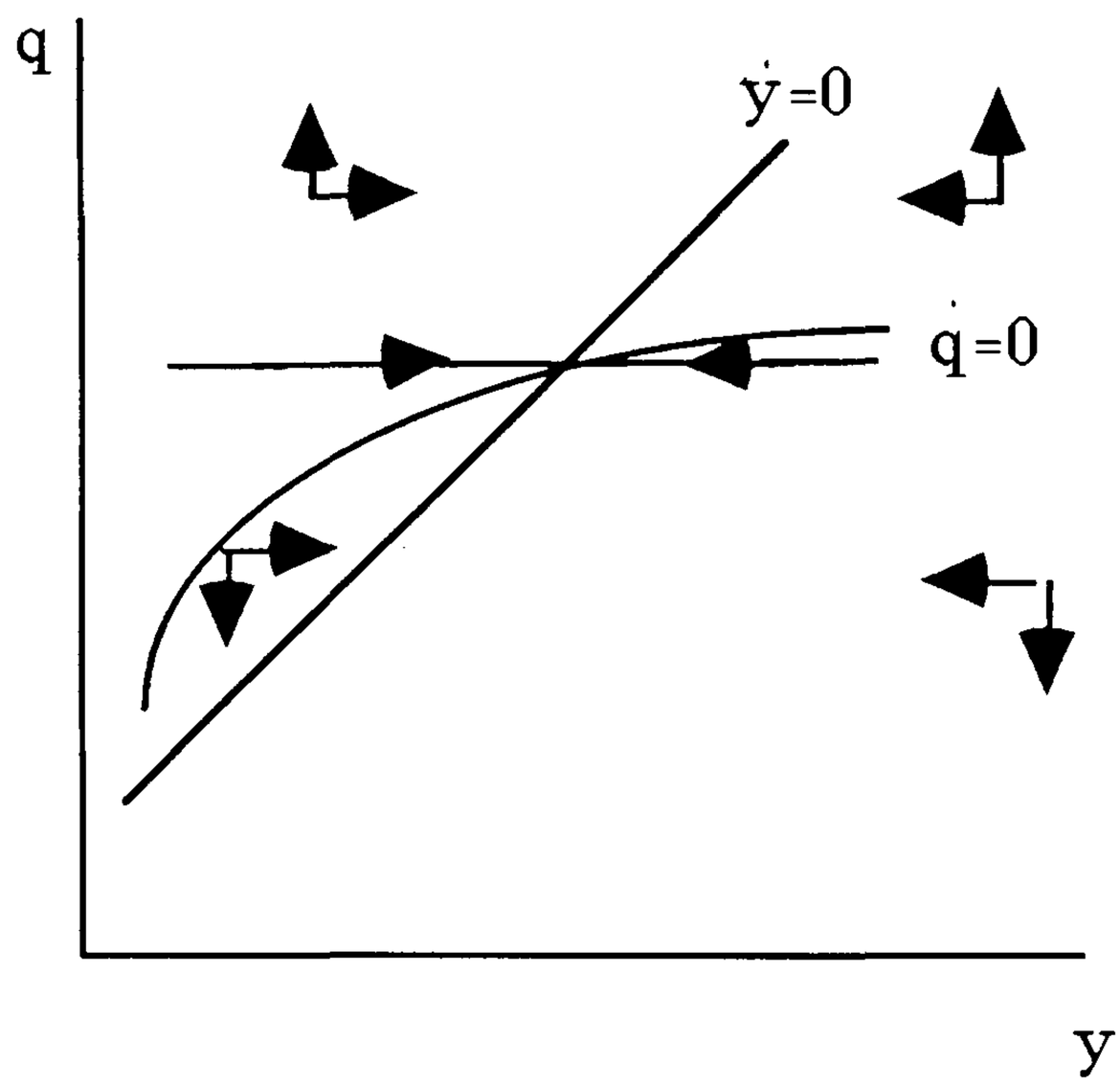

Figure 2.2 A dynamic interpretation of the Blanchard model in output, stock market space. In this case the model represents the 'bad news case' only.

The steady state stock market schedule is also upwardly sloping in the "good news" case, as the stock market depends on the ratio between steady state profit and steady state interest rates. When output rises, both interest rates rise, through a rise in the transactions demand for money, and profits rise. So the encouraging effects of a rise in company profits exceeds the negative effect of a rise in interest rates. Thus the stock market rises with an increase in output.

Following a monetary expansion, the stock market jumps, and short-term interest rates fall. The jump depends on the expansion being unanticipated. It is assumed that the rise in money balances causes an increase in output and profits, and reduces the interest rate to clear the money market. Due to an expected rise in the transactions demand for money, it is assumed short term interest rates will rise. The long term rate

also rises, but by less. In the "good news" case the effect of increased profits dominates the expected rise in interest rates, so after its initial rise, the stock market continues to rise, but the price of long-term bonds falls. The opposite occurs in the "bad news" case, where the stock market "overshoots".

In the particular case of the monetary expansion being unanticipated, the initial jump in the stock market on announcement of the change in policy has interesting implications as regards the type of expectations governing any change. As mentioned this model is of the rational expectations variety, but in the case where the expansion is unanticipated, the expectations assume a different form, namely regressive expectations. The use of this form of expectation to control the adjustment dynamics arising from a disturbance, has also been used by Dornbusch (1976), in his ' sticky price' model of exchange rate determination, although in this model they are equivalent to rational expectations. Also in his model they were used to determine the expected change in the exchange rate, rather than the stock market, although in both cases they produce the "overshooting" of the exchange rate and stock market respectively, with regard to monetary policy .

In the Blanchard model,which is illustrated in Figure 2.3, an anticipated monetary expansion is analysed when the price level is assumed to be fixed. The analysis is similar to Wilson's (1979), in that there is a pre-monetary (AA') and post-monetary (SS') expansion schedule. Following the announcement of the expansion (Y') the stock market jumps,from its initial position at E, in anticipation of the forthcoming rise in output and profits, which result from the predicted lower interest rates. Between announcement and implementation , output increases (Y"), as do short term interest rates, but the long term rate falls, as it is expected that the short term rate will decline after the policy is implemented. In the "good news" case the stock market continues to rise up until implementation occurs, following which the stock market continues to rise, but at a much slower rate until it reaches a new equilibrium at point E_1. In the "bad news" case, "overshooting" of the stock market occurs, as the effect of a rise in real interest rates dominates the effect of the rise in profits.

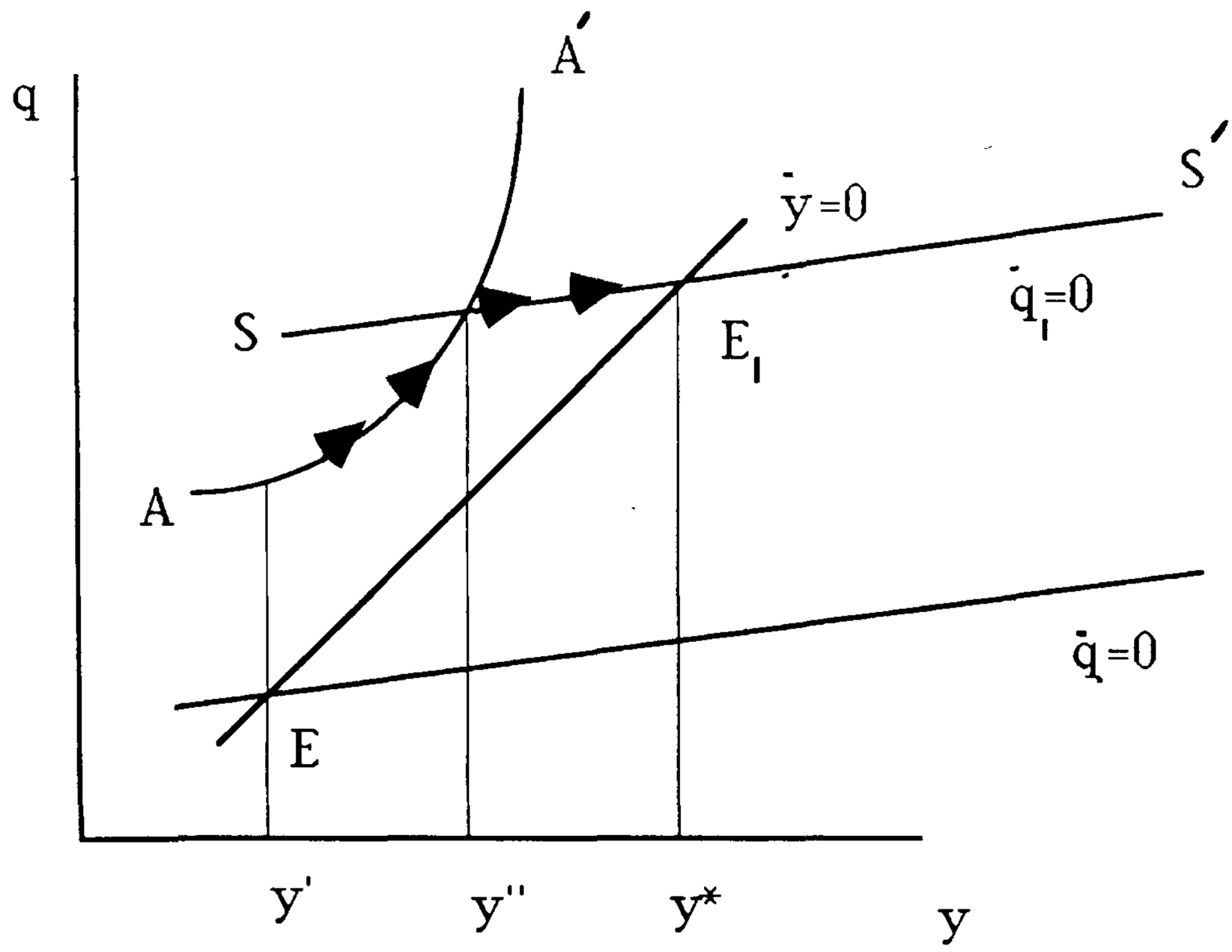

Figure 2.3 The reaction in Blanchard's model of output and the stock market to an anticipated change in monetary policy.

When analysing the effects of monetary policy and fiscal policy on the interrelationship between the stock market and exchange rate, Blanchard, in general assumes prices are fixed. However there is one exception to this following a monetary expansion. This complicates the analysis, as it requires the nominal variables to adjust to movements in the price level. The mechanism used for the adjustment process is based on the rational expectations model, in which it is assumed actual inflation equals the expected rate of inflation. The expected rate of inflation then equals the difference between actual prices and long term equilibrium prices. At this rate output is equal to its full employment level, and nominal money balances are at their equilibrium value. This mechanism allows for perfect flexibility of prices in the long term, but over the short term there is a gradual adjustment to the equilibrium state, which depends on the coefficient determining the speed of adjustment.

The incorporation of this price adjustment process affects the dynamics of any adjustment in the stock market and income following any change in monetary policy. Following a rise in money balances, assuming it was unanticipated, there is a rise in real money balances, as prices fail to adjust immediately. This causes a fall in the nominal interest rate to clear the money market. In the medium term prices are

expected to rise, such that the expected higher inflation rate reduces the real rate of interest, (Mundell effect). Over the long term, the real rate rises, as prices rise, ensuring that real money balances fall. This process ensures there is a unique value for the stock market as it adjusts to the monetary expansion and to the condition that it must move towards its steady state point in the long term. So introducing the price adjustment process has an important effect on output and the stock market, through its effect on the real rate of interest.

The Blanchard model analyses the impact of fiscal policy on the stock market and output, assuming prices are fixed. The analysis is based on an anticipated fiscal expansion, as it is argued that most fiscal expansions are known about before they are implemented. The main difference to changes in monetary policy is that the effect on output and the stock market is more complicated, depending on whether it is the "good news" or "bad news" case. In the good news case, the anticipated rise in profits outweigh the anticipated rise in short term interest rates, so overall the stock market rises. Between announcement and implementation, the rise in the stock market causes an increase in output and the short-term interest rate.

The long-term interest rate jumps in the same way as the stock market, as short-term interest rates are anticipated to rise. In the "bad news" case the stock market falls, when the policy is announced, decreasing output from the private sector between the time of announcement and implementation. However output from the public sector has not as yet risen, so overall output falls. When the policy is implemented, short and long term interest rates rise. After the increase in public spending, output increases. However the stock market continues to decline, as interest rates rise. So in aggregate, the stock market declines, and output rises, whereas in the "good news" case both stock market and output rise.

The model used by Gavin (1989) is basically the same as that of Blanchard's, but applied to an open economy scenario. The main difference is that in the aggregate demand schedule there is also a variable representing the real exchange rate and again it has a positive relationship with aggregate demand. There is also the conventional UIP condition using interest rate differentials. Gavin's model is based on the assumption that prices are flexible, and in the short-term they are sticky following a monetary disturbance. However in the long-term, following a monetary expansion, prices increase proportionately with the increase in the money supply.

This is an identical process to the Blanchard model, likewise output has a common response, as the adjustment path rises to begin with, then gradually declines after the change in monetary policy. Inflation initially jumps, immediately after the expansion, but then gradually declines asymptotically to its original value. Stock prices also have an identical reaction to the Blanchard model. This suggests that the addition of an exchange rate variable has little effect on these variables.

2.2.1. The effects of changes in monetary policy on the Gavin model

Both Gavin and Blanchard assume that it is more common for any change in monetary policy to be anticipated. This has important effects on the impact of the change, and the dynamics of adjustment. The economy tends to be influenced by the announcement of the change in the policy both before and after the policy is implemented. In general, when changes in monetary policy are anticipated, and when expectations are formed rationally, the announcement of any change has an immediate effect on the economy, as if the policy was being implemented then. This results in 'leads' as well as the more accustomed 'lags' in the price level adjustment.

In a model developed by Wilson (1979) the analysis takes into account the effect of an anticipated change in the price level following a monetary policy change, on the exchange rate. In effect Gavin then adds a stock market variable to the model, so as to investigate any interactions between the stock market and exchange rate following an anticipated change in monetary policy. The Blanchard model also analyses the interrelationship between output and the stock market in terms of an anticipated change in monetary policy. In general, the greater is the change in the money supply, the larger is the effect on the exchange rate and the longer is the time lag between announcement and implementation of any policy change, the less is the effect on the economy at the time of announcement.

There are a variety of reactions by the exchange rate to a monetary expansion. The first is the jump or "overshooting" reaction, in which there is an immediate depreciation of the exchange rate, before appreciating asymptotically back to its long term equilibrium position. This can occur in either the bad news or good news cases. This is exactly the same reaction as occurs in Dornbusch (1976). This reaction is primarily due to the stickiness of prices in the goods sector, causing domestic interest

rates to fall below their foreign counterparts. This difference in returns requires that there is an expectation of a future appreciation of the exchange rate, to ensure parity between domestic and foreign interest rates is maintained.

However unlike Dornbusch (1976), there is a circumstance where the exchange rate appreciates following a rise in the money supply. Whether this occurs depends on the value assumed by the coefficient on the price level, which determines the speed at which the price level converges back to its long term equilibrium value. So an increase in the money supply gives rise to a jump appreciation of the exchange rate, only if the price level does not adjust sufficiently quickly back towards its equilibrium level.

This unusual reaction by the exchange rate is due to the stock market and in particular the impact the stock market has on aggregate demand. After the monetary expansion, short-term interest rates fall as in the Blanchard model, due to the need to clear the market. So aggregate demand and output also increase, raising the price level. Demand for nominal balances increases, as prices rise, requiring a rise in nominal interest rates to clear the market. Assuming inflation is now expected to fall, reversing the "Mundell affect", real interest rates rise sharply, above the foreign interest rate. If this occurs immediately after the expansion, long-term rates rise, causing an instantaneous appreciation of the exchange rate.

This will only occur if a number of fairly stringent assumptions hold, as well as the need for the good news scenario to apply as the rise in output requires an increase in the stock market. First it requires a low price adjustment coefficient . The slower prices adjust, the larger is the impact on output and real interest rates. In which case, the stock market would not rise fast enough or high enough to produce the reverse "overshooting", through its effect on aggregate demand.

A small marginal propensity to save and low elasticity of aggregate demand to the exchange rate are also needed. The smaller is the marginal propensity to save, the higher is the Keynsian multiplier, and so the greater is the effect of output on aggregate demand. A high elasticity of aggregate demand to the exchange rate, suggests an appreciation of the exchange rate reduces output through a reduction in import prices and higher export prices. This again would have the wrong effect on output and interest rates to produce the "reverse overshooting" of the exchange rate.

The models of Blanchard and Gavin both analyse monetary policy when it is anticipated and come to broadly the same conclusions. The main result is that most changes in output, interest rates and profits occur before the policy is implemented, and likewise movements in the stock market and the exchange rate are almost complete before the expansion occurs. In addition Gavin finds that the way the exchange rate and stock market react to changes in the money supply depends on the lag between announcement and implementation of the policy change.

2.2.2. The Effects of changes in fiscal policy on the Gavin model

The analysis by Gavin (1989) regarding fiscal policy, is similar to Blanchard's, as the dynamics of adjustment depend on whether the "good news" or "bad news" case holds. In Gavin's open economy model, the analysis now needs to consider whether the exchange rate or stock market have the strongest influence on the goods market. If there is a real appreciation of the exchange rate, then there must be a fall in the stock market, to ensure that the real interest rate and output are maintained at there steady state levels. So it depends on which has the most powerful effect, as to whether aggregate demand and thus output rises or falls. This is a similar dichotomy to the "good news" and "bad news" responses.

Viewing the phase diagram in Figure 2.4 in exchange rate and stock price space, the steady state exchange rate schedule is downward sloping regardless of whether it is the good or bad news case. This schedule equates real and steady state output, and domestic and world interest rates. This can be explained by the domestic interest rate being determined uniquely by real output. If prices and money are constant, the domestic interest rate exceeds the world interest rate only when output exceeds its steady-state level. It slopes downwards for the previous reason, if the real exchange rate depreciates, the stock market must decline to ensure output and real interest rates are at their steady state position.

The steady-state stock market schedule slopes upwards in the "good news" case and downwards in the "bad news" case. In the "good news" case a depreciation of the exchange rate increases aggregate demand, and thus the stock market. This is because any rise in interest rates is more than offset by the rise in profits. In the "bad news" case the steady state stock market schedule slopes downwards. Taking a point on the

steady state exchange rate schedule, such as 'a', there is a rise in the stock market, but no change in output or the interest rate. So share prices have risen but profits have not changed and there needs to be an expectation of a capital gain on the shares. Thus the expected change in the stock market will exceed zero. At a point above the exchange rate schedule, profits and interest rates rise, but interest rates rise more, so a larger capital gain is now required. Below the exchange rate schedule the opposite occurs, and no anticipated capital gain is needed. This is illustrated in Figure 2.4

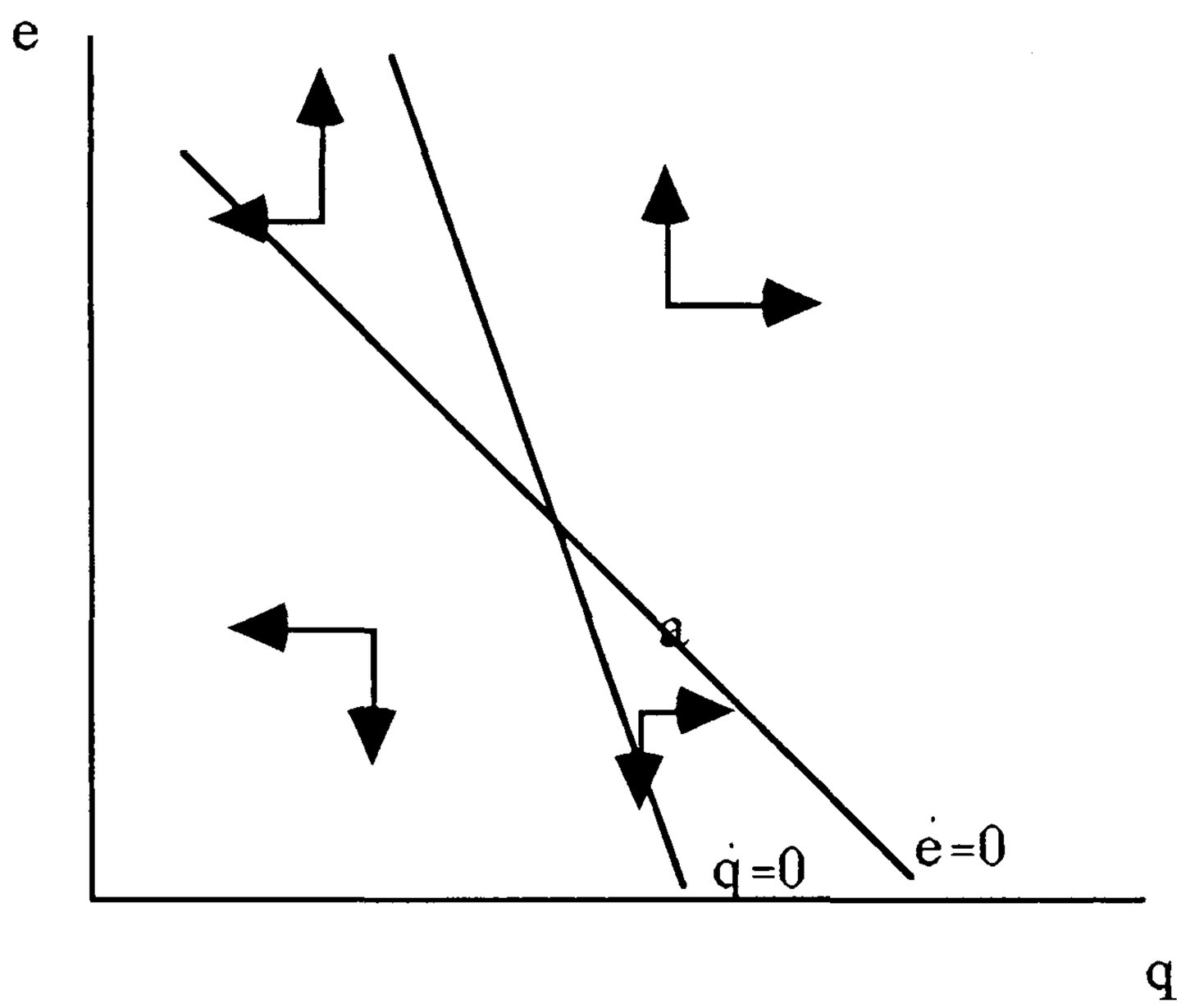

Figure 2.4 A phase diagram illustrating the relationship between the stock market and the exchange rate, using the "bad news" case.

For the same reason as Blanchard, only an anticipated fiscal expansion is considered here, although Gavin also analyses an unanticipated fiscal expansion. In the "bad news" case, between announcement and implementation of the policy, aggregate demand and output will fall, as in the Blanchard model. In that model the fall in output was due to the decline in the stock market, whereas in Gavin's analysis, the fall is due to a real appreciation of the exchange rate. As in the Blanchard model, real interest rates, both long and short, rise after the policy is implemented, and it is the general anticipation of this rise which causes the exchange rate to appreciate. Again an important feature of the anticipated fiscal expansion is that the length of time between announcement and implementation plays an important role in determining

whether output rises or falls on announcement of the fiscal expansion. As the delay between announcement and implementation rises, so the smaller is the change in the economy's initial equilibrium position.

When the expansion is implemented in Figure 2.5, the economy must be at a certain point, i.e. 'a', before implementation it must be on the pre-expansion arm labelled B, the point on this arm to which the jump occurs depends on the lag between announcement and implementation of the policy change. If the lag is short then the jump is to a position near the schedule at A. Regardless of how long the fiscal expansion lasts for, the exchange rate will appreciate and stock market fall. So in the following Figure 2.5, the economy starts at an initial equilibrium E. Following the expansion the new equilibrium will be at E'. Prior to implementation the economy is on the schedule at B, afterwards it is on A.

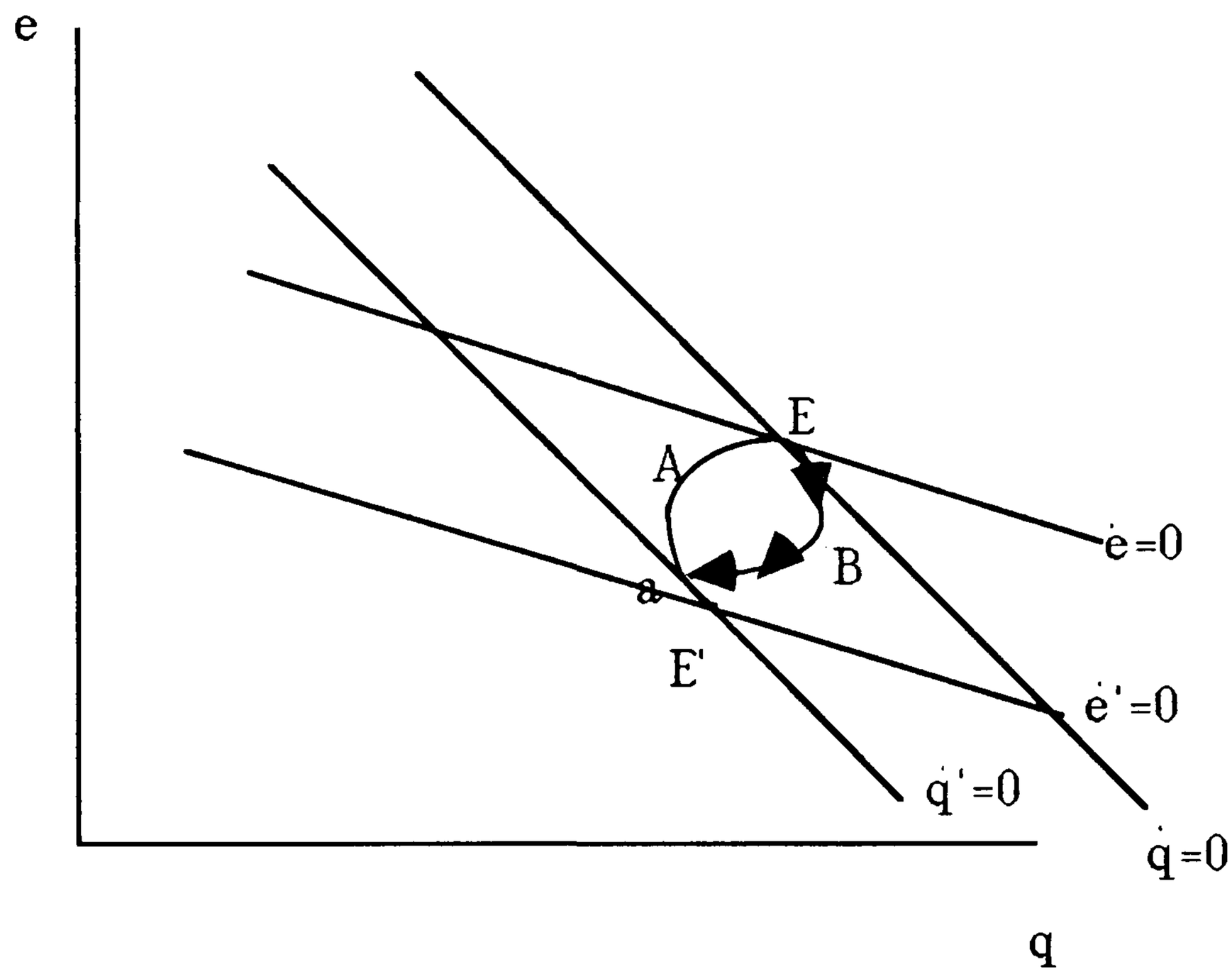

Figure 2.5 An anticipated fiscal expansion in the Gavin model, with the "bad news" case.

Following the announcement of the fiscal expansion, the stock market could actually rise if the intended implementation is far enough into the future. This is because prior to implementation interest rates are low, and the anticipated higher interest rates are

so far into the future that they have no affect on the stock market. If the lag is short then the higher interest rates following implementation are not so far off, and the stock market falls.

In the "good news" case there are important implications arising from the rise in the stock market. This relates to whether a rise in the stock market exerts more influence in the goods market than the change in the exchange rate. Gavin analyses the case where the stock market dominates, which is when the stock market rise following the increase in output, causes aggregate demand to rise, thus outweighing the adverse effects of the exchange rate appreciation.

Between announcement and implementation of the fiscal policy, the economy begins on the B schedule, as in diagram 2.6. When the policy is implemented, the economy lands at a point such as Y, which assume that it will be a long fiscal expansion. This point is fairly distant from SS0, the steady-state equilibrium point. However if the fiscal expansion had been short, then the economy would have landed at a point such as X, close to SS0. Once the expansion occurs, the economy must be on the A schedule.

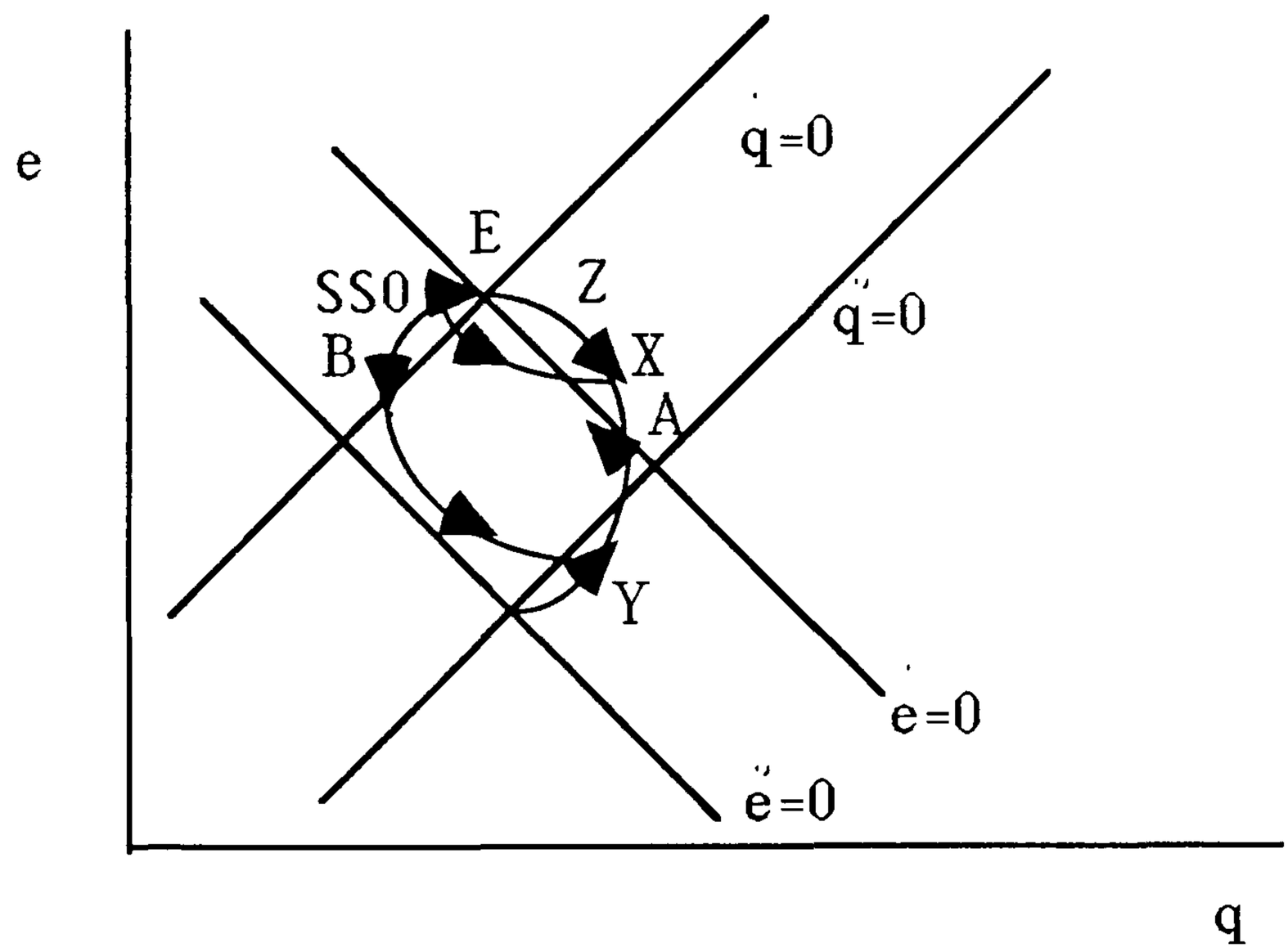

Figure 2.6 An anticipated fiscal expansion in the Gavin model, with the " good news case".

As is apparent from this diagram, if the delay between announcement and implementation is long, the economy goes into recession. This is because the longer

there is until the fiscal expansion, the less its influence on profitability is taken into account, in share holders present value calculations. Thus there is less of an impact on the stock market and thus output. If it is short it will jump to a point such as Z, which being above the steady state exchange rate schedule indicates a position of high output.

In the "good news" case, whether there is a rise or fall in output, when the expansion is announced depends on three factors. First the length of time the expansion is expected to last, second the lag between the policy's announcement and implementation and thirdly whether the stock market has a strong or weak reaction. If the lag between announcement and implementation is reasonably short, and the expansion is predicted to be brief, and the stock market reacts strongly to the expansion, then output will rise when the expansion is announced. This can be explained more fully by viewing the expected rise in output after the expansion increasing the stock market, this increases aggregate demand and output, through a rise in investment.

Overall, it is possible for an anticipated fiscal expansion to produce a rise in output, stock market prices and an appreciation of the exchange rate. The correlation between stock markets and exchange rates however can be either positive or negative depending on the three factors already mentioned, which are; the good and bad news case, the strong and weak stock market cases and the time lag between the announcement of a policy change and its implementation.

2.2.3 Appraisal of the Mundell-Fleming models

The main problem with the Mundell-Fleming class of model is that they are small economy based models, so that it is assumed that all changes in foreign variables are exogenous. In addition it is assumed that expectations on future exchange rates are static, this produces expectational errors during the period of transition to long-run equilibrium. The income-expenditure framework which underlyes both the Blanchard, Tobin and Gavin models lacks any solid microfoundations for the behaviour of the public and private sectors, Also little is said about the intertemporal budget constraints and the failure of the public and private sectors to consistently look forward.

The specific models used by Blanchard (1981) and Gavin (1989) require a number of different cases to be considered, each of which produces significantly different outcomes. As it is impossible to analyse all possible situations, specific cases are chosen, which tend to be selected on an ad hoc basis. There is no attempt to show which case is the most probable. In addition there is no allowance made for a number of different factors that would effect the results, including the need to take account of trend monetary growth as well as inflation.

The main criticism of Tobin's model is regards the nature of the relationship betweeen stock prices and investment. It is often argued that stock prices are too volatile and subject to speculative bubbles, to accurately reflect levels of investment (Merton and Fischer 1984). In addition there is some confusion about how the relationship is to be interpreted, particularly how the dynamics of the adjustment process are to be incorporated into the model. This process needs to be analysed in the context of adjustment costs and how expectations are formed. Empirically the main problem is concerned with the difficulty of measuring marginal q and although average q is often used as a proxy, it is not always an adequate reflection of marginal q.

2.3. Monetary models

The monetary model concentrates on analysing exchange rate movements in terms of differences in stocks of assets between countries. For this reason the emphasis is on the money demand function, as well as which assets should be included in the function. There are two main papers which incorporate the stock market into the money demand function, although both tend to be more empirical than theoretical. The first was by Hamburger (1977) and the most recent by Friedman (1988), both arguing for the inclusion of a wider range of assets. A more theoretical approach to how the exchange rate and stock market interact, within the context of this class of model, is then offered by Kouri (1977) and Niehans (1987).

The first occasion in which the stock market and exchange rate are mentioned in the same model was in a paper by Kouri (1977). The aim of the research was ostensibly to analyse the affects of monetary policy under flexible exchange rates to determine if it differed to the effects under a fixed exchange rate regime. To this extent it differs to the other theoretical models discussed here as it does not specifically analyse the

reaction of the stock market and exchange rate following an exogenous disturbance. It does however offer some important insights into the general relationship between these two variables, introducing an alternative specification for Uncovered Interest Parity (UIP) and the role of the Capital Asset Pricing Model (CAPM) in the analysis of international capital markets.

The analysis uses a general equilibrium model of the international capital markets, in which it is assumed international transactions are largely settled by credit amongst trading partners, so the net demand for transactions balances is insignificant. This assumption removes the problem associated with 'Gresham's Law', on the problem of the coexistence of different monies. This is a common assumption in this type of exchange rate model.

In addition the problems associated with UIP are also circumvented by stipulating that the expected change in the exchange rate is not only equal to the differential between domestic and foreign interest rates, but also by a variance term and a currency premium, which in effect compensates for the systemmatic inflation risk of a specific country's currency. Kouri assumes that bonds and equities can be bought and sold in both countries. If the inflation rate and the real return on equities are correlated, then the interest differential in UIP will also be affected by the average real return on capital assets.

Investor's are assumed to face the problem of how best to maximise their utility by choosing a particular portfolio, subject to a budget constraint. The constraint is that income is composed of capital gains from equities and interest payments on bonds, with the difference between consumption and income defined as savings. Consumption is taken to be a constant proportion of wealth and demand for money depends on wealth rather than current income, wealth is comprisesd of money, bonds and equities.

The equilibrium relationship between expected returns on equities in different countries is shown to depend on a standard CAPM relationship. Assuming that the total demand for a particular country's equity is equal to the market value of the existing supply of equity, then investors are compensated for systemmatic or market

risk, in terms of expected return.[2] Kouri interprets this to mean that as long as there is no relationship between inflation rates and equity returns, then exchange rate flexibility does not alter the equilibrium relationship between returns on risky capital. This implies that commodities are determined in a world market, not by domestic factors.

The analysis of monetary policy does not specifically involve equities, although they are implicitly relevant through being a component of wealth. Any change in monetary policy in effect changes the currency premium, through the effect on the proportion of wealth invested in bonds and the average return on the market portfolio of bonds. However there is no direct link between changes in the stock market and exchange rate. By assuming investors have the same expectations and same level of risk aversion, as well as wealth being endogenous, Kouri derives a relationship between the ratio of the money stock to wealth and the nominal interest rate. The conclusion is that for a country integrated into the world economy, especially capital markets, then flexible exchange rates do not increase a country's autonomy as regards monetary policy.

In Niehans (1987) it is assumed that capital goods are financed by homogenous securities, that are traded internationally. Also private wealth consists of securities and real balances, which are assumed to be constant and real balances consists of securities and the ratio of money to the market value of capital. The analysis concentrates on Tobins q and the aim is to examine the consequences of differences in the parameter that determines the deviations of q from their steady state values. Additionally capital outflows are expressed as the ratio between a country's net foreign assets in terms of consumer goods and Tobin's q.

The comparative statics allows the effects of changes in the money supply on the interest rate to be determined, and once this is done then the comparative static effects of other open market operations on other variables can also be determined. For instance the purchase of bonds causes a reduction in the world interest rate. Then the capital stock rises as do prices in the domestic economy, but not by as much as the

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[2] A detailed discussion of the CAPM and its implications can be obtained from any standard text such as Elton and Gruber (1991) ' Portfolio and Investment analysis'.

rise in the money supply, and this causes the domestic currency to depreciate. There is also a cumulative capital outflow as domestic net foreign assets would have risen.

Assuming that the demand for foreign bonds and domestic shares are affected identically by a change in the ratio of real income to wealth, and that the interest semi-elasticity's of demand for assets are likewise the same, it means the yield differential on domestic and foreign interest rates are affected by the terms of trade and the ratio of domestic shares to foreign bonds. Also the yield on foreign bonds is determined by the terms of trade and nominal exchange rate. The coefficient on the ratio between the share price and price level is found to be important in determining the adjustment path of the domestic share price and exchange rate, because it determines the interest differential.

The dynamics of the Niehans model are a little different to those of other models, as the analysis concentrates less on the extent to which monetary policy can be anticipated, and more on the mobility of capital goods. Firstly the analysis is simplified by reducing the model to two differential equations. In the case where capital goods are assumed to be mobile, it is assumed that capital goods prices between the two countries are equalised. The two differential equations are in terms of the change in q and change in the capital stock and expectations are assumed to be formed rationally. The equilibrium of this system is a saddle point,with the stable arm approaching from the north west and south east.

Following an unexpected rise in the money supply, the capital stock rises to a new equilibrium level monotonically, and q instantaneously overshoots, which is followed by a gradual fall back to its previous level. There is also an immediate fall in the world interest rate. However the fall involves some overshooting, with the adjustment dependent on the gradual change in the capital stock. As regards to the exchange rate, the monetary expansion causes a steady state depreciation as expected. However in some circumstances this can involve overshooting followed by a gradual appreciation.

When capital goods are assumed to be immobile, in one country the capital stock adjusts with finite speed, in the other with infinite speed. As previously the domestic monetary rise causes an immediate fall in world interest rates. In this situation the exchange rate can undershoot or overshoot, and an initial appreciation is again possible. This is because there is a capital outflow and trade surplus after the

expansion, due to inertia in the domestic stock of capital in contrast to that abroad. So initially the domestic country gives up goods and services to acquire more securities, hence the trade surplus and possible appreciation of the exchange rate.

On the other hand, when the domestic capital goods prices adjust with infinite speed, the exchange rate overshoots as expected, but there is also an immediate overshooting of the domestic capital stock and gradual expansion of the capital stock abroad. Therefore the initial capital outflow falls short of its equilibrium level. Overall with integrated security markets, as with the Kouri model, floating exchange rates fail to insulate a country from the monetary policy consequences of another country. As capital flows can be in either direction, so there is no specific causality between exchange rate movements and flows of capital.

2.3.1 Appraisal of the Monetary models

The main criticism of Monetary based models is that they rely on two fundamental identities, which are Purchasing Power Parity and Uncovered Interest Parity. The former has been subject to much debate, although recent evidence suggests it does hold in the long run (Macdonald 1993). Uncoverd Interest parity however does not hold, due to the presence of a time varying risk premium in the exchange rate. These models also tend to use the standard money demand functions, which have tended to be insufficiently stable over the recent float, possibly an alternative function would have been better (Hamburg 1983).

2.4 Portfolio balance models

There are a number of models which analyse the interaction between the exchange rate and stock market assuming that domestic and foreign assets are not perfect substitutes. These models vary in complexity, from those which just incorporate equities into investors portfolios to those which also attempt to model the banking sector . There are basically three categories of model analysed in this section; microfoundation models (Grinols and Turnovsky 1994), the standard portfolio balance (Aoki 1986) and banking sector models (Uctum and Wickens (1989). In general these models produce more predictable outcomes than the other types of model.

2.4.1 Microfoundation models

The Grinols and Turnovsky (1995) model can be regarded as a general equilibrium model, in which the exchange rate is viewed as a mechanism that balances asset holders choices as regards their portfolio's. As part of the risk averse assumption, the mean and variance of the main variables are calculated, including government policy, the money supply and foreign inflation rate. Agents face an optimisation problem, in which intertemporal utility is maximised by the allocation of wealth between domestic money, equities, domestic bonds and foreign bonds.

Using stochastic calculus it is possible to derive an expression for the change in the real return on various assets by not just their return, but also their variance. For instance the change in the real return on money is determined by the the return on money as it changes with respect to time and a normally distributed random variable. Where the return with respect to time is equal to the domestic price level and the variance of the price level. It is also assumed that equity investment is the real investment opportunity as represented by capital. As before the change in its rate of return is equal to the change with respect to time and a random variable.

The level of domestic inflation depends on the portfolio balance allocations. Assuming that portfolio shares are constant through time, this gives the expected rate of inflation as varying proportionately with the growth in money and inversely with the expected growth rate in traded assets. The variance of the growth rate in traded assets is affected proportionately by variances in productivity changes, foreign prices and domestic fiscal disturbances. The differential expected real rate of return between equities and domestic bonds reflects a relationship in terms of risk between two risky assets. In addition any difference needs to be compensated for by differences in return on the other side of the equation.

As already mentioned all three models include UIP in some form. Even though this model is primarily concerned with risk, UIP can also be shown to hold as long as domestic monetary risk is assumed to be zero. This suggests that UIP holds even when agents are risk averse. The equilibrium relationship between the endogenous variables, which can be solved in terms of the exogenous variables listed earlier can be reduced to a pair of equations involving the exchange rate and price level. This is based on an important relationship in which it explains the share of capital in the

traded portion of the investors portfolio. The extent of this relationship determines the effect of the exogenous variables on the exchange rate and price level.

The relationship between the exchange rate and price level can then be represented by an equilibrium condition between real rates of return and portfolio balance. At the intersection the expected rates of depreciation and inflation occur. An increase in the mean and variance of the domestic money supply increases both the expected inflation rate and exchange rate, by moving the Portfolio preference schedule outwards. With fiscal policy, a rise in expected government policy increases the exchange rate and price level, but when the stochastic element of government expenditure is raised the two variables can move in a number of ways depending on which effect is dominant. Any change in policy causes an instantaneous jump in the exchange rate so that portfolio balance in stochastic terms is maintained.

Any changes in the foreign inflation rate variance will have an effect on the domestic economy and thus the exchange rate and stock market. In effect both the rate of return and portfolio balance curves shift downwards following a rise in the foreign inflation variance, thus the mean domestic rate of inflation must fall. Depending on the relative shifts in these two curves, the exchange rate can appreciate or depreciate after the monetary expansion. There is an additional affect indirectly on the risk premium in the exchange rate through the change in the share of capital in the traded portion of the investors portfolio.

The portfolio balance approach to the exchange rate produces some similar results to the models mentioned earlier in that the reaction of the exchange rate to disturbances can be in either direction depending on certain affects, in particular of the respective stock markets and the extent to which the investors portfolio includes capital in its traded portion. Finally the Grinols and Turnovsky (1995) paper suggests that the foreign exchange risk premium can only be zero when the exchange rate is uncorrelated with domestic wealth.

2.4.2 Standard Portfolio Balance Models

The conventional portfolio approach is used by Smith (1992) and Sarantis (1987). As both models were developed for the purpose of empirical analysis, the theory supporting them is only briefly discussed. In these cases the return on shares is added

to the more usual assets; money and nominal Government bonds. Smith's theory involves an optimising inter-temporal model in which the consumer chooses between the consumption of products or investment in assets. Neither of these two models includes any specific measure for risk unlike Grinols and Turnovsky (1994).

There are three assets in these types of model, bonds which earn the riskless rate, domestic money which earns no rate of return and equities. In the Sarantis model foreign bonds are also included as a specific asset. The main difference between these two models is that the Smith model can incorporate more than two countries, whereas the Sarantis model is based on bilateral exchange rates, and thus two countries. In the Sarantis model the supply of money and the other assets are determined by the relative returns to all four assets and the level of wealth. The asset demand functions in Smith's model are different, as all include a constant relative risk aversion term.

There is also a need to maximise the expected present discount value of utility in the Smith model, in which both the quantity of goods consumed and real money balances are included. Also in the case of shares, the share of wealth held by an agent from one country in the shares of another , depends on the difference between the average return on shares and the riskless rate of return, as well as the covariance matrix of share returns. Similarly for the share of wealth held in bonds from one country, by agents from another country. In which case the share of bonds depends on the difference in returns between the domestic and foreign bonds, having adjusted the rate of return for the expected change in the exchange rate. Again the covariance matrix of exchange rates will influence the result, as well as the share of wealth held in the form of shares.

The share of wealth held in the form of domestic currency will be determined by the proportion held in the form of bonds and domestic shares. The market equilibrium condition for any particular country, occurs when the supply of assets equals the demand for assets from one country by all other countries. This particular model assumes that the expected change in the exchange rate is zero, as it changes only when the exogenous variables change in an unpredictable way. However in the Sarantis model UIP[3] is assumed to hold throughout, and expectations are assumed to

[3] For an alternative view of the use of UIP in Portfolio balance models see Macdonald and Taylor (1992).

be formed regressively. In the Grinols and Turnovsky (1994) model as risk is analysed, UIP is not assumed, although one particular result suggests it can hold even when agents are risk averse.

An analysis by Aoki (1986) compares three types of policy; open market operations, foreign exchange intervention and sterilized intervention. Open market operations consist of an exchange of money with domestic shares of equal value. Foreign exchange intervention consists of an exchange of foreign money with foreign bonds which are of equal value in the domestic currency. Sterilized intervention consists of an exchange of domestic shares with foreign bonds of equal value, again as measured in terms of the domestic currency. In all three cases, the total amount of assets held by the authorities is held constant. The effect of these three actions on the exchange rate, domestic share price and Tobins q, is then investigated. In this model, Tobins q is defined as the ratio of the share price to the price level. This assumes the replacement cost of capital is proportional to the general price level.

The Aoki model has an asset and a goods sector, with both the money supply and foreign bond stocks are assumed to be exogenous. The models dynamics depend on the interest parity relations which determine the way in which the exchange rate reacts to any disturbance. The other source of adjustment stems from the domestic interest rate and share price relation, which determines the reaction of the domestic share price. Having specified the time paths for the differential between domestic and foreign interest rates, it is then possible to locate the time paths for the exchange rate and terms of trade. The terms of trade represented by the negative of the real exchange rate is proportional to the ratio of the share price to the exchange rate.

The terms of trade jumps initially following the announcement to all three types of policy. After the jump the adjustment is monotonic, assuming that the important coefficient on the ratio between the share price and price level is negative. The exchange rate can follow a number of adjustment paths, depending on the difference between the time the policy change is announced and the time when it is implemented. Only the open market operations produce a monotonic adjustment path, as the time path can neither change sign (i.e. moves from being above to below its initial equilibrium value or vice versa.), nor reach a maximum or minimum point.

For both foreign exchange intervention and sterilized intervention, there are a variety of possible adjustment paths, depending on the lag between announcement and implementation of the policy change, as well as the sign on the real rate of return on domestic shares. It also depends on the interest semi-elasticity's of demands for the three assets. There are two opposing effects which determine the type of adjustment path the exchange rate takes. They are the different impact magnitudes and different speeds of adjustment.

The foreign exchange intervention can produce both "undershooting" and a misadjustment of the exchange rate. Again this depends on the lag between announcement and implementation of any policy, when the exchange rate changes sign and when it reaches its maximum or minimum value. For example, if the exchange rate changes sign following the announcement of the policy change at time T, but before the policy is implemented, then the exchange rate misadjusts as in Figure 2.6 In this case the exchange rate initially appreciates, but then depreciates until it exceeds its equilibrium value. Finally on implementation it reaches a new depreciated value. However if the change in sign occurs after implementation, then the exchange rate undershoots. This case is illustrated in Figure 2.7

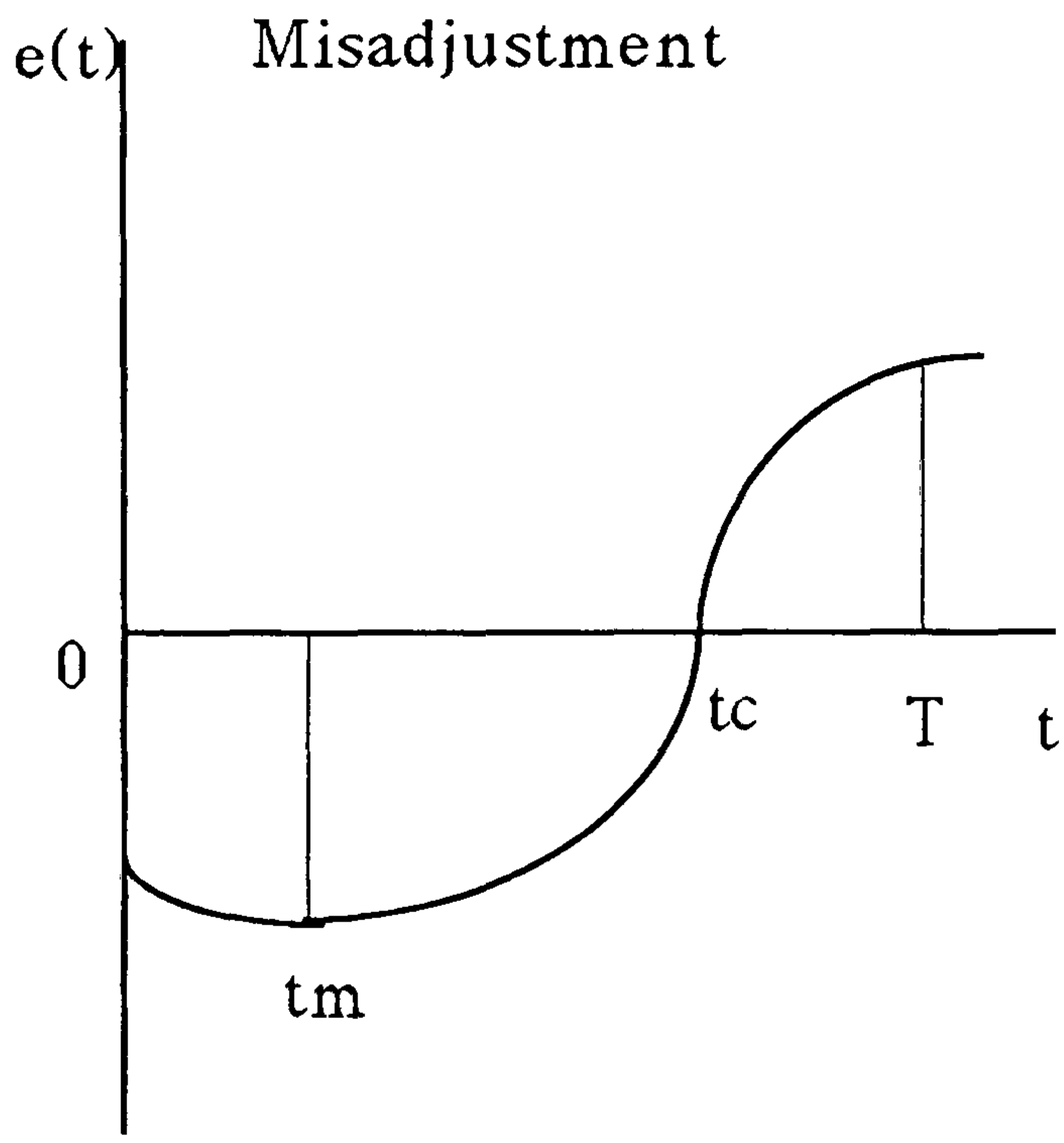

Figure 2.7 Misadjustment of the exchange rate in the Aoki model.

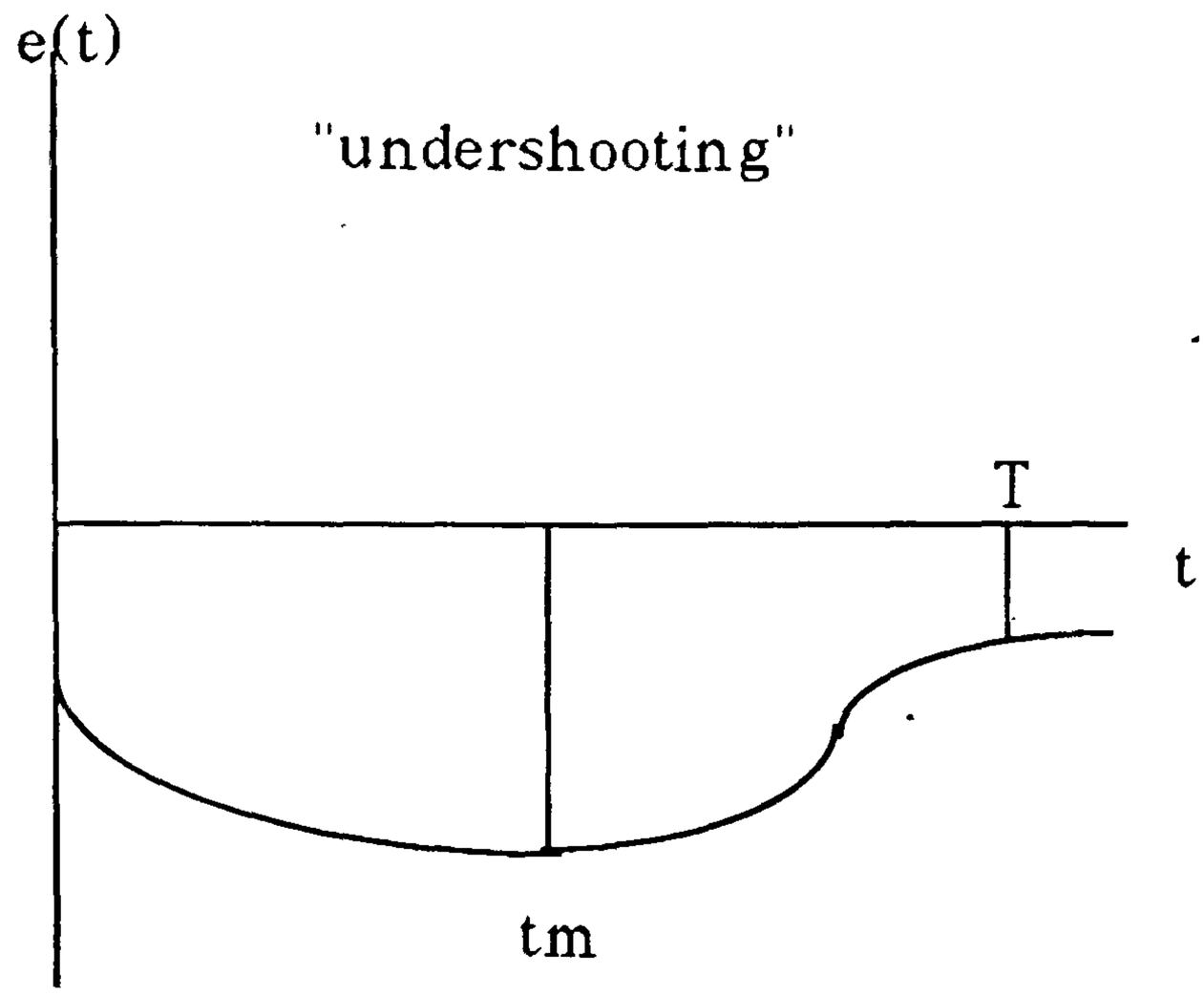

Figure 2.8 Undershooting of the exchange rate in the Aoki model.

2.4.3 Banking sector models

In a model developed by Uctum and Wickens (1989), the stock market and exchange rate are analysed in conjunction with the banking sector. The importance of relating the stock market and the banking sector was first noted by Tobin (1982) and this model builds on that initial theory.The model involves the exchange rate, stock market and factors affecting the level of investment. It contends that financial flows between countries are mostly between banks, and that most investment involves the use of bank loans. This is particularly the case for small nations with under-developed capital markets. For such countries, including the banks assets and liabilities is important in a model of exchange rate determination.

This theoretical model is based on the portfolio balance approach, and assumes that different countries assets are not perfect substitutes. The model consists of six assets; money, bank deposits, bank loans, foreign securities, physical capital and shares. It is assumed that firms finance their investment partially through bank loans and partially through the profits of previous years. Investment goes into physical capital, which produces domestic output, implying the supply function is endogenous. Certain assumptions are made such as expectations being formed rationally and less commonly that foreign securities are perfect substitutes with domestic bank deposits. Thus a fairly strong assumption is made, that only domestic bank deposits are held by

foreigners, which in practise is highly unlikely. All firms are assumed to have shares, which are tradable on the stock market, also the use of rights issues to raise capital is not possible.

The firms optimise future discounted profits, which are subject to certain restricting conditions relating to debt, capital accumulation and new loans. The change in the capital stock depends on gross investment and excludes worn out capital. The change in outstanding debt depends on new borrowing minus the amount of debt that has been repaid. New borrowing is determined by the proportion of gross investment financed by the price of new loans. The rate of return on shares is determined by the expected capital gain and any dividend, which is related to the firms profit.

The asset demands follow a similar pattern to Tobin's, with the demand for money depending on the rate of return on shares, bank deposits, the foreign interest rate adjusted for changes in the exchange rate and income. The banks reserve requirements will also have some affect, although a greater influence on their own balance sheets. It is also assumed Uncovered Interest Parity holds, so reflecting the assumption that foreign and domestic bonds are perfect substitutes. Aggregate demand for goods is determined by investment, the real exchange rate and some form of autonomous demand.

The main variables to be determined are the stock market index and exchange rate, which are expressed in terms of the exogenous variables. These are money balances, the foreign interest rate, autonomous demand, rate of amortisation of debt and the proportion of investment financed by bank loans. The real value of the firm is a positive function of the change in output, capital stock, and inversely to the discount rate and rate at which the capital stock changes. Where it is assumed its real value can only increase. In this case the price of a share is dependent on the value of a firms capital stock per share.

The rate of return on shares is a function of money balances and the return on foreign bonds, and thus domestic bank deposits. Taking the capital stock as a function of the real exchange rate and autonomous demand, then the exchange rate is a function of money balances, the foreign interest rate, prices and autonomous domestic demand. If there is an increase in the money supply, then the exchange rate will depreciate in the long term, due to a rise in the domestic price level. Either a domestic monetary

expansion, or conversely a foreign monetary contraction cause the share price to decline.

In the short-term, it is assumed that prices and the capital stock are fixed. Output is then given and the goods market is unable to clear. The dynamics of the adjustment depend on the sign of the rate of change in total debt relative to a change in the money supply. The sign is affected by the response in the loan supply to the difference in the loan and deposit rate of interest. The sign on this coefficient is positive if the loan supply is almost perfectly elastic, such that the difference in the rates is insignificant. It is negative if the loan supply is strongly affected by the difference in the interest rates. The two cases give varying reactions in the exchange rate and total debt, to changes in any of the exogenous variables.

If the coefficient governing the change in total debt, after a change in money balances exceeds zero, then the steady state exchange rate and debt schedules slope downward. In this case the exchange rate appreciates following a fall in interest rates, which is because if a rise in money balances raises outstanding debt, the exchange rate must appreciate due to the rise in interest rates brought about by the increased demand for loans. i.e. the increased reserve requirement dominates the lowering of aggregate demand. In these circumstances a monetary expansion causes a jump depreciation of the exchange rate, as it has no effect on the long term level of debt.

If the rate of return on shares declines, then like a contractionary monetary policy, the exchange rate "jump" appreciates. The mechanism for this adjustment is provided by the money demand function. A fall in return means the share price has risen, thereby reducing the demand for money, which requires a rise in the interest rate to clear the markets, and so the exchange rate appreciates.

Tobin's q can also be analysed in this framework, as if q was to decline, the exchange rate would depreciate instantly, whilst demand for loans and the price of shares gradually decrease. A change in foreign monetary policy would also affect the demand for loans, such that a contractionary foreign monetary policy reduces share prices and the demand for loans. A problem with the model is that it is difficult to determine the movement of the steady state debt schedule, so the analysis is dependent on the long-term solution to determine the adjustment dynamics for any change in the supply or demand for loans.

In the case where the total debt elasticity of the money supply is negative, then the steady state debt schedule becomes indeterminate. The steady state exchange rate schedule becomes upward sloping, as any change in the exchange rate is accompanied by a similar change in the interest rate as in Figure 2.8. In this case, the effect of the extra borrowing in reducing aggregate demand dominates the effects of the increased reserve requirements which accompany the extra borrowing. In this case, a fall in the interest rate causes an appreciation of the exchange rate and a fall in total debt. So the effects of monetary policy, fiscal policy and the share price are the same as before.

The affects of a change in Tobin's q and an exogenous change in the foreign interest rate are different. Both shift the steady state exchange rate to the left, as for a given interest rate the exchange rate would have depreciated, if the foreign interest rate rises or q declines. In this case the exchange rate "overshoots" and then gradually moves to its equilibrium position. Again the analysis of the steady state debt schedule is dominated by its long run behaviour.

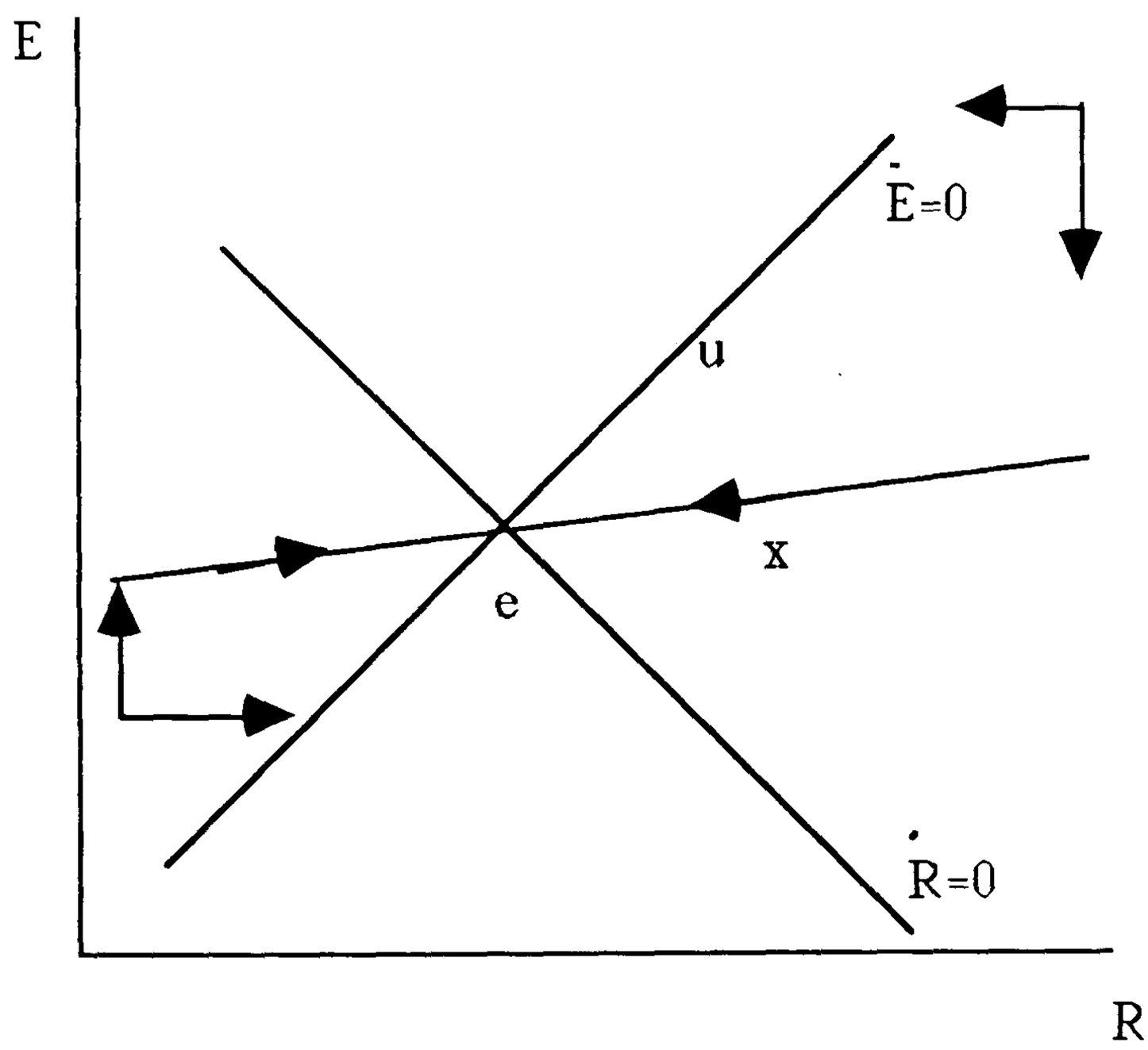

Figure 2.9 A phase diagram showing the relationship between total debt and the exchange rate, when the total debt elasticity to money is negative.

Starting from a position like x, after the rise in foreign interest rates, the exchange rate "overshoots" to u, then appreciates to its equilibrium at e. In the first case no "overshooting" was possible and the exchange rate jump appreciates or jump depreciates onto the saddle path, before continuing its move in the same direction to its equilibrium position. Unlike Gavin and Blanchard, the analysis excludes such factors as whether the monetary or fiscal policies are anticipated, the "good news" or "bad news" cases, and the complication of the strong or weak stock market affect. For this reason the results tend to be more definite and unambiguous.

2.4.4 Appraisal of the Portfolio Balance models

These models tend to suffer from a number of problems, as for instance price and income effects are excluded from the model, as they are assumed to be constant. In addition the relative riskiness of the assets is ignored, for instance in Smith (1992) the coefficient of relative risk aversion is assumed to be constant across all the countries tested. In most of the models the banking sector is ignored, mainly to ensure the model is reasonably simple. However when it is assimilated into the model, as in Uctum and Wickens (1989), the model is simplified by applying two strong assumptions. They assume that domestic bank deposits and foreign securities are perfect substitutes and foreign investors only hold domestic bank deposits and not securities, which is not supported by the evidence.

2.5. Conclusion

The models reviewed in this chapter indicate that the relationship between the stock market and exchange rate is ambiguous and depends on a number of factors such as the 'good news' and 'bad news' cases. In addition both monetary and fiscal policy changes have an ambiguous effect on the exchange rate when the stock market is included in the analysis, in contrast to conventional exchange rate models. This means that when testing these models the emphasis is less on the type of relationship between the exchange rate and the other variables and more on if the stock market has a significant affect. When the stock market is significant, then in general the relationship between the exchange rate and the other variables does not need to be directly specified.

It is difficult to identify the possible signs on the variables, as in all three types of model there are myriad changes that can occur in the relevant variables. In most of the papers analysed, all possible outcomes of an exogenous innovation are not included, due to constraints on space. Instead a particular case is assumed to hold, such as the "bad news" case, and the effects of the "good news" case are ignored. Despite this a generalised summary table of the possible signs on the variables is included below, in most of the scenarios analysed the variables can move in either direction. It is also possible over the short term for a variable to increase to begin with, then decrease to a level either above or below the initial value.

Table 2.1 Theoretical signs on the endogenous variables; the stock market (S), exchange rate (E), output (Y) and prices (P), following an exogenous disturbance.

Models	S	E	Y	P
Monetary Model				
monetary policy	+-	+-	+\	
IS/LM Model				
monetary policy	+	+-	+\	+
fiscal policy	+-	+-	+\	+
Portfolio Balance Model[4]				
monetary policy	+-	+-	+\	+-

(\-no movement in either direction)

[4] All the Portfolio Balance models tend to produce different results, depending on the model specifications. For instance both the Sarantis and Uctum and Wickens models suggest the exchange rate always depreciates after a rise in the money supply, in contrast to the Aoki paper.

Chapter 3

A Review of the Empirical Literature between the Exchange Rate and Stock Market Indices

3.1 Introduction

The aim of this chapter is to examine the main tests of the relationship between the stock market and the exchange rate. This allows a comparison to be made between the results of other researchers tests and the results of the tests conducted in later chapters. There have been two methods for testing the relationship between the exchange rate and stock market. The first method is to test the predictive power of a model of exchange rate determination, in which a variable representing the stock market is included. This variable takes the form of the differential between two country's main stock market indices, although the most appropriate index to use depends on what exactly is being tested and whether there are compatible indices available in both countries. The second method involves analysing the relationship between the excess return (risk premium) on the foreign exchange market and stock market, of which there are a large number of alternative models.

The first approach has not been extensively tested and of the three main models only the Portfolio balance model has been used to establish whether any relationship between the stock market and exchange rate exists. Neither the Monetary model or IS/LM type model, as defined in Chapter 2 has yet been used in conjunction with a stock market variable. However these two models have been extensively tested without a stock market variable, using a number of different econometric techniques, but in general the results have not been entirely satisfactory (see Isard 1987).

The second method has been tested in a variety of ways, and has met with some success. Not surprisingly, the 'Capital asset pricing model' CAPM has featured prominently in many of the tests, to measure risk and expected return on the stock market. The exchange rate has frequently taken the form of covered or uncovered interest parity UIP to express it in excess return form. If either of these relationships holds, then there is no risk premium present in the exchange rate, although in the

case of UIP, it is not possible to distinguish if the failure of the relationship is due to the risk premium or the failure of rational expectations or both. Tests on the relationship have been in both a single CAPM risk premium form and differential between two CAPM's risk premiums. The latter form is because it is felt that exchange rate excess return is likely to be related to the relative returns between the two stock markets.

It has been argued that the stock market and to an extent the exchange rate are not significantly affected by other variables, or that the stock market is not an important determinant of other macroeconomic variables[1] . A test by Doan Litterman and Sims (1983) offers some support for the view that very few factors explain stock market movements. Using a forty eight month horizon, the forecast variance of the following variables gives the amount that is explained by their own innovations; Stock market index 95%, GNP 11.7% and the exchange rate 54%. So this hypothesis appears to have some support, particularly for the stock market.

In the following analysis, the work is split into two sections. First there is a section concentrating on extended portfolio balance models of the exchange rate. The second section is concerned with a variety of tests on the respective risk premiums in the stock market and exchange rate.

3.2 Portfolio balance model (Model based tests)

There have been three tests using a conventional model of exchange rate determination. This has entailed using a Portfolio Balance model, in which an additional asset has been included representing the stock market. Previous tests of this model were restricted to nominal government bonds, or bonds and money, although the theory behind this model can equally be applied to the stock market. The overwhelming results from these tests has failed to find support for the Portfolio balance model (Macdonald and Taylor 1992). Failure of the model has been argued to be primarily due to the restricted use of the assets available to international

[1] For evidence that the stock market significantly affects both consumption and output see Merton and Fischer (1985) as well as Boswell (1975). Although there is strong evidence of a significant effect from the stock market, the tests suffer from serial correlation. There are also a number of empirical tests supporting Tobin's q theory. In particular Von Furstenburg (1977) in the USA and Oulton (1981) in the UK, although again serial correlation was a problem.

investors. This deficiency is rectified in a model developed by Smith (1992) and by Sarantis (1987) and Sarantis and Stewart (1991). As the models differ in a number of respects, the Smith model is described first and then both the Sarantis and the Sarantis and Stewart models and comparisons made at the end.

The Smith model consists of a world economy made up of the USA, UK and Germany. The estimating equation is based on a world market-clearing relationship, in which the left hand side variable represents the world's net supply of pound assets. On the right hand side, the terms represent the supply of all three country's assets expressed in terms of Sterling, as well as the interest differential between US and UK bonds and UK and German bonds. In addition the covariance between the two country's exchange rates are included in the equation. Due to lack of data, the wealth of UK residents is determined in a separate equation. This consists of a government deficit, outstanding UK bonds, money and equities. The current account deficit or surplus is also included, as it directly determines the equilibrium level of assets held by investors. Following a process of linearisation, the estimating equation is defined as;

$$\begin{aligned} E_{UK} = \alpha_0 + \alpha_1 E_{UG} + \alpha_2(R_K - R_U) + \alpha_3(R_G - R_U) + \alpha_4 S_K + \alpha_5 S_G + \\ \alpha_6 S_U + \alpha_7 A_K + \alpha_8 A_G + \alpha_9 A_U + \alpha_{10}(A_K - A_K^{K(D)}) + \alpha_{11} CCAS^K \end{aligned} \tag{3.1}$$

where;

E is the bilateral spot exchange rate

R is the return on government bonds

S are the stock of equities

A is net quantity of money and bonds (stock)

$CCAS^K$ is UK cumulated current account surplus or defecit.

$A_K^{K(D)}$ is the debt of the UK government (stock)

The subscripts are K for the UK, U for USA and G for Germany.

The hypothesised signs of the coefficients are;

$\alpha_0, \alpha_{10} > 0, \alpha_2, \alpha_{11} < 0$ and $\alpha_1, \alpha_7, \alpha_8, \alpha_9 > 0$ if the net world supply of UK assets is positive.

Quarterly data was used, covering the years 1974 quarter 1 to 1988 quarter 3. Due to the assumption of equities and exchange rates being endogenous, an instrumental

variables technique was used. A test for parameter constancy during the time period was rejected, and using 1979 quarter 2 as the point of structural break, the hypothesis of no structural break was rejected. This represented the change in the UK government and the lifting of capital controls. The results are fairly encouraging as during the second sub period(1979-88) UK equities have a significant effect on the exchange rate at the 95% level, and during the first sub period UK equities are significant at the 90% level of significance.

The results of these tests are quite surprising, as it is usually felt the US stock market should have the most significant impact on the exchange rate. However in these tests it is not a relevant influence. In contrast the UK stock market has a relatively powerful effect and even the fairly small German stock market is significant in the first sub period. This latter result is also unexpected, as it is usually thought the second sub period should be when the stock market would be most influential. This is due to the increase in capital mobility brought about by removing capital controls and financial innovations in the 1980's.

Another surprising result is the significance of the UK and German money and bonds, in the first sub period, which tends to contradict the results from other tests. Again The US money and bond supplies have no effect in either sub period. According to recognised theory, it should have been the second sub period when their effect should have been most apparent.

Sarantis (1987) and Sarantis and Stewart (1991) use the same basic model, which is an augmented Portfolio Balance model, in which stocks of equities are incorporated. The 1987 paper uses the Error Correction Model (ECM), whereas the 1991 paper uses cointegration and an ECM, so the long and short run effects can be analysed separately. In general the results from the ECM are better in terms of significance and explanatory power, than the tests with cointegration.

The countries that are tested in Sarantis (1987), with the UK as the base currency are basically the G7 countries excluding Canada. The variables in the model include both domestic and foreign variables separately, although the foreign holding of domestic bonds and equities was excluded due to the lack of suitable data. Dummy variables for both current and future oil production are included to reflect the

importance of oil production to the UK economy. In the Sarantis and Stewart tests, the same countries are tested , excluding Italy. The equation tested was as follows;

$$\Delta e_t = \alpha_0 + \alpha_1 \Delta m_{t-i} + \alpha_2 \Delta b_{t-i} + \alpha_3 \Delta k_{t-i} + \alpha_4 \Delta f_{t-i} + \alpha_5 \Delta m^f_{t-i} + \alpha_6 \Delta f^f_{t-i} + \alpha_7 \Delta o^{cp}_{t-i} + \alpha_8 \Delta o^{rs}_{t-i} + \alpha_8 (e - p^f + p)_{t-i} + u_t \quad (3.2)$$

The expected signs on the variables were the following:
$\alpha_1 < 0, \alpha_2$ and $\alpha_3 <$ or $> 0, \alpha_4$ and $\alpha_5 > 0, \alpha_6 < 0, \alpha_7$ and $\alpha_8 > 0, \alpha_9 < 0$

where;
m-nominal stock of domestic money (mostly M1)
b-nominal stock of domestic bonds.
k-nominal stock of domestic equities.
f-nominal stock of foreign assets denominated in a foreign currency.
o(cp)-current oil production
o(rs)-future oil production (reserves).

This equation was then estimated from 1972 to 1981 using quarterly data. The variables are included using both domestic and foreign variables separately and this means that the equation includes a large number of independent variables, up to seventeen excluding the constant. This is one reason the explanatory power is fairly high, reaching 0.9 in the Franc\Sterling test. To ensure all the dependent variables are I(0), they have all been first differenced.

The signs on the money supply variables tend to be as predicted for the domestic money supply and not as expected for the foreign money supply variables. The exception to this is the Yen\Sterling test in which the lags are signed as predicted. The sign on the foreign money supply is also far less significant than the domestic money supply. Overall the stock of domestic bonds tends to be significant. The stock of foreign assets tends to be insignificant and mostly the signs are not as expected, especially for the foreign variables again.

In all cases the stock market is significant, although in the Yen\Sterling test it is only significant at the 10% level. In general the variable is more significant with a single lag than with no lags. In the cases of the three European countries with Sterling, the oil variables tend to be highly significant in contrast to the tests with the USA and

Japan. This may just reflect the fact that the EMS was formed in 1979, but the UK did not join supposedly due to it being an oil producer, perhaps the strong significance for the European countries in some way reflects this. The error correction term is significant in all the tests except the Yen\Sterling test where it is only significant at the 10% level, as was the case with the stock market variable. Similarly for the price differential, although this variable is only significant with three lags.

Finally the steady state solutions, in which the variables appear in levels, all show that the oil production and oil reserves all have a significant effect. However the relative price produces a long run elasticity of the exchange rate of well below unity, especially the Franc\Sterling test. The long-run exchange rate is affected by the changes in the growth paths of all the assets, which would induce a certain amount of variation into the real exchange rate, as occurs .

$$\Delta e_t = 0.252 - 0.628\Delta m_t + 1.019\Delta b_t - 1.887\Delta b_{t-1} + 1.101\Delta b_{t-2} - 0.103\Delta k_t + .166\Delta k_{t-1}$$
$$(2.92) \quad (2.35) \quad (1.69) \quad (3.29) \quad (1.93) \quad (1.77) \quad (2.66)$$
$$-0.042\Delta k_{t-2} - 0.319\Delta m_t^f - 0.099\Delta f_{t-1}^f + 0.005\Delta o_t^{cp} + 0.012\Delta o_t^{rs} + 1.277\Delta e_{t-1}$$
$$(3.28) \quad (0.44) \quad (2.75) \quad (1.14) \quad (0.36) \quad (3.39)$$
$$+0.007\Delta o_{t-3}^{cp} + 0.014\Delta o_{t-1}^{rs} - 1.243(e - p^f / p)_{t-1} + 0.955(e - p^f / p)_{t-2}$$
$$(2.12) \quad (1.12) \quad (3.28) \quad (2.80)$$
$$-0.016(p^f / \mathrm{p})_{\mathrm{t-2}}$$
$$(1.77)$$
$$R^2 = 0.76 \qquad lm_1(3,19) = 2.5$$

Table 3.1 The Sarantis Portfolio Balance Model including equities for the UK\USA exchange rate (All variables are in logarithms).

The Sarantis and Stewart tests were conducted on quarterly data, from 1971 to 1990 Q3 All the variables were tested for stationarity using the Dickey-Fuller (DF) and Augmented DF (ADF) tests, all of which indicated the variables were I(1). The Engle-Granger two-stage test was used to test for cointegration. There was no evidence of cointegration for the UK\USA tests, but for the Germany\UK and

Japan\UK tests there was partial evidence of cointegration, as there was some conflict between the DF and ADF results. The most conclusive result was for the France\UK test.

There are three ECM's reported, as the UK\USA model did not cointegrate. In contrast to the Sarantis models the explanatory power is much lower, for example, the Germany\UK test produced an R^2 statistic of just 0.28 in the Sarantis and Stewart model compared to a statistic of over 0.7 in the other model. In the German model all the main variables were significant, except the oil variable and all the diagnostics were passed. The Japan test was the most successful of the three with a reasonable explanatory power, significant variables including the oil variable and a well specified model. The France\UK test was similar to the German\UK test, although there were fewer significant variables, which were consequently dropped from the model due to the success of the cointegration result, the France\UK ECM is reported below;

$$\Delta e_t = -.011 - .059\Delta k_t + .085\Delta b_t + .072\Delta b_{t-4} - .045\Delta f_t^* + .0354\Delta e_{t-1} - .428 res_{t-1}$$

(1.86) (2.04) (2.93) (2.70) (1.70) (3.02) (4.70)

$R^2 = .29$ DW = 1.91 LM(4) = 1.58

Table 3.2 The ECM from the Sarantis and Stewart model for the France\UK test.

Overall the Sarantis model outperforms both the Sarantis and Stewart as well as the Smith models, although it is hard to tell if this is due to the use of bilateral exchange rates with just two countries or the different econometric techniques. Also the Sarantis model produces a significant equity variable with far more consistency than Smith's model. The main cause of concern in the Sarantis model is using the real exchange rate as the long run equilibrium relationship, however the Sarantis and Sarantis and Stewart techniques are far superior than that used by Smith, as it analyses the short run and long run influences separately.

3.3 Tests on the relationship between risk premiums

Recent analysis has suggested that there is strong evidence of a risk premium in the foreign exchange market (Macdonald and Taylor 1992), as there is in the stock market. A number of empirical tests have been used to attempt to characterise these

risk premiums, and investigate the degree of their interrelationship. One of the first attempts to analyse risk premiums in the foreign exchange market, in terms of the risk in a stock market was by Robichek and Eaker (1978). Assuming foreign exchange acts as a capital asset, in equilibrium, the expected future spot exchange rate should be equal to the forward rate. In this case the rate of return on the risky asset just equals the riskless rate, so no risk premium is required. According to the CAPM, this will only occur if the rate of return on the risky asset and the market portfolio are uncorrelated. The estimating equation is;

$$(k_j - i) = \alpha_j + \beta_j(k_m - i) + u \tag{3.3}$$

where;
k_j is the rate of return on a foreign currency investment in country j.
i is the riskless rate of return in dollars.
k_m is the rate of return on the market portfolio.

If $\alpha \neq 0$ it is possible to earn a rate of return above that assumed by the CAPM. If $\beta \neq 0$ then a risk premium exists in the exchange rate and is determined by the US stock market. Ten countries were studied; Belgium,US, UK, Canada, Netherlands, France, Italy, Japan, Switzerland and West Germany. The time period studied was June 1973 to June 1976, and 30 day data was used.

The results of the Robichek and Eaker tests showed that the constant is not significantly different to zero for any of the countries tested. In at least five cases, the risk premium coefficient is significantly different to zero, thus a risk premium exists and exchange rate risk is not completely diversifiable. The risk premium in the exchange rate associated with the covered interest parity condition is therefore related to the risks associated with the US stock market.

Chiang (1991), tests a model which analyses excess returns in the foreign exchange markets, using bilateral exchange rates, in terms of the relative risks in the two country's stock markets. The innovation of this model is that rather than use the US stock market to represent stock market risks in general, it is the relative risks between two stock markets which are considered. As the CAPM is used to model the risks, they are in an ex ante form. The relationship which is used to represent excess return in the foreign exchange market is UIP, in which the expected change in the

exchange rate, given the information available at the initial time period, should equal the differential in domestic and foreign interest rates and a risk premium.

The relative risk premiums on the stock markets are expressed in the standard CAPM risk premium form for both the domestic and foreign stock markets. Specifically this is the difference between the expected return on the market portfolio and the riskless rate of interest. This relationship is illustrated in Equation 3.4. Chiang's study uses monthly data from March 1973 to January 1987. The risk free rate was the appropriate one month Eurocurrency deposit rate. In this study the stock market variable took the form of the composite stock price index for each country. Chiang uses a two-input transfer function model[2] to overcome some of the limitations of OLS estimation.

The empirical model consists of the UIP relationship on the left hand side of the equation, and the expected risk premium of each country's stock market on the right. A problem with estimation is that expected stock returns are not directly measurable. Using the value at time t+1 as a proxy is likely to produce correlation between the error term and regressors. Instead an optimal forecast scheme is used, where the expected return is a function of current information. The optimal forecasts are assumed to be produced through an ARIMA process. Taking this into account generates the following estimating equation;

$$(S_{t+1} - S_t) - (r_t - r_t^*) = \alpha_0 + \alpha_1(R^e_{mt+1} - r_t) + \alpha_2(R^{e*}_{mt+1} - r_t^*) + \eta_{t+1} \qquad (3.4)$$

where;

s - spot exchange rate

r - riskless rate of return

R^e_m - expected return on the market portfolio

The hypothesis is that α_1, α_2 are significantly different to zero.

Previous studies on risk premia in the stock market and exchange rate have discovered a number of empirical problems, associated with the separate time series dynamics. First there has been a tendency to find serial correlation, higher than just

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[2] The transfer function model is a multi input ARIMA system, where each of the input and output series are modeled by a univariate ARIMA model. The input and output series are then modeled using an impulse response function.

first order. The left and right hand side variables may follow different time series due to a particular underlying stochastic process. This can produce a potential for making excess returns by following a trading rule, the remedy to this is to use a type of filter. As Chiang argues that time lags will play an important role in determining the relationship, a method for finding the most effective lag length needs to be incorporated.

The results of the tests by Chiang support the theory that it is the relative risks in the stock market which explain the presence of risk premiums or excess returns in the foreign exchange markets. The coefficients on the risk premium in the stock market are correctly signed and significant, particularly in the US\Canada test. It is also shown that the risk premium in the foreign exchange market does not appear to effect the stock market. There is also support for the first set of tests by Giovannini and Jorion (1987), as the US nominal interest rate has a negative coefficient, and the foreign nominal interest rate has a positive coefficient. But unlike them, Chiang finds no relationship between relative nominal interest rates and risk premia in the foreign exchange market.

Using West Germany as a typical example;

$$wg(y_{t+1}+.0059) = .116x_{t+1} - .201^{*}_{t-8} + (1-.14L^2)^{-1}e_{t+1}$$
$$(1.85) \qquad (1.68) \qquad (2.44) \qquad (1.75)$$

se =.165 $\quad R^2 = .07 \quad$ Ljung - Box = 14

Where for the output series;

$$(y_{t+1}+.0054) = e_{t+1}$$
$$(1.93)$$

Where for the input series;

$$x^{*}_{t+1} - .00026 = (1-.262L-.212L^3)^{-1}(1-.174L^6)e_{t+1}$$
$$(.06) \qquad (3.50) \qquad (2.11)$$

Table 3.3 Chiang's Results for West Germany, first with the input series, then the ARIMA models for the output and input series.

Despite the apparent success of these tests, it is not entirely obvious why the econometric technique that was chosen was considered the most appropriate. Taking into account the use of monthly data, it is difficult to believe that the stock market is so much more efficient than the foreign exchange markets, despite the larger number of dealers in the stock market. If it is more efficient then it hard to believe it is by

more than a matter of days. In which case one would expect the relationship to be almost immediate rather than consisting if a complicated lag structure. This view is supported by the lack of success in the UK\USA test, which considering their respective stock markets should have been the most successful test.

There have been two separate pieces of research on risk premiums in the stock market and exchange rate by Giovannini and Jorion (1987, 1989). The first piece of research is divided into two, firstly analysing the extent to which risk premiums in the stock market and exchange rate exhibit certain common characteristics, and secondly an analysis on the variation of conditional second moments of the risk premiums. This section is excluded as it is not entirely relevant to the aims of my research. The second piece of research is based on the specification of the conditional second moments of returns, and its implications for the CAPM, which in this study has a market portfolio consisting of the US stock market and foreign currency assets.

In the first piece of research, there are three tests on the relationship between the risk premium in the foreign exchange market and stock market. The first test on the risk premiums involved a test to examine if the conditional (expected) variance of rates of return covary with nominal interest rates. It was assumed that an increase in nominal interest rates would have a predictable effect on the risk premiums in the foreign exchange and stock markets. Also the relationship would be positive. The conditional variance of rates of return is represented by;

$$\varepsilon_{t+1}^2 = \alpha_0 + \alpha_1 i_t + \alpha_2 i_t^* + \eta_t \tag{3.5}$$

Where ε_t represents the risk premiums on the stock market and foreign exchange market. They are defined as;

$\varepsilon_{t+1} = s_{t+1} - f_t$

$\varepsilon_{t+1} = r_{t+1} - i_t$

where;

ε_t is the risk premium.

s_t is the spot exchange rate.

f_t is the forward exchange rate.

i_t is the riskless rate of interest.

The excess rate of return on the stock market is represented by the amount the stock market exceeds the Eurodollar rate, which is assumed to be riskless. The excess rate of return on foreign exchange is the differential between the forward and spot exchange rate. Then squared returns, representing the conditional variance of rates of return are regressed against a constant, Eurodollar interest rate and foreign currency Eurodeposit interest rate. To ensure there is no bias, the variance-covariance matrix of estimates is estimated, so that a consistent variance-covariance matrix for projection coefficients can be computed. This analysis is then extended in the second test to the risk premiums of the stock market and foreign exchange market. There are three risk premiums to be estimated;

a) The risk premium of a deposit denominated in a foreign currency over the US stock market.
b) The risk premium of a deposit denominated in a foreign currency over a Eurodollar deposit.
These are represented by the two following relationships;

$$\begin{aligned} E(\varepsilon_{t+1} \setminus I_t) &= E(\Delta s_t + i_t^* - r_{t+1} \setminus I_t) \\ E(\varepsilon_{t+1} | I_t) &= E(\Delta s_t + i_t^* - i_t \setminus I_t) \end{aligned} \tag{3.6}$$

c) The risk premia of the US stock market over a Eurodollar deposit.

The estimating equation in this second test consists of lagged values from the realising return differentials;

$$\varepsilon_{t+1} = \alpha_0 + \alpha_1 \varepsilon_t + \alpha_2 \varepsilon_{t-1} + \eta_t \tag{3.7}$$

The null hypothesis is that both $\alpha_1, \alpha_2 \neq 0$, if the two risk premia are autocorrelated, then they are in effect moving together over time.

The estimating equation in the third test is based on the relationship between the risk premiums and the nominal interest rate differentials, or alternatively the forward premium. This is because the most likely source of variation in the risk premiums is likely to be related to the domestic and foreign interest rates. In this case the estimating equation is;

$$\varepsilon_{t+1} = \delta_0 + \delta_1 i_t + \delta_2 i_t^* + \eta_{t+1} \tag{3.8}$$

The null hypothesis is that there is no risk premium between either the Eurodollar or stock market and Eurocurrency deposits. In addition there is a test to find if the differential between the risk premiums on the stock market and Eurodollar (foreign exchange) are related to the interest rates. This means that $\delta_1, \delta_2 = 0$.

In the second piece of research by the same authors, the theory is based around the CAPM relationship, with the additional assumption that the vector of investment shares in risky assets is subject to the covariance matrix of returns and a risk aversion coefficient. This gives the following estimating equation;

$$r_{t+1} = \mu + \rho\Omega_{t+1}x_t + \varepsilon_{t+1} \tag{3.9}$$

where;
r_{t+1} is the difference in returns between the market portfolio and risk free rate
μ is a constant, and accounts for affects not captured by the CAPM.

and where;
$\Omega_t = \Gamma + A^*\varepsilon_{t-1}\varepsilon_{t-1}' + B^*\Omega_{t-1} + \phi i_t i_i'^a$

where;
ε_t is a vector of lagged forecast errors.
i^* is a vector of foreign currency asset interest rates.

The symmetric matrices Γ, A, B and ϕ are constrained to be positive definite.

Giovannini and Jorion (1987) use weekly data producing a maximum of 596 observations between August 1973 and December 1984. Like the tests by Smith the relationship between the stock market and exchange rate were different in the 1970's and 1980's. Their structural break was chosen as October 1979. The data on the stock market was in the form of a value weighted index, and the interest rates were one week Eurocurrency rates. The countries tested were; France, Germany, Switzerland, UK, Italy, Japan and the USA. In the second test by these authors weekly data was again used, although this time the tests were done only on the UK, Germany and Switzerland against the US dollar.

To begin with, the first Giovannini and Jorion test rejects the view that forward currency contracts exhibit constant conditional variances of rates of return, for all the currencies tested. In addition all those variables that were significant, were positively signed so that as conditional variances have risen, so nominal interest rates have been higher. The same result occurred for the US stock market's risk premium. In the second test on the relationship between the realised differences in returns, so testing for variation in risk premia, leads to a rejection of the null hypothesis that variation is present. Only the Yen and Gilder show any evidence of there being any relationship between the lagged values of realised differences of returns. Thus there is very little evidence of autocorrelation between the risk premiums and the risk premiums converge over time.

In the third test, the tests on the relationship between the risk premiums and the domestic and foreign interest rate differential produce negative coefficients for the US interest rate and positive coefficients for the foreign interest rate. However the explanatory power of these regressions was very low. Thus a fall in the US interest rate produces a rise in the foreign exchange risk premiums whilst the opposite occurs for a fall in the foreign interest rate. When the risk premium for the stock return on the Eurodollar rate was tested, it was found to be negatively correlated with the US interest rate. There was a remarkable degree of similarity between the behaviour of the two risk premiums with the interest rates, again confirming their convergent behaviour.

The final test based on the same estimating equation as the third test, but using the projected difference in returns on the stock market and foreign exchange market and nominal interest rates produce insignificant coefficients, but significant constants, suggesting the presence of constant risk premiums. The similar behaviour of the stock market and foreign exchange market risk premiums indicates that the theoretical approach to the two risk premiums should be through a general, rather than specific type of model, as the results for all the currencies tested was so striking.

Using the UK pound as an example, and the sample of 1979-1984, the following set of results were reported. In the first case the risk premium is regressed on lagged risk premiums. In the second test the risk premium is regressed on the interest rate.

	Eurocurrency deposit rate minus									
	Eurodollars					Stock market				
79-84	$\hat{\alpha}_0$	$\hat{\alpha}_1$	$\hat{\alpha}_2$	P value	R^2	$\hat{\alpha}_0$	$\hat{\alpha}_1$	$\hat{\alpha}_2$	P value	R^2
	-.24*	-.06	-.01	.562	.0038	-.24	-.05	00	.703	.0044
	-.83	-2.69	-5.17*	.004*	.0318	-1.44*	4.11	-.94	.146	.0108

Table 3.4 The risk premium on the foreign exchange and stock market in which the coefficients marked with a * are significant. The first line of figures refer to the regression of the risk premium on its lags, the second to the risk premium on the interest rate. The parameters are the same as described in the estimating equations (3.7) and (3.8).

Giovannini and Jorion (1987) produce results which suggest that there are strong similarities between the two risk premiums. Referring to the second and third tests it appears that ex-ante excess returns in both the foreign exchange and stock markets move together over time.

Giovannini and Jorion (1989) then test the CAPM and the time variation of conditional second moments, which offers no evidence to support the theory that conditional variances can explain the time variation of risk premiums in the stock market and foreign exchange markets. Unlike the previous tests, in this study the over identifying restrictions of the CAPM are rejected, although the specific restrictions rejected are not reported. To begin with, assuming a constant covariance matrix, the risk premiums are both significant and negative. But the sign is wrong and will not produce the required optimisation.

In the heteroskedastic model (GARCH), the initial test on the constancy of conditional second moments is rejected. Allowing for variability in the covariance of returns, gives a positive but insignificant risk premium. In the test of the alternative more parsimonious model the results are almost exactly the same. In the model where conditional second moments are constant, the interest rate has a significant coefficient, but it is not in the GARCH model, although otherwise the results are

much the same. Overall including the conditional covariances in the model does not adequately explain the time variation of the risk premium.

Giovannini and Jorion (1987) produce results which suggest that there are strong similarities between the two risk premiums. Referring to the second and third tests it appears that ex-ante excess returns in both the foreign exchange and stock markets move together over time. However in their second piece of research, they fail to find an explanation for the similarities in behaviour of the two risk premia by using the time variation of conditional second moments.

Finally Bakaert and Hodrick (1992) and Canova and De Nicolo (1995) use VAR's to analyse the relationship between the exchange rate and stock market as well as other relevant macro-economic variables. The main difference between the two pieces of research is that the Bakaert and Hodrick paper uses only measures of the stock market and foreign exchange market, whereas in the Canova and De Nicola paper a number of different variables are used in addition to these two variables. Comparing these two articles illustrates how the result can vary quite widely depending on the definitions of certain variables and the way in which they are derived.

In the Hodrick paper the aim is to examine whether excess rates of return in the stock market and exchange rate can be predicted using dividend yields and the forward premium for the exchange rate. The VAR is made up of six variables, which are; the relevant foreign exchange excess return, the US stock market and the companion country's stock market excess return. To these variables are added the forward premium and both stock markets dividend yield. This gives the following estimating equation, which constitutes a first order VAR;

$$Y_{t+1} = \alpha_0 + AY_t + u_{t+1} \tag{3.10}$$

where;
A is a 6x6 matrix.
u_{t+1} is a vector of innovations in Y_{t+1} relative to its past history.

The Canova and De Nicola paper analyses the dynamic interaction between inflation, stock market returns (capital gain and dividends), the term structure of the interest rate, the growth rate of industrial production and the bilateral exchange rate.

The main concern of the paper is to analyse how shocks to a particular variable affect other variables in the VAR and the direction of causality. The tests are split into two, firstly on a closed economy model, and secondly on an open economy in which the USA is analysed with the other three countries. These countries are the UK, Germany and Japan, and particular emphasis is placed on the extent to which shocks in the USA are transmitted to the other countries.

The economic technique used in both tests is the VAR, although it is used in slightly different ways as the aims of the two papers are slightly different. The reason this technique is used is because it describes time series behaviour fairly well and also the dynamic feedback mechanisms which are a part of the model. In both VAR's the bilateral exchange rate is used as well as both the domestic and foreign variables of the countries tested.

The Hodrick tests used monthly data, from January 1981 to December 1989. The countries tested are the USA, UK, Germany and Japan. In the Canova tests the same countries are tested, and their data is also monthly from 1973 month one to 1993 month twelve. The exchange rates in both studies are all bilateral, using the US dollar. In the Hodrick test due to the use of risk premia there were more problems in locating suitable data. For Germany the dividend yield was based on data adjusted for tax complications. The exchange rate data consisted of daily bid and ask values, and after the use of a number of filters, the observations required a number of adjustments. Transaction costs and the affects of market rules were incorporated into the price of the foreign exchange.

The results from the Bakaert and Hodrick tests are divided into two. One step ahead predictability tests for the stock markets give mixed results. Expected returns for the US and Japan are positively correlated with lagged US returns, but negatively correlated with Japanese returns. Dividend yields are all negatively correlated with the cross country risk premia, and positively correlated with the own country risk premia. All forward premiums are negatively correlated. There is equally strong evidence of predictability in the UK and German risk premiums in their stock markets.

Only for the dollar\DM and dollar\pound is there any evidence that past returns predict present market values. A sensitivity test on the VAR involved testing the

individual signs of the domestic and foreign interest rates, as opposed to simply the forward premium. Like Giovannini and Jorion the US interest rates are always negatively signed and the foreign interest rates are always positively signed, the sensitivity test is satisfied.

In the case of the long run statistics for the VAR, there is evidence of mean reversion for UK and US stock prices, but not the Japanese or German. Excess returns in the foreign exchange market are more predictable than the stock markets. Rises in dividends and the forward premiums means rises in the foreign exchange markets and stock markets respectively. Also rises in the forward premium lead to a lower risk premium on the stock markets for all countries. The tests on latent variable models were not a success, even when two latent variables were used. If the volatility bounds on the dollar IMRS include foreign stock market returns as well as the US returns, then they exceed the bounds when only the US returns are included.

In the case of the closed economy model, Canova found that domestic cross correlations show that the variables exhibit only fairly weak relationships, with the exception of the USA. The only variables which exhibit any degree of correlation are the slope of the term structure and inflation, where the US is most significant. Surprisingly in nearly all cases the sign of the correlation varies between countries for all the variables. International co-movements of variables indicates that only the stock market return and inflation are significant. In general there is little evidence of co-movements between other variables from different countries.

Viewing the results of the Canova test, the first point of note is that analysing the dynamic interdependencies in the closed economy produces distinct differences between the countries tested. In the UK and Germany, a shock to stock returns, slope of the term structure, growth rate in industrial production and inflation are all negligible. There is thus little predictive power as regards movements in financial markets for both inflation and production. There is only a slight effect from real stock returns to industrial production growth.

Japan lies somewhere between the UK test,German test and the US test, as there is some evidence of an interdependence between inflation, industrial production and the slope of the term structure. But there is no relationship between stock returns and the other variables. In the US the term structure slope is related to inflation and

industrial production, but stock returns have little strength. There is a weak negative relationship between real stock returns and inflation, although causality appears to run from inflation to the stock market.

In the international interdependencies the most obvious result is the strong relationship between the four stock markets, running from the USA to the other countries. In addition the strength of this relationship is stronger than between the bond markets. There is evidence that shocks in inflation and industrial production are transmitted to other countries from the USA, although not by the US foreign exchange markets. However the term structure slope has stronger predictive power than stock returns as regards the other variables. Shocks to the foreign exchange markets have only a negligible impact on the other variables in the system, and tend to be dynamically affected by their own shocks from previous times.

There is some slight evidence of shocks to the US stock returns causing a slight appreciation of the dollar, and a shock in Japan's stock returns does explain a small but significant amount of the volatility in the Yen\Dollar exchange rate. Overall within the system analysed the exchange rate movements appear to be exogenous with respect to all the other variables. In addition the signs on the different countries variables differ from one another, following a specific disturbance. As a whole there are considerable heterogeneities for all the variables, especially as regards the propagation mechanism of the shocks across countries. It also appears that shocks induced by the real sector are far more significant in their effects than those from the financial markets or monetary policy. A potential problem that the authors encountered were the potential instabilities, although there was no apparent break in the data, however, shortening the time span strongly reduced the significance of some of the variables.

These papers reveal the importance of which measure of the stock market and foreign exchange market is used, as in the Hodrick paper the dividend and forward premium are effective predictors of changes in excess returns in the exchange rate and stock market, but when Canova uses just the stock return and exchange rate, the results are far less significant. It appears that in the type of model used in the two tests described, the dividend yield is a better variable than the stock market, however when based on a specific theory it is usually a stock market index that is more suitable as in the Blanchard (1981) and Friedman (1988) models.

A problem with much of this area of research is the absence of any theoretical basis for the tests. Generally the models have consisted of projection equations. A theoretical basis is particularly necessary because the magnitude of the volatility has been found to vary quite substantially between the tests. Using the international CAPM to test for the relationship between the stock market and the exchange rate is subject to the conventional criticisms of the CAPM, as described in the 'Roll critique'. In particular all the studies which have attempted to formulate an international market portfolio have restricted the assets to the US stock market and foreign exchange of the six or seven main countries. Also when the over identifying restrictions of the CAPM were rejected as in the Giovannini and Jorion (1989) tests, it could have been due to a failure of any of the underlying assumptions of the model.

3.4 Conclusion

Overall there is some evidence to support the view that the exchange rate and stock market are interrelated. However there is a lack of model-based tests other than tests on the Portfolio Balance model, which are necessary before any firm conclusions on the relationship can be made. It appears that both returns to the stock market are correlated with the equilibrium exchange rate, and with the exception of one study, the risk premium on the stock market is correlated with the risk premium on the exchange rate. There is a wide variety of econometric techniques used, and with the tests on the risk premium some of the techniques have been particularly complicated, which makes interpretation of the results difficult. In some cases the technique has been over elaborate, and perhaps a more straightforward method would produce results that gave more comparable results.

One important finding from a number of the tests, in particular the Sarantis tests, is that the signs on the variables depends on the countries being tested. This reflects some of the conclusions of the theoretical chapter, in that a number of different scenarios are possible depending on how specific variables react to changes in the stock market. Also how the stock market is measured appears to be important, although in most cases it will depend on how it is measured in the theoretical model. It also appears to be difficult to determine the exact mechanism through which the

stock market affects the exchange rate, as in theory it could be output, investment and consumption.

Chapter 4

Capital Controls and Liberalisation

4.1 Introduction

The aim of this chapter is to analyse the changes that have occurred to capital controls and exchange restrictions and comprises a synopsis of the restrictions on capital movements in the six countries that are to be tested, over the relevant time period. This is important as changes in controls can help in explaining the empirical results in later chapters. This section analyses changes in the context of how they have changed in the six countries throughout the 1970's and 1980's, dividing the countries into those which abolished most of the controls in 1974, those that began removing them in 1979 and those that removed them gradually during the 1970's and 1980's. In addition there is a further section which details the data used in the empirical chapters and explains any changes that were made to the data.

4.2 Exchange restrictions and controls

Since the end of the Bretton-Woods agreement in the early 1970's, there has been a continuous debate on the relevance of capital controls and whether they are beneficial or just inhibit the free movement of capital. Following the move to floating exchange rates, it is perhaps surprising that they were not abolished immediately. However a common viewpoint at the time was that once abolished it would be very difficult to reinstate them again. Some countries, noteably the USA did remove most restrictions following the end of fixed exchange rates, but the majority chose not to, with some such as France waiting until the early 1990's before abolishing the final restrictions.

One effect of exchange controls is that they lead to an 'investment currency' market, in which there is an implicit premium over the official exchange rate. It has been suggested that the removal of capital controls must have had some effect on the stock market and exchange rate (Artis and Taylor 1991), but it is impossible to quantify the effect due to the coincidence of other major events. In particular the second oil price shock and subsequent world recession. For instance in the UK the Bank of England (1981) suggested the removal of capital controls must have had a depreciating effect on the exchange rate, although there was no direct evidence of it.

In the six countries that are tested in the empirical chapters, over the time period under consideration, the level of controls on the exchange rates and on various capital movements has varied markedly. There has also been substantial differences in the way those controls have been applied. For instance in the UK the controls have been fairly specific, whereas in Japan they have tended to be more ambiguous. In addition there have been certain events, that have affected some countries more than others. The main example of this is the formation of the EMS in 1979, which significantly affected the UK and Germany.

Beginning in 1974 there were wide scale controls on capital movements. This was primarily to ensure that the worlds exchange rates were not excessively volatile, as at that time it was felt that such volatility was caused mostly by capital flows rather than monetary policy. However the earlier attempts to control the exchange rate under the 'Bretton-Woods' agreement had been abandoned, and in most industrial countries the currency floated freely.

4.2.1 USA and Canada

The USA contrasts with the UK in the mid 1970's, in that the USA has a floating exchange rate, but there are no exchange controls on incoming or outgoing capital payments by either residents or non-residents. In addition there were no restrictions on foreign currency positions held by the banks, but there was routine surveillance of foreign exchange transactions of individual banks. The banks were also expected to meet marginal reserve requirements on Eurodollar borrowings from their foreign branches.

Towards the end of the 1970's there were a few changes made to the existing controls. The main change was to the supervision of the US banks foreign currency dealings. For instance the banks had to submit a weekly report on their spot positions. They also needed to report their assets and liabilities in specified currencies. Any foreign Government wishing to invest directly in the US had to consult with the US government first.

Canada is similar to the USA in that it had a free floating exchange rate and only a few minor controls on capital flows. However Canadian borrowers are obliged to explore their own markets before making any payments abroad. Also inward direct investment depends on whether it is of any benefit to the Canadian economy. The

main restriction in Canada was introduced in 1978, when the Government announced there was to be no more borrowing in the Petrodollar market, although private investment was welcomed as long as it did not upset the foreign exchange market.

4.2.2 UK,Germany and the Netherlands

These three countries are grouped together because they are members of the EMS, so most of their restrictions were abolished either during or just after 1979. In many respects the introduction of the EMS and its requirement that capital could move freely within Europe, did not have an instant effect. Participating countries, particularly the UK made attempts to introduce some aspects of the treaty before 1979. Others notably Germany introduced changes a year or so afterwards.

In the UK, in the early 1970's, apart from the free float there were some restrictions on foreign currency dealings. There were restrictions on the accumulation of spot foreign exchange by dealers and limits on their open positions. Though all commercial banks were entitled to authorise most current payments requiring exchange control permission. Also non-residents external accounts in the UK required permission for transfers and sales of other foreign currencies.

Capital transfers by residents to countries outside the scheduled territories (These were only a few independent states such as the Isle of Man), required official approval. However they were allowed to sell foreign assets in order to purchase other foreign assets, but even this required approval. Direct investment in foreign countries was also restricted to certain projects where the return would be beneficial to the UK's balance of payments. In addition the investment return had to exceed the total cost of the investment within eighteen months. The final condition was that only half the funding for the project could originate from domestic sources, the rest had to be raised from foreign borrowings.

There are also some restrictions on how much of the foreign currency earnings that investors were allowed to keep. Normally it was only a third of net earnings after tax. The purchase of marketable foreign currency securities for portfolio investment could only be financed by investment currency or foreign currency borrowing, and only through professional UK managers. There were also restrictions on the purchase of property abroad. In general the restrictions on capital being exported from the UK were very tight.

The importing of capital into the UK was almost as restricted. Participation of foreign capital in the form of a direct investment was subject to individual authorisation by the regulators, but was normally granted. Foreign currency receipts from the exporting of goods and services had to be surrendered at official rates unless permission was given for funds to be used. Any investment in the UK by non-residents required permission from the Bank of England, and needed to be financed from foreign currency in proportion to the non-residents interest in the equity of the company.

Raising capital in the UK by non-residents also required permission, as did the issuance of shares to non-residents. However permission was normally given for working capital requirements, but only in certain circumstances when there was an expansion of capacity. These circumstances referred to the level of control in the company by non-residents. There were also restrictions on UK banks lending to foreigners and UK residents borrowing from foreign banks. One exception to this was in some cases exporters were allowed to borrow foreign currency for short periods.

UK residents were allowed to sell foreign currency securities that they owned outside the UK, but only after a quarter of the proceeds were sold to an authorised bank at the official market rate, before they could reinvest the proceeds in other foreign securities. When non-residents sold Sterling securities in the UK for Sterling, then the proceeds had to be held in an external account. Certain authorised banks could accept foreign currency deposits and use them in their foreign currency business, although the authorities imposed a ceiling on each banks position.

In the mid 1970's, some liberalisation slowly became apparent, and in 1977 some important exchange rules were altered. To begin with non-resident concerns could borrow Sterling without any restrictions being imposed and UK financial companies were allowed to retain larger balances in foreign currency. In 1978 capital outflows to members of the EEC were allowed and official exchange was made available up to half a million pounds or fifty percent of the total investment. There were also new arrangements as regards loan-financed portfolio investment so that the loan could be repaid over longer time periods.

In 1978 more restrictions were eased, especially some of the controls that applied to portfolio investments. Institutional investors, who invested in foreign currency securities issued by investment trusts or unit trusts were no longer restricted in the value of the assets which might be held in foreign currency securities. Also authorised

depositors were allowed to sell most foreign currency securities, that were held in restricted deposit accounts.

In 1979 the EMS was formed, and in the UK there was a change in Government, both of which induced a radical change in their approach to capital controls. Basically in the latter half of 1979 practically all of the UK's controls were abolished. On July 18th all EEC securities were exempt from restrictions, then on October 24th all remaining restrictions were lifted.The only slight control left was that some non-residents were excluded from issuing instruments in the UK, especially where it involved the take-over of important UK companies or so called undesirables. Following the abolition of exchange controls, the banks were free to maintain control of their foreign currency exposure. Despite membership of the EMS, Sterling did not join the ERM, however there was small scale smoothing operations carried out by the authorities.

There has been a prolonged debate as to whether the formation of the EMS significantly affected capital flows and the integration of the European and World financial markets. In one respect the UK is a good example of this effect as the controls were removed relatively quickly in 1979, but the problem of other important events occurring at the same time still applies. However there has been a study on the effects of certain stock markets following the removal of controls in 1979 (Artis and Taylor 1991), particularly the UK stock market.

The analysis involved testing if stock markets were cointegrated after 1979, but not before, in which case the removal of controls had caused closer integration. The sample was from 1973 to 1979 and 1979 to 1986, and apart from the UK, the USA, Germany, Japan and the Netherlands were used. The results showed that the stock markets of Germany, Japan and the Netherlands produced cointegration with the UK stock market after 1979, but not before. However the UK\USA result indicated no cointegration before or after 1979. As emphasised by Hall and Haldane (1992), closer integration between exchange rates had been evident before 1979, so possibly this would also apply to stock markets, in which case the results may be ambiguous.

After the demise of the 'Bretton-Woods" system, Germany and the Netherlands maintained controls on the movement of their exchange rates with five other European countries, whereby the rate was maintained within two and a quarter percent of a specified central rate. The other five participating countries were; Belgium, Denmark, Luxembourg, Norway and Sweden. Apart from this Germany's

exchange controls were not particularly restrictive compared to the UK's. However there were a number of minor controls.

There was in Germany certain direct controls on inward capital transactions between residents and non-residents. This included German money market paper and fixed interest securities issued by Germany, which had a maturity of less than four years. German banks were also subject to minimum reserve requirements as regards their foreign liabilities with maturities of less than four years.

Germany also introduced a number of changes to the controls, in the mid 1970's, especially in 1975 when the Government abolished the need to seek authorisation on the payment of interest on bank accounts held by non-residents. Also non-residents were entitled to purchase fixed interest securities of a longer maturity. In 1978 the restrictions on these securities were eased further, particularly where the maturity was less than four years. In the Netherlands upward pressure on the Guilder was countered by restricting capital inflows that occurred through borrowing abroad. However in Germany there were no similar attempts to counter the appreciation of the DM.

The main change in Germany in the late 1970's, was related to its being a founder member of the ERM in 1979, along with Belgium, Denmark, France, Ireland, Italy, Luxembourg and the Netherlands. Their spot exchange rates were maintained within two and a quarter percent above and below the cross rates derived from the central rates expressed in ECU's. In order to maintain this rate, the Bundesbank intervened in the markets in concert with participating countries. In principle, the Bundesbank also intervened in currencies that were non-members of the EMS.

In 1980, Germany still maintained a number of implicit capital controls. For instance in principle residents and non-residents could export capital freely, but a voluntary monitoring system was used to discourage capital outflows of international bond issues on the German capital markets. Of those direct controls still in place, there were some liberalisations of the restrictions, particularly a reduction in the minimum maturity of domestic fixed term securities eligible for sale to non-residents. An important change in Germany occurred in 1981, when all those restrictions that applied to the sale of money market paper and fixed interest securities were abolished. The only control left was the minimum reserve requirement for the banks on the levels of foreign liabilities they were allowed to maintain.

The Netherlands has much in common with Germany, as it is a member of the DM zone, however its capital controls were more extensive. Inward and outward capital

transfers, and the shifting of foreign owned capital within the Netherlands was subject to restrictions. Also all capital transactions had to be notified to the balance of payments department. All borrowing and lending abroad was restricted, and there were restrictions on borrowing and lending between head offices.

Capital issues in the Netherlands on behalf of non residents were restricted, and all Dutch banks foreign liabilities were not allowed to exceed their claims. However transactions in foreign and domestic securities were permissible between residents and non-residents, but this rule did not apply to treasury bills or certificates of deposit. Also residents could freely buy foreign securities, and non-residents could transfer the proceeds from the sale of Dutch securities, but when residents held securities abroad, it was subject to a deposit requirement.

By 1980 in the Netherlands there were still extensive restrictions on capital movements, despite its membership of the EMS. Due to monetary policy, inward transfers of capital originating from short and medium term borrowing abroad by non-bank residents was restricted, although some long-term borrowing was permissible. In the early 1980's the Guilder was coming under pressure within the ERM, and many controls were if anything strengthened in an effort to support it. For instance all capital transfers by non bank residents had to be notified to the authorities.

There was also a queue system introduced for non-resident borrowers using the Dutch capital markets. Despite these and many other similar controls the Guilder was devalued by 3.6% in 1982. It was not until 1983 that the main capital controls in the Netherlands were removed. By then practically all of the main restrictions in the UK, USA, Germany and Canada had gone.

In the EMS in general , there were concerns that the removal of restrictions could create problems with regard to speculative attacks on certain weak currencies. In 1987 a package of reforms were unveiled, to prevent this problem occurring. It provided for intra-marginal assistance by a strong currency if a weak currency required support. In addition more co-ordination of policies were called for particularly as regards interest rates. In the UK this manifested itself in the shadowing of the DM in the late 1980's (Macdonald and Taylor 1992).

By the early 1990's little had changed since the early 1980's, although it was not until 1990 that Italy and France abolished all their exchange controls. This was required as a part of the single European Act. One substantial change in Europe had

been the increase in members of the ERM and the subsequent removal of capital controls by most of the member countries. In October 1990 the UK joined the ERM, but only remained a member for two years before being forced to leave in September 1992. Most changes in regulation referred to financial innovation particularly in the burgeoning SWAP markets around the world, but in general capital was subject to far fewer restrictions than occurred fifteen years previously.

4.2.3 Japan

The Japanese authorities maintained a floating exchange rate following the breakdown of the Bretton-Woods agreement, although forward contracts required a permitted underlying transaction, involving either exports or imports. Inward direct investment of a long-term nature needed the approval of the Finance Minister, but no criteria at this point were published regarding which industries would be approved. The Japanese authorities feared capital flows into Japan would raise the value of the Yen, so reducing the competitiveness of Japanese exports. This fear was the main motivation for the retention of capital controls, especially in the 1970's. In 1977, there was a significant depreciation of the Yen, which resulted in some restrictions being lifted, but the worry over a strong Yen has been present throughout the last twenty years.

Outward direct investment required approval by the Finance Minister, but usually only in exceptional cases. However, the Japanese stipulated two types of non-resident accounts and their use depended on the type of transaction. One was the non-resident free Yen account into which the proceeds from exports could be paid. The other was the non-resident Yen deposit account, into which only the proceeds from the sale of debentures could be paid.

Foreign investment in Japan in the form of securities was subject to approval by the authorities. Equities could be bought freely for portfolio reasons, but loans in the form of securities were restricted. Additional restrictions on the buying of equities occurred where the limits on foreign ownership were exceeded. Foreign companies were also restricted in bringing funds into Japan and the establishing of branches in Japan. In the mid 1970's there were about twenty industries in which foreign control was not allowed, but this number gradually declined throughout the 1970's until there were no controls in the 1980's.

The transfer abroad of capital and investment abroad were subject to approval, but were usually given for direct, portfolio and property investments. However there were

restrictions on short-term securities and unlisted securities. Banks were also told that they were not allowed to encourage the buying of foreign securities by residents, although the extent of this rule was not published. All foreign exchange banks were subject to controls in their overall position in foreign currency. As the above description suggests, the extent of capital controls in Japan was very ambiguous and was almost certainly more restrictive than the UK.

There were a number of policies aimed at liberalising Japan's capital markets in the late 1970's. For instance the industries in which non-residents were not allowed to invest were further reduced. The banks were also ordered not to discourage the public from buying foreign securities. In 1975 foreign insurance companies were allowed to deal in Japan. In 1977 greater freedom was granted to Japanese banks as regards medium and long-term loans to non-residents. The restriction on the purchasing of short-term foreign securities was also lifted. However the main problem over the ambiguities on capital transfers were not materially changed.

In 1980 unlike the UK and Germany, Japan did not explicitly remove its capital controls, instead it tried to clarify the position. Capital transactions were permitted, but in some circumstances there was a need for prior approval, in which there was required a waiting period. Under 'emergency conditions' all capital movements required prior approval. Such conditions were defined as; substantial affects on the balance of payments, drastic fluctuations in the exchange rate and an international flow of funds large enough to affect domestic monetary stability. However no numerical details were reported and presumably what designated drastic movements was a matter of opinion.

In a similar way direct investment in Japan was allowed, but again there were a number of exceptions. For instance, it was not possible to buy shares in an unlisted firm or where in excess of ten percent of a firm was owned by a non-resident. Then more ambiguously, investment was not permitted in designated firms in Japan, where any foreign interference would have national implications. The Japanese banks were also restricted in a similar manner. Foreign exchange banks were subject to certain controls over their net positions in foreign currency, again the controls were not specified. In 1981 foreign banks were also allowed into Japan, but they were subject to Japanese regulations.

A particularly strong change over the last twenty years has been the role played by Japan in the international financial markets. For instance Japan has become one of the highest investors in foreign capital. In 1988 the Japanese held $ 431 billion of foreign

investments compared with $157 held by US residents. In addition there is now a far stronger presence by Japanese financial institutions in the worlds financial centres. This has been facilitated by changes in certain laws removing restrictions on the activities Japanese banks could perform.

4.3 Capital market liberalisation

There have been a number of dramatic changes in the main stock markets during the 1970's and 1980's, which were facilitated by economic, political as well as technological trends during this time. The main trend, as with capital controls, has been the move to deregulate international financial markets, as they have increasingly become more integrated. This process has reflected the lifting of restrictons on the banks and other financial institutions. This deregulation has forced radical changes throughout the world, such as the move towards financial conglomerates, which incorporate banking as well as broking operations.

Other significant trends in the financial services sector have included the reduced levels of protection for both savers and borrowers, as financial products have become more complex and markets deregulated. One specific developement relates to the increased use of securitisation, whereby debt is turned into equity. In addition security markets have become more global, as during the 1980's there has been a significant growth in the amount of international equity trading. In the context of these global developments, the liberalisation in the individual countries is now examined.

4.3.1 USA and Canada

The USA is the worlds largest stock market and as with the foreign exchange markets, the USA began the process of deregulation before anyone else. Beginning in 1975, a year after the removal of capital controls, the rules guvorning the amount of commission that could be charged on specific financial transactions was abolished. This act is aften equated to the UK's "big bang' in 1987, although it did not include the removal of restrictions on the transactions particular institutions could conduct. Specifically the SEC rule 19B-3 was abolished, which meant all fixed commission rates were removed, precipitating large reductions in the commissions charged by institutions. One effect of the deregulation was the rise in alternative share dealing institutions, such as the National Association of Share Dealers (NASD), which offered more competitive services than the New York stock market. In addition the reduction in regulation facilitated a number of firms merging.

Since 1983, the SEC has moved to tighten up some aspects of the regulation. Rule 36-9, which took effect from 1986, requires that all banks that also act as stock brokers to register as brokers/dealers, such that they are subject to the controls that restrict these broking businesses. In addition stricter accounting guidelines were introduced, as well as the need for greater disclosure by the banks. In 1984, the Insider Trader Act became law. whereby securities law became part of criminal law, despite a lack of definition on what insider trading involves.

In 1986 a number of new restrictions on mergers were intoduced, to try to reduce "green-mailing". This process arose when financiers threatened to take over a business unless they were paid a substantial sum. This law involved a reduction in the time period before purchasers of more than 5% of a company's shares should disclose their stake. Throughout the 1980's the Glass-Steagall law of 1933 remained, which barred commercial banks from underwriting corporate stocks and bonds. In 1989 the Federal Reserve allowed deposit-taking banks to engage in securities underwriting, through separate incorporated and capitalised affiliates. This lead to the movement towards integrated providers of financial services.

Canada has long been dependent on the USA for its financial stability. This was most apparent in the 1960's when in 1967 Canada was exempt from the US interest equalisation tax, following a collapse in the Canadian financial markets after the USA first announced the policy was to be introduced. The asymmetry of regulation between these two countries continued up until 1988 when it was placed on a more formal footing with the Canada-US Free Trade Agreement (CUSFTA). In particular the Canadian financial institutions were granted exemption from the Glass-Steagall restrictions, as well as the dispute resolution mechanisms that other countries were subject to.

4.3.2 The UK

Throughout the 1960's and 1970's the UK stock market was subject to myriad restrictions. This meant there was a limit to the commissions firms could charge, limits on the types of business firms could conduct as well as limits on the firm structures. This began to change in the late 1960's with firms being allowed to form themselves into limited companies. Also in 1970, overseas firms were allowed to compete on the same basis as their parent firms.

In 1982 reforms began to increase as foreign capital began to flow into the country. The limits on the amount of shares outside firms were allowed to hold in member

firms rose from 10% to 29.9% (in 1986 this was raised to 100%). This move encouraged the ownership of securities firms by the banks, a feature that was accelerated in 1986. In 1984 member firms were allowed to act in a dual capacity, when trading in foreign securities, with "Chinese walls" existing betweeen the broking and jobbing parts of the firm.

In July 1983 there was an agreement betweeen the stock exchange and Government which was the precursor of "big bang" and the liberalisation of the markets and this entailed increasing the competitiveness of the London Stock Exchange in line with the foreign capital markets. In the autumn of 1986 the London Stock Exchange fulfilled its part of the agreement with the Government, when it abolished fixed and minimum dealing commissions. In addition the broker-dealer stock market firms could act on their own behalf for their clients. This deregulation was matched by increased conglomeration of financial institutions as well as greater competition amoung market participants.

At the same time as the increased deregulation, the Government brought forward legislation, which imposed a new regulatory framework, to cover the financial services industry in general and meet the additional requirements arising from the rise in share and pension ownership. Traditionally the stock market in the UK had relied on self regulation, under the new framework there were to be six self-regulatory organisations which had responsibility for a number of over-lapping markets. For instance the London Stock Exchange was guvorned not only by the Exchanges own regulatory body, but also the International Securities Regulatory Organisation (ISRO). These self-regulatory bodies were subject to overall control by the Securities and Investment Bourd (SIB), which had the necessary power transferred to it in 1987.

In 1980, insider dealing was made a criminal offence, whereas before it had been self regulated. Ironically cases of insider dealing subsequently increased, due to the perceived fall in regulation. The 1985 legislation reinforced the moves against insider dealing, giving the Department of Trade and Industry (DTI) inspectors greater power. As with the USA, a number of smaller markets have appeared. In 1980 the Unlisted Securities Market (USM) began operation and the unofficial Over The Counter (OTC) market contnued to grow in strength. Since "big bang" the main changes in regulation have been related to the burgeoning derivatives markets, as well as the consequences of a number of scandals, which have lead to a tightening of the requirements for disclosure and supervision.

4.3.3 Germany and the Netherlands

In contrast to the UK and USA, the German stock markets have had a subordinate role in the provision of finance, to the universal banks. During the 1960's to the late 1980's finance for industry was either obtained from internal sources or from the usually family owned savings banks. The domination of the stock markets by the big three banks stems from the Framework Law of 1934, which placed a variety of restrictions on the stock markets. There are eight local stock markets in Germany, with the largest being in Frankfurt, these are under the control of the individual Federal States.

A particular feature of these markets is the lack of legislation guvorning insider trading, which highlights the close relationship between the banks and industry, with the banks often owning an equity stake in the firms they lend to. The restrictions on the stock markets covered the usual areas of controls on commission and trading in equities, but the most restrictive practise was that the markets were only allowed to operate for two hours a day.

It was not until the late 1980's that German regulation forced a change in the nature of the stock markets in Germany. This was due to a mixture of changes in European law on investment services as well as the loss of business to other foreign markets. The legislation produced two laws to promote financial markets, which were passed in 1991 and 1993. This lead to a German Stock Exchange, based in Frankfurt, where the local stock markets and brokers each held 10% of the total equity in this market. The bill also produced a new supervisory office for securities under the Finance Ministry, although the powers were shared with the State supervisors.

For the first time insider trading became illegal, which was based on a specific European directive, although the measure was not introduced until three years after the directive had intended. In addition German corporate law was aligned on European corporate practise. This included new laws on disclosure and also small investors were encouraged with the threshold of the minimum value of shares that could be held being lowered from 50DM to 5DM.

The Amsterdam Stock Exchange, being based on the German system has largely followed the same regulatory path as German's. The main difference between the two markets has been concerned with the smaller size of this market, with the consequent lack of liquidity and traders. As with Germany this market has also become less

regulated in the late 1990's due to the Single Market Act as well as various European directives covering company law.

4.3.4 Japan

Including the main Tokyo Stock Exchange as well as the seven regional stock markets, Japan's combined markets are ranked second in the world. Despite this up until 1979 Japan had one of the most regulated markets in the world. As a result of the USA post-war occupation, the Japanese financial system was highly comparmentalised to prevent the big pre-war conglomerates reappearing. In addition foreign ownership of Japanese securities were restricted, although in 1960 foreign investment in Japan was allowed up to 25% of the firms value. Throughout the 1970's the restrictions on foreign participation in the Japanese markets were gradually lifted and in 1972 foreign mutual funds could be sold in Japan.

But as other countries liberalised their financial systems, Japan was forced to follow suit. Beginning in 1977 a whole set of reforms were introduced, including reducing the annual listing fee and withdrawing the minimum number of shareholders rule. In addition Japanese investment trusts were allowed to buy foreign shares. In 1979 the Foreign Exchange and Foreign Trade Control Law was introduced which liberalised in principle foreign investment by the Japanese, although some restrictions still remained.

In 1984 a "Financial Accord" was signed with the USA and covered the internationalisation of the Yen and new financial instruments amoung other matters. In 1985 the Tokyo Stock Exchange agreed to open up its market to foreign securities firms and in November of that year six foreign firms began trading. Through the inclusion of more foreign firms in 1986, universal banks (Deutsche Bank) were allowed to trade in the market, something which equivalent Japanese banks were still barred from.

The changes in regulation did not remove the fairly inefficient nature of the Japanese markets. The main authority guvorning the markets is the Ministry of Finance Securities Bureau, which administers disclosure of information, insider trading and margin trading. Although the rules appear stringent, the practise is weaker. In 1992 the Financial System Reform Act was passed which introduced a number of measures to increase competition within the markets, such as less restrictions for foreign financial companies. It also included measures on developing ways in which the Securities Bureau could regulate itself. This Act however has only been implemented

gradually and some of the old style regulations still persist as Japan attempts to ensure stability of its markets by regulation.

4.4 Data sources

When choosing data there are a number of factors which need to be considered. Firstly which data best represents the variables in the theoretical model. Then which countries are to be tested needs to be analysed, bearing in mind availability of data and the relevance of the country's economy as regards to the model. The most important consideration with regards to the models I intend to test is the size and importance of the stock market. Finally the consistency of the data across those countries which are to be tested has to be taken into account. Although obtaining completely consistent data across countries is not possible as all generate their data with regard to national idiosyncrasies.

Most of the data only exists in one or two forms, such as output, the exchange rate and the government deficit. As Gross Domestic Product is produced by all countries whom potentially could have been tested, this series was chosen to represent output. As practically all countries seasonally adjust the data themselves, and express it in real terms, the data was collected in this form. There is only one option as regards the government budget deficit or surplus. Most countries seasonally adjust the data automatically, as it is subject to considerable variations depending on when the country's taxes are collected. Those countries that did not adjust their data, were adjusted by a method described later on. Like output, the government budget deficit is expressed in real terms.

When testing the IS\LM related models, which in its original sense is a closed economy model, the variables all relate to the domestic economy alone. So when adding an exchange rate variable, it is more consistent with the model to have a general exchange rate which relates the domestic currency to a basket of other currencies, rather than in terms of just one other currency. This is because it is assumed that the economy in question trades with more than one other country. The SDR option was selected instead of the ECU because it includes the important US$ and Japanese Yen, the two most actively trading nations.

The exchange rate written in terms of SDR's is taken from the "International Financial Statistics" published by the IMF, and the series is denoted by the letters aa. The SDR basket of currencies comprises the five countries which have the highest

exports[1] over the preceding five years. Over the period in question this is the US$, Deutsche Mark, French Franc, UK Sterling and Japanese Yen. The relative weights for this exchange rate over the recent time period has been US$ 40%, DM 21%, Yen 17% and 11% each for the Franc and Sterling. This weighting also reflects the dominance of the US stock market over the others analysed in this study.

The single most important factor in deciding on which countries to choose was the availability of stock market data. For this reason the US, UK, Germany and Japan were the most obvious candidates, as all have important markets in which stocks are internationally traded. Canada is another fairly significant country in terms of trade and the stock market. The final selection was dependent on the availability of data, as well as the relative importance of their stock market. The country which fitted these criteria best was the Netherlands because it had the data needed for the analysis over a reasonable time period (17 years). Secondly it is a member of the European Monetary System, and one which has attempted to affiliate its economy to the leading European economy; Germany. This enables the analysis to include comparisons between members and non members of the EMS.

All data is quarterly from 1974 quarter one to 1993 quarter four, as by 1974 the countries analysed had floating exchange rates. The exception to this is Canada which begins in 1975 and the Netherlands which begins in 1977, because of a lack of data before these dates. For the US the "Standard and Poor Industrial share " index was used, and for the UK the " FT all share " index was chosen. The German index is the "Commerzbank share price" index and for Japan the "Tokyo new share price " index was used. The Canadian index was the "Toronto composite' index and the Netherlands index was the " All share" index.

The variable representing the price level was the same in all countries; the "consumer price index " except for the UK, which uses the " retail price index" and this corresponds to the other countries consumer price indices. This difference between the other countries and the UK occurs in other data as well such as the money supply, but in general the data is consistent. Only the US and Germany produce seasonally adjusted data , so the data for the other countries was adjusted according to the formula described later on. However the data required very little adjustment and it is debatable as to whether the price level needs to be seasonally adjusted.

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[1] In some cases, traded exports may not accurately reflect the size of capital flows.

When the real exchange rate is generated the foreign or world price level is taken as the Aggregate industrial price level as produced by the IFS. This level is drawn from the price level of the developed industrial nations, mainly the five countries used to derive the SDR exchange rate, but also a number of other less significant industrial nations. Due to the dominance of these five countries in the derivation of the world price level, it is a good approximation to a price level for those countries in the SDR exchange rate. Like the domestic price level it too has been seasonally adjusted.

The interest rate is the conventional three-month treasury bill rate for all countries except Japan which does not produce data on such a rate. Instead the interest rate is the compatible three month time deposit rate. The final set of data refers to the money supply. The initial choice is between a broad definition of money such as M2 or M4 , or a narrow definition such as M0 which measures just the amount of notes and coins.

As in the context of this study money is a form of competition to shares, taking a portfolio balance type of approach, the most appropriate measure of money is a broad one. For this reason, as well as notes and coins, there also needs to be some measure of money held in the form of demand deposits, savings deposits and to some extent time deposits held at all depository institutions. In all countries except the UK these items make up the M2 measure of money, and in the UK they make up the M4 measure. Whenever any measure other than M0 is used a number of complications arise as regards consistency, but overall these measures can be regarded as being reasonably consistent across the countries[2] tested .

4.5 Data adjustments

A minor problem with the government deficit is that it varies according to whether the economy is above or below its full employment long run equilibrium level. When above this level, taxes are unusually high, government spending unusually low, so that the deficit is below its equilibrium level. To adjust the amount to take this problem into account, some measure of the difference between the output level at time t and its equilibrium output level at time t needs to be included. So the government budget deficit is then adjusted by some index to bring it up to what it would have been had the economy been performing at its equilibrium level. The index used is described in the next sub-section.

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[2] All data was collected from Datastream.

This index for the fiscal measure has a smoothing effect on the data, although its accuracy depends on how well the equilibrium level of output is derived. The method used here has been the following and applies to the fiscal measure variable used in a number of different models. Firstly the output series was regressed against a time trend using "Ordinary Least Squares" (OLS);

Country	Coefficient	R^2
USA	.006117	.9747
UK	.005583	.9572
Germany	.00558	.9572
Japan	.009674	.9935
Canada	.007228	.9637
Netherlands	.004857	.9212

Table 4.1 The relationship between the log of output and a time trend

The coefficients reported above give the quarterly growth rates, the R^2 value is also reported to ensure the time trend fits the data reasonably well. As is evident from the results, the growth rates in the respective countries vary substantially, with the Japanese growth rate almost twice that of the UK and Netherlands. For this reason the full employment equilibrium level of output differs between these countries. For Japan over the time period as a whole, their rate of unemployment never rises above 3% , whereas except for 1974, the other countries all have unemployment rates in excess of 3%, sometimes in excess of 10%.

So using the above method to determine the full employment equilibrium level of output can be open to criticism. However if we try to define the full employment level of output, and full employment the research will enter areas which are beyond the scope of the original aims. For this reason the long-term equilibrium level of output is used, and this excludes the cyclical variations in output.

The elasticity's of government expenditure and taxation with respect to output were derived by regressing government expenditure on output and taxation on output (All in logs). This gives the following results;

country	elasticity of G	R^2	elasticity of T	R^2
USA	.8795	.9376	1.059	.9522
UK	1.0221	.9946	1.0794	.9892
Germany	1.1445	.9381	.8527	.7780
Japan	1.1927	.9555	.9003	.7670
Canada	1.1359	.9128	1.1441	.8957
Netherlands	1.1353	.1987	-.0211	.0395

Table 4.2 The elasticity of government expenditure and taxation with respect to output.

All give fairly predictable results with the exception of the Netherlands, which may be due to their strict adherence to the " European Monetary System" and need to control government expenditure and taxation or due to the inherently less reliable data from a smaller country.

To obtain the equilibrium output level required the following steps; the output level in 1974 quarter 1 for all countries except the Netherlands was multiplied by the coefficient on the individual time trend. This process was then carried out for each time period so that any particular time period's output level was the sum of last periods level and the last period level multiplied by the time trend coefficient. 1974 quarter 1 was chosen as the starting point because it is the beginning of the data, and more importantly throughout 1974 all five countries had an unemployment rate of below 3%, or else at its lowest point over the period in question.

For the Netherlands, data on output is only available from 1977 quarter 1 , so this point was used as the starting point. Most countries equilibrium output level and actual output level are fairly strongly correlated as can be seen from the R^2 statistic with the exception of the mid 1970's, early 1980's and early 1990's during three particularly strong recessions.

In general, data produced from government accounts needs to be seasonally adjusted . For this reason data on government budget deficits, the money supply and output are all seasonally adjusted, usually by the authorities compiling the data. However the government budget defecits of Japan and the Netherlands, and also the money supply of the Netherlands had not been adjusted and so was adjusted using the formula in Appendix A.

The correct measure of fiscal policy will be essential if the affects of changes in fiscal policy are to be analysed. To use just government expenditure as the measure, fails to take account of the expansionary or deflationary affects of the policy action. To counteract this criticism, the changes in tax revenue also need to be taken into account. However using the government's budget deficit or surplus still fails to take account of the other factors which affect the level of expenditure and taxation, independently of government actions. Most obviously a rise in income causes an increase in tax revenue, and a reduction in the governments budget deficit.

To reduce the impact of this problem, it is more effective if the budget balance is analysed relative to a given level of income, preferably the full employment level of income. There are a number of criticisms of such a system. Firstly the full employment level of income needs to be near to the normal levels of income at which the economy operates, otherwise inaccurate results will be produced. In this case the affect of the fiscal policy would be greater than it actually is. Secondly it assumes the affect of a unit increase in government spending, is the same as an equal rise in taxation. However this will depend on the level of saving, as part of the affects of taxation falls on the level of savings, either as dividends or capital gains.

Fiscal policy can be represented in a varying degree of complexity, depending on which economic influences are to be incorporated into the model. It is possible to create a macro econometric model which includes the affects of monetary policy and exchange rate dynamics as well as wage and price controls (Artis and Green 1982). For the purposes of this research, such a complicated measure is unnecessary as the aim is to analyse the affects of fiscal policy on the stock market over a fairly long period of time, rather than a detailed analysis of fiscal policy and its determinants.

On the other extreme, as already mentioned using just government expenditure would fail to measure whether a change in fiscal policy is expansionary or deflationary, and even including taxation into the measure fails to relate the fiscal measure to the economy as a whole. For instance taxation is determined by the level of income amongst other factors. The budget deficit has been adjusted using the conventional " long-term trend" of "full employment " deficit. This takes into account the degree to which government spending and taxation respond to changes in output. The formula takes the following;

$$A.D. = (G - T) + \frac{GDP^p - GDP^a}{GDP^a}(GE_G - TE_T)$$

Where the GDP terms refer to potential and actual GDP and E_G and E_T are elasticity's of government expenditure and taxation with respect to output respectively.

As with the rest of the model, the adjusted budget deficit needs to be in real terms, to take account of the real capital gains which occur due to inflation. This makes the assumption that decisions concerning spending are determined by real capital gains as much as by other components of income. This problem can be in theory counteracted by weighting the individual components of income depending on the propensity to consume those individual components. Likewise the problem of differing reactions of government expenditure and taxation to a change in income can be remedied by weighting both variables. But weighting the components of the budget is done by " a combination of input-output information, regression analysis and informed judgement " (NIESR 1982 p 95). Using such a system of weights produces a highly subjective value for each component, which could not be compared between countries, and so is not used in this study to ensure each country's data is as compatible as possible.

There are numerous other problems in attempting to construct a measure of fiscal policy, such as the consequences on monetary policy of financing the deficit, as well as secondary multiplier affects and the dichotomy between discretionary and automatic changes in the budget deficit, which relate to the affects of inflation on the deficit. However it needs to be stressed that the aim of the research is not to produce a complete macroeconomic model explaining how fiscal policy is measured, but to analyse the relationship between the stock market and exchange rate. For this reason a general measure of fiscal policy which takes account of the changes in income due to the economic cycle is sufficient to measure the general affect of fiscal policy on the stock market over the last twenty years.

4.6 Conclusion

During the 1970's and 1980's, all six of the countries analysed have gradually removed all their capital controls. This has facilitated a sharp rise in the amounts of capital moving between the worlds capital markets, as well as a rise in the presence of foreign banks in all the main financial centres around the world. This has inevitably lead to increased levels of capital market integration and a closer relationship between the main exchange rates and stock markets. The absence of exchange restrictions in the USA and Canada should mean that these two countries have a particularly strong relationship between their stock markets and exchange rates. Although it is difficult to

specifically ascertain when Japan removed its controls, the presence of some restrictions could affect some of the results with this country.

Appendix A

So to ensure consistency the data is adjusted using a standard formula, which is the basis of the formulae used by the authorities in the other countries. In practise their adjustments also include some ad hoc changes which are specific to a particular country. However despite these changes the adjusted data is reasonably consistent. The data needs to be in this seasonally adjusted form because the markets when pricing a stock or a currency, use data which is adjusted for all discrepancies, whether seasonal or due to differing accounting conventions. Infact some data is only produced in a seasonally adjusted form. The data has been adjusted by the following method.

It is assumed that the data has four components; a long run trend (L), seasonal trend (S), cyclical trend (C) and an irregular trend. To begin with the long-term and cyclical factors are isolated from the seasonal and irregular factors. This is done through a smoothing method. If the variable m is quarterly data, then the first step is to construct a four quarter average;

$$\overline{m} = \frac{1}{4}(m_{t+2} + m_{t+1} + m_t + m_{t-1})$$

This is an estimate of L*C. Dividing the original data by this estimate isolates the S*I factors.

$$\frac{L*C*S*I}{L*C} = S*I = \frac{m}{\overline{m}} = a$$

Next the irregular factor needs to be removed giving an estimate of S. This is accomplished by averaging the values of S*I in their corresponding quarters.
So if a_1 is quarter 1, then;

$$\hat{a}_1 = \frac{1}{\text{no. of years}}(a_1 + a_5 + a_9 ....)$$

Most of the countries studied have twenty years of data or eighty observations, we have;

$$\hat{a}_1 = \tfrac{1}{20}(a_1 + a_5 + a_9 + \ldots\ldots a_{81})$$
$$\hat{a}_2 = \tfrac{1}{20}(a_2 + a_6 + a_{10} + \ldots\ldots a_{82})$$
$$\hat{a}_3 = \tfrac{1}{20}(a_3 + a_7 + a_{11} + \ldots\ldots a_{83})$$
$$\hat{a}_4 = \tfrac{1}{20}(a_4 + a_8 + a_{12} + \ldots\ldots a_{84})$$

These four indices should sum to four if there is no long run trend in the data. If not then they need to be adjusted by the amount;

$$\frac{4}{(\hat{a}_1 + \hat{a}_2 + \hat{a}_3 + \hat{a}_4)}$$

The final step is to divide each value of m by the corresponding index. This removes the seasonal factor leaving the other three factors;

$$m_1^a = \frac{m_1}{\hat{a}_1},\ m_2^a = \frac{m_2}{\hat{a}_2},\ m_5^a = \frac{m_5}{\hat{a}_1}$$

Seasonally adjusting the price level was more contentious, as the price level is theoretically driven by the market and should not require any adjustments. However the way in which the index is generated may produce seasonal elements in the data. So to counteract this all prices were seasonally adjusted, except the USA and Germany as there prices were already adjusted. In practise very little adjustment was required for all the countries.

Chapter 5

Causality, Cointegration and Co-dependence between Stock Markets and Exchange Rates

5.1 Introduction

The aim of this chapter is to determine whether there is any statistical relationship between the stock market and exchange rate. The tests on the relationship involve cointegration, Granger causality tests and the Engle and Kozicki (1993) test for co-dependence. To begin the empirical analysis of the interrelationship between the exchange rate and stock market, it is first necessary to determine the extent to which one variable influences the other in some simple bivariate tests.An obvious criticism of such an approach is that it does not refer to any underlying model or theory. However despite this it provides valuable information on such issues as causality between the variables, whether they move together in the short or long-term and the nature of such a relationship, if it exists.

The tests are carried out on both bilateral and multilateral exchange rates, as well as nominal and real variables. As there are so many ways of expressing variables representing the exchange rates and stock market, it is important to analyse the most relevant rather than restricting the analysis to simply the most common representations. The emphasis in this section is on bilateral exchange rates and because this expresses the relative prices of two currencies, the stock market variable represents the difference between the domestic and foreign stock market indices.

As a contrast to this approach, tests are also conducted on a multilateral exchange rate, which expresses one currency in terms of a group of others (See data section for details). In this test only the domestic stock market is used, as it would be too cumbersome to include all the stock markets of the countries represented in the multilateral exchange rate. In addition both the exchange rate and stock market are in real terms, which acts as a precursor to the later tests on a more complete model in which all the variables are in real terms. In general with the bilateral exchange rates the stock market differential performed much better than the domestic stock market index on its own.

The tests on the multilateral exchange rates are carried out on all six countries, however the tests on bilateral currencies are only carried out on the main relationships. The tests on the bilateral exchange rates are not conducted on all the countries, since cointegration requires all the variables to be non-stationary I(1) and the variables for the tests with Canada and the UK are I(0).

Following the introduction, there is a description of the data and how it has changed over the last twenty years, followed by the descriptive statistics. Then there is a section testing for the time series properties of the variables, including tests for the direction of causality between the variables, cointegration and co-dependence and this includes tests on the variables for stationarity. In the final section the same tests are conducted on multilateral exchange rates and domestic stock markets. When applying the test for cointegration, the first step is to test for stationarity and then to test for cointegration, in this case using the Johansen ML procedure.

5.2 Data

In the Appendix B, there is a graphical representation of the exchange rate and stock market in nominal terms for all the countries analysed. In all six countries the stock market has appreciated over the twenty or so years. In the 1970's there was only a marginal rise overall, and it was not until 1981 that the worlds stock markets began a significant rise. Only really in Germany is there any appreciable difference to this trend as their rise did not begin until 1985.

All six markets experienced a fall in 1987 and 1989 quater four, the former was after a sharp rise months earlier. Germany also had a sharp fall in 1990 following reunification, whereas Canada's market fell in 1982 before recovering as a result of a change in economic policy. All countries markets continued to rise during the 1990's except Japan's, which in 1989 fell sharply following a very steep rise. The fall and resultant volatility was due to the first signs of inflation in the Japanese economy.

In general the exchange rate indicates that Germany, Japan and the Netherlands have appreciated against the main currencies, whereas the UK, USA and Canada have depreciated. A particular feature occurs in the early 1980's when the US dollar appreciated against the world's currencies, before depreciating equally sharply in the mid 1980's. In all the other graphs, the depreciation of their currencies is obvious during this time. In the early 1990's the UK currency experienced a particularly sharp decline as a result of the policy towards the ERM. Japan's currency also experienced a

strong appreciation in the early 1990's possibly due to the ever-increasing trade surplus they achieved with the rest of the world.

There have been wide variations in the volatility of the respective stock markets and exchange rates, as illustrated in Tables 5.1 to 5.3. The tests are conducted on 80 observations using quarterly data, from 1974 quarter 1 to 1993 quarter 4. In terms of the coefficient of variation the UK is the most volatile, whereas the Canadian market is the least. It is evident that the larger markets with a higher volume of trade are the most volatile and the smaller markets less volatile. As would be expected the exchange rates are less volatile than the stock markets. The Canada\US exchange rate is by far the least volatile as expected and the Japan\US exchange rate by far the most volatile. This trend is repeated with the exchange rates using the UK pound.

The degree of correlation between the stock markets follows a fairly predictable trend, as all except Japan have coefficients above 0.9. This indicates that the worlds stock markets tend to move together. The Japanese stock market has a coefficient with both the USA and UK stock markets of about 0.8. This evidence along with that of the measures of variation in stock markets and exchange rates illustrates the greater volatility in Japanese capital markets over the past twenty years. This may be partly due to the Japanese economy being perceived as more risky than others, especially during oil shocks.

Table 5.1 Descriptive statistics on the stock markets,where max is the maximum value and min the minimum, SD is standard deviation and C V is the coefficient of variation. The units of measurement are the standard market index units. Sample consists of 80 observations.

Country	max	min	mean	SD	C V
UK	1682	66	605	443	0.733
USA	540	71	233	140	0.604
Germany	2431	525	1244	572	0.460
Japan	2881	278	1027	727	0.708
Canada	4321	973	2491	1010	0.405
Netherlands	280	51	129	63	0.493

Table 5.2 Descriptive statistics for the bilateral exchange rates with the US dollar/

Country	max	min	mean	SD	C V
UK	0.865	0.387	0.570	0.104	0.182
Germany	3.184	1.409	2.122	0.432	0.203
Japan	305	105	206	61	0.300
Canada	1.380	0.970	1.200	0.101	0.089
Netherlands	3.55	1.59	2.291	0.484	0.216

Table 5.3 Descriptive statistics for the bilateral exchange rate with the UK pound.

Country	max	min	mean	SD	C V
Germany	6.187	2.431	3.752	0.901	0.239
Japan	707	158	381	157	0.414
Canada	2.851	1.521	2.091	0.279	0.133
Netherlands	5.220	2.730	3.870	0.650	0.167

5.3 Stationarity

The test for stationarity used throughout this thesis is the Augmented Dickey-Fuller test (ADF). The lags used are determined by the Akaike criteria, although this is often regarded as being ad-hoc. The tests below are on the data used in this chapter, which is nominal and in logarithms. Also the exchange rates are all bilateral. The results suggest all the variables are I(1), except the differential between the Netherlands and US stock market and differntial between the Canadian and UK stock market. The Canada\UK exchange rate is also I(0).

The nature of the relationship between the UK and Canada is evident throughout this thesis and suggests both their exchange rates and stock markets have a number of common features. For instance both have had relatively unobtrusive capital controls since 1979, so capital has been able to flow freely between them. This in theory should have made the exchange rate more unpredictable rather than producing stationarity.

Table 5.4 Tests for stationarity[1] on the stock market differentials with the US stock market, where s is the log of the stock market differential. (The critical values for the DF and ADF tests are -2.57 and -2.89 at the 10% and 5% levels of significance respectively, taken from Fuller (1976)).

	s		Δs		
Country	lags	ADF	lags	ADF	I
UK	4	-2.581	2	-5.173	1
Germany	0	-1.753	3	-4.151	1
Japan	0	-1.220	4	-3.580	1
Canada	3	-1.582	2	-3.291	1
Netherlands	4	-3.061			0

(A Δ indicates the variable is first differenced)

Table 5.5 Test for stationarity on the stock market differentials with the UK stock market

	s		Δs		
Country	lags	ADF	lags	ADF	I
Germany	0	-1.517	7	-2.901	1
Japan	0	-1.032	5	-3.550	1
Canada	4	-4.194			0
Netherlands	0	-1.944	4	-3.320	1

(A Δ indicates the variable is first differenced)

[1] There is a general debate in the literature about whether macroeconomic time series contain a unit root or not. Perron (1989) argues that variables that appear to have a unit root may in fact be trend stationary, where a break is included in in the data for a specific event, such as a large fall in the stock market. This implies using the various tests for stationarity such as the Dickey-Fuller test may not be giving a reliable result, when a break appears in the time series. It is often suggested that whether a variable is stationary is important. however there is no way of proving if it is stationary or not. For this reason the ADF statistics are used as a quick test. In particular it is often difficult to determine whether variables are I(1) or I(2) and for this reason a number of different lags are reported for the ADF test, in some cases in addition to the lag selected by the Akaike criteria.

Table 5.6 Test for stationarity on the exchange rates with the US dollar, where e is the log of the exchange rate.

	e		Δe		
Country	lags	ADF	lags	ADF	I
UK	3	-2.466	6	-2.350	1/2
Germany	0	-1.471	3	-3.181	1
Japan	5	-0.650	3	-3.582	1
Canada	3	-2.571	2	-3.573	1
Netherlands	0	-1.312	3	-2.830	1

(In the case of the test for the first differenced UK\USA exchange rate, the DF statistic is -7.60 and ADF(1) statistic is -7.04, which suggests it is I(1)).

Table 5.7 Test for stationarity on the exchange rates with the UK pound.

	e		Δe		
Country	lags	ADF	lags	ADF	I
Germany	0	-1.771	3	-4.231	1
Japan	1	-0.984	6	-3.050	1
Canada	7	-3.561			0
Netherlands	0	-0.590	3	-3.701	1

5.4 Granger causality tests

To establish a causal relationship between stock prices and the exchange rate, the most appropriate method is the Granger causality test. As Granger suggests, when a time series is stationary, one variable is said to cause a second variable if the prediction error of the first variable falls by using past values of the second variable as well as past values of the first. The actual test is for the coefficients on the causal variable being significantly different to zero, and this was accomplished using the LM statistic. The model to be tested took the following form;

$$\Delta E_t = \alpha + \sum_{i=1}^{M} \beta_i \Delta E_{t-i} + \sum_{i=1}^{M} \eta \Delta S_{t-i} + u_t \qquad 5.1$$

The next main point of contention is the relevant number of lags to use. In this study two, four and eight lags were included as this enables a comparison to be made between any short run and long run effects. In fact even longer lags could have been reported as with Bahmani-Oskooee and Sohrabian (1992), however with quarterly data more than two years of lags is difficult to interpret in economic terms. As before the data is from 1974 quarter 1 to 1993 quarter 4.

Table 5.8. Granger causality tests with the US dollar (Lagrange Multiplier test, critical values are 5.99, 7.81 and 15.5 for 2,4 and 8 lags respectively; le is the exchange rate and ls the differential between the domestic and foreign stock markets)

Countries	e			s		
(Lags)	(2)	(4)	(8)	(2)	(4)	(8)
UK\USA	0.327	2.313	11.272	1.668	1.367	3.052
Gernany\USA	7.202*	10.168*	12.592	3.033	3.228	4.332
Japan\USA	2.757	4.091	13.247	2.508	11.633*	12.306
Canada\USA	0.776	0.971	6.578	8.797*	10.100*	14.438
Netherlands\USA	0.917	2.847	7.356	0.275	4.184	12.924

Table 5.9 Granger causality tests with the UK pound.

Country	e			s		
(Lags)	2	4	8	2	4	8
Germany\UK	1.936	2.527	5.417	0.181	0.610	1.409
Japan\UK	2.072	5.005	7.202	1.878	2.562	9.709
Netherlands\UK	0.643	1.392	3.315	0.855	1.831	1.595

This is the case with the UK\USA test, although with eight lags the test statistic is just below the critical value at the 10% level of significance. The Germany\US test is quite different with a strong short-run effect from the stock market to the exchange rate, with a less significant effect in the long run. This tends to support the theory that the German stock market and exchange rate move together over time.

In the Japan\US test the main effect is from the exchange rate to the stock market, especially in the long run, although with eight lags there is also evidence of the stock market affecting the exchange rate at the 10% level of significance. The Canada\USA test is the most clear cut case as it suggests that the effect is from the exchange rate to the stock market in both the short and long run. Finally the Netherlands\USA test suggests no effects in either direction.

In all the other tests not involving the USA, there is no evidence of causality in either direction. This point emphasises the importance of the US stock market in determining the exchange rate. But these particular tests need to be treated with some caution, as the Granger causality test has received a number of criticisms. In particular it is argued that any effect that is apparent may not have been caused by either variable being tested, but by another variable or variables that is affecting both variables simultaneously. For instance a rise in output could cause both a rise in the stock market and an appreciation of the exchange rate.

There appears to be some evidence of the exchange rate affecting the stock market, as was found in the Bahrami-Oskooee and Sohrabian study. This is an interesting result as most research suggests that there is very little effect from any macroeconomic variables on the stock market (Merton and Fischer 1985). The only evidence of any significant effect is by the money supply and even then only the unanticipated component of the money supply (Pearce and Roley 1983). If this relationship is likely to hold in any country, then the most obvious one would be a country that depends on export and imports, particularly where they have a strong trade surplus or deficit. This may explain why the Japan\USA result suggests that the exchange rate is so influential in determining the stock market.

These Granger causality tests appear not to offer any particular evidence about the stock market and exchange rate relationship. However they are of relevance in illustrating a feature that dominates the results from all the tests in this research. The result from the tests using bilateral exchange rates in which the USA is included are far more significant than in those tests where it is not included. This is because there is some evidence of causality from the stock market to the exchange rate in the Germany\US and Japan\US tests and some evidence of causality running from the exchange rate to the stock market in the Canada\US test, but no evidence of causality in either direction in the UK tests.

This may reflect two factors that dominate the US economy. Firstly, there have been no capital controls in the USA over the time span of the tests and secondly the

strength of the US stock market and the economy has ensured capital has flowed between the USA and other countries relatively freely. In effect the US stock market reflects the US dollar, in that it acts as relatively safe investment for risk averse investors.

5.5 Common Trends

Table 5.10 Tests for cointegration with the US dollar using the Johansen Maximum Likelihood Procedure (critical values are for r=1; 19.96 (17.85) and r=2; 9.24 (7.53) at the 5% (10%) levels of significance, taken from Johansen and Juselius (1991)). The sample consists of 80 observations.

Countries	r=1	r=2	vectors
UK\USA	14.518	4.156	0
Germany\USA	18.838	2.801	0\1
Japan\USA	7.516	2.939	0
Canada\USA	9.547	2.269	0
Netherlands\USA	16.794	4.005	0

Table 5.11. Cointegration tests with the UK pound

Countries	r=1	r=2	vectors
Germany\UK	22.103	4.408	1
Japan\UK	8.843	2.313	0
Netherlands\UK	8.379	1.937	0

The technique used in this test is the Johansen Maximum Likelihood Procedure with a VAR(4), due to the use of quarterly data, running from 1974 quarter 1 to 1993 quarter 4.. Again it is the logarithm of the nominal exchange rate and stock market differential that is being tested for a long-run relationship. As both variables measure the price of a commodity, which are subject to the same basic influences related to the business cycle and certain exogenous influences, they might be expected to

cointegrate. This could occur even if there were no short run effect, however when tested they appear not to have any common trend.

The UK and USA, as with Bahmani-Oskooee and Sohrabian (1992) fail to cointegrate[2]. In addition there is no evidence of cointegration between the Japan\USA, Canada\USA or Netherlands\USA, although in the latter case, the test produces a statistic only marginally below the 10% significance level. In contrast the Germany\USA test does produce cointegration at the 10% of significance.

In the tests on those countries not including the USA, the same pattern occurs as with those with the USA. The UK\Germany test produces evidence of cointegration at the five percent significance level. None of the other tests offer any signs of cointegration, even the Netherlands\UK test is negative, which suggests in this set of tests the Netherlands is not reacting in a similar way to Germany. As with the Germany\USA test, the long run vectors give correctly signed stock market variables which are highly significant and which have coefficients of above unity.

The difference between the German results and the others is a trend that runs throughout nearly all the results. Initially it appears that this result indicates that the German stock market and exchange rate are more closely related than in the other countries, over the long run. However this result needs to be interpreted in the light of another study in which the relationship just tested appeared to hold far more closely in developing countries, such as India and South Korea than in the developed countries (Ronge 1995). An alternative explanation could be because these markets are relatively inefficient (Chelley and Pentecost 1994).

Taking this into account, then the result obtained above is really quite interesting, as it suggests that Germany's relationship between its stock market and exchange rate is of a different nature to other developed countries. So the cointegration result is implying that a stock market, which does not have an important place in the general economy, cointegrates with the exchange rate, but where it has an important and comprehensive relationship with the economy as in the UK, it fails to cointegrate. This may be because other factors influence the relationship to a greater extent.

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[2] When the nominal bilateral exchange rate for the UK and USA was used with real differential between the two countries stock markets there was evidence of cointegration, which produces a stable ECM.

5.6 Common Cycles

Due to the nature of the time paths of the stock market and exchange rate, it seems probable that they would follow common cycles rather than common trends. The main reason for this is that both are closely related to movements in the business cycle, and the accompanying cycle in company profits of a particular economy. In addition both variables tend to follow movements in interest rates, the money supply and output. As the economy expands, interest rates tend to rise to deflate the economy, this causes a capital inflow which appreciates the exchange rate and causes the stock market to rise. Whereas in a recession, interest rates tend to fall to encourage an economic upturn, causing an exchange rate depreciation and fall in the stock market.

In terms of the test for co-dependence, the technique is examining whether common serial correlation features exist, which are not the result of the long-term trend, as the variables being analysed are first differenced. In effect the test is examining if the residuals from the bivariate regression of the exchange rate against the stock market are white noise, such that the serial correlation of both variables have cancelled each other out. The Sargan LM test is then used to determine if a significant common feature existed, based on the adequacy of the previous information through the lagged values of the variables.

So far the co-dependence method has been predominantly applied to output and levels of consumption, both of which were thought to follow a common cycle, which was confirmed by the co-dependence tests (Kozicki and Engle 1993). Bearing this in mind, as well as the results of the tests relating output and the stock market, theoretically it appears that the stock market and exchange rate should co-depend.

Co-dependence can be defined as a serial correlation common feature, that occurs when elements of a stationary vector produce a linear combination of those elements, that is an innovation with respect to all observed information prior to time t (See appendix A). As emphasised by Engle and Issler (1995), If a variable cointegrates, then this does not prevent or imply co-dependence. Similarly, if no cointegration is present then co-dependence may still be present. The specific test for co-dependence is based around a two-stage least squares regression of one stationary variable on another. The instruments then comprise the lagged values of all the variables, which in the following tests are the first four lags as used by Engle and Vahid (1993). In

addition the error correction term lagged once is also incorporated into the instruments.

Bearing in mind that we are seeking to find a linear combination of the first differences of the variables that has no correlation with the past. Then Engle and Kozicki (1993) show that the relevant statistic for determining if co-dependence is present is the LM statistic for the legitimacy of the instruments. In this case it is Sargan's statistic, where the degrees of freedom are equal to the number of over identifying restrictions. As is evident in Table 5.12, in addition to the test with the first four lags and error correction term, following the example of Vahid and Engle (1993), a second test is included without the first lag on the variables, and the error correction term is lagged twice and these results are included in Tables 5.12 and 5.13, below the main tests. The null hypothesis being tested is that co-dependence is present in the results in Table 5.12 and Table 5.13.

Table 5.12. Tests for co-dependence with the US dollar, between the exchange rates and differential between stock market indices. (The LM statistic has a chi-squared distribution, with critical values of 12.6 and 15.5 for 6 and 8 degrees of freedom respectively)

Countries	Beta		LM statistic
UK\USA	0.000542	(0.00352)	12.867
	-0.0814	(0.104)	6.642
Germany\USA	0.369	(2.258)	12.251
	0.287	(1.747)	7.256
Japan\USA	-0.386	(-1.884)	2.982
	-0.295	(-1.416)	0.692
Canada\USA	0.0145	(0.147)	7.054
	0.0359	(0.343)	6.092
Netherlands\USA	0.598	(2.118)	6.740
	0.590	(2.056)	5.936

(The t-statistics are in parenthesis)

Table 5.13 Test for co-dependence with the UK pound.

Countries	Beta	LM statistic
Germany\UK	0.0903(0.566)	2.470
	0.0969(0.598)	2.199
Japan\UK	-0.685(-2.283)	5.948
	-0.740(-2.336)	2.428
Netherlands\UK	-0.0962(-0.433)	8.427
	-0.0626(-0.224)	7.732

(The LM statistic has a chi-squared statistic, with critical values of 12.6 and 15.5 for 6 and 8 degrees of freedom respectively, t-statistics are in parenthesis)

The results from the co-dependence tests all accept the null hypothesis of co-dependence being present with varying degrees of ease. At one end of the spectrum, there is the UK and USA, which produces a chi-square statistic of 12.867, which is only just significant. At the other end is the Japan\USA test which is highly significant with a chi-square(8) statistic of 2.982. It is also evident that there is no difference between the German results and the rest, so the state of development of the stock market appears not to affect the degree to which it co-depends with the exchange rate.

What the results do show is that both the stock market and exchange rate follow a common cycle, which may or may not be related to the business cycle. As is demonstrated later, risk in both markets tends to be highly correlated, suggesting market participants react to information in a fairly similar way. This suggests that although the stock market may not appear to be related to the fundamental economy, it still follows a similar pattern to the exchange rate.

5.7 Tests Using Real Variables.

Table 5.14. Co-dependence Results with real variables, where e is the log of the real exchange rate and s is the log of the real stock market differential.

Country	Beta	LM statistic
UK	-0.0123(-0.0932)	10.003
	-0.229(-1.30)	0.535
USA	-0.188(-0.944)	8.522
	-0.221(-0.942)	7.70
Germany	0.135(1.137	14.120
	0.158(1.293)	8.945
Japan	-0.204(-1.486)	4.362
	-0.104(-0.608)	2.694
Canada	0.0741(0.682)	5.681
	0.102(0.901)	3.669
Netherlands	0.817(1.615)	1.403
	-0.010(-0.752)	1.218

(t-statistics are in parenthesis, critical values are as before)

Table 5.15 Granger causality tests.

Country	e			s		
	2	4	8	2	4	8
UK	3.041	4.175	10.316	2.70	3.405	10.405
USA	1.134	1.433	2.195	0.757	1.405	5.115
Germany	3.795	9.244	4.736	2.309	1.485	4.814
Japan	0.848	0.836	3.795	4.974	6.722	14.604
Canada	1.635	0.882	4.518	1.451	4.554	6.188
Netherlands	0.907	1.916	7.275	1.075	1.895	6.702

(The notation is as before)

Table 5.16 Tests for cointegration

Country	r=1	r=2
UK	7.398	1.323
USA	9.558	0.791
Germany	15.530	3.590
Japan	9.969	1.494
Canada	21.029	5.506
Netherlands	14.837	4.853

The tests were repeated using real variables as in the model in the following chapter, where both the real exchange rate and real stock market index are used and the exchange rate is in a multilateral form. In general, repeating the tests using the real variables, produces much the same results as before, which is what would be expected. However there are two interesting exceptions. Firstly the German test does not produce significant levels of cointegration. This perhaps implies that over the time period as a whole, PPP has not been a suitable way of measuring the real German exchange rate, and also it could be the influence of the Japanese exchange rate.

Secondly in Canada, using real variables produces strong evidence of cointegration. To an extent this reflects the relatively unimportant nature of the Canadian stock market to international investors, and the lack of exchange controls used by Canada. A further point of interest is that the German test only just passes the test for co-dependence with four lags, although passes more easily with three. This again may reflect the inappropriate nature of PPP with the German exchange rate.

5.8 Conclusion

These results suggest their is little evidence of common trends, but considerable evidence of common cycles in all the countries tested. This implies, that any analysis involving the exchange rate and stock market requires an error correction model (ECM) framework, as it is likely to be more successful than one which emphasises only cointegration and this is done in the following chapters. They also show how these two variables move over time. The cointegration results, although predominantly failing, highlight an important feature of many of the results, which is that Germany behaves in a significantly different way to the other countries. The

Granger causality tests give fairly ambiguous results, which means a more detailed model is required to determine the extent to which one variable affects the other.

Appendix A

Codependence

There is an area of analysis related to cointegration termed codependence, which is concerned with the co-movements amongst a set of time series variables. In general, the aim is to discover whether a serially correlated common feature occurs between a set of variables, that has previously been first differenced. Engle and Vahid (1993), describe a serially correlated common feature as a linear combination of the first differenced variables in which there occurs an innovation with respect to all observed information prior to time t.

Beginning with a moving average representation, it is possible to define a first differenced variable Y as being I(0), in which case it can be given a Wold representation;

$$\Delta Y_t = \mu + C(L)\varepsilon_t \tag{5.2}$$

C(L) is a matrix polynomial in the lag operator L.
ε_t is an n*1 vector of I(0) one step-ahead linear forecast errors in Y_t.
This takes into account information on lagged values of Y.μ is assumed to be zero, otherwise there would be a time trend in the levels. Rewriting the first equation in a similar form to Granger and Engle (1987) gives;

$$\Delta Y_t = C(1)\varepsilon_t + \Delta C^*(L)\varepsilon_t$$

Then integrating both sides gives; (5.3)

$$Y_t = C_1 \sum_{s=0}^{\infty} \varepsilon_{t-s} + C^*(L)\varepsilon_t$$

This equation then represents the Beveridge-Nelson cycle decomposition, whereby the series is decomposed into a trend part or random walk, as well as a 'cycle' part which is stationary. If the rank of C(1) is k<n, then it is possible to decompose it into products of two matrices of rank k, and in addition the trend can be divided into linear combinations of k random walks, rather than n. This is an important feature and is called the 'common trend representation' or BNSW decomposition, after Beveridge, Nelson, Stock and Watson;

$$Y_t = AT_t + C_t$$
$$r_t = T_{t-1} + \sigma'\varepsilon_t$$
Where; (5.4)
$$T_t = \sigma'\sum_{s=0}^{\infty}\varepsilon_{t-s} \text{ and } C_t = C^*(L)\varepsilon_t$$

In this case there will be r linearly independent cointegrated vectors, that form a basis for the null space of C(1). Thus when a set of I(1) variables is first differenced and are found to be serially correlated, then a linear combination occurs of the differences, that is an innovation only when the levels of the variables produce common cycles in their BNSW decomposition.

It is possible to take the analysis of common cycles further than just viewing them as cycles which are in effect cancelling each other out in particular linear combinations. In fact they can be expressed in their lowest common denominator, such that if there exists a set of S linear independent combinations of the elements of π non-stationary variables that also follow random walks, then the set of variables must share n-s common cycles. In addition the linear combination of the levels in which there are no common cycles will also follow random walks. Therefore;

$$\overline{\alpha}'C_0^* = 0 \Rightarrow \overline{\alpha}'(1 - C(1)) = 0 \Rightarrow C(1)'\overline{\alpha} = \overline{\alpha} \tag{5.5}$$

Having common cycles suggests that the unit roots for the matrix C(1) as well as the co-factor vectors, represent the eigenvalues which correspond to the unit eigenvalues of $C(1)'$.

Combining the ideas behind cointegration and common cycles gives the following relationship. Consider an n vector of I(1) variables termed Y(t), which produces r linearly independent cointegrating vectors. Assuming that elements of Y(t) have common cycles, then at the most there will be n-r linearly independent co-factor vectors, which eliminates the common cycles. This assumes that they are linearly independent of the cointegrating vectors.

To represent an infinite moving average process often requires a finite VAR. Assuming Y(t) has a finite VAR, with the model expressed in differences;

$$A(L)Y_t = \varepsilon_t \Rightarrow A(L) = I + A_1 L + A_2 L^2 .....+ A_p L^p$$

$$\Delta Y_t = A^{**}(L)\Delta Y_{t-1} - A(1)Y_{t-1} + \varepsilon_t$$

Where; (5.6)

$$A_i^{**} = \sum_{j=i+2}^{j=D} A_j$$

If no cointegration occurs A(1) is a zero matrix, but when cointegrated A(1) has a rank r, which can be decomposed into the product of two matrices of rank r. Under this circumstance a VAR in differences only would be misspecified, as important variables would have been omitted. In this case the following representation holds;

$$A(1) = \beta\alpha', C(1)A(1) = 0, \alpha' C(1) = 0, C(1)\beta = 0 \tag{5.7}$$

This gives the ECM of the cointegrated series;

$$\Delta Y_t = A^{**}(L)\Delta Y_{t-1} - \beta Z_{t-1} + \varepsilon_t$$

Where; (5.8)

$$Z_{t-1} = \alpha' Y_{t-1}$$

If common cycles exist then there needs to be a non predictable linear combination of differences, which means that;

$$\overline{\alpha}' A_i^{**} = 0 \text{ for all i.}$$

$$\overline{\alpha}' A(1) = 0 \Rightarrow \overline{\alpha}'\beta = 0 \tag{5.9}$$

So all $A^{**'}$ smust be of less than full rank.

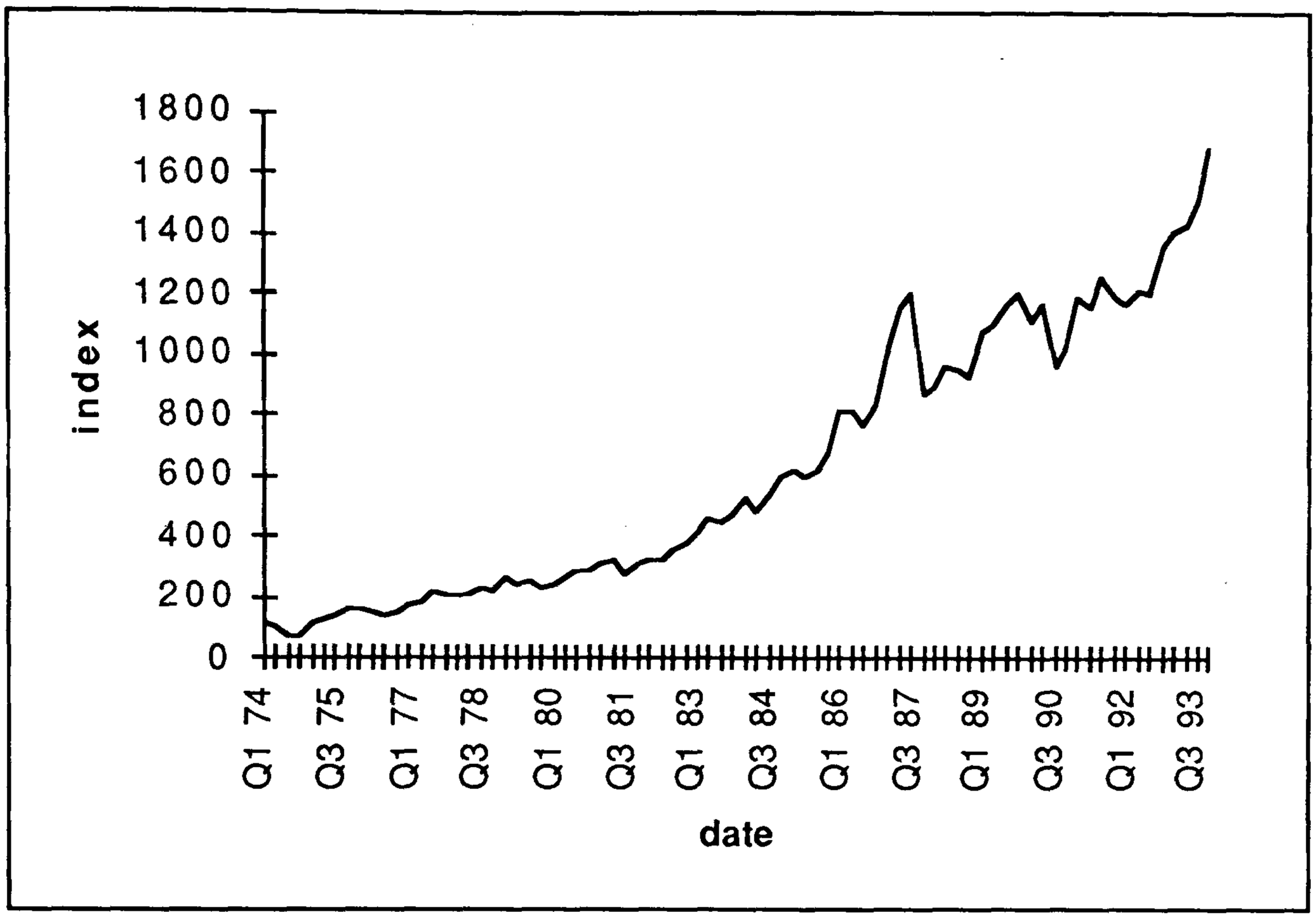
In addition their left null spaces need to overlap with each other and with the left null space of A(1).

As with cointegration there are a number of special cases. Firstly where there are r linearly independent cointegrating vectors and n-r linearly independent co-feature vectors. Under such circumstances every set of cointegration and co-feature vectors give a projection operator that at time t decomposes the innovation into a trend and cycle component. Likewise with the first order cointegrated system, the subsequent ECM would have no lagged differences on the right hand side of the equation.

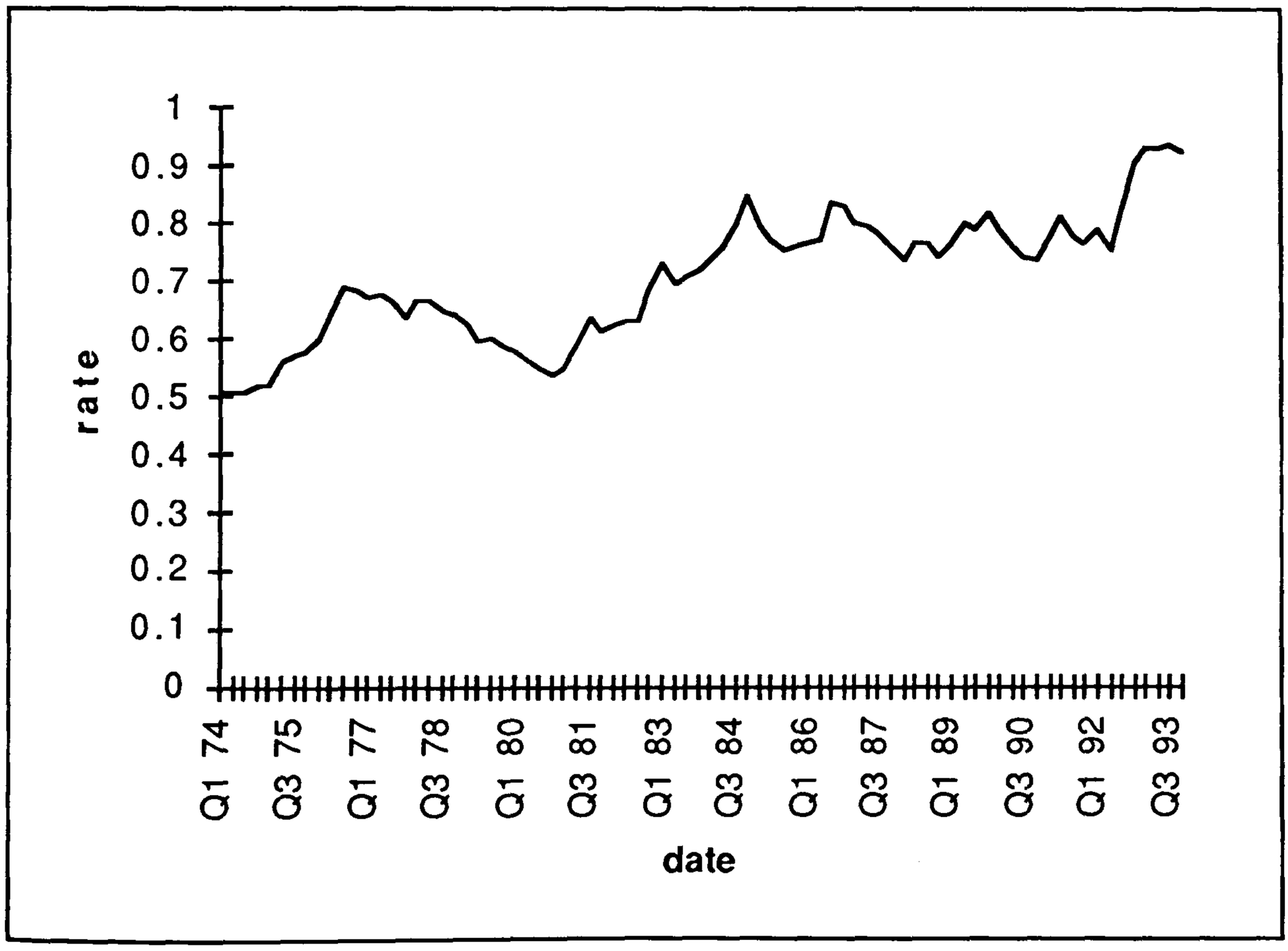
Appendix B

(All exchange rates are nominal and multilateral, as detailed in the chapter on the data. All stock market graphs represent a market index, in nominal form. The data is quarterly and runs from 1974 quarter 1 to 1993 quarter 4, except Canada that begins in 1975 and the Netherlands that begins in 1977)

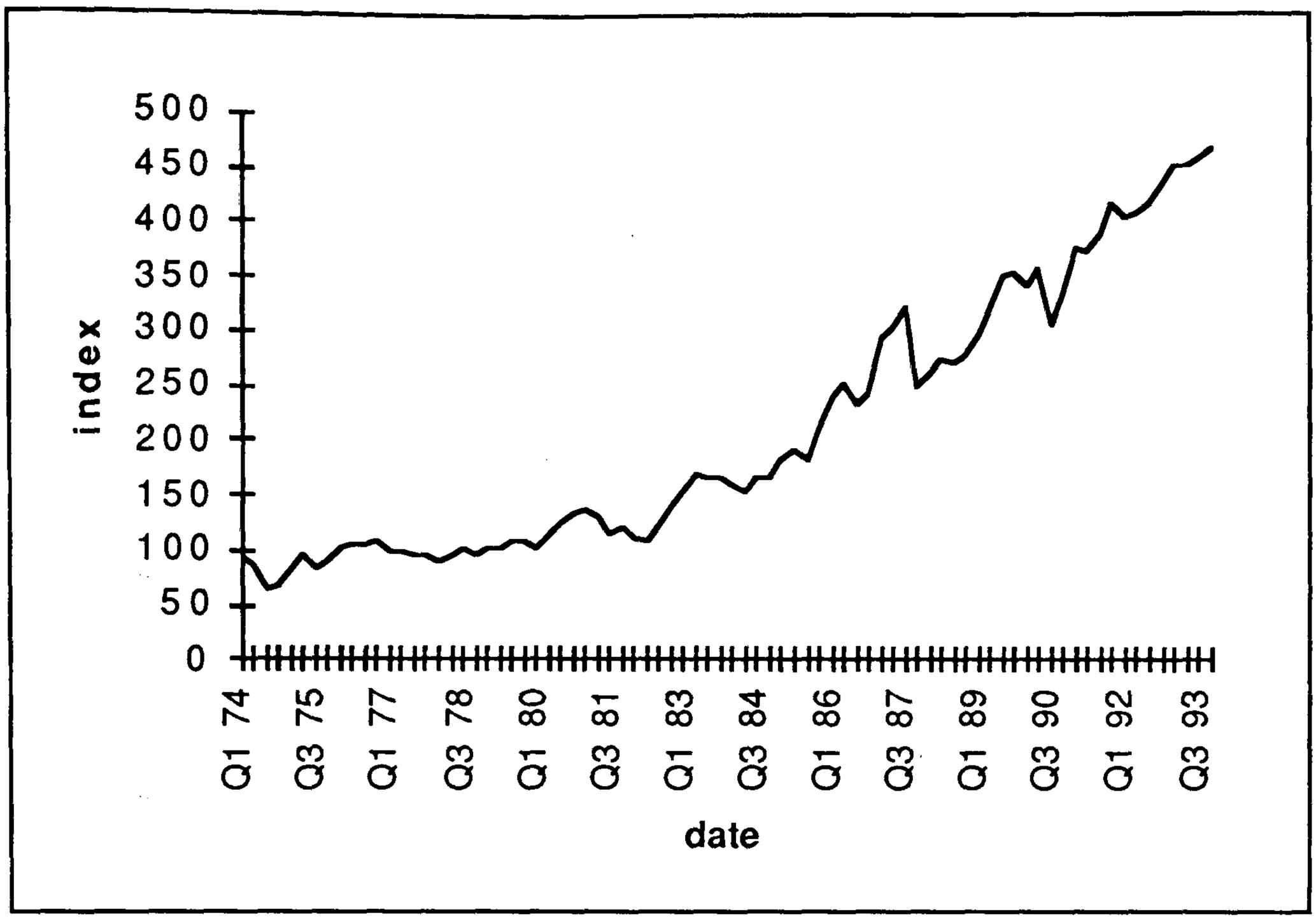
UK stock market



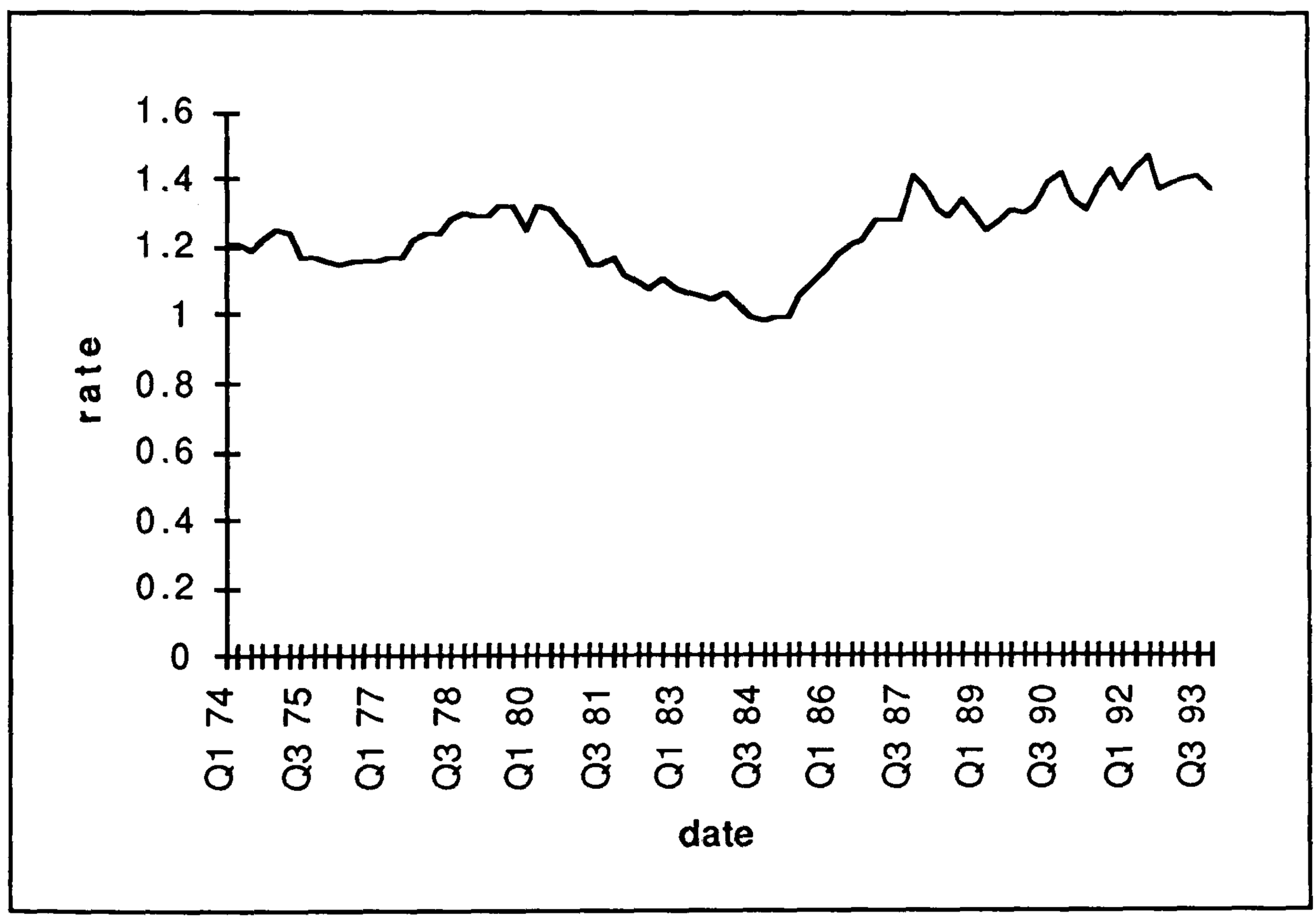
UK exchange rate



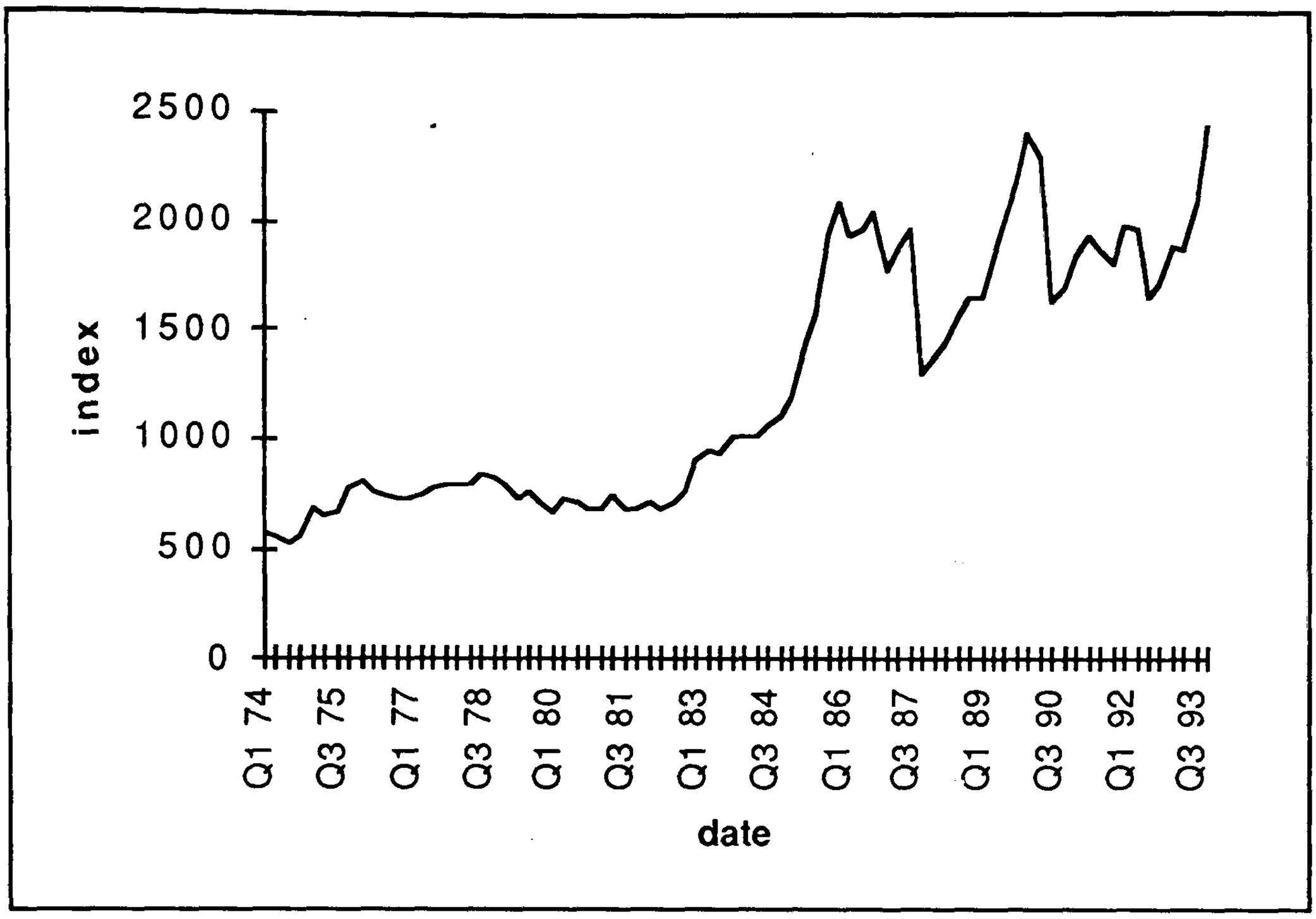
US stock market



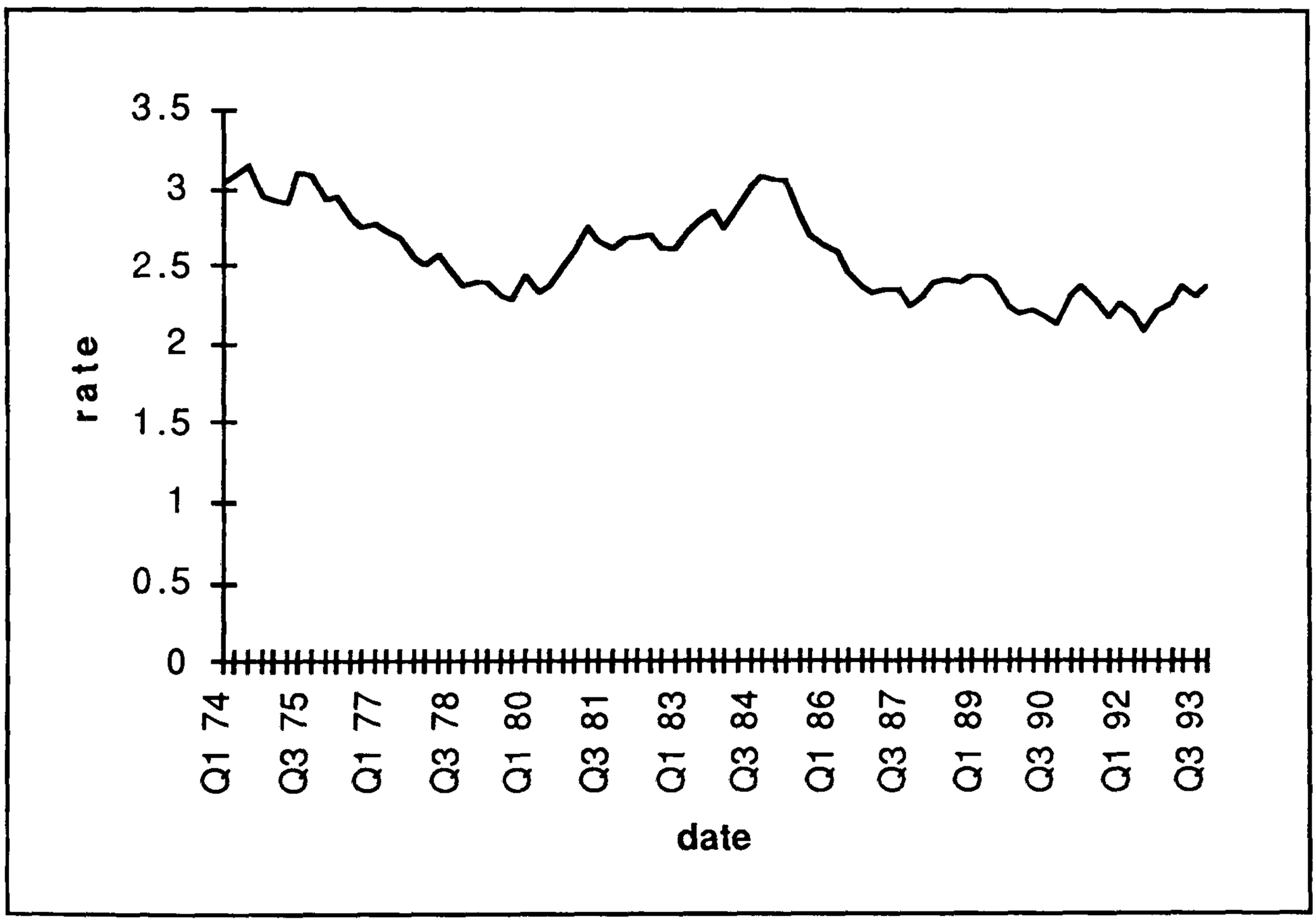
US exchange rate



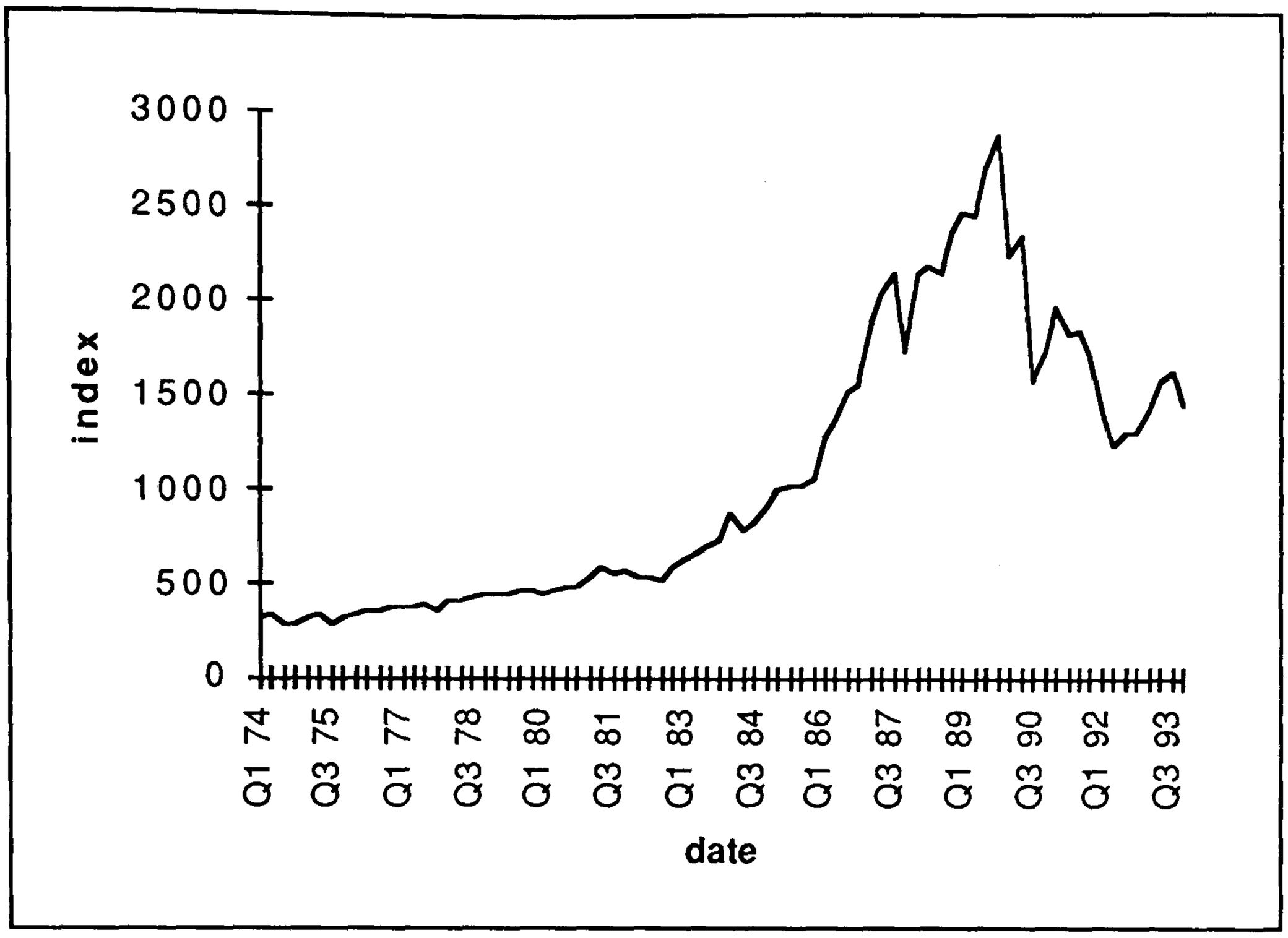
German stock market



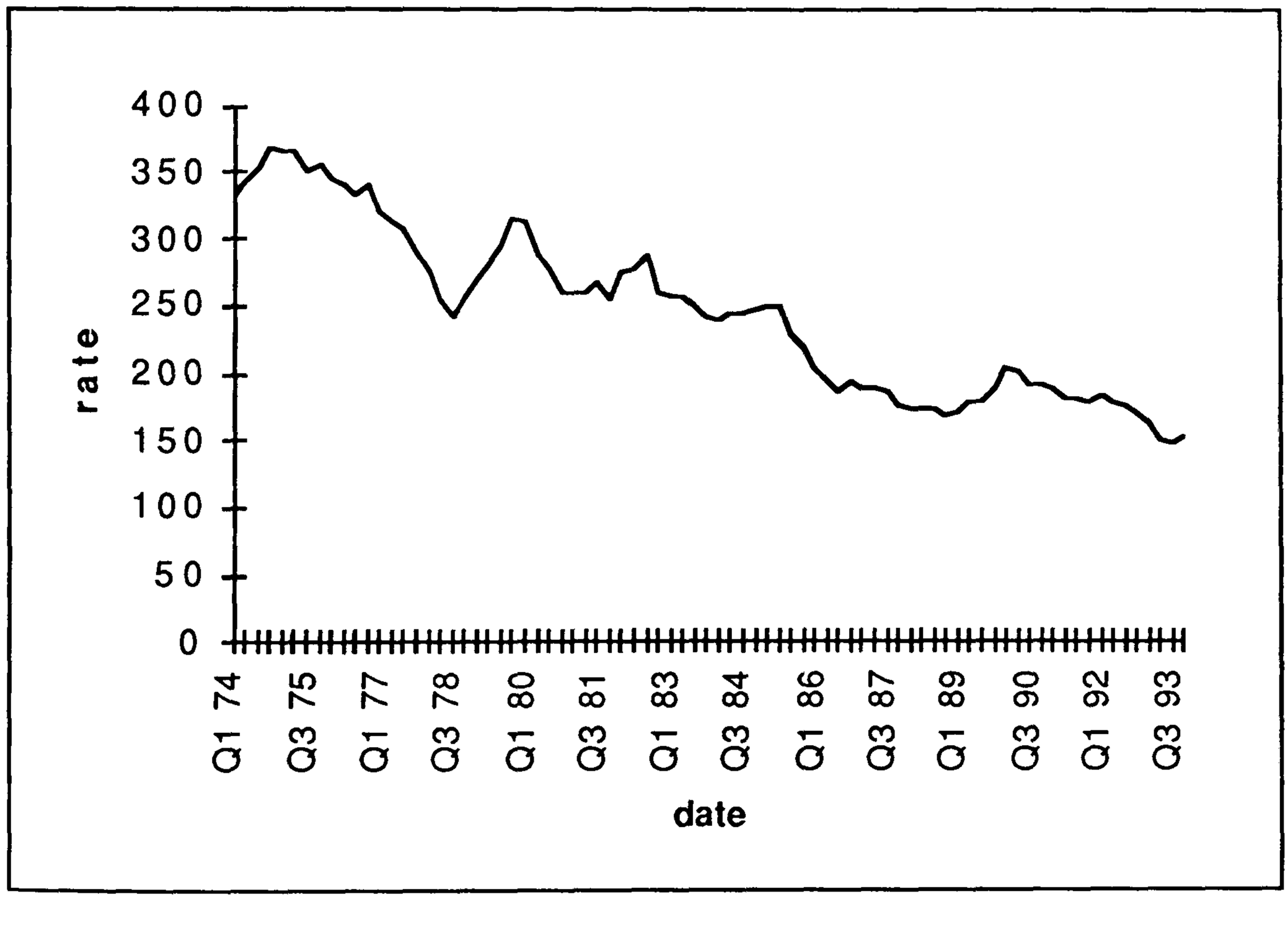
German exchange rate



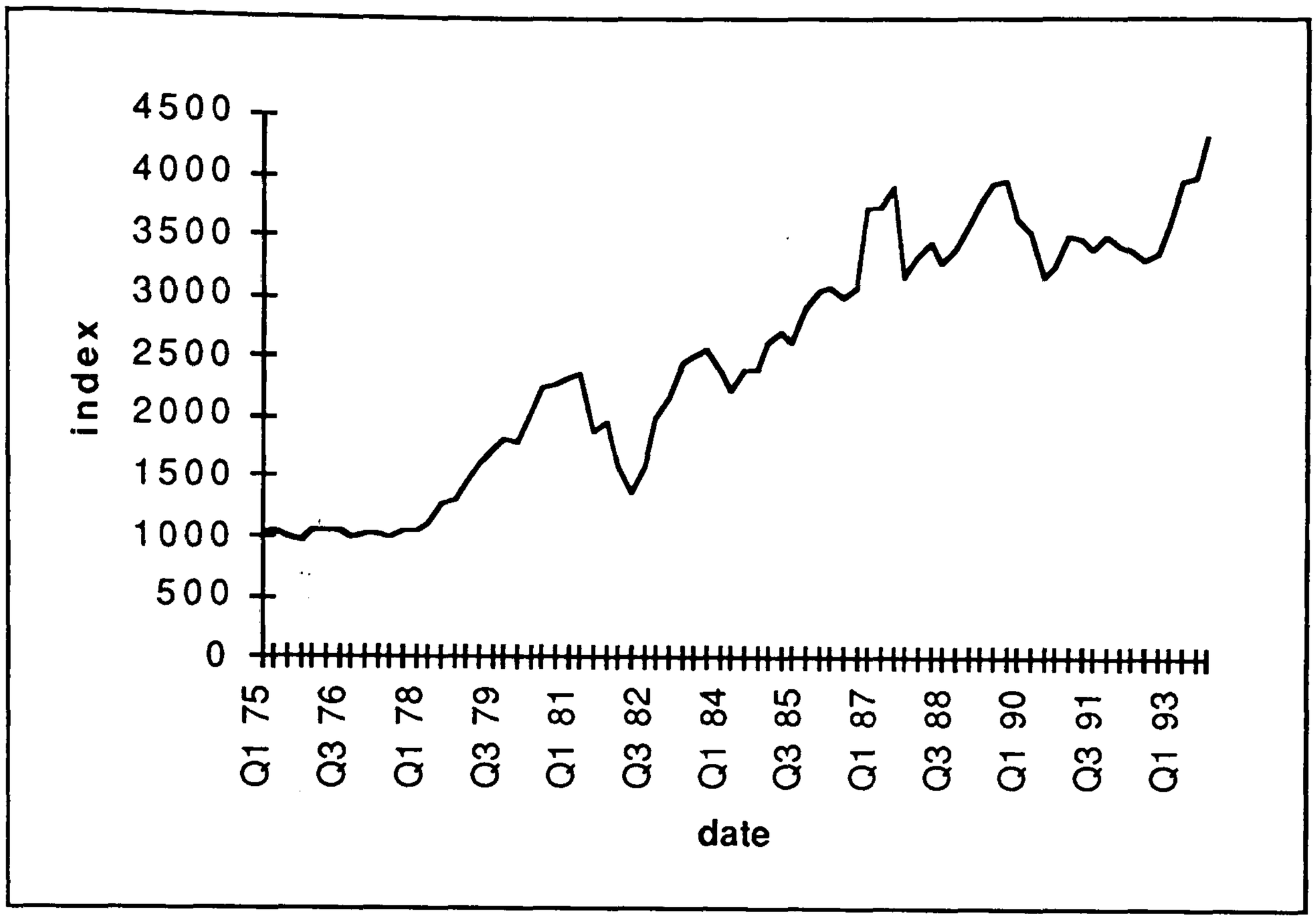
Japanese stock market



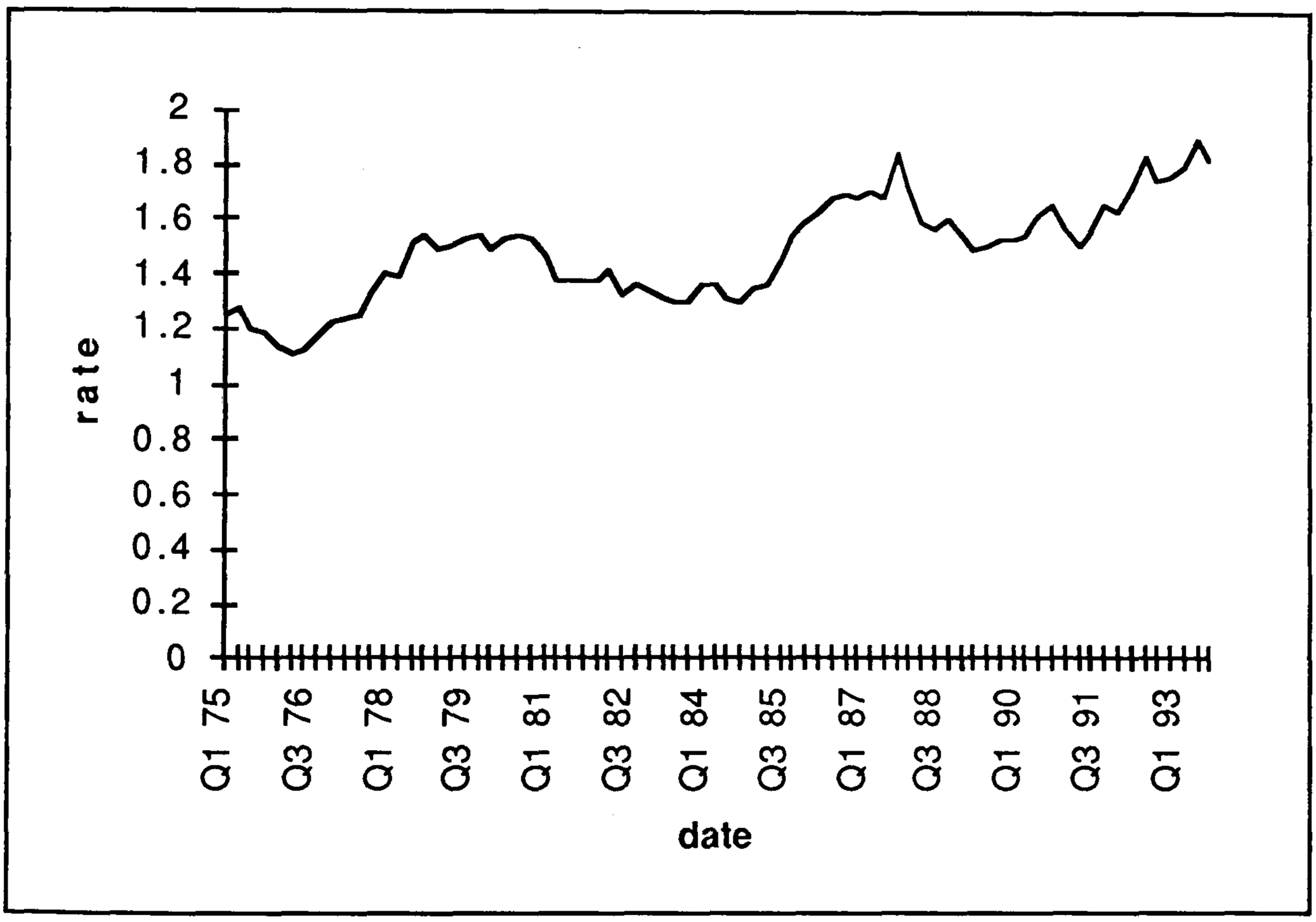
Japanese exchange rate



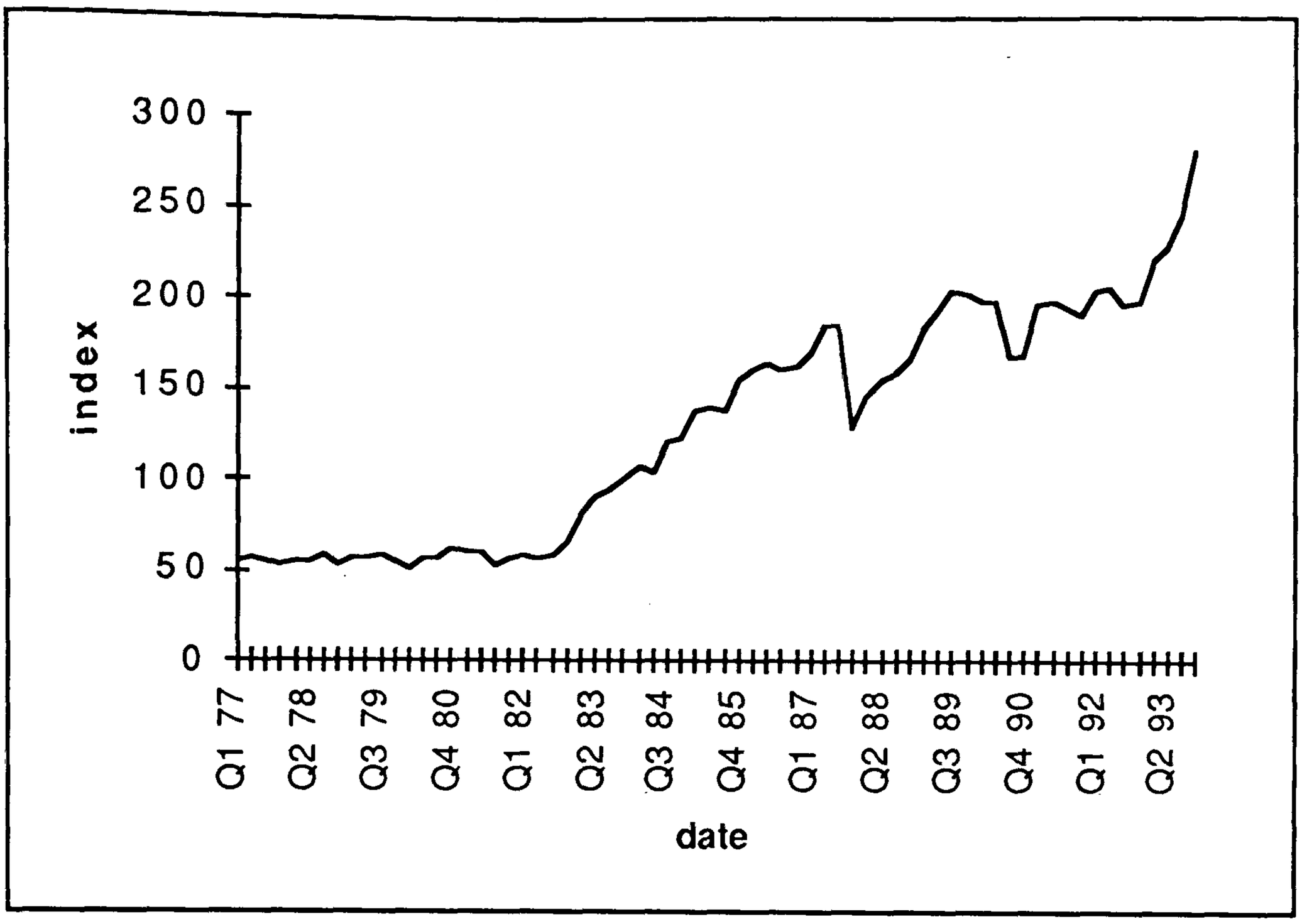
Canadian stock market



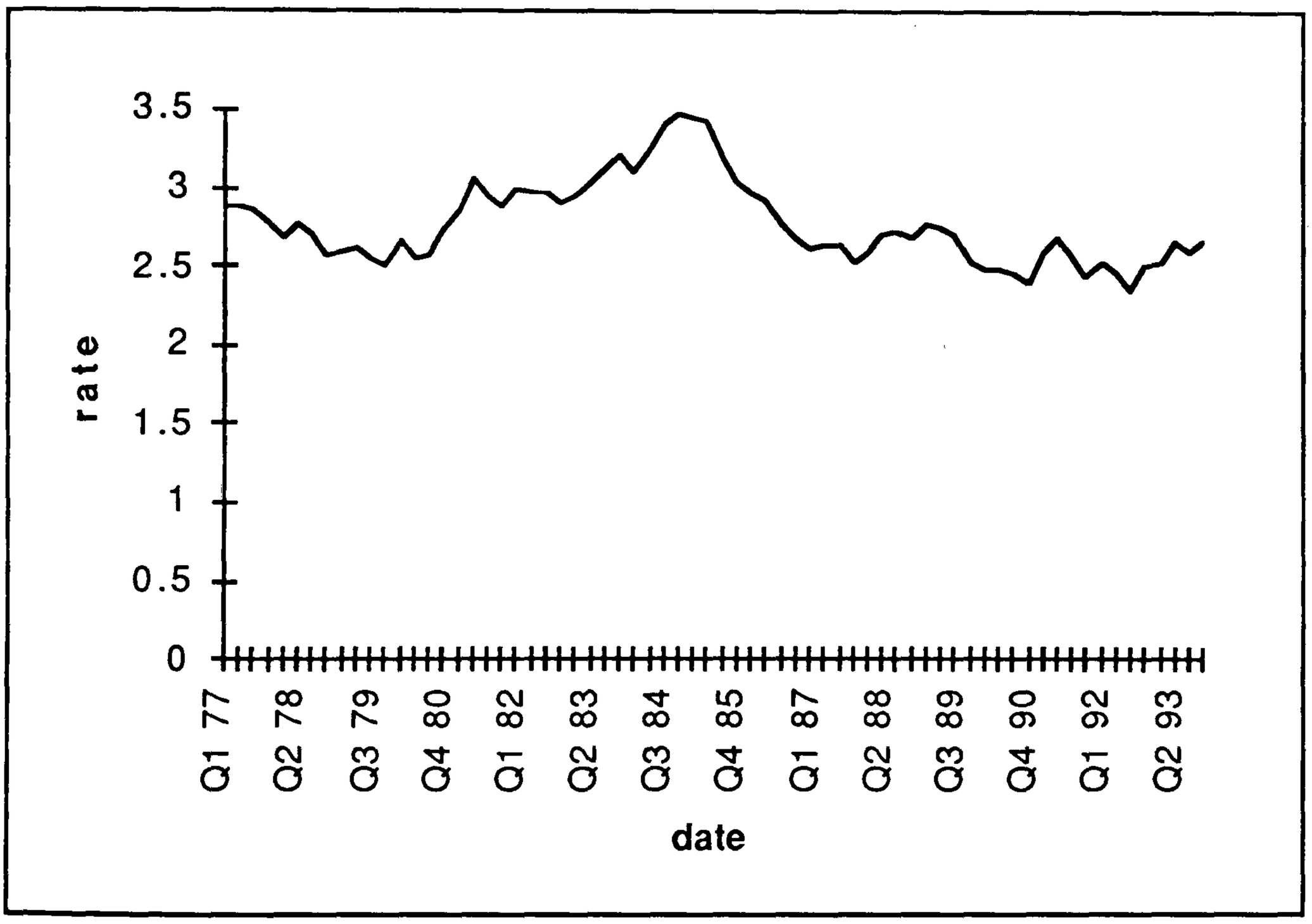
Canadian exchange rate



Netherland's stock market



Netherland's exchange rate



Chapter 6

An IS/LM-Type Model of Exchange Rate and Stock Market Interaction

6.1 Introduction

The aim of this chapter is to develop and analyse a version of the IS/LM model, which incorporates a stock market index. The theory is based on the models of Blanchard (1981), in which the reasons for the inclusion of a stock market index in the aggregate demand function are explained, as well as an analysis by Gavin (1989), in which the former model is applied to an open economy. Following the tests for stationarity and cointegration, there is an analysis of the short run dynamics using an error correction model (ECM). The results are then analysed in the context of the modified model and previous literature.

6.2. The modified IS/LM model

In the Blanchard model, the main innovation is that aggregate demand is determined by the level of the stock market as well as the current income and a measure of fiscal policy. Assuming that aggregate demand and output were continually in equilibrium in the most basic scenario, then output would be determined by the stock market and a fiscal measure. In addition to these variables included in the Blanchard model, to take account of the effects of the balance of payments, a variable representing the real exchange rate is incorporated, as used by Gavin (1989).

If exports rise and imports remain constant the exchange rate appreciates as demand for the domestic currency rises, likewise if capital flows into the economy the exchange rate again appreciates. Also a depreciation of the exchange rate will facilitate an improvement in the balance of payments, assuming the Marshall-Lerner condition holds This next section sets out a simplified version of Blanchard (1981) and Gavin (1989), in order to facilitate empirical analysis, in the context of the IS/LM framework. The aggregate demand for goods and services[1] is given as :

$$y = \alpha s + \chi bd + \theta e \tag{6.1}$$

[1] See the theoretical literature review for the motivation for including the stock market in the aggregate demand function.

where all variables are in logs and where:
s is the level of the stock market

y is current income

bd is a measure of fiscal policy

e is the spot real exchange rate

The inclusion of the real exchange rate, reflects the fact that the model is for an open economy, such that a real depreciation improves competitiveness and stimulates demand, through an increase in the competitiveness of exports, as well as home produced goods relative to imports. This again assumes the Marshall-Lerner condition holds.

The money market equilibrium is written as;

$$m - p = \delta y - \phi i \tag{6.2}$$

where;
i is the nominal interest rate

m is the money supply

p is the price level

This is the standard log-linear LM curve with the real money supply assumed to be exogenous. Solving for y and substituting into (6.1), gives the following in terms of i:

$$i = \frac{\delta(\alpha s + \chi bd + \theta e) + p - m}{\phi} \tag{6.3}$$

Under floating exchange rates, we can assume that e moves to continuously clear the market for foreign exchange, so:

$$T = -\dot{K} \tag{6.4}$$

Where T is the trade (current) balance and $\dot{K}$ is the capital inflow, where; $\dot{K} = \partial K / \partial t$

The trade balance is assumed to depend directly on e and inversely on y, since a rise in the former improves competitiveness, while a rise in y sucks in more imports leading to a deterioration in T. Thus:

$$T = -\tau y + \gamma e \tag{6.5}$$

The capital inflow depends directly on the nominal interest rate differential, (i-i*), since in equilibrium the foreign exchange market always clears and in equilibrium $E\dot{e} = 0$, so we can write:

$$\dot{K} = \kappa(i - i^*) \tag{6.6}$$

The equilibrium exchange rate is therefore derived from combining equation (6.4), (6.5), and (6.6), substituting for y and i from (1) and (3), gives;

$$e = \frac{\phi\kappa i^* + \alpha(\tau\phi - \kappa\delta)s + \chi(\tau\phi - \kappa\delta)bd + \kappa(m - p)}{[\phi(\gamma - \tau\theta) + \kappa\delta\theta]} \tag{6.7}$$

The relationship between e and all the explanatory variables is ambiguous, (as in the Blanchard (1981) and Gavin (1989) models) To derive unambiguous results we need to consider the relative strengths of the output and interest rate effects, as captured in the model by κ and γ

<u>Assume</u> $\kappa = 0$ (Zero capital mobility)
Then (6.7) becomes;

$$e = \frac{\alpha\tau q + \chi\tau g}{\gamma - \tau\theta} \tag{6.8}$$

$$\frac{\delta e}{\delta q} = \frac{\alpha\tau}{\gamma - \tau\theta} \gtrless 0, \text{ but} > 0 \text{ if } \gamma > \tau\theta$$

$$\frac{\delta e}{\delta g} = \frac{\chi\tau}{\gamma - \tau\theta} \gtrless 0, \text{ but } > 0 \text{ if } \gamma > \tau\theta$$

If we assume the Marshall-Lerner condition holds, so that $\gamma \geq 1$ and since we expect τ and θ to be fractions, then $\gamma > \tau\theta$. Therefore:

$$\delta e / \delta q > 0, \ \delta e / \delta g > 0$$

<u>Assume</u> $\kappa = \infty$ (Perfect capital mobility)

Now (6.7) becomes;

$$e = (\frac{\phi}{\delta\theta})i^* - (\frac{\alpha}{\theta})q - (\frac{\chi}{\theta})g + (\frac{1}{\delta\theta})(m-p) \tag{6.9}$$

In this case there is a clear inverse relationship between e and q as well as e and g. Given the prevalence of capital mobility in the modern world, this is the estimation equation for this chapter. To summarise we have;

$$e_t = \beta_0 + \beta_1 i_t^* + \beta_2 q_t + \beta_3 g_t + \beta_4 (m-p)_t + u_t$$

Where u_t is a random error term and a priori it is expected that:

$$\beta_1 > 0,\ \beta_2 < 0,\ \beta_3 < 0,\ \beta_4 > 0$$

Blanchard stresses an important dichotomy within the model which he terms the "good news" and the "bad news" scenarios. In the "good news" case, a rise in output leads to an increase in profits, and a subsequent rise in short term interest rates. If the rise in output increases profits to a greater extent than the interest rate rise reduces them, then the stock market rises. So an increase in the money supply can raise or reduce the level of the stock market.

Bearing this in mind, any rise in the money supply will cause a fall in the interest rate to clear the money market. This in turn leads to either a rise or fall in the stock market, depending on whether the good news or bad news scenario applies . If it causes a rise in the stock market as investors move out of bonds through a process of arbitrage, then the rise in the demand for shares and the stock market leads to a rise in Tobins q above its equilibrium level, which makes investment more profitable. This facilitates increased capital expenditure and thus increased output. The increase in output facilitates a fall in the government budget deficit as tax receipts rise.

The rise in the stock market will lead to an incipient capital inflow, which appreciates the exchange rate, whereas the rise in the money supply and fall in the interest rate will lead to a depreciation. It depends on whether the effect of the stock market rise is dominant or whether the affect of the interest rate fall and money supply rise dominates as to whether the exchange rate appreciates or depreciates. (See literature survey on the Gavin model 1989, for more detail)

6.3 Empirical Results

The results from the OLS regressions are not reported for the above model, this is because all suffer from serial correlation and fail various other diagnostic tests. However despite this there is evidence from the tests that the stock market is a significant determinant of the exchange rate, especially for the USA and Canada. Examining the R^2 statistic as well as the DW statistic does offer some interesting information. In most regressions the R^2 statistic exceeds the DW statistic, sometimes by a large margin. For instance in the US regression the former statistic is 0.5 and the latter is just .27. In general when the R^2 statistic exceeds the DW statistic then cointegration is probably present. So due to this the next stage is to test for cointegration in the model.[2]

Table 6.1 Test for stationarity of the exchange rate and stock market, using the Augmented Dickey-Fuller test, (the critical values are -2.57 and -2.89 at the 10% and 5% levels of significance, taken from Fuller (1976). s is the log of the real stock market and e is the log of the real exchange rate). The sample consists of 80 observations.

Country	s		Δs		e		Δe	
	lags	ADF	lags	ADF	lags	ADF	lags	ADF
UK	4	-0.542	4	-5.128	7	-2.546	6	-2.140 (-7.216)
USA	0	-0.784	8	-3.091	4	-1.884	8	-2.654
Germany	0	-1.080	4	-4.270	8	-1.363	8	-3.140
Japan	6	-1.203	5	-2.896	5	-1.812	7	-3.237
Canada	0	-1.954	7	-3.237	0	-1.195	6	-2.342 (-10.821)
Netherlands	0	-0.100	3	-3.599	6	-2.020	4	-3.227

(A Δ indicates the variable is first differenced form and the statistics in parenthesis are the equivalent Dickey-Fuller statistics))

[2] A similar model was also tested where the stock market was the dependent variable and the exchange rate the independent variable. In general it was evident that the stock market has a more significant effect on the exchange rate than vice versa

Table 6.2 Test for stationarity of the log of the real money supply and the log of the real fiscal measure.

Country	m		Δm		bd		Δbd	
	lags	ADF	lags	ADF	lags	ADF	lags	ADF
UK	8	-1.095	8	-3.118	1	-3.230		
USA	8	-1.100	8	-1.148 (-4.423)	0	-3.712		
Germany	0	2.492	3	-2.980	3	-3.977		
Japan	8	-1.418	8	-1.870 (-9.066)	3	-3.582		
Canada	8	-0.567	8	-2.534 (-7.532)	2	-2.054	3	-5.116
Netherlands	8	-0.0479	8	-1.973 (-9.263)	2	-1.330	1	-4.855

Table 6.3 Test for stationarity of the interest rate.

Country	i*		Δi*	
	lags	ADF	lags	ADF
UK	0	-2.172	5	-3.672
USA	3	-1.337	8	-2.600
Germany	2	-2.512	2	-3.034
Japan	1	-2.288	8	-2.467
Canada	4	-1.478	4	-3.177
Netherlands	4	-2.958		

The sample period is from 1974 quarter 1 to 1993 quarter 4. In their level forms all the stock market variables and exchange rate variables are non -stationary, as is the case with the money supply. The fiscal measures are stationary I(0) for the UK, USA, Germany and Japan, but for Canada and the Netherlands they are non stationary. In both the latter countries their budget deficits have increased throughout the 1970's and 1980's. For the Netherlands this has been due to its membership of the ERM, whereby it has lost control of monetary policy and only has fiscal policy as a means of affecting aggregate demand. Canada has experienced a number of occasions in which the Government has attempted to increase demand in the economy, especially in the

early 1980's. This has usually involved sudden falls in interest rates and rises in the budget deficit.

Interest rates are all non-stationary except for the Netherlands. Again this is due to its membership of the ERM, and the need to maintain its exchange rate at a set level. This has been managed mainly by control of the interest rate. This is also why Germany has an almost stationary interest rate at the 10% level of significance. In the following Johansen Maximum Likelihood tests, all the variables are entered as I(1), except for the fiscal measure for the UK, USA, Germany and Japan, and the interest rate for the Netherlands. In those tests that exhibit signs of being I(2), the DF and ADF(1) statistics as well as the Box-Pierce statistics are also noted. In all the variables in question the overwhelming evidence pointed to their being I(1). In addition, as Granger (1986) notes, the cointegration technique can equally well be applied to I(2) variables.

Table 6.4 Johansen Maximum Likelihood results using the modified IS/LM Model (null hypothesis on the first row, alternative on the second). The critical values are recorded below and taken from Johansen and Juselius (1991).

Country	r=0 r>=1	r<=1 r>=2	r<=2 r>=3	r<=3 r>=4	r<=4 r>=5
UK	105.433	36.149	17.708	5.753	
USA	68.992	39.443	17.945	1.383	
Germany	66.017	31.650	12.769	5.423	
Japan	84.606	43.317	11.654	5.257	
Canada	161.394	63.831	36.712	19.687	6.165
Netherlands	91.839	46.359	17.064	5.771	
5%	*53.12*	*34.91*	*19.964*	*9.24*	
10%	*49.65*	*32.00*	*17.85*	*7.52*	

(In the case of their being five possible vectors the critical value is 76.069 (5%) and 71.80 (10%))

The trace results from the Johansen ML procedure indicate there is evidence of cointegration[3] in all six countries with the UK, USA and Japan producing two vectors and Germany a single vector. These results are based on the trace of the stochastic matrix, as this is the most commonly used of the Johansen Maximum Likelihood tests. The results based on the maximal eigenvalue of the stochastic matrix were also analysed, but these were less consistent in that they suggested that there was one cointegrating vector for the UK test, but three for the US test. In the other tests the results were the same as for the trace based test. Canada produces evidence of at least three vectors, with some suggestion of a fourth. The Netherlands also has two vectors from a possible three, despite the fiscal measure being included as an I(1) variable.

A dummy variable was added to Canada's test in order to achieve three cointegrating vectors. As the fiscal measure is included as an I(1) variable three vectors were required to produce one that gave a negative error correction term in the ECM. The Canadian dummy covers 1982 quarter 2 during which there was a wholesale change in economic policy with sharp reductions in interest rates and large rises in government expenditure as they attempted to recover from recession which had also caused a fall in the stock market.

The results from the UK and especially the USA were particularly strong as there is evidence of three cointegrating vectors at the 10% level of significance in both countries. Neither country required any dummies as was the case with Japan. The German result is disappointing, particularly when looking at the ECM and this suggests the model is not effective in accounting for Germany's exchange rate, either in the long run or the short run. The Netherlands result differs to that of Germany's as the fiscal measure is I(1), and the interest rate is I(0). In order to achieve two vectors, a dummy variable was required for 1993 quarter three, when the ERM experienced substantial difficulties.

Table 6.5 Long run vectors for the modified IS/LM model derived from the above calculation (The results in parenthesis are the restriction that the variable is insignificantly different to zero, using the LM test, which has a chi-squared distribution, with a critical value of 3.84. The numbers in parenthesis under the countries refer to the vector that was chosen.)

[3] There is a debate over whether it is best for there to be a single cointegrating regression present or as many as possible. In general the more there are the greater is the stability of the system. (See Dickey et al 1991)

Country	k	s	m	i*	bd
UK	-0.598	-0.067	0.108	-4.837	
(2)	(42.701)	(50.310)	(45.042)	(6.551)	
USA	-1.167	-0.240	0.188	2.090	
(2)	(9.110)	(11.678)	(9.774)	(10.501)	
Germany	-2.274	1.996	-1.680	0.877	
(1)	(3.308)	(4.663)	(2.403)	(0.001)	
Japan	7.655	0.311	-0.499	0.070	
(1)	(8.650)	(9.925)	(10.824)	(23.606)	
Canada	-2.695	-0.126	0.488	0.174	-0.090
(3)	(6.860)	(51.401)	(5.592)	(1.170)	(29.121)
Netherlands	3.223	0.416	-0.478		0.627
(2)	(24.471)	(4.131)	(1.852)		(24.711)

(k is a constant, s is the real stock market index, m is the real money supply, i* is the foreign nominal interest rate[4] and bd is the real fiscal measure)

In the UK and the USA the results are the same, but in Canada and the Netherlands there are some differences in the behaviour of the variables, due to the presence of the fiscal measure. For the UK, USA and the Netherlands the second vector was most suitable and for Japan the first was chosen. But Canada produced its best results with the third vector, as it alone produced a stable ECM. Germany produced just one vector. The choice of vector depended on whether the long run vector was correctly signed with coefficients of an appropriate size. In addition it also depended on whether it produced a suitable error correction term.

In the UK the stock market is correctly signed as a negative influence, as is the interest rate. A rise in the stock market attracts funds into the UK economy causing an appreciation of the exchange rate. The coefficient on the money supply is also correct indicating a rise in the money supply causes a depreciation of the exchange rate. As is evident from imposing the restriction of the variable equalling zero, the long-term stock market effect is highly significant, as is the money supply. The interest rate though significant has far less of an effect than the stock market, suggesting in the UK the stock market plays the dominant role.

[4] Since we assume the expected change in the exchange rate is 0, then the domestic and foreign interest rates are the same and we can proxy the foreign rate with the domestic rate.

The same result occurs in the USA, as the stock market and interest rate are correctly signed, as is the money supply. All three variables are significantly different to zero, however the stock market is nothing like as significant as in the UK, although it is still more significant than the interest rate and the other variables. The coefficients are also much as expected, however as with the UK the coefficient on the interest rate is higher than would be expected, such that a small change in interest rates produces a relatively large change in the exchange rate.

Germany only produces the single vector, and this is a very weak result. Only the stock market is significant, and even so is much less significant than in all the other results. The variables are not correctly signed, which is a possible reason for the resultant ECM being unstable. The Japanese result produces significant variables but with unexpected signs. Unlike the previous results the interest rate is more significant than the stock market, this could be a result of the relative difficulties in moving capital into and out of Japan. Another possible reason is that the Japanese authorities have attempted to keep the Yen as low as possible to encourage exports (see chapter on exchange restrictions). So low interest rates have increased output and thus exports producing an appreciation of the exchange rate. At the same time this has produced a fall in the money supply along with a rise in the stock market as equities become more attractive.

Canada is another different variety, as the stock market and money supply have the correct signs, but the interest rate is positively signed. However restricting it to zero suggests it is also insignificant, in contrast to the stock market which is highly significant. The budget deficit is also incorrectly signed and highly significant, as an expansionary fiscal policy is associated with an appreciation of the exchange rate. As was shown by the Gavin model, this scenario is quite possible. Overall it appears a rise in the stock market has the strongest effect on the exchange rate, as with the UK, which suggests that in the long run capital flows between stock markets dominate the exchange rate. This is supported by Canada's lack of exchange restrictions.

Finally the Netherlands which has a correctly signed government deficit, but positively signed stock market and money supply. Both the money supply and the stock market are insignificant The weakness of the stock market suggest that capital flows into the Netherlands are not an important determinant of the exchange rate, which is not surprising given the relatively small scale of its capital markets. The dominant effect is from the fiscal measure, which illustrates how important fiscal policy is when a country can no longer control its monetary policy as its exchange rate is fixed.

Table 6.6 ECM results for the modified IS/LM model.(All variables are in logs and as defined earlier)

UK

$$\Delta luke = 0.009 - 0.193 eres_{t-1} - 0.066\Delta s_{t-2} - 0.085\Delta s_{t-8} + 0.213\Delta m_t$$
$$(0.861) \quad (5.479) \quad (1.857) \quad (2.735) \quad (2.369)$$
$$+0.241\Delta uke_{t-1} + 0.260\Delta uke_{t-7} + 0.661\Delta i^*_{t-3} - 0.005 bd_{t-3}$$
$$(2.650) \quad (2.780) \quad (2.522) \quad (1.772)$$

$R^2 = 0.508$ DW = 1.815 LM(4) = 6.533 Reset = 2.140

Normality = 0.757 Heteroskedasticity = 0.866 LM(2) = 1.204

ARCH(4) = 6.291

USA

$$\Delta luse = -0.001 - 0.097 eres_{t-1} - 0.675\Delta i^*_t + 0.605\Delta use_{t-4} - 0.755\Delta m_{t-7}$$
$$(.227) \quad (3.518) \quad (2.752) \quad (6.632) \quad (2.205)$$
$$-0.074\Delta s_{t-7} + 0.017 bd_{t-7} + 0.542\Delta i^*_{t-4} + 0.095 D1$$
$$(1.838) \quad (3.341) \quad (2.171) \quad (3.247)$$

$R^2 = 0.517$ DW = 2.081 LM(4) = 2.497 Reset = 0.325

Normality = 0.861 Heteroskedasticity = 0.551 LM(2) = 0.285

ARCH(4) = 2.535

Germany

$$\Delta \lg e = -0.018 + 0.071 eres_{t-1} + 0.437\Delta m_t + 0.016\Delta i^*_t + 0.018 bd_t - 0.383\Delta ge_{t-1}$$
$$(1.382) \quad (7.139) \quad (2.003) \quad (1.889) \quad (3.985) \quad (3.858)$$
$$-0.544\Delta ge_{t-2} - 0.330\Delta ge_{t-3} - 0.234\Delta ge_{t-6} - 0.268\Delta ge_{t-7}$$
$$(5.283) \quad (3.173) \quad (2.387) \quad (2.587)$$
$$+1.400\Delta i^*_{t-7} - 2.290\Delta i^*_{t-8} - 0.498\Delta m_{t-6}$$
$$(1.676) \quad (2.911) \quad (2.566)$$

$R^2 = 0.654$ DW = 1.950 LM(4) = 5.677 Reset = 0.180

Normality = 0.828 Heteroskedasticity = 1.981 LM(2) = 0.062

ARCH(4) = 7.966

Japan

$$\Delta ljpe = -0.096 - 0.089 eres_{t-1} - 0.092\Delta s_t + 0.309\Delta jpe_{t-1} - 0.460\Delta jpe_{t-5}$$
$$(1.434) \quad (2.016) \quad (2.101) \quad (3.074) \quad (4.067)$$
$$+0.033 bd_{t-1} + 2.010\Delta i^*_{t-3} - 0.106 D1$$
$$(2.384) \quad (1.776) \quad (2.845)$$

$R^2 = 0.392$ DW = 2.020 LM(4) = 1.033 Reset = 1.872
Normality = 1.052 Heteroskedasticity =.002 LM(2) = 0.135
ARCH(4) = 3.288

Canada

$$\Delta lcne = -0.028 - 0.124 eres_{t-1} - 0.104\Delta s_t + 0.307\Delta cne_{t-4} + 0.327\Delta cne_{t-7}$$
$$(0.569) \quad (2.447) \quad (2.022) \quad (2.622) \quad (6.742)$$
$$-0.302\Delta m_{t-7} - 0.035\Delta bd_{t-3} + 0.026\Delta bd_{t-7}$$
$$(2.063) \quad (2.390) \quad (2.011)$$

$R^2 = 0.328$ DW = 1.750 LM(4) = 4.397 Reset = 0.009
Normality = 0.415 Heteroskedasticity = 0.223 LM(2) = 1.223
ARCH(4) = 3.698

Netherlands

$$\Delta \ln le = -0.009 - 0.022 eres_{t-1} + 0.184\Delta s_t + 0.009\Delta bd_t + 0.249\Delta nle_{t-4}$$
$$(0.586) \quad (2.149) \quad (3.189) \quad (2.096) \quad (2.180)$$
$$-0.258\Delta \ln le_{t-5} + 1.14\Delta i^*_{t-6} - 0.883\Delta i^*_{t-7} + 0.048\Delta bd_{t-3}$$
$$(2.284) \quad (2.713) \quad (2.305) \quad (2.901)$$
$$+0.044\Delta bd_{t-4}$$
$$(2.578)$$

$R^2 = 0.428$ DW = 1.702 LM(4) = 3.316 Reset = 0.041
Normality = 2.269 Heteroskedasticity = 0.001 LM(2) = 2.651
ARCH(4) = 0.541

(The following dummy variables were added: US; D1-1987q4. Japan; D1- 1989 Q4. The diagnostic tests in all the ECM's are as follows: R^2 statistic represents the explanatory power of the equation, DW is the Durbin-Watson test for 1st order serial correlation, LM(i) is the Lagrange Multiplier test for ith order serial correlation, Reset

is the test for functional form, Normality is tested by the Jacque-Bera test for normality of the residuals and ARCH tests for Autoregressive Conditional Heteroskedasticity [Engle 1982]).

For the UK the model seems reasonably well specified, with a negative, highly significant error correction term (ECT), reasonable goodness of fit statistic and all the diagnostics passed. One slight problem with the error correction term is that the coefficient is only 0.19, suggesting a slow adjustment towards equilibrium. The most powerful determinants of the exchange rate are previous changes in the earlier quarters, both with changes in the previous quarter and changes experienced in the previous year. This reflects the efforts of the authorities to stabilise the exchange rate as much as possible during the time period analysed and the existence of mean reversion.

The stock market is correctly signed and exerts a fairly powerful effect, especially when compared to the effect of the interest rate. It is signed as predicted, with a rise in the stock market indicating an incipient capital inflow, which produces an appreciation of the exchange rate. There appears to be two separate effects, the initial effect of the capital inflow gradually forcing an appreciation of the exchange rate over a matter of months. The second effect occurs two years prior to the appreciation and reflects the ability of the stock market to predict any underlying improvement in the domestic economy well before it occurs. It also is due to the time lag any rise in investment takes before it is implemented and has any substantial effect on industry and output and the competitiveness of the domestic economy.

As expected a rise in the money supply causes an instantaneous depreciation of the exchange rate, also as the coefficient exceeds unity, there is evidence of overshooting. The interest rate has only a slight effect three quarters prior to a change in the exchange rate. It is positively signed suggesting a fall in the domestic interest rate produces an appreciation. The reason for this may be that a fall in the interest rate would, as expected lead to a rise in investment. However such a rise would require a lag before it was capable of production and thus increasing output and competitiveness, so appreciating the exchange rate.

All the diagnostics were passed without the need to include any dummy variables, and the goodness of fit statistic at 0.51 is reasonable. The fiscal measure had only a slight effect three quarters prior to a move in the exchange rate, and suggests that a rise in the budget deficit caused an appreciation, which as suggested by Gavin is quite possible, although a depreciation is more likely.

The US result is similar to the UK result as the ECT is negative and significant, the only difference is that a dummy variable is required to ensure the diagnostics are passed. Also the coefficient on the error correction term is below 0.1. The effect from any change in the money supply, is negative and over a year before the exchange rate moves. This negative effect occurs in many of the tests on the USA, and as argued later is related to its relationship with the stock market. The government budget deficit not unexpectedly has a fairly strong effect and like a rise in the money supply would cause the exchange rate to depreciate, although not until well over a year after the expansion. The long time lag could be due to the time taken for any resultant inflationary pressures to build up in the economy, and to reduce future competitiveness in the US economy.

As with the UK a rise in the stock market produces an appreciation of the exchange rate, but in this case there is only a long term effect from over a year previously. The most powerful determinant of any movement in the exchange rate is the previous years change. As the sign is positive, it indicates there is a long term trend in the exchange rate, in which annual factors have a contributory effect. The dummy variable represents 1987 quarter 4, when the stock market suffered a large fall over a couple of weeks, which significantly effects this model. The diagnostics indicate a reasonably good equation, with an acceptable goodness of fit statistic of .52.

An interesting aspect of this model is the effect of the interest rate. There is an instantaneous effect, which produces an appreciation of the exchange rate, as predicted by UIP. However a year previously there is another effect causing a depreciation. This effect could be related to the business cycle, whereby a fall in interest rates causes a rise in demand and inflation, which would then cause the exchange rate to depreciate. This is the only country in which this effect occurs, emphasising the power of US interest rates throughout the world.

As with the output model, the German exchange rate model is poorly specified. The ECT is not even negative, which indicates the model is unstable. Again the different nature of the German capital markets with respect to the German economy and nature of German finance are the reasons for the poor performance. However despite this, the model is reasonably good with a high explanatory power and significant effects from the money supply, fiscal measure and interest rate. By far the most powerful effects come from previous levels of the exchange rate, with the negative coefficient indicating attempts to control its movements. However due to the failings of the model it has to be concluded that the Blanchard theory does not apply to Germany.

Japan produces a reasonably good model, although the ECT is only just significant at the 5% level of significance, however it is correctly signed. As with the UK , there is an almost immediate appreciation of the exchange rate following a rise in the stock market. In some respects, the immediate effect is quite surprising for a country like Japan, as with risk averse investors one would expect a lag between a rise in the domestic stock market and an appreciation of the exchange rate as foreign capital was attracted into the domestic economy.

However there is a significant difference between Japan and the other two countries, in that the interest rate is positive and its effect is after a fairly long lag. This is due to Japan's reliance on exports and the consequent large trade surplus with the rest of the world. So a fall in interest rates would cause a rise in investment, and a rise in output, which increases as the stock market rises. The subsequent rise in exports after nine or ten months leads to an appreciation of the exchange rate which far outweighs any depreciation caused by the earlier fall in interest rates. So for this reason Japan's economy behaves slightly differently to the US or UK.

Once again the exchange rate has the strongest impact on any change in the exchange rate. Initially it follows what occurred in the previous quarter, but after just over half a year there is a strong movement back towards the previous degree of change in the opposite direction. This reflects the intention of the Japanese authorities whom attempt to keep the exchange rate around about some predetermined level. As with the US, a rise in the budget deficit produces a fairly rapid depreciation. Also as with the US a dummy variable for 1987 quarter 4 is required to ensure all the diagnostics are passed. However the goodness of fit statistic at just 0.39 is fairly low.

Canada has a good model with a very significant ECT , but a low goodness of fit statistic of 0.33, but despite this the stock market reacts in the same way as the previous examples. Once again the effect from the stock market is almost immediate and signed as expected. The interest rate has no apparent effect, as was the case in the long run. Both the money supply and government budget deficit are significant, although the signs on the budget deficit indicate that its effect is mixed with a short term appreciation and longer term depreciation. The strongest effect once more stems from previous changes in the exchange rate, especially the previous years changes, which like the US suggests there is an annual pattern.

The Netherlands result is a little bit like the German result, except the error correction term is negatively signed, albeit with a very low coefficient. The stock

market is positively signed and has an immediate effect, and the interest rate is also positively signed although the effect is from over a year previously. The difference in the Netherlands stock market is once more due to their attempts to align their currency to the DM. Any rise in the stock market would indicate the Netherlands economy was expanding, which in turn implies inflationary pressures and downward pressure on the Guilder. By far the strongest effect stems from the fiscal measure, and all suggest a rise in the budget deficit causes a depreciation of the exchange rate, again due to the affects of ERM membership. Overall the explanatory power is reasonable and all the diagnostics are passed without the need for any dummy variables.

In general the results from using a real interest rate in the equation were much the same as using the nominal interest rate. However in most tests the stock market was more significant when using real interest rates, and the error correction term more significant, especially for the UK. This is probably due to foreign exchange market participants tending to use real rather than nominal variables.

6.3 Conclusion

This chapter offers evidence that the exchange rate and stock market do interact, despite the direct lack of cointegration between the variables. As predicted the UK and USA give the best results in the long and short-run as both have large important stock markets, with relatively few restrictions on capital flows. The results also provide some support for the theories of Blanchard and Gavin. As following a rise in the money supply, the exchange rate does not automatically depreciate, but can on occasions appreciate.

Chapter 7

A Monetary Model of Exchange Rate and Stock Market Interaction

7.1 Introduction

The aim of this chapter is to develop an alternative monetary model, which incorporates a stock market variable and to test the models using cointegration and error correction models (ECM). There are principally two basic objectives: firstly to find if the stock market has any affect on the exchange rate and in particular determine whether this alternative version of the monetary model produces evidence of cointegration. Secondly to attempt to explain some of the failings in other exchange rate models by introducingthe stock market into the analysis.

In this chapter the stock market variable enters the model in the LM relation, in contrast to the previous IS\LM type model in which it was introduced in the IS relation. To begin with the theory behind the inclusion of a stock market variable in the monetary model is analysed. Then some of the failings of the conventional monetary models are described and reasons why the inclusion of a stock market variable should improve the performance of the model are offered. Following the tests the results are analysed using the theories already produced and other explanations are offered based on the theory of the conventional theories.

The basic monetary model consists of two markets; the goods market and the money market. It is assumed that the domestic and foreign bonds are perfect substitutes and that the market for bonds clears instantaneously. This means UIP holds for assets of a similar risk and maturity structure. In addition it is assumed that monies are not traded internationally so that only domestic investors hold domestic currency. There are a number of assumptions from the Classical school of economic thought which are incorporated into this model. The main ones are that the labour markets always clear instantaneously which implies that output is always at the full employment level.

Overall the price level is determined by the money markets and the real exchange rate is assumed to be constant such that PPP holds continuously, an assumption which is not, in general, supported by the evidence (See Pentecost 1993). Within the broad spectrum of monetary models, the main differences occur through the mechanism by which investors form their expectations on future movements in the exchange rate. This has a strong influence on how the resultant dynamics of the movements in the exchange rate are determined. In general it is assumed that investors form their expectations rationally, but other models have used adaptive, extrapolative and regressive expectations. The latter are used in Frankel's real interest parity model with some degree of success (Frankel 1979).

Within the broad context of the monetary model it may be stated that in general these models change so as to ensure equilibrium occurs in the supply and demand for asset stocks throughout the world. Therefore it is fairly easy to argue that some measure of the stock market needs to be included so that risky assets that reflect the levels of investment and consumption make up the asset base, rather than analysing assets in the form of riskless return. For instance economies with high levels of investment may be thought of as offering a higher potential return, though more risky. The stock market variable could be included in the money demand function in a similar way to that suggested by Hamburger (1977) to help counteract the instability of the money demand function .

In the monetary model, the behavioural relationship for the domestic money demand function is positively related to the price level and real income level and inversely related to the domestic nominal rate of interest. The interest rate in this relationship reflects the speculative demand for money and thus substitutability between money and bonds. So an increase in the rate of interest raises the opportunity cost of holding money so that the demand for cash balances is reduced. This concentration on a single asset rather than other varieties of asset is arguably a serious defect in this money demand function. Others have argued that some form of foreign money should be represented within such a relationship (Mizen and Pentecost 1996).

If it is assumed that foreign and domestic residents can hold both foreign and domestic money, then a particular form of the monetary model is produced, namely the Currency substitution model. Also through the medium of wealth effects, both the capital and current accounts are to some extent integrated. For equilibrium to be

attained there has to be a balance in the current account, which some argue is a more sensible equilibrium condition than PPP. Another version of this type of model have added a variable for foreign money into the domestic money demand function, which assumes that the worlds capital markets are fairly integrated for currency substitution to occur. Although such an additional variable would improve the theoretical aspect of the monetary model, on balance it is not introduced into this model as its empirical support is not all that strong and the main emphasis is on the stock market.

However there is evidence to support the view that a broader range of asset returns needs to be included in the money demand function (Hamburger 1977, 1983) . It needs to be taken into account that these effects were only just significant, although due to financial innovation and the removal of exchange restrictions these affects may be more considerable since the early 1980's . In the tests it was also the dividend yield which was used rather than the level of stock prices (capital gain\ loss) . There have also been attempts to include the stock market by the inclusion of a variable representing the volume of financial transactions. Thus as transactions rise, so more money is needed in which case income velocity would fall.

When the monetary model has been empirically tested, there appears to be a distinct difference between those models tested with 1970's data and those using 1980's data. In general this class of model is reasonably well supported for the 1970's. but performs rather poorly for the 1980's (Macdonald and Taylor 1992). Driskell, Mark and Sheffrin (1991)[1] put the failure of these models down to there simplifying assumptions. In particular the assumption of perfect capital mobility and substitutability are challenged, although the assumption of rational expectations which is often criticised as a contributory factor in the models failure was found to hold in this model.

There has been as yet little success in finding cointegrating vectors for the conventional monetary model for all countries tested (Meese 1986, Boothe and Glassman 1987, Sarantis 1994). However Macdonald and Taylor (1994) found evidence of three cointegrating vectors for the UK\US dollar exchange rate from 1976

[1] In an alternative version of the monetary model developed by Driskill, Mark and Sheffrin (1994), the long run equilibrium was represented by a relationship between the nominal exchange rate, price level and output. When tested for cointegration, in most countries one cointegrating vector was found. However in the subsequent ECM, in which the money supply and stock market were also included, the equations were found to be unstable as the error correction term was positive.

to 1990 using monthly data and the Johannsen maximum Likelihood procedure, using the real interest monetary model. In addition the signs were correct although the restrictions of equal elasticity's for the domestic and foreign money demand were not supported, as were none of the other restrictions imposed on the model. Also the ECM had very little explanatory power and the money supply variable was insignificant. Despit these weaknesses, the model did perform well in out of sample forecasting, when it outperformed a random walk forecasting mechanism. However this paper differs to the others and the model examined here in that the restriction that the domestic and foreign variables have the same elasticities was not applied.

7.2 An Alternative Monetary Model

There are essentially three ways in which a direct relationship can occur between the demand for money and level of stock prices , as stipulated by Friedman[2] (1988) . As already discussed wealth and stock prices are closely related and also stock prices are more volatile than income levels, so a rise in the stock market would also increase the wealth to income ratio. This higher ratio would in turn lead to a rise in the money to income ratio, or alternatively a lower velocity. This is basically the same conclusion as Hamburger (1977).

Secondly, this relationship between money demand and the level of the stock market can be explained in terms of risk and how agents adapt to changes in the level of risk without requiring a shift in their levels of risk aversion. A rise in stock prices means there has been an increase in the expected return from a set of risky assets and thus a change in the level of risk aversion. However, to offset this change, agents may increase the amount of riskless assets in the portfolio, which would require extra money balances, at the expense of long term bonds.

Thirdly, a rise in stock prices means the level of financial transactions also rises so that there is an increased need for cash. These three factors, which are termed the income/wealth effects, mean a rise in stock prices produces an increase the demand for money. On the other hand as stock prices rise so stocks become more attractive to investors as a part of their portfolio's. This would lead to these agents substituting

[2] In this article Friedman uses the stock price level as represented by a market index as the measure of the stock market, in contrast to the article of 1956 in which the return on equities is used.

stocks for money, so that the relationship would in this case be in the opposite direction and this is termed the substitution effect.

Thus, the effect of the stock market on money demand is an empirical question and depends on the relative strengths of the income and substitution effects, if it is assumed only domestic stocks effect the domestic money demand. With the advent of such financial products as unit trusts and related investment packages many investors hold international shares traded on foreign stock markets. In this sense the effect of the stock market differs to that of foreign currency.

This produces the following relationship, where m_d is the nominal demand for money, p is the price level, y is the real income level, i is the nominal rate of interest and s is the real level of the stock market (as represented by a particular index). All variables except the interest rate are in logs.

$$m_d = p_t + \alpha y_t - \beta i_t + \chi s_t \tag{7.1}$$

It is assumed that the same relationship holds for foreign money demand so that;

$$m_d^* = p_t^* + \alpha y_t^* - \beta i_t^* + \chi s_t^* \tag{7.2}$$

It is further assumed that M2 is the relevant measure for money demand, as it is a better aggregate for analysing short term changes in cash holdings (Friedman 1988). It is further assumed that the usual market equilibrium conditions exist whereby;

$$\begin{aligned} m_d &= m_s \\ m_d^* &= m_s^* \end{aligned} \tag{7.3}$$

To complete the analysis it is assumed that absolute PPP holds, so:

$$p_t = p_t^* + e_t \tag{7.4}$$

Where e is the log of the exchange rate defined as the domestic price of foreign currency.

By substituting into the money demand function we have the following relationship:

$$(m_s - m_s^*) = (p_t - p_t^*) + \alpha(y_t - y_t^*) - \beta(r_t - r_t^*) + \chi(s_t - s_t^*) \tag{7.5}$$

Then by solving for the price differential and using the PPP relationship, the following is produced in which the exchange rate is expressed as a function of differentials in the money supply, income , interest rates and the stock market;

$$e_t = (m_t - m_t^*) - \alpha(y_t - y_t^*) + \beta(r_t - r_t^*) - \chi(s_t - s_t^*) \tag{7.6}$$

This result is the basis for the monetary approach with the additional feature of the inclusion of the stock market, which in this model is the differential between the domestic and foreign stock market, which is arguably a more satisfactory way of analysing the affect of the stock market on the exchange rate in a monetary based model than simply using just the domestic stock market. This is mainly because the exchange rate reflects movements of capital between countries and not just the state of the domestic stock market.

The monetary approach also assumes that domestic and foreign bonds are perfect substitutes, in which case uncovered interest parity (UIP) holds:

$$\Delta e_t = e_t - e_{t-1} = r_t - r_t^* \tag{7.7}$$

Thus the expected depreciation of the exchange rate depends on the extent to which the domestic interest rate exceeds the foreign rate. So far there has been no allowance made for how expectations on future exchange rate movements are formed. In the long term the expected change is zero in which case the interest rate differential drops out of the final equation.Therefore the reduced form of the equilibrium exchange rate can be written as:

$$e_t = \alpha_0 + \alpha_1(m - m^*) + \alpha_2(y - y^*) + \alpha_3(s - s^*) + u_t \tag{7.8}$$

where:

$\alpha_1 > 0$

$\alpha_2 < 0$

$\alpha_3 \gtrless 0$, depending on the relative strength of the income and substitution effects.

7.3 Empirical Results

The model is tested over the period 1974 quater 1 to 1993 quarter 4. The choice of countries tested is constrained by the need for I(1) variables and as is evident the Canada\US and Canada\UK tests fail to produce I(1) variables, so for the remaining countries they are all tested with the US dollar to begin with and then the UK pound.

Table 7.1 Test for stationarity for the exchange rate with the US dollar. (critical values is -2.87 (-2.59) at the 5% (10%) level of significance, taken from Fuller 1976). The sample consists of 80 observations.

		e		Δe	
country	lags	ADF	lags	ADF	I
UK	3	-2.466	7	-3.884	1
Japan	5	-0.654	3	-3.582	1
Germany	0	-1.471	3	-3.185	1
Canada	3	-2.577	2	-3.569	0/1
Netherlands	0	-1.310	3	-2.834	1

Table 7.2 Test for stationarity for the exchange rate with the UK pound.

	e		Δe		
country	lags	ADF	lags	ADF	I
Japan	1	-0.984	6	-3.050	1
Germany	0	-1.769	3	-4.229	1
Canada	7	-3.564			0
Netherlands	0	-0.571	5	-3.761	1

(All variables are in logs, where a variable name is used, it refers to the differential between the domestic and foreign variable)

Table 7.3 Test for stationarity for the money supply differential with the US dollar

		m		Δm		
country	lags	ADF	lags	ADF	I	(DF and ADF(1))
UK	3	0.398	5	-1.988	1/2	-5.212 -4.216
Japan	1	-0.768	2	-3.211	1	
Germany	4	-0725	3	-2.223	1/2	-5.887 -3.842
Canada	3	-1.380	4	-1.960	2	
Netherlands	8	-0.645	8	-1.884	1/2	-10.670 -9.448

Table 7.4 Test for stationarity for the money supply differential with the UK pound

		m		Δm		
country	lags	ADF	lags	ADF	I	(ADF and DF(1))
Japan	5	-0.183	4	-2.155	1/2	-6.431 -5.070
Germany	4	-1.203	3	-2.336	1/2	-6.218 -4.013
Canada	5	-0.331	4	-2.618	1	
Netherlands	8	-1.750	8	-1.017	1/2	-10.123 -8.936

Table 7.5 Test for stationarity for the output differential with the US dollar

		y		Δy	
country	lags	ADF	lags	ADF	I
UK	0	-1.543	4	-4.504	1
Japan	0	-1.721	2	-3.502	1
Germany	4	-2.458	3	-2.948	1
Canada	0	-2.119	4	-3.430	1
Netherlands	1	-1.650	3	-3.665	1

Table 7.6 Test for stationarity for the output differential with the UK pound.

	y		Δy			
Country	lags	ADF	lags	ADF	I	(DF and DF(1))
Japan	0	-1.269	3	-2.957	1	
Germany	0	-1.374	3	-2.893	1/2	
Canada	0	-2.655	2	-4.474	0/1	
Netherlands	8	-1.843	3		1/2	-8.231 -6.005

Table 7.7 Test for stationarity for the stock market differential with the US dollar

	s		Δs		
Country	lags	ADF	lags	ADF	I
UK	4	-1.895	4	-4.627	1
Japan	0	-1.448	4	-3.354	1
Germany	0	-2.952			0/1
Canada	4	-1.964	3	-2.515	2
Netherlands	3	-1.535	4	-2.689	1/2

Table 7.8 Test for stationarity for the stock market differential with the UK pound

	s		Δs		
Country	lags	ADF	lags	ADF	I
Japan	0	-1.669	5	-3.320	1
Germany	2	-2.782	4	-4.735	0/1
Canada	4	-0.682	6	-2.924	1
Netherlands	0	-2.577	4	-3.466	1

Table 7.9 Test for cointegration using the Johansen ML procedure, in the modified monetary model, with the US dollar. (critical values are listed for each cointegrating vector below the statistics, except Germany's, which are represented by the value one place further on .)

Country	r>0	r>1	r>2	r>3
UK	59.11	27.229	14.002	5.853
Japan	58.416	27.962	11.857	2.824
Germany	35.88	15.535	.618	
Netherlands	70.906	32.123	12.960	1.688
5%	*53.116*	*34.910*	*19.964*	*9.243*
10%	*49.648*	*32.003*	*17.852*	*7.525*

Table 7.10 Test for cointegration with the UK pound.

Country	r>0	r>1	r>2	r>3
Japan	66.923	34.759	14.852	3.738
Germany	71.983	36.609	10.442	2.986
Netherlands	112.403	19.647	9.424	3.176

(Critical values as above)

Table 7.11 The cointegrating vectors for the monetary model for the exchange rates with the US dollar, where Y is the differntial between domestic and foreign output, S is the differential between domestic and foreign stock market indexes and M is the differential between the domestic and foreign money supplies.

Country	k	y	s	m
UK	-11.11	2.691	1.695	-0.046
		(5.623)	(18.629)	(0.240)
Japan	-3.688	-3.688	0.542	-0.299
		(9.153)	(3.194)	(0.033)
Germany	2.734	1.496		-0.283
		(0.902)		(0.435)
Netherlands	101.976	-20.84	-0.591	4.441
		(6.035)	(0.209)	(2.248)

(The terms in parenthesis refer to the LM test for the retriction that the variables is equal to 0, which follows a chi-squared distribution, with a critical value of 3.841 (5%)).

Table 7.12 The cointegrating vectors for the monetary model with the UK pound.

Country	k	Y	S	M
Japan	-0.829	5.512	0.784	3.097
		(12.191)	(9.358)	(11.698)
Germany	12.35	1.681	-0.117	-0.361
		(18.724)	(12.296)	(8.258)
Netherlands	-2.262	6.069	0.169	-0.504
		(34.577)	(0.168)	(8.052)

In general most of the variables are I(1), except in the two cases involving Canada with the US dollar and UK pound. In the case of the UK\Canada test the exchange rate is I(0), which as already mentioned is due to the similarity in behaviour of these two exchange rates. Similar problems have occurred with the Canada\US test in which the exchange rate is again borderline I(0). In addition to this the money supply is I(2), but the Dickey Fuller statistic indicating it is I(1), but all the lags indicate I(2). Even the stock market differential is only just I(1) with evidence of it being I(2) at the

5% level of significance. For these reasons there has been no attempt to find cointegrating vectors between the exchange rates of these two countries.

The stock market variable in the Germany/US test suggests it is borderline I(0), and there is also evidence at the 10% significance level of the Germany/UK test being I(0). However for the purposes of the models the Germany\UK variable is treated as I(1), and in the Germany\USA cointegrating vector the stock market variable is included as an I(0) variable. This result also shows the nature of the relationship between Germany's stock market and particularly the US stock market, as one tends to follow the changes in the other. As the US stock market is so strong, it seems fair to suggest that Germany's stock market follows the US, which again indicates that the German capital markets are different to the others tested. As earlier, where the ADF test suggests a variable might be I(2), the DF and ADF tests with different lags are also analysed. In addition the Box-Pierce tests are also considered and on balance the variables can be assumed to be I(1).

For the Friedman monetary based model all seven tests give the one cointegrating vector. In the Japan\UK test there is evidence of two vectors at the 10% critical level. In all cases, except the Germany\UK test the evidence of one vector is very strong, especially the Netherlands\UK test. In the Germany\UK test there is evidence of two vectors. A closer analysis of the cointegrating vectors indicate a fairly ambiguous result, in which the variables reflect the long term movements of the respective exchange rates and stock markets.

In some cases the money supply[4] is negative, however a mitigating factor appears to be that when it is restricted to being zero, the LM test on the restriction shows in most cases it is not significantly different to zero, especially in the tests involving the US dollar. Only in the three tests with the UK not including the US is it significantly different to zero, and even here the stock market usually is the dominant feature. It is not surprising that the tests with the USA suggest that the stock market is far more important than the money supply, as between the USA and many other countries there is a large flow of equities which far outweighs the flows of any monetary assets.

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[4] Applying the restriction that the money supply be equal to unity tended to reduce the significance of the other variables

In the case of the UK\USA test the signs show that the money supply has no affect at all on the model, by far the strongest influence comes from the stock market and its positive sign reflects that over the time period in question the rise in output and the stock market have tended to indicate rising inflation and a balance of trade deficit.. The same is the case for the Japan\US test where again the money supply is irrelevant, although the appreciation of the Japanese currency which was due to the greater levels of output in Japan have not produced a similar rise in the Japanese stock market especially since the steep declines it suffered in the early 1990's as a result of the first signs of inflation. The Germany\US test is similar to that with the UK, as the German currency has continued to appreciate despite the increases in output and stock market in the US relative to Germany. In the Netherlands test the only significant factor is the output level, both money supply and stock market are irrelevant, possibly due to the longer use of capital controls by the authorities.

The Japan\UK test is one of the few results in which the money supply is more important than the stock market and for this reason the signs show that a rise in the money supply depreciates the exchange rate, but raises output and the stock market. In the Germany\UK test the stock market is still more important than the money supply, so that the negative sign on the stock market indicates any inflow of capital appreciates the exchange rate and the negative money supply simply reflects the wealth affect on the German money supply from the relative rise in the German stock market. There could be an additional reason for this sign which involves the UK authorities attempts to "shadow" the Deutschmark in the mid 1980's and the ERM membership, whereby the authorities have intervened to use monetary policy to control the exchange rate. In the Netherlands test the stock market is irrelevant, and the negative sign on the money supply might reflect the Netherlands membership of the ERM.

Figure 7.13 ECM's for the modified monetary model.(Variables are as defined earlier)

UK\USA

$$\Delta uke = 0.0140 - 0.107res_{t-1} - 1.034\Delta m_t - 0.300\Delta uke_{t-1} + 0.264\Delta uke_{t-3}$$
$$(1.352) \quad (-3.095) \quad (-1.857) \quad (2.694) \quad (2.403)$$
$$+0.341\Delta uke_{t-7} - 0.263\Delta s_{t-1} - 0.173\Delta s_{t-2} - 0.179\Delta s_{t-5} - 0.196\Delta s_{t-6}$$
$$(3.143) \quad (-2.930) \quad (-1.997) \quad (-2.355) \quad (-2.651)$$
$$-0.804\Delta y_{t-2} - 1.232\Delta m_{t-6}$$
$$(-1.792) \quad (-2.310)$$

$R^2 = 0.384$ DW = 1.926 LM(4) = 1.043 Reset = 0.098

Normality = 0.159 Heteroskedasticity = 1.156 LM(2) = 0.647

ARCH(4) = 1.862

Japan\USA

$$\Delta jpe = -0.027 - 0.136res_{t-1} - 1.511\Delta m_t - 1.896\Delta m_{t-8} + 2.123\Delta y_{t-7} - 0.295\Delta s_{t-6}$$
$$(-3.177) \quad (-4.054) \quad (-1.781) \quad (-2.639) \quad (3.082) \quad (-3.594)$$
$$-0.157\Delta s_{t-2} + 0.340\Delta jpe_{t-1} + 0.265\Delta jpe_{t-4}$$
$$(-1.863) \quad (2.915) \quad (2.285)$$

$R^2 = 0.348$ DW = 2.188 LM(4) = 5.332 Reset = 0.556

Normality = 0.205 Heteroskedasticity = 0.792 LM(2) = 2.802

ARCH(4) = 4.014

Germany\USA

$$\Delta ge = 0.410 - 0.110res_{t-1} + 0.580\Delta m_t - 0.793\Delta m_{t-3} - 1.098\Delta y_{t-4} - 0.183\Delta s_{t-1}$$
$$(5.244) \quad (-2.308) \quad (1.725) \quad (-2.627) \quad (-2.374) \quad (-4.348)$$
$$+0.173\Delta ge_{t-4} - 0.697\Delta m_{t-6}$$
$$(1.774) \quad (-2.370)$$

$R^2 = 0.410$ DW = 1.954 LM(4) = 6.243 Reset = 1.323

Normality = 1.063 Heteroskedasticity = 1.115 LM(2) = 1.155

ARCH(4) = 3.450

Netherlands\USA

$$\Delta nle = 1.006 - 0.010 res_{t-1} + 0.454 \Delta s_t - 1.102 \Delta y_{t-4}$$
(-0.697) (-0.813) (3.032) (-2.223)

$R^2 = 0.194$ DW = 1.841 LM(4) = 5.384 Reset = 0.704
Normality = 0.769 Heteroskedasticity = 0.448 LM(2) = 2.868
ARCH(4) = 2.261

Japan\UK

$$\Delta jpuke = -0.026 - 0.215 res_{t-1} + 1.344 \Delta m_t + 1.143 \Delta m_{t-4} + 0.409 \Delta jpuke_{t-1}$$
(-2.224) (-4.461) (2.265) (2.065) (3.884)

$$+ 0.104 \Delta s_{t-4} + 0.106 \Delta s_{t-8}$$
(1.687) (1.847)

$R^2 = 0.372$ DW = 2.031 LM(4) = 3.670 Reset = 0.619
Normality = 1.315 Heteroskedasticity = 0.131 LM(2) = 1.951
ARCH(4) = 5.132

Germany\UK

$$\Delta guke = 0.009 - 0.326 res_{t-1} + 0.509 \Delta m_{t-1} + 0.559 \Delta m_{t-3} + 0.574 \Delta m_{t-6}$$
(1.246) (-6.173) (2.470) (2.539) (1.778)

$$+ 0.571 \Delta m_{t-7} + 1.392 \Delta y_{t-2} - 0.137 \Delta s_{t-4}$$
(2.720) (3.869) (-2.720)

$R^2 = 0.504$ DW = 1.847 LM(4) = 1.120 Reset = 1.285
Normality = 0.323 Heteroskedasticity = 0.002 LM(2) = 0.902
ARCH(4) = 0.794

Netherlands\UK

$$\Delta nluke = 0.001 - 0.046res_{t-1} - 0.320\Delta m_t - 0.443\Delta m_{t-1} - 0.401\Delta m_{t-7}$$
$$(.073) \quad (-2.675) \quad (-2.464) \quad (-3.861) \quad (-3.622)$$
$$-0.855\Delta y_{t-1} + 1.223\Delta y_{t-5} - 1.722\Delta y_{t-8} - 0.145\Delta s_{t-5} - 0.126D1$$
$$(-2.622) \quad (3.511) \quad (-4.785) \quad (-1.992) \quad (-3.411)$$

$R^2 = 0.568$ DW = 1.628 LM(4) = 6.081 Reset = 0.941

Normality = 0.923 Heteroskedasticity = 0.106 LM(2) = 1.797

ARCH(4) = 4.404

(For the Netherlands a dummy variable for 1992 q3 was required).

In the short term tests, as to an extent with the long run tests for cointegration, there is a distinct difference between those tests with the USA and those in which it is not included. In the tests with the USA the stock market effect tends to be stronger than the effect from the money supply variables. where this occurs the money supply variables are almost always negatively signed, whereas when the money supply is stronger as with the tests not incorporating the USA, it is almost always positively signed as expected. The UK\USA test is a prime example of this as the stock market is substantially more significant than the money supply and the money supply is negatively signed.

There are apparently two distinct mechanisms involved in determining the exchange rate which depends on whether it is with the US dollar or another country. In the case of the money supply being stronger, then the conventional monetary model applies and a rise in the money supply causes a depreciation of the exchange rate. However when[5] the stock market has the stronger influence it is flows in equity assets that dominate the determination of the exchange rate and the money supply has little affect on it and reacts to the changes in the stock market as described by Friedman (1988). Thus the rise in the domestic stock market after some time lag induces capital into the domestic stock market causing it to rise and the exchange rate to appreciate. However the rise in the stock market causes a rise in the domestic money demand through the wealth effects outlined earlier.

[5] Testing for causality between the stock market and money supply, using Granger causality tests, failed to produce conclusive evidence that there was causality between the variables in either direction, although as mentioned earlier this test is subject to some criticism.

In the test with the UK and USA the error correction term is significant at the 5% level of significance and negative. However the coefficient is very low and just 0.1, which indicates a very slow readjustment back to equilibrium. This may reflect the behaviour of these two currencies, in particular during the early 1980's when there was a prolonged appreciation of the dollar which was followed by a very gradual readjustment back to the levels experienced previously. This point is supported by the positive signs on the exchange rate variables, which indicate that there is a short and long run effect from previous exchange rate levels. This suggests that this exchange rate tends to move in the same direction as previously rather than moving around an equilibrium level, hence the very low coefficient on the error correction term. However compared to the coefficient on the error correction term on the Macdonald and Taylor (1993) model of 0.024, 0.1 is perhaps not too bad.

The money supply in the short run has the same problem as in the long run as it is negatively signed, but as in the long run its effect is totally dominated by the stock market. The effect is both immediate and in the long run in which both the coefficients exceed unity. The output level is negatively signed, in the short run unlike the long run, the effect is only within the previous half year, and not particularly strong. This is not the same with the stock market in that it is negatively signed, and has two distinct effects, one in the short run and another in the long run. The stock market effect is the dominant influence in this model with all four variables being significant at the 5% level of significance, and it is more powerful than the rest of the variables put together. Although The coefficient on the stock market is much lower than for the output or money supply, implying a lower elasticity. The explanatory power of 0.4 is reasonably good for a test on an exchange rate model. All the diagnostics are passed easily so no dummy variables were needed so that the model is kept as simple as possible. The functional form test is particularly good.

The Japanese tests gives a fairly similar result to the UK\US with the exception of the output variable which is positive, unlike in the long run cointegrating vector. Also the error correction term is far more significant, as it passes the 1% level of significance. The coefficient is above 0.1 but is still low implying a slow adjustment. This factor is supported by the positive sign on the previous exchange rate variables as with the UK and US. As is often the case with Japan there is evidence of an annual affect on the exchange rate.

As with the previous case, the money supply term is negative, but in this case it is the level of two years previously which has the most important effect. The long-term effect is also evident with the stock market differential, which is the correct sign and highly significant, even at the 1% level of significance. Overall it is the values from about two years previously which have the most pronounced effect, which suggests it is the expectation of movements in future values of other variables and the exchange rate, which provide the motive for including the stock market in this test. There is also a much less powerful effect from the stock market and money supply just before the change in the exchange rate, but as in the long term the stock market provides the strongest effect. Again it appears that equity asset flows between these two countries determines their exchange rates and the money supply has only a slight effect.

The Germany\US test is the odd one out as is usually the case. The error correction term is significant, but has the lowest level of significance and is correctly signed. Thus the stock market is not so important in determining the long run cointegrating relationship for this test, although of more importance in the short term There is a mix of signs on the money supply, with a positive signed term having an immediate effect. There is also a highly significant negatively signed stock market variable which has an effect from the previous time period. There is not an obvious difference in strength between the money supply and stock market in this test which is why the exchange rate is partially determined by movements in the money supply and partially by changes in the stock market.

It is again the relative differences of the German capital markets which has provided this hybrid result in that like other tests with the USA the flows of equity assets is important, but not important enough to dominate the effects from changes in the money supply. The Netherlands suffer from a similar problem in that the error correction term is not negative. This shows that as found previously the Netherlands economy acts in a different way to the others tested here, due to the smaller size of its economy, as well as relatively lesser importance of its stock market. In the Netherlands the error correction term is also insignificant, and the stock market though significant has the wrong sign.

A good result occurs with the Japan\UK test as the error correction term is extremely significant and with a coefficient above 0.2. The previous exchange rate is still

positively signed suggesting it is following some form of trend. This is one of the few cases in which the money supply has an immediate effect as well as an effect from the year previously. Also the effect is positive as was the case in the long run., as the money supply dominates the stock market so determining the exchange rate. The stock market has two effects both from over a year previously, which are positively signed. The rise in the money supply is clearly associated with the "bad news case" in this test so causing a fall in the stock market. The goodness of fit is approaching 0.4, and the functional form test shows this is a reasonable model.

Despite the mediocre result of the Germany\US test, the Germany\UK test works surprisingly well. It is very similar to the Japan\UK test with a very significant error correction term. This term produces by far the best coefficient as it exceeds 0.3. Similarly the money supply is positively signed with a particularly significant effect just prior to the exchange rate movement as well as one and a half years previously. The stock market is negatively signed but only significant a year before the exchange rate change, and far less powerful than the money supply. The output variable, which is positive as it is in the long run, rises with any increase in the money supply.

The goodness of fit is particularly high and all the diagnostics are comfortably passed. Bearing in mind the differences of the German stock market, this is the best result, although the stock market itself has only a limited impact on the exchange rate. for this reason the money supply is correctly signed as the stock market effect as outlined by Friedman would have only a minor effect on the money supply. The dummy variable refers to the time the UK left the ERM and enables all the diagnostics to be passed.

The Netherlands\UK test differs to the others in that output has a more powerful effect than either the money supply or the stock market, and also a dummy variable is required to ensure the diagnostics are passed. The error correction term is negative and significant but the coefficient is very low. All the money supply variables are negatively signed as is the stock market. Overall both money supply and output have effects both immediately prior to the exchange rate movement and over a year before any change, and the dominance of the output variable is why this test appears not to follow the same rules as the other tests In the context of the Netherlands relative size, the strong effect of the output level suggests that trade flows are important between countries of a significantly different size.

In the previous test the inclusion of the dummy variable had a significant effect on the overall equation, producing a goodness of fit which exceeds 0.5. In other tests including the UK, a similar value would have occurred if the same dummy had been included, but the Jacque-Bera test indicated that it was not essential. So the low values of the goodness of fit measure are not too great a cause of concern. A strong trend throughout many of the results is that the stock market differential has its main effect about a year to a year and a half before a change in the exchange rate. This point emphasises the fact noted earlier that the stock market moves on expectations of variables whereas the exchange rate moves only after those variables have changed. Only the UK\US result suggests that there is any immediate effect from the movement in the stock market differential.

7.4 Tests of the Monetary Model Including an Alternative UIP Specification

In this section the monetary model examined earlier is analysed with the addition of a risk premium variable. There are two basic reasons for this. Firstly the conventional uncovered interest parity (UIP) condition has failed (Isard 1987) and viewing exchange rates in terms of risk is more acceptable given the risk averse nature of foreign exchange markets. Secondly, it has the advantage over using interest rates as it is not specifically related to the money supply variable and so can be added to the ECM without inducing multicollinearity with the money supply term. The risk adjusted version of UIP takes the following form;

$$E\Delta e_t = \alpha_0 + \alpha_1\{(E(R_{mt}) - r_t) - (E(R^*_{mt}) - r^*)\} = \alpha_0 + \alpha_1(rp)$$

where;

e_t is the exchange rate. (7.9)

R_{mt} is the return on the market portfolio.

r_t is the riskless rate of return.

In the following error correction terms, the long-run equilibrium condition is the same as that used in the monetary model, without the risk premium differential as the expected change in the exchange rate is zero. The risk premium differential is

incorporated in the ECM's and as with the conventional form of UIP, the risk premium differential is expected to be positively signed.

In the case of the UK/USA test the term is only significant when lagged twice, which suggests that there is a fair amount of risk aversion between these two countries. The term is correctly signed and the coefficient just below unity. Also the addition of this variable improves both the error correction term and overall explanatory power of this relationship. The other variables are roughly the same as in the previous monetary model except they are more significant. The Japan\US test has two significant terms, one is an instantaneous effect and the other is again from half a year previously. The latter term is most significant and the coefficient is well above unity. Once again the addition of this variable has a helpful effect on the rest of the equation. The significance of the immediate term suggests that there is perceived to be less risk between Japan and the US than the UK and US, which is due to the continuous growth of the Japanese and to a lesser extent US economies up until the early 1990's.

In the Germany\USA test the risk premium variable is only significant at the 10% level, but has the immediate effect as predicted. In the equation in which the error correction term was wrongly signed, namely the Netherlands with the US, the risk premium is significant with an immediate effect. In addition for the Netherlands there is also an effect from the variable lagged once and twice. However the addition of this variable tends not to improve the overall equation. In general the tests with the US work reasonably well despite the dominance of the risk premium term when lagged twice.

In tests involving the UK the results are not as good. Only the Japan\UK test gives a significant risk differential terms and in this case they are only when lagged once and four times. This suggests between these countries most investors require more time to react after a change in the riskiness of a particular country. The other two tests with the UK failed to produce a significant risk premium term. This reflects the lower levels of capital flowing between these countries and the UK compared to with the USA and tends to support the finding of the monetary models earlier which shows the stock market is more important with the US dollar than with the UK pound.

Figure 7.14 ECM's for the Friedman monetary model with the alternative UIP condition, where rp refers to the risk premium differential.

UK/USA

$$\Delta uke = 0.017 - 0.116res_{t-1} - 1.279\Delta m_t + 0.296\Delta uke_{t-1} + 0.338\Delta uke_{t-3}$$
$$(1.703) \quad (3.373) \quad (2.315) \quad (2.696) \quad (2.972)$$
$$+0.352\Delta uke_{t-7} - 1.293\Delta m_{t-6} - 0.256\Delta s_{t-1} - 0.187\Delta s_{t-2} - 0.170\Delta s_{t-5}$$
$$(3.285) \quad (2.461) \quad (2.951) \quad (2.181) \quad (2.283)$$
$$-0.179\Delta s_{t-6} + 0.832\Delta rp_{t-2}$$
$$(2.441) \quad (2.313)$$

$R^2 = 0.403$ DW = 1.817 LM(4) = 3.561 Reset = 0.272
Normality = 0.057 Heteroskedasticity = 0.295 LM(2) = 1.830
ARCH(4) = 2.460

Japan\USA

$$\Delta jpe = -0.028 - 0.116res_{t-1} + 1.628\Delta y_{t-2} + 2.810\Delta y_{t-7} - 1.423\Delta m_{t-1}$$
$$(3.445) \quad (3.827) \quad (2.673) \quad (4.252) \quad (1.900)$$
$$-2.489\Delta m_{t-8} - 0.226\Delta s_{t-2} - 0.216\Delta s_{t-6} + 0.315\Delta ljpe_{t-1} + 0.452\Delta ljpe_{t-4}$$
$$(3.562) \quad (2.821) \quad (2.737) \quad (3.004) \quad (3.809)$$
$$+1.090\Delta rp + 1.430\Delta rp_{t-2}$$
$$(2.512) \quad (3.087)$$

$R^2 = 0.476$ DW = 2.127 LM(4) = 1.395 Reset = 0.007
Normality = 0.933 Heteroskedasticity = 0.001 LM(2) = 1.289
ARCH(4) = 3.583

Germany|USA

$$\Delta ge = 0.382 - 0.089res_{t-1} - 0.751\Delta m_{t-3} - 0.173\Delta s_{t-1} + 0.211\Delta ge_{t-4} + 0.805\Delta rp$$
$$(4.637) \quad (2.083) \quad (2.347) \quad (3.881) \quad (1.949) \quad (1.749)$$

$R^2 = 0.340$ DW = 1.949 LM(4) = 4.739 Reset = 1.677
Normality = 0.437 Heteroskedasticity = 1.619 LM(2) = 3.030
ARCH(4) = 4.393

Netherlands\US

$$\Delta nle = 0.001 + 0.007res_{t-1} + 0.360\Delta s_t + 1.62\Delta rp_t + 0.927\Delta rp_{t-1} + 1.10\Delta rp_{t-2}$$
$$(0.095) \quad (0.560) \quad (2.184) \quad (2.935) \quad (1.735) \quad (2.053)$$

$R^2 = 0.247$ DW = 1.883 LM(4) = 5.680 Reset = 0.257

Normality = 1.881 Heteroskedasticity = 0.487 Arch(4) = 1.647

Japan|UK

$$\Delta jue = -0.028 - 0.159res_{t-1} + 1.565\Delta m_t + 0.245\Delta jue_{t-1} + 0.115\Delta s_{t-4}$$
$$(-2.542) \quad (-3.559) \quad (2.721) \quad (2.433) \quad (1.887)$$
$$+ 0.887\Delta rp_{t-1} + 0.916\Delta rp_{t-4}$$
$$(2.477) \quad (2.551)$$

$R^2 = 0.426$ DW = 2.166 LM(4) = 2.368 Reset = 0.569

Normality = 0.897 Heteroskedasticity = 0.059 LM(2) = 1.753

ARCH(4) = 2.488

7.5 Conclusion

The answer to the first question as regards the influence of the stock market, is that it is not only relevant but in many of the models it is the most important factor which determines the exchange rate, especially between countries with large stock markets. In particular, the addition of a stock market variable to the monetary model produces evidence of cointegration, which validates the long-run equilibrium relationship implied by the monetary approach. Most previous tests on various versions of the monetary model had failed to produce consistent evidence of cointegration (Sarantis 1994).

The answer to the second question is similar in that it is possible to explain some of the "wrong" signs found in conventional models by the effects of the stock market on both macro-variables and the exchange rate. In particular it possibly differentiates between those countries whose exchange rates could be determined by capital flows and those whom are more effected by monetary policy. Finally, the tests show that the

risk premium form of UIP works for a majority of countries although as expected the tests with the Netherlands are the least predictable. This is something that leads to further investigation in Chapter 8.

Chapter 8

International Asset Pricing, Foreign Exchange Market
Risk and Uncovered Interest Parity

8.1 Introduction

The analysis of the relationship between the risk premiums of the stock and the foreign exchange markets is an implicit test that the exchange rate contains a risk premium. It has been suggested that the reason for the failure of uncovered interest parity (UIP), is the presence of a time varying risk premium (Macdonald and Taylor 1992). So if a relationship is shown to hold, then a risk premium is present, which confirms that UIP in its present form cannot hold. This has important implications for the modelling of the exchange rate, as most models incorporate the UIP condition.

Exchange rates contains a risk premium if an additional expected return is required on the relatively risky compared to the less risky bond. It is usually defined as:

$$\rho = E(\Delta e) - (r - r^*)$$

This implies that there are perceived differences in risks between domestic and foreign bonds, such that those bonds are not perfect substitutes. There also has to be risk aversion on the part of economic agents to the perceived differences in risk, such that investors will only accept an increased risk if there is a sufficient rise in expected real return to compensate for it. Exchange rate risk can be due to a number of factors, such as inflation risk and political risk. In addition it can also be caused by exchange control risk and default risk, which are the risk that capital controls will be introduced and the risk that Governments will default on their debt repectively.

The stock market risk premium or excess return refers to the Capital Asset Pricing Model (CAPM) concept of the degree to which the return on the stock market exceeds the riskless return. In practise there is no such thing as a riskless return so the return

on treasury bills or eurodeposit rates are used. The interpretation of this expression is that any excess over the risklesss rate of return must involve a risk premium.

The analysing of capital markets across countries requires a slightly different approach to that used in other chapters. Where a systems form of estimation is to be used then to begin with the country's comprising the system have to be chosen. Secondly as the test is for a relationship across countries, the implications of the removal of capital controls on the countries tested has to be considered. The most obvious group of countries to test is those that comprise the G-7, which are the UK,USA, Germany, Japan, Canada, France and Italy. This means that France and Italy need to be added to the data set, which is possible in this case as data is available for the relevant variables. Also as most capital controls were removed by 1982, the data for one set of tests with monthly data starts from January 1982.

The use of two different data sets then allows a comparison to be made between the relationship using monthly and quarterly data, as well as over slightly different time spans. Due to the nature of the results, it is important to analyse them in different ways, as becomes obvious later. This chapter includes an analysis of the theory of the risk premium in the two markets, then has an outline of the model to be tested. The model is then tested using cointegration, error correction models (ECM's) and Zellner's seemongly unrelated regression analysis (SUR), finally the results are compared and discussed.

8.2 A model of the risk premium

In this section the relationship between the respective risk premiums on the exchange rate and stock market are analysed. The two sets of risk premiums are derived from UIP for the exchange rate and the CAPM for the stock market, as illustrated later. The model to be tested is based on the Chiang model (1991), which is itself a development of the model used by Robichek and Eaker (1978), in which the foreign stock market risk premium is also included. The main difference between the methodology used here and that used by Chiang, is that instead of using the Transfer Function model, cointegration and ECM's are utilised. The advantage of this technique is that it enables a distinction to be made between the short run and long run interdependencies.

The model requires the assumption that agents use nominal rather than real rates of return, which obviates the need to use PPP. This means investors ignore inflation and hence consider the nominal returns as being real returns. This assumption can be justified in this context, since as Adler and Dumas (1983) note, aggregate price levels have a low variability relative to security returns and exchange rates, and hence inflation risks are relatively trivial and can be safely ignored. Furthermore, the use of real returns rather than nominal returns would imply that investors expect PPP to hold. Evidence due to Adler and Dumas (1983) and cited in Pentecost (1993) suggests PPP is not supported by the data which supports the case for arbitrage with respect to nominal rather than real rates.

The international asset price parity condition is assumed to hold. Although the relationship is usually referrred to as UIP, it can be equally applied to the return on equities as the return on bonds. This relationship using the return on equities can be derived in a number of different ways, for instance Roll (1979) derives it through a speculative process in international commodity markets. In this case the equation is derived consistently, as both conditions use the return on equities. Thus the expected return on asset j in the domestic country should equal the expected return on an asset in the foreign country with the same characteristics plus the expected rate of depreciation of the domestic currency over a specific time span. This suggests the expected returns in the home country are equal to the expected returns in the foreign country, when measured in the domestic currency;

$$E(R_{j,t+1} \setminus I_t) = E(R^*_{j,t+1} \setminus I_t) + E(R_{e,t+1} \setminus I_t) \tag{8.1}$$

where;

$R_{j,t+1}$ is the required rate of return on asset j at time t + 1.

$R_{e,t+1}$ is the expected rate of appreciation of the foreign currency, between t and t + 1.

$E(.\setminus I_t)$ is the expectations operator conditional on the information set at time t.

The expected excess return of asset j in the domestic capital market is a linear combination of the market return in the home country, relative to the risk free rate, plus the market return in the foreign capital market, again relative to the risk free rate as given by:

$$E[R_{j,t+1} \setminus I_t] - r_t = \beta_{j1}(E[R_{m,t+1} \setminus I_t] - r_t) + \beta^*_{j2}(E[R^*_{m,t+1} \setminus I_t] - r^*_t)$$

where;

R_m denotes the market rate. (8.2)

r the risk free rate of interest.

The final term shows the interdependence between the domestic and foreign stock markets. In the traditional Capital Asset Pricing Model (CAPM) where domestic markets are independent of the foreign markets then $\beta^*_{j2} = 0$. A similar equation can be written for the foreign return on asset j as follows;

$$E[R^*_{j,t+1} \setminus I_t] - r^*_t = \beta^*_{j1}(E[R^*_{m,t+1} \setminus I_t] - r^*_t) + \beta_{j2}(E[R_{m,t+1} \setminus I_t] - r_t) \tag{8.3}$$

Combining equations 8.1 to 8.3 and using $(E[e_{t+1} \setminus I_t] - e_t)$ as a proxy for $E[R_{e,t+1} \setminus I_t]$, where e_t is the natural logarithm of the current spot exchange rate, and summing over all assets j we obtain:

$$(E_t e_{t+1} - e_t) - (r_t - r^*_t) = \beta(E_t R_{m,t+1} - r_t) - \beta^*(E_t R^*_{m,t+1} - r^*_t) \tag{8.4}$$

In this specification the β's are equally weighted averages of their respective β_j's. The last equation denotes the equilibrium situation based on market efficiency. If the CAPM model holds then the β's are expected to be unity and minus unity respectively. The dynamic market adjustments can be represented in the following ECM:

$$\begin{aligned}\Delta[(E_t e_{t+1} - e_t) - (r_t - r^*_t) = \alpha_0 + \alpha_1 \Delta[(E_t R_{m,t+1} - r_t)] + \alpha_2 \Delta[(E_t R^*_{m,t+1} - r^*_t)] \\ - \gamma[(E_t e_{t+1} - e_t) - (r_t - r^*_t) - \hat{\beta}(E_t R_{m,t+1} - r_t) \\ + \hat{\beta}^*(E_t R^*_{m,t+1} - r^*_t)]_{t-1} + u_t\end{aligned} \tag{8.5}$$

Where all terms must be stationary and γ represents the speed of adjustment back to equilibrium following a disturbance. Δ is the first difference operator and ^'s denote the long run parameters. If $-1 < \gamma < 0$, adjustment back to equilibrium following a disturbance is monotonic. If $\gamma < -1$ adjustment is oscillatory.

As alluded to earlier, it is not anticipated that the equations for the G-7 countries would be independent. In this case the error terms for the relevant ECM's would be

correlated, in which case estimating the equations individually would produce biased results . To overcome this the equations are estimated using Zellner' SUR (Zellner 1962), sometimes referred to as disturbance related or error related regression analysis. The validity of this procedure is tested for by using the Breusch and Pagan (1980) Lagrange Multiplier (LM) test statistic;

$$LM_{BP} = T\sum_{m=2}^{M}\sum_{n-1}^{m-1}\left[\frac{\hat{\sigma}_{mn}}{(\hat{\sigma}_{mn}\hat{\sigma}_{nn})^{1/2}}\right]\chi^2_{M(M-1)/2}$$

where; (8.6)

$$\hat{\sigma}_{mn} = \frac{\hat{u}'_m\hat{u}_n}{T}$$

The above term refers to the product of the estimated residual vectors from the system of equations given be the ECM, where M is the number of equations, T is the number of observations and lower case m and n denote the estimated covariance between the m'th and n'th equations of the system.

There are two ways of estimating an equation by SUR. The most common method involves an iterative process, in which the residuals from the other equations are used as explanatory variables in an OLS regressions, then repeating this process with the updated residuals until the estimated coefficients are statistically equal from one run to the next. The other method, used here, includes computing the covariances amongst the estimated residuals from the first stage of the OLS regression. These estimates of the covariances are then used to 'clean up' the estimation. In general there is very little to choose between the two methods, as both have the same asymptotic characteristics.

8.3 Empirical Results

8.3.1 Results using monthly data

Table 8.1 Test for stationarity of the stock market risk premiums using the DF and ADF tests. The sample consists of 144 observations, from 1982 month 1 to 1993 month 12.

Country	SMRP		ΔSMRP		
	lag	ADF	lag	ADF	I
UK	0	-1.258	10	-2.790	1
USA	10	-0.535	6	-5.176	1
Germany	0	-1.327	4	-2.914	1
Japan	0	-1.412	5	-3.553	1
Canada	1	-1.702	8	-3.498	1
France	0	-1.862	7	-2.908	1
Italy	0	-1.935	7	-3.414	1

(Foreign currency per us dollar, ERRP is the exchange rate risk premium. SMRP is the stock market risk premium. A Δ indicates the variable is first differenced and the lags were determined by the Akaike criteria. The critical values are -2.57 (-2.93) at the 5% (10%) levels of significance)

Table 8.2 Test for stationarity of the exchange rate risk premiums with the US dollar.

Country	ERRP		ΔERRP		
	lag	ADF	lag	ADF	I
UK	0	-2.265	7	-4.384	1
Germany	0	-0.752	8	-3.342	1
Japan	0	-1.707	6	-5.015	1
Canada	6	-1.856	6	-5.787	1
France	0	-1.933	9	-3.966	1
Italy	3	-2.208	5	-4.176	1

Table 8.3 Test for stationarity of the exchange rate risk premium with the UK pound.

Country	ERRP		ΔERRP		
	lag	ADF	lag	ADF	I
US	0	-2.265	7	-4.384	1
Germany	0	-0.552	10	-2.754	1
Japan	0	-1.421	5	-4.818	1
Canada	7	-3.522			0
France	0	-1.690	5	-4.588	1
Italy	0	-1.623	10	-2.791	1

Table 8.4 Test for the number of cointegrating vectors using the trace test of the Johansen ML procedure, with the US dollar. The critical values are from Johansen and Juselius (1990).

Country	r=1	r=2	r=3
UK	48.365	17.814	4.260
Germany	60.264	17.921	1.466
Japan	37.727	18.000	7.493
Canada	38.455	15.498	4.171
France	42.871	15.815	5.250
Italy	43.219	19.170	6.651
5%	*34.910*	*19.964*	*9.243*
10%	*32.003*	*17.852*	*7.525*

Table 8.5 Test for the number of cointegrating vectors using the trace test of the Johansen ML procedure, with the UK pound

Country	r=1	r=2	r=3
UK	48.365	17.814	4.260
Germany	37.929	11.655	2.383
Japan	57.336	15.776	5.275
France	37.417	11.372	1.959
Italy	33.096	13.214	2.544

Table 8.6 The Cointegrating vectors for the risk premiums, against the US dollar

Country	k	domesticrp	usrp	$H_0{:}\beta = -\beta^*(\chi^2_{0.05}(1) = 3.841)$
UK	0.039	1.005	-1.003	1.038
Germany	-0.168	0.984	-1.014	17.831
Japan	-0.054	0.996	-1.006	1.043
Canada	0.027	1.008	-1.006	1.383
France	-0.062	0.0996	-1.002	3.937
Italy	-0.062	0.996	-1.002	2.516

(Where usrp is the US stock market risk premium and domesticrp refers to the domestic country's stock market risk premium)

Table 8.7 The cointegrating vectors for the relationship between the risk premiums against the UK pound.

Country	k	domesticrp	ukrp	$H_0{:}\beta = -\beta^*(\chi^2_{0.05}(1) = 3.841)$
Germany	-0.069	0.993	-1.013	4.121
Japan	-0.012	1.000	-1.000	2.506
France	0.004	1.002	-1.001	0.031
Italy	-0.032	1.000	-1.013	0.339

Table 8.8 ECM's for the relationship between the risk premiums for the system with the US dollar.

UK\USA

$$\Delta erp = 0.001 - 0.904 res_{t-1} + 1.003\Delta ukrp - 0.012\Delta ukrp_{t-5} - 0.009\Delta ukrp_{t-6}$$
$$(0.28) \quad (12.19) \quad (189.4) \quad (2.43) \quad (1.68)$$
$$-1.005\Delta usrp$$
$$(85.12)$$

$R^2 = 0.995$ DW = 1.887 LM(4) = 6.974 LM(6) = 7.141
LM(8) = 7.311 LM(12) = 13.535 Normality = 0.628 ARCH(12) = 8.359

Germany\USA

$$\Delta erp = -0.005 - 0.901 res_{t-1} + 0.977\Delta gerp + 0.041\Delta gerp_{t-2} - 1.048\Delta usrp$$
$$(0.79) \quad (14.20) \quad (69.00) \quad (1.94) \quad (61.00)$$

$R^2 = 0.978$ DW = 1.059 LM(4) = 3.530 LM(6) = 7.868
LM(8) = 8.219 LM(12) = 14.20 Normality = 5.032 ARCH(12) = 5.104

Japan\USA

$$\Delta erp = -0.005 - 1.091 res_{t-1} + 0.986\Delta jprp - 1.032\Delta usrp$$
$$(0.91) \quad (14.19) \quad (43.77) \quad (64.47)$$

$R^2 = 0.978$ DW = 2.071 LM(4) = 3.424 LM(6) = 5.978
LM(8) = 7.311 LM(12) = 13.535 Normality = 0.628 ARCH(12) = 8.359

Canada\USA

$$\Delta erp = 0.001 - 1.237 res_{t-1} + 1.012\Delta carp - 1.001\Delta usrp + 0.014\Delta usrp_{t-3}$$
$$(0.34) \quad (15.71) \quad (216.4) \quad (132.4) \quad (2.58)$$
$$-0.007\Delta carp_{t-4} - 0.007\Delta erp_{t-5}$$
$$(1.67) \quad (1.76)$$

$R^2 = 0.997$ DW = 2.106 LM(4) = 6.511 LM(6) = 7.112
LM(8) = 9.482 LM(12) = 12.646 Normality = 0.220 ARCH(12) = 10.463

France\USA

$$\Delta erp = -0.001 - 0.947 res_{t-1} + 0.989 \Delta frrp - 1.048 \Delta usrp$$
$$(0.14) \quad (15.35) \quad (114.1) \quad (69.27)$$

$R^2 = 0.987$ DW = 1.967 LM(4) = 2.553 LM(6) = 3.585
LM(8) = 5.533 LM(12) = 7.040 Normality = 2.321 ARCH(12) = 16.415

Italy\USA

$$\Delta erp = -0.000 - 0.878 res_{t-1} + 0.977 \Delta itrp - 1.022 \Delta usrp + 0.330 D1$$
$$(0.04) \quad (14.85) \quad (125.60) \quad (59.12) \quad (6.40)$$

$R^2 = 0.988$ DW = 1.925 LM(4) = 2.036 LM(6) = 2.403
LM(8) = 2.703 LM(12) = 10.077 Normality = 0.113 ARCH(12) = 11.874

Table 8.9 ECM's for the relationship between the risk premiums for the sytem with the UK pound.

USA\UK

$$\Delta erp = -0.001 - 0.918 res_{t-1} + 1.018 \Delta usrp - 1.005 \Delta ukrp$$
$$(0.28) \quad (12.20) \quad (97.65) \quad (160.6)$$

$R^2 = 0.995$ DW = 1.913 LM(4) = 6.778 LM(6) = 7.287
LM(8) = 7.845 LM(12) = 13.526 Normality = 0.883 ARCH(12) = 7.894

Germany\UK

$$\Delta erp = -0.002 - 0.923 res_{t-1} + 0.977 \Delta gerp - 0.182 gerp_{t-4} - 1.004 \Delta ukrp$$
$$(0.49) \quad (14.33) \quad (74.19) \quad (3.83) \quad (141.40)$$
$$+ 0.195 \Delta ukrp_{t-4} + 0.189 \Delta erp_{t-4} - 0.115 D1$$
$$(4.19) \quad (4.09) \quad (3.51)$$

$R^2 = 0.994$ DW = 1.887 LM(4) = 7.290 LM(6) = 9.193
LM(8) = 9.928 LM(12) = 13.210 Normality = 3.154 ARCH(12) = 14.007

Japan\UK

$$\Delta erp = -0.002 - 1.091 res_{t-1} + 0.981 \Delta jprp - 0.025 \Delta jprp_{t-8} - 0.998 \Delta ukrp$$
$$(0.25) \quad (14.91) \quad (44.21) \quad (1.93) \quad (114.3)$$

$R^2 = 0.991$ DW = 1.955 LM(4) = 4.916 LM(6) = 9.549
LM(8) = 12.258 LM(12) = 16.626 Normality = 1.144 ARCH(12) = 18.593

France\UK

$$\Delta erp = 0.002 - 0.968 res_{t-1} + 0.992 \Delta frrp - 1.005 \Delta ukrp$$
$$(0.45) \quad (13.68) \quad (103.6) \quad (134.3)$$

$R^2 = 0.994$ DW = 1.839 LM(4) = 6.435 LM(6) = 9.293
LM(8) = 9.724 LM(12) = 12.006 Normality = 3.154 ARCH(12) = 17.168

Italy\UK

$$\Delta erp = 0.006 - 1.025 res_{t-1} + 0.982 \Delta itrp - 1.005 \Delta ukrp$$
$$(0.98) \quad (13.94) \quad (108.8) \quad (114.3)$$

$R^2 = 0.993$ DW = 1.952 LM(4) = 5.332 LM(6) = 5.917
LM(8) = 7.565 LM(12) = 13.528 Normality = 0.797 ARCH(12) = 12.830

(The following dummy variables were includeed: Italy\USA; D1-1992 m9 and Germany\UK; D1-1992 m9.)

The following Breusch-Pagan statistics were produced for the two systems. The chi-squared statistics are LM(10) 18.307 and LM(15) 24.996 at the 5% level of significance.

The result for the test with the US dollar: LM(15)-328.44

The result for the test with the UK pound: LM(10)-183.22.

The tests are conducted from 1982 month 1 to 1993 month 12. All the stock market risk premiums are I(1), as are all the exchange rate risk premiums against the US dollar. It is only the Canada\UK exchange rate that exhibits any sign of stationarity. As with the exchange rate and stock market, it appears there is a close relationship between risk premiums in these two countries. Once again the similarities in financial

structures and traditions has produced a stationary variable. Due to the I(0) variable the Canada\UK risk premium is not included in the system of ECM's with the UK pound, thus there are only five equations in that system rather than the six in the system with the US dollar.

The trace results of the Johansen ML procedure indicate that there is at least one cointegrating vector in both the tests with the UK pound and US dollar. However in the German, Italian and French tests against the US dollar there is some evidence of two vectors but only at the 10% level of significance. Overall the values are higher for the tests with the US dollar, than the UK pound, which indicates a greater stability for the risk premiums when measured against the US dollar.

Tests on the long-run cointegrating vectors suggests that all the domestic stock market risk premiums are positively signed and the coefficient is either just above or just below unity. similarly all the foreign stock market risk premiums are negatively signed with coefficients as predicted. In nearly all the tests there is no significant difference between the domestic and foreign stock market risk premiums. The two main exceptions are the Germany\USA and Germany\UK test. The lower significance of the German stock market risk premiums is not surprising given the evidence from most other tests in which the German stock market is involved. In addition the France\USA test also marginally fails, although the France\UK test passes easily.

All the results have in common, support for the hypothesis that the risk premium in the exchange rate is positively related to the risk premium in the domestic stock market and negatively related to that in the foreign stock market. The magnitude of the t-statistics suggests that the relationship is particularly significant and that it occurs almost immediately when using monthly data. A further feature is that the explanatory power of the equations in all cases exceeds 0.97.

The Breusch-Pagan statistics suggest the use of a systems form of estimation is very important, as both reject the assumption of common parameter vectors. This shows that the risk premiums across the countries tested are strongly interrelated, which indicates that the capital markets across the G-7 countries are interdependent. It also suggests that the way in which levels of risks are determined in these different countries is on a similar basis with shared information.

In all cases the constant is insignificant, with a very low coefficient. This suggests that the risk premium in the exchange rate is not constant, varying with the risk premium in the stock market. In addition the error correction term is negatively signed in all tests and highly significant, producing a t-statistic of over 15 in the Canada\USA test. In addition in all tests the coefficient on the error correction term exceeds 0.8 and in some cases it exceeds unity, again in the Canada\USA test it reaches a value of above 1.2.

The most favourable result is produced by the Canada\USA test in terms of the significance of the variables. The Canadian stock market risk premium has a t-statistic which exceeds two hundred, producing a particularly low standard error. In addition the Canadian stock market risk premium is more significant than that in the USA. This suggests that it is the risk premium of the country which has the smaller of more risky economy which has the most important part in deciding the levels of risk in the exchange rate. This is also the case the UK\USA test, which is almost identical to the former test, where the UK stock market risk premium is over twice as significant as that in the USA.

A feature that the Canada\USA and UK\USA tests share is that both have some significant lags. In the former test both stock market risk premiums and the exchange rate risk premiums have a significant lag, although neither are anything like as significant as the impact effect. In the UK\USA test only the lags on the UK stock market are significant and as with the Canada test the lags tend to be between four and six months. In the other tests with the USA there is even less evidence of any lags and in the French, Italian and Japanese tests there are no significant lags. These results support the theory that the relationship between risk in the exchange rate and stock market does not involve a complicated lag structure, with only a marginal relationship with the level of risk in previous months.

The results from the ECM's with the UK pound are very similar to the results with the US dollar, which suggests the results are not dependent on the strength and efficiency of the US capital markets. In most tests the domestic stock market risk premium is less significant with the UK pound than the US dollar and the UK stock market risk premium more significant than that of the USA. Again this reflects the greater risk of the UK economy and markets relative to the USA.

There is one exception to the above, in the case of Germany. In the Germany\USA test the result is the same as in all the others, as there are no significant lags required for the ECM, but in the Germany\UK test there is an important difference. In order to overcome the problem of serial correlation, four month lags were required for both stock market risk premiums and the exchange rate risk premium. There were no other lags required for this test and all three lags were relatively significant. This may reflect the attempts by the UK authorities to manage their exchange rate in terms of the DM. This was most apparent during the UK's membership of the ERM, but also during the mid 1980's, the then Chancellor of the Exchequer attempted to 'shadow' the DM (Macdonald and Taylor 1992). This indicates that every four months some attempt is made to intervene in the markets, which would have altered the levels of risk associated with this particular exchange rate.

Both the Germany\UK and Italy\USA tests required dummy variables for September 1992, when both the UK and Italy experienced problems with the ERM. This caused a certain amount of volatility in the foreign exchange markets, which adversely affected the two currencies. The Italy\UK test did not require a dummy variable for this month, presumably because the problems associated with the ERM occurred at the same time for both countries. In addition the France\UK test fails the Bera-Jacque test for normality, making statistical inference from this equation more problematic.

The LM test for higher order serial correlation shows that in all the tests this is not a problem. To ensure this was the case, the test was conducted with four, six, eight and twelve lags. To this extent, these results differ to those of Robichek and Eaker (1978), also they suggest the use of the Transfer Function model by Chiang (1991) was not the only method of overcoming the problem of serial correlation. In addition the diagnostics are passed in all the tests except the France\UK test, indicating statistical robustness and no evidence of mis-specification.

An important point is that the coefficients on the error correction terms suggests that the speed of adjustment back towards the equilibrium following a disturbance is fairly rapid. In most countries it is over 90% complete within a month, as would be expected in the context of highly integrated markets. In these cases the adjustment is monotonic, but in some cases the coefficient on the error correction term exceeds unity. This is the case with the Canada\USA, Japan\USA, Japan\UK and Italy\UK tests. This suggests the adjustment may be oscillatory, particularly for Canada,

although the lagged residual for Japan is not statistically significant from unity, which suggests that departures from equilibrium are corrected immediately.

There has been a wide ranging discussion in the literature on whether the exchange rate overshoots. These results seem to offer some support for this contention as a number of tests give a coefficient on the stock market risk premiums that exceeds unity. This is particularly the case for the France, Germany and Japan tests with the US dollar, where the exchange rates overshoot in response to the US stock market risk premium. A rationalisation for these exchange rate overshooting findings may be that a rise in the excess return on the US stock market provokes a purchase of US stocks by overseas residents which leads to an appreciation of the dollar. The dollar appreciation is then further enhanced by other short run investors purchasing dollar assets to make short run profits from an appreciating currency.

The above analysis concurs with a number of other empirical studies on the exchange rate. The extrapolative expectations described in the overshooting process, is not inconsistent with the empirical evidence of (Frankel and Froot 1987) and (Allen and Taylor 1990), whom found that using survey data, exchange rate expectations are formed in an extrapolative way. It also supports the view that very short term bubbles exist in the foreign exchange markets, where despite investors viewing a currency as overvalued, they still demand it as they expect more appreciation before the fall back to equilibrium, by that time they would already have taken profits.

8.3.2 Results using Quarterly Data

(Foreign currency per us dollar, ERRP is the exchange rate risk premium. SMRP is the stock market risk premium. A Δ indicates the variable is first differenced. The critical values are -2.57 (-2.93) at the 5% (10%) levels of significance, from Fuller (1976)) The sample consists of 80 observations.

Table 8.10 Test for stationarity of the exchange rate risk premiums against the US dollar.

country	ERRP		ΔERRP		
	lag	ADF	lag	ADF	I
UK	7	-1.944	7	-3.895	1
Germany	3	-0.674	8	-2.614	1
Japan	9	-1.97	9	-2.319	1\2
Canada	2	-3.006			0
France	2	-2.096	4	-3.840	1
Italy	0	-3.051			0

Table 8.11 Test for stationarity of the stock market risk premiums

country	SMRP		ΔSMRP		
	lag	ADF	lag	ADF	I
UK	0	-2.44	5	-3.592	1
USA	9	-1.811	8	-2.613	1
Germany	2	-2.449	2	-3.159	1
Japan	8	-1.771	9	-3.007	1
Canada	3	-2.105	4	-3.162	1
France	1	-2.590	5	-3.528	0\1
Italy	0	-1.927	2	-4.267	1

(ERRP and SMRP represent the exchange rate and stock market risk premiums respectively)

Table 8.12 Test for stationarity of the exchange rate risk premiums against the UK pound.

country	ERRP		ΔERRP		
	lag	ADF	lag	ADF	I
Germany	5	-2.324	5	-3.129	1
Japan	5	-1.995	6	-3.538	1
Canada	3	-2.998			0
France	0	-2.479	5	-3.592	1
Italy	0	-2.540	3	-3.880	1

Table 8.13 Test for cointegration using the US dollar

Country	UK	Germany	Japan	France
r=1	44.521	23.633	39.438	51.983
r=2	14.489	8.586	9.108	13.975
r=3	2.829	1.006	1.972	2.677

(The critical values are the same as reported for the monthly data)

Table 8.14 Test for cointegration using the UK pound

Country	USA	Germany	Japan	France	Italy
r=1	44.521	40.308	51.685	45.271	37.665
r=2	14.489	13.282	12.970	18.078	17.826
r=3	2.829	1.641	4.780	5.362	5.463

Table 8.15 The cointegrating vectors for the relationship between the risk premiums against the US dollar.

Country	k	domesticrp	usrp	$H_0:\beta = -\beta(\chi^2_{.05}(1) = 3.841)$
UK	0.100	1.015	-1.010	0.526
Japan	-0.090	1.015	-1.006	3.578
France	-0.177	0.974	-1.006	14.188

Table 8.16 The cointegrating vectors for the relationship between the risk premiums against the UK pound.

Country	k	domesticrp	ukrp	$H_0:\beta = -\beta(\chi^2_{.05}(1) = 3.841)$
USA	-0.100	1.010	-1.015	0.526
Germany	-0.051	0.995	-1.000	0.324
Japan	-0.053	1.009	-1.005	1.133
France	-0.043	0.991	-0.995	0.213
Italy	-0.067	0.991	-0.997	0.074

The following Breusch-Pagan LM statistics were produced, the critical values are chi-square (3) 7.81 and chi-square (10) 18.3.

With the USA, Chi-square(3) -31.809.

With the UK , Chi-square(10) - 136.54.

Table 8.17 ECM's for the system with the US dollar, using quarterly data.

UK\USA

$$\Delta erp = 0.000 - 0.941 res_{t-1} + 1.015 \Delta ukrp - 1.006 \Delta usrp$$
$$(0.007) \quad (-9.754) \quad (131.1) \quad (-108.1)$$

$R^2 = 0.997$ DW = 1.892 LM(4) = 5.000

Normality = 4.544 Heteroskedasticity = 0.462

LM(2) = 1.449 ARCH(4) = 2.636

Japan\USA

$$\Delta erp = -0.0015 - 0.972 res_{t-1} + 0.965 \Delta jprp - 1.015 \Delta usrp$$
$$(-0.131) \quad (-8.699) \quad (42.47) \quad (-122.8)$$

$R^2 = 0.996$ DW = 1.951 LM(4) = 1.930

Normality = 3.639 LM(2) = 0.064 ARCH(4) = 2.791

France\USA

$$\Delta erp = -0.003 - 1.112 res_{t-1} + 0.989 \Delta frrp - 1.003 \Delta usrp + 0.031 \Delta erp_{t-2}$$
$$(-0.264) \quad (-9.861) \quad (79.44) \quad (-86.06) \quad (3.231)$$

$R^2 = 0.994$ DW = 1.951 LM(4) = 2.045

Normality = 0.460 LM(2) = 0.184 ARCH(4) = 2.199

Table 8.18 ECM's for the system with the UK pound, using quarterly data.

Germany\UK

$$\Delta erp = -0.000 - 1.007 res_{t-1} + 0.976 \Delta grp - 0.995 \Delta ukrp$$
$$(0.007) \quad (10.260) \quad (46.800) \quad (117.700)$$

$R^2 = 0.995$ DW = 1.925 LM(4) = 1.720

Normality = 5.112 LM(2) = 0.301 ARCH(4) = 2.071

Japan\UK

$$\Delta erp = -0.001 - 1.110 res_{t-1} + 0.992 \Delta jprp - 1.010 \Delta ukrp + 0.120 \Delta erp_{t-3}$$
$$(0.089) \quad (10.700) \quad (43.180) \quad (129.301) \quad (1.893)$$

$R^2 = 0.996$ DW = 2.016 LM(4) = 2.334

Normality = 2.002 LM(2) = 0.463 ARCH(4) = 1.847

USA\UK

$$\Delta erp = 0.001 - 0.886 res_{t-1} + 1.008 \Delta usrp - 1.012 \Delta ukrp$$
$$(0.089) \quad (8.854) \quad (141.901) \quad (130.400)$$

$R^2 = 0.997$ DW = 1.883 LM(4) = 3.924

Normality = 0.104 LM(2) = 0.840 ARCH(4) = 9.340

France\UK

$$\Delta erp = 0.001 - 1.100 res_{t-1} + 0.988 \Delta frrp - 0.992 \Delta ukrp$$
$$(0.351) \quad (11.550) \quad (88.621) \quad (102.300)$$

$R^2 = 0.995$ DW = 1.961 LM(4) = 4.709

Normality = 3.553 LM(2) = 0.620 ARCH(4) = 10.752

Italy\UK

$$\Delta erp = -0.006 - 0.849 res_{t-1} + 0.994 \Delta itrp - 0.996 \Delta ukrp$$
$$(0.351) \quad (7.909) \quad (80.150) \quad (86.601)$$

$R^2 = 0.995$ DW = 1.913 LM(4) = 7.502

Normality = 1.197 LM(2) = 6.446 ARCH(4) = 5.405

The exchange rate risk premiums between the Sterling\ US dollar, DM| US dollar, Yen\US dollar, and Franc\US dollar are all I(1) variables as would be expected as none of these countries have attempted to ensure these bilateral exchange rates remained relatively fixed during the time period tested. They have by and large been allowed to vary by as much as the markets have judged their respective values and risks, which has usually involved a trend in one direction. In many cases the domestic currencies have appreciated against the dollar, and the risk premium been reduced, as their economies have become more stable relative to the USA. This is particularly the case with Germany and Japan, whereas the American economy's role as a reserve currency has become less pronounced. The only exceptions are the Canadian dollar\ US dollar exchange rate and Italian Lira\ US dollar exchange rates which are I(0) The former reflects the relatively stable relationship, especially since the formation of the North American Free Trade Association, although the latter case is less easy to explain, other than the Italian economy has had capital controls up until 1990.

The stock market risk premiums are all I(1) . The one exception is the French risk premium which is I(0) at the 10% level of significance, but not the 5% level. This result may reflect the capital controls that France has retained throughout the 1980's as well as the lower importance of the French stock market within the French economy as a whole. These factors have meant that the risk premium in the French stock market has not risen by as much as in the other countries. In the exchange rates with the UK pound, all are I(1) except UK|Canada, which is I(0), as is the case with most variables between these countries.

The trace results of the Johannsen Maximum Likelihood tests show one cointegrating vector present in all cases except the DM\ US dollar test. However, even in this test the result only just fails at the 10% level of significance. The reason for this failure, is as discussed earlier and supports the view that Germany's stock market has a minor role in the German economy. In the tests with the UK pound, there is evidence of one cointegrating vector in all the cases tested. In the France and Italy tests there are indications of two vectors at the 10% level of significance.

The long-run vectors are all similar as they are correctly signed, with a positive domestic risk premium coefficient and negative foreign coefficient. In almost all cases the coefficient is unity, when taken to two decimal places. Testing if the

coefficients are significantly different to zero produces positive results, not surprisingly so are not reported. This suggests that in all countries tested, in the long run the exchange rate risk premia and the domestic and foreign stock market risk premia are very closely related and that the agents in both markets have access to the same types of information, and use it in the same way to decide the levels of risk for both markets, or at least within a fairly short time scale. The tests on whether the risk premiums in the stock markets are the same suggests that in all cases the result is positive except the France\USA test. This would be due to the differences in size and importance of the respective stock markets.

The Breusch-Pagan statistic suggests that for both systems of equations, the assumption of common parameter vectors can be rejected. In particular in the system with the UK pound the statistic is very large, indicating the strength of the relationship between the risk premium in these countries. In the test using the US dollar, the results are remarkably uniform, as the explanatory power is high, as are the t-statistics and in most cases the relationship is almost immediate, with very few lags being significant. Also all the diagnostics are passed, without the need for any dummy variables.

The best result is that in the UK\USA test, as the explanatory power is very high and t-statistics both above 100. The error correction terms are all correctly signed and very significant. The coefficients on the error correction terms are either 0.9 or just above unity. This indicates that adjustment back to equilibrium is almost complete within three months. Where the coefficient exceeds unity, there is some evidence of overshooting, as in the France\USA test. The France|USA test also differs to the others in that the exchange rate risk premium from six months previously is significant, suggesting when the markets decide in the appropriate levels of risk, reference is made to previous levels.

The system of tests using the UK pound are almost identical to the others, suggesting the relationship does not depend on the strength of the US economy and financial markets. As before the explanatory power and t-statistics are high, particularly for the UK risk premium. In addition the coefficients on the risk premiums are about unity and all are correctly signed. The error correction terms tend to suggest overshooting is taking place as the coefficient exceeds unity, except for the Italy\UK test in which it is

only 0.85. In general the results from the tests using quarterly data give similar results to those using monthly data, although overall the variables are less significant.

8.4 Uncovered Interest Parity: An Alternative Representation

The results in the previous section are interesting in that they describe, and in part explain, the risk premium in the exchange rate, but they can also be used as a basis for a re-examination of one of the most important relationships in economics, namely Uncovered Interest Rate Parity (UIP). Bearing this in mind it is argued that as an alternative to the conventional riskless rate of return, either a return which includes a measure of risk, or a specific measure of risk, should be used in this relationship.

The original theory behind UIP has been ascribed to J.M. Keynes in the 1930's when the world's financial markets operated entirely differently and far more regulation was in place, so that international capital flows were far less. In the 1980's and 1990's capital markets are more integrated (Holmes and Pentecost 1992) and capital controls and related regulations far less pronounced, thus an alternative to the conventional UIP is now required.

The Uncovered Interest Rate Parity (UIP) condition plays a critical role in determining the dynamics of any change in the exchange rate. In equilibrium it states that the expected rate of depreciation of the exchange rate is exactly equal to the differential between the domestic and foreign interest rate. This assumes certain contentious conditions are met such as assets being perfect substitutes, investors being risk neutral such that no risk premium needs including and usually that investors form their expectations rationally. All of these assumptions tend not to hold, as assets are not perfect substitutes due to the presence of political and credit risk. Investors are generally risk averse, preferring less risk given a constant return, and also rational expectations has failed the various tests to determine whether it holds (Frankel and Froot 1987).

In general, the criticism concentrates on the presence of a risk premium due to different levels of perceived risk inherent in most economies, which itself depends on the political and economic specifics of any particular economy. In most cases UIP has used short-term interest rates which tend to be relatively risk free and thus fail to reflect the relative levels of risk apparent in an economy. As the exchange rate is

determined by markets which will take a long-term perspective as well as looking at short-run effects it seems that UIP also needs to include some measure of the long-term risks of an economy.

Due to the prevalence of the risk premium being mentioned as a major cause of the failure of UIP the first area to examine is whether the risk premium can be directly or indirectly modelled. It is often defined as the difference between the forward exchange rate and future spot rate, assuming rational expectations. The other alternative is to find a suitable proxy and this could involve using the expected returns from the relative stock markets or some measure of the relative risk premiums. The reason behind including such a variable stems from the relationship discovered initially by Chiang (1991) between the risk premium in the bilateral spot exchange rate and the relative risk between the domestic and foreign stock markets, and which is supported by the results in the previous section. This theory assumes that the stock markets have more influence over the exchange rate than vice versa as they react more quickly to changes in the macroeconomy. This theory was supported by the results suggesting the stock market risk premium could be relatively exogenous.

The expected return on the two country's stock markets as represented by a market index, could be used as an alternative to the interest rate. This would involve a CAPM type of relationship;

$$E(R_m) = R - \beta_{mm}(E(R_m) - R)$$

where;

R_m – *the* market return (8.7)

R - the riskless rate of return

β - correlation between the market portfolio's

Clearly as beta in this case is predicted to be unity, we are left with the expected return on a country's stock market as the alternative to the interest rate. However, as it is the risk premium that is of most interest, the alternative to the interest rate would be: $(E(R_m) - R)$.

This represents the degree to which the return on the stock market exceeds the riskless rate of return and in many respects is much better than using just the expected return from the stock market, as it includes a measure of the riskless return on which

to base the stock market return. So to this extent it acts as a variation on the UIP condition rather than an attempt at a completely different measure. If the stock market return is high then the riskless rate of return will likewise be high, however the differential between them will depend on how quickly the returns react to different perceptions of risk within an economy. As with Chiang the differential between the domestic and foreign risk premium will need to be considered as this will reflect the dynamics of the UIP condition.:

$$E(S_{t+1}) - S_t = (E(R_m) - R) - (E(R_m^*) - R^*) \tag{8.8}$$

where the domestic risk premium is the first expression on the right hand side of the equation. The higher is the risk premium associated with any particular economy, the more likely is it to attract foreign capital. The more risky an economy is perceived to be, either the lower is its stock market return and the higher its riskless interest rate, so the smaller the risk premium. The more successful is an economy the higher is the expected return from the stock market, whereas less successful economies have a relatively high interest rate to ensure stability and account for the higher risks of that economy so the further these are apart the more successful is that economy expected to be.

To an extent introducing stock market returns will add a variety of complications unrelated to the expected change in the exchange rate. For instance the size and development of a particular stock market will have an influence on the risk premium, such that the more developed it is , the less volatile it should be and thus the lower the risk premium. However the size and development of a country's stock market is often unrelated to its economic strength, often because of different financial structures for example Germany. It also fails to take account of a particular country's trade position and whether the authorities are attempting to manage the exchange rate.

8.4.1 Uncovered Interest Parity: Empirical results

The following results are based on the relationship;

$$E\Delta s = E_{t-1}(s_t - s_{t-1}) = \alpha + \beta(\{R_{m_t} - r_{t-1}\} - \{R_{m_t}^* - r_{t-1}^*\}) \tag{8.9}$$

This equation is similar to equation (8.3), except it includes the restriction that the domestic and foreign interest rates are the same. Another way of viewing this equation is that if the risk premium in the exchange rate and differential between the domestic and foreign stock market risk premiums are closely related, then using this stock market risk premium to proxy exchange rate risk should be an effective way of explaining exchange rate movements in terms of risk rather than just return.

This suggests that it is not the differential in returns that drives the changes in the exchange rate, but the differential in risk premiums, as risk is perceived as being more important to international investors. However there is a problem with testing the above relationship, as one variable is predominantly I(1) and the other I(0). A possible way around this problem is to use a dynamic model such as an Error correction model. In this case, assuming the exchange rate is I(1), the long run equilibrium relationship would take the following form;

$$e = \beta\{(R_m^e - r) - (R_m^{e*} - r^*)\} \tag{8.10}$$

Where e is the bilateral spot exchange rate. In this case the error correction term, would take the form;

$$[e - \beta\{(R_m^e - r) - (R_m^{e*} - r^*)\}] \tag{8.11}$$

This series needs to have a constant unconditional mean of zero, which does not require this particular error correction term to be stationary. One reason for this is that the variance of such a series is non-constant. However such a series will not fit the Engle-Granger definition of cointegration which requires an I(0) error correction term. One reason the error correction term may not pass the Dickey-Fuller test for stationarity is because the series may be a near integrated process, such that the process generating these two variables may have a root which is close to but not actually on the unit circle. It has been proved (See Bannerjee et al 1993) that similar finite sample characteristics can be noted in both unit root and near integrated processes.

Therefore despite the lack of the stationary error correction term, the model may not be spurious if the residuals of the ECM are themselves I(0). This presupposes that the exchange rate is I(1) such that the change in the exchange rate is I(0). In some cases

this does not occur and the exchange rate is I(2). This suggests a more appropriate model for these countries includes the uncovered interest parity condition acting as the long run relationship, which is against the conventional view which uses it as a dynamic condition. In the following tests monthly data was used, from 1982 month 1 to 1994 month 1[1] .

Table 8.19 ADF test for stationarity on the exchange rates, critical values are -2.87(-2.59) at the 5%(10%) levels of significance, where ER refers to the bilateral exchange rate and ΔER is the first differenced form.). The sample consists of 144 observations.

Country		ER	ΔER		
	lags	ADF	lag	ADF	I
UK\USA	6	-1.732	10	-3.438	1
Japan\USA	11	-1.091	10	-2.368	1
Germany\USA	0	-0.960	10	-2.606	1
Canada\USA	10	-2.010	7	-3.165	1
Japan\UK	0	-1.870	6	-4.467	1
Germany\UK	5	-1.510	5	-5.130	1
Canada\UK	0	-2.521	10	-3.778	1
Germany\Japan	0	-1.231	4	-4.081	1
Japan\Canada	11	-1.087	10	-2.326	1
Germany\Can.	0	-0.925	10	-2.839	1

[1] Tests were also carried out using the quarterly data from 1974 quarter 1 to 1993 quarter 4. In general these tests gave similar results to the monthly tests, although the variables were less significant.

Table 8.20. Tests for stationarity of the risk premium differentials, where RPD refers to the risk premium differential and ΔRPD is the first differenced form.)

Country	RPD		ΔRPD		
	lag	ADF	lag	ADF	I
Japan\Germany	0	-1.009	4	-3.787	1
Canada\Japan	1	-1.815	8	-3.448	1
Canada\Germany	0	-0.361	8	-3.407	1
UK\USA	0	-2.424	7	-4.324	1
Japan\UK	0	-1.468	7	-4.117	1
Japan\USA	0	-2.082	6	-4.868	1
Germany\UK	0	-0.580	9	-3.232	1
Canada\UK	7	-3.496			0
Canada\USA	6	-1.863	6	-5.707	1
Germany\USA	0	-1.568	8	-3.186	1

Table 8.21 Residuals from the following E.C.M's where the E.C T. is I(1), the critical value is -2.89 (-2.57) at the 5% (10%) level of significance, from Fuller (1976).

Country	lags	ADF	I
UK\USA	5	-4.149	0
Japan\USA	10	-2.198	1
Germany\USA	8	-3.088	0
Canada\USA	7	-3.358	0
Germany\UK	11	-2.756	1\0
Japan\UK	5	-3.925	0
Japan\Canada	10	-2.851	0
Germany\Japan	6	-3.866	0
Germany\Canada	10	-2.939	0

(In the following ECM's, "ect" represents the error correction term, which is the difference between the dependent and independent variables in levels)

Table 8.22 ECM's for the alternative version of the UIP condition, using monthly data.

UK\USA

$$\Delta uke = 0.016 - 0.520ect_{t-1} + 1.320\Delta ukrpd + 0.918\Delta ukrpd_{t-7} - 1.101\Delta ukrpd_{t-10}$$
$$(2.966) \quad (3.639) \quad (3.314) \quad (2.439) \quad (3.073)$$
$$-0.166\Delta uke_{t-6} + 0.117D1$$
$$(2.286) \quad (5.100)$$

$R^2 = 0.351$ DW = 1.808 LM(12) = 5.131 Reset = 0.525
Normality = 2.054 Heteroskedasticity = 0.303 LM(4) = 1.290
LM(6) = 4.028 LM(8) = 4.205 ARCH(12) = 6.218

Germany\USA

$$\Delta ge = -0.002 + 0.012ect_{t-1} + 1.66\Delta grpd + 0.139\Delta ge_{t-11} + 0.138D1$$
$$(0.711) \quad (0.131) \quad (2.570) \quad (1.704) \quad (4.056)$$

$R^2 = 0.159$ DW = 2.001 LM(12) = 4.576 Reset = 0.395
Normality = 0.001 Heteroskedasticity = 0.517 LM(4) = 0.918
LM(6) = 1.750 LM(8) = 3.035 ARCH(12) = 9.044

Japan\USA

$$\Delta jpe = -0.003 - 0.318ect_{t-1} - 0.078\Delta jprpd - 0.208\Delta jpe_{t-6}$$
$$(1.048) \quad (2.261) \quad (.139) \quad (2.492)$$

$R^2 = 0.071$ DW = 1.811 LM(12) = 11.193 Reset = 0.122
Normality = 5.875 Heteroskedasticity = 1.493 LM(4) = 1.457
LM(6) = 3.917 LM(8) = 3.919 ARCH(12) = 17.121

Canada\USA

$$\Delta cne = 0.006 - 0.210ect_{t-1} + 0.446\Delta rpd - 0.293\Delta rpd_{t-8} + 0.038D1$$
$$(2.474) \quad (2.743) \quad (2.530) \quad (1.797) \quad (5.078)$$

$R^2 = 0.243$ DW = 1.983 LM(12) = 9.535 Reset = 0.432

Normality = 4.477 Heteroskedasticity = 0.500 LM(4) = 0.980

LM(6) = 1.889 LM(8) = 6.614 ARCH(12) = 7.356

Germany\UK

$$\Delta gue = -0.004 - 0.011ect_{t-1} + 0.289\Delta rpd + 0.612\Delta rpd_{t-1} - 0.770\Delta rpd_{t-10}$$
$$(1.010) \quad (0.165) \quad (1.031) \quad (2.165) \quad (2.729)$$
$$-0.155\Delta \lg ue_{t-5} - 0.094D1$$
$$(1.977) \quad (4.123)$$

$R^2 = 0.231$ DW = 1.794 LM(12) = 7.003 Reset = 2.320

Normality = 0.426 Heteroskedasticity = 0.329 LM(4) = 2.665

LM(6) = 3.817 LM(8) = 4.748 ARCH(12) = 15.776

Japan\UK

$$\Delta jue = -0.015 - 0.401ect_{t-1} + 1.120\Delta rpd - 0.788\Delta rpd_{t-10} - 0.168\Delta jue_{t-6}$$
$$(4.404) \quad (3.785) \quad (3.259) \quad (2.324) \quad (2.231)$$
$$-0.153\Delta jue_{t-12} - 0.128D1$$
$$(2.013) \quad (4.466)$$

$R^2 = 0.292$ DW = 2.067 LM(12) = 8.968 Reset = 1.078

Normality = 2.825 Heteroskedasticity = 0.041 LM(4) = 2.704

LM(6) = 5.795 LM(8) = 7.088 ARCH(12) = 13.637

Germany\Japan

$$\Delta gje = 0.000 - 0.148ect_{t-1} + 1.301\Delta rpd + .1.450\Delta rpd_{t-5} + 0.075D1 - 0.095D2$$
$$(0.041) \quad (1.114) \quad (2.106) \quad (2.266) \quad (2.916) \quad (3.707)$$

$R^2 = 0.199$ DW = 1.726 LM(12) = 10.032 Reset = 0.082
Normality = 1.082 Heteroskedasticity = 1.496 LM(4) = 4.287
LM(6) = 4.601 LM(8) = 7.849 ARCH(12) = 16.669

Canada\Japan.

$$\Delta cje = -0.013 - 0.400ect_{t-1} + 0.850\Delta cjrpd - 0.804\Delta cjrpd_{t-4}$$
$$(3.638) \quad (3.237) \quad (1.873) \quad (1.723)$$

$R^2 = 0.094$ DW = 1.962 LM(12) = 11.055 Reset = 0.108
Normality = 2.905 Heteroskedasticity = 0.053 LM(4) = 0.405
LM(6) = 2.054 LM(8) = 2.392 ARCH(12) = 10.587

Canada\UK { OLS as both variables are I(0)}

$$\Delta cue = 0.005 + 0.660rpd + 0.120D1 - 0.110D2$$
$$(1.847) \quad (4.118) \quad (5.190) \quad (3.475)$$

$R^2 = 0.267$ DW = 2.046 LM(12) = 13.804 Reset = 0.431
Normality = 1.403 Heteroskedasticity = 0.545 LM(2) = 0.081
LM(4) = 1.693 LM(6) = 2.886 LM(8) = 7.046 ARCH(12) = 3.208

The following dummy variables were included:UK\USA; D1-1992 m9 and 10, Germany\USA; D1-1991 m3, Canada\USA: D1-1992 m9 and 11, Germany/UK; D1-1992 m9, Japan\UK; D1-1992 m9, Germany\Japan; D1-1993 m2, D2-1984 m2, Canada\UK; D1-1992 m9 and 11, D2-1983 m3.

All the tests are from 1982 month 1 to 1993 month 12.The most obvious point to note is that these results are no way near as good as the results relating to the risk premiums. The main reason for this is that in the earlier tests the risk differential in the stock market fully explains the risk premium in the exchange rate. However it is evident that in the uncovered interest parity tests there are other factors required to explain the expected change in the exchange rate. This view is supported by the low goodness of fit statistics, which in the latter tests are about 0.3, compared with above 0.95 in the former tests. This means that it needs a more complete model which includes both asset and goods markets and a mechanism for changes in prices.

Before concentrating on the risk premium differential, it is worth noting the other possible combinations. In the case of the traditional uncovered interest parity relationship, in which short term interest rates are used, the tests all failed, so are not reported. This is much the same outcome as experienced by other tests using a variety of methods (Macdonald and Taylor 1992). In some of these tests the differential is often not only insignificantly different to nought, but also incorrectly signed. This tends to particularly be the case with countries other than Germany, as with these results Germany is often different to the other countries. Another possibility involves using the return to the stock market, which would have the benefit of including some measure of risk, so answering many of the criticisms of UIP. The results from these tests followed a similar pattern to those with the risk premium, but the differential was far less significant and goodness of fit statistic appreciably lower.

The best results were attained when the differential between the risk premiums was used. Initially both risk premiums were included in the tests individually, as with the earlier tests, but the results were mixed. For instance in the case of the UK and USA, the UK risk premium was significant, whereas the USA's was not. So to obviate this problem just the differential was included, as can be seen in most cases this relationship proved reasonably effective, reflecting the importance of the differential when considering movements of capital between countries, rather than the specific level of each individual risk or return. Regardless of which method was used, both OLS and ECM's gave similar results.

In general the monthly results are reasonably good, with the exception of tests involving Germany. Overall the change in the exchange rate is I(0), and the risk premium differential is I(1). The Dickey-Fuller tests on the exchange rate show that it

is predominantly I(0). In almost all cases the risk premium differential is I(1), with the exception of the Canada\UK exchange rate, which is I(0). This result supports evidence from other chapters which shows that the UK and Canada have a highly stable relationship with regards to risk in their respective economies. This again shows the importance of historical and cultural factors when analysing risk between two countries. Perhaps more surprisingly is that risk differentials between the USA and Canada are not I(0) considering the strength of the relationship between these two countries, encountered in the earlier section.

The results of the error correction models can be broadly divided into two. Firstly there are the pure E.C.M.'s in which Germany is one of the countries in the test. In all these examples the error correction term is insignificant and in some cases it is even positive suggesting an unstable relationship. Thirdly there are the E.C.M.'s in which Germany does not appear, and in all cases, except the Japan\USA test the error correction term is significant and the model works reasonably well, albeit the goodness of fit statistic is low and a number of dummy variables are required to pass the diagnostic tests.

In the Japan\USA test the error correction term is reasonably significant and the coefficient of 0.4 suggests a fairly quick return to equilibrium. But in the Japan\Canada test the error correction term is significant and the risk premium differential is unlike in the Japan\USA test significant . This is a little surprising as country's exchange rates with the US and Canada tend to behave in a similar way. As the Japan\USA test is the only one that fails, with the exception of the German tests, the explanation for the insignificance of the risk premium differential must be due to the huge capital flows that have been moved between these two countries, as set out in chapter four. Due to the relative risklessness of the two economies, it may be that investors take less account of the relative risks of these economies when making their investment decisions.

In the Germany\USA test the error correction term is insignificant, as is the case with all the tests in which Germany is included. However the risk premium is significant and correctly signed and there is also some influence from the exchange rate ten months previously although the sign is negative. In addition a dummy variable is required for 1991 month 3 representing the consequences of German reunification. So

although the risk premium differential is significant and the residuals from this test are stationary, in the short run the relationship does not hold for Germany.

Of the other three tests in which Germany is included, in all three cases the error correction term is insignificant. Only in the Japan\Germany test is the risk premium differential significant with no lags required. However in the UK\Germany case the main influence occurs after one lag and there is a further significant influence ten months previously which is oppositely signed. All these tests require dummy variables to pass the diagnostic tests and all three goodness of fit statistics are below 0.3, the dummy variables representing reunification and in the case of the Germany\UK test, the UK leaving the ERM.

One of the strongest results is the UK\USA test, in which both error correction terms and the risk premium differential are significant at the 1% level. This reinforces the evidence from the other tests involving these two countries in the previous chapter. The error correction term has a coefficient of roughly 0.5 suggesting a reasonably quick readjustment. There is a further significant influence from the risk premium seven periods previously, also as in the UK\Germany test there is a highly significant influence but oppositely signed, ten months previously. As in most cases the coefficient on the risk premium exceeds unity, as a relatively small change in the risk differential is required for any change to occur in the exchange rate. The strength of this result is mainly due to the strength of these countries capital markets, but is also due to the lack of capital controls during the 1980's.

There is a significant effect from the change in the exchange rate six months previously, although it is in the opposite direction. This appears to be a common feature in many tests, whereby the change in the exchange rate six or twelve months previously exerts a strong influence, again suggesting seasonal factors are playing a part. Also as with almost all tests the time around the UK's exit from the ERM requires a dummy variable This appears to have had a particularly strong affect on the perceived riskiness of Sterling, as would be expected. In addition this test produces the highest goodness of fit statistic in excess of 0.35. Again all diagnostics are passed with a good Reset result.

It would be expected that the Canada\USA result would have been reasonable due to the close proximity of these two countries, however it was not as good as some of the

others. This may be because the asset markets are not as closely linked as between other countries. The error correction term is reasonably significant but a coefficient of just 0.2 is very low, suggesting a slow readjustment. Also the risk premium differential is significant, but again the coefficient is below 0.5. The dummy variable for 1992 months 9 and 11 is particularly significant and represents the changes in the Canadian economy and political situation that occurred about then.

A particularly favourable result occurred with the Japan\UK test with both the error correction term and risk premium differential being significant at the 1% level of significance. However the coefficient on the error correction term is roughly 0.4, so adjustment occurs fairly slowly. Once again the lagged risk premium differential of ten months previously is significant and oppositely signed, a key feature of the UK exchange rate. There is also a strong effect from the change in the exchange rate six and twelve months previously, also important features of both the UK and Japan. As with other tests a dummy variable for the UK leaving the ERM is needed, and all the diagnostics are acceptable.

Arguably the most effective result is with the Canada\UK test, in which a simple OLS test is carried out for this wholly I(0) relationship. As can be seen the risk premium differential is highly significant, although the coefficient is fairly small at just 0.66. This suggests a large movement in the risk premium is required to produce a significant change in the exchange rate. In order to produce normally distributed residuals two dummy variables are needed. The first is for 1992, months 9 and 11, the second for 1985 month 3, both are due to economic and political changes, following changes in government. The constant term is significant as is the case in most of the tests involving the UK, particularly with the Japan\UK test. This suggests the UK change in the exchange rate has some predictable features possibly related to the continual decline against most currencies over this time period. despite the limited number of variables in this regression, the explanatory power is still reasonably high.

8.5 The Kalman Filter

There are two main reasons for using a time varying parameter method like the 'Kalman Filter' to test for UIP, regardless of whether return or risk is used. Firstly it overcomes many of the problems associated with rational expectations such as the lack of information available to investors. The problem of being purely forward

looking is overcome to some extent by the way this method makes use of past information to calculate future or expected values of a variable. The relevance of this method to this relationship is discussed later, the mechanism of the Kalman filter is included in the appendix to this chapter. In the previous section there was evidence which implies that when forming expectations on the future exchange rate using differentials in risk premiums investors behave rationally over a monthly span. This supports the general feeling that the failure of UIP is due to a time varying risk premium, although some of the basic criticisms of rational expectations remain (Macdonald and Taylor 1992).

The basic equation to be examined is as follows:

$$\Delta s_t^e = s_t - s_{t-1} = \alpha_{it} + \beta_{it}\{(R_m^e - r) - (R_m^{e*} - r^*)\}$$

The $\alpha_{it}(i = 1,2,3...)$ parameters are stochastic constants. (8.12)

The β_{it} is a stochastic parameter.

The stochastic constants partial out influences which act systematically on the expected change in the exchange rate. Such a relationship suffers from the problem of omitted variables when using an OLS based technique, however this stochastic constant takes account of this although at the cost of a less persuasive explanation of the determinants. So unfortunately it is impossible to say whether there are any causal links between these variables. Also by construction the error processes are inherently stationary which overcomes the need to first difference variables, overcoming one of the most serious problems when using OLS (Hall and Haldane 1991)

As with the conventional UIP condition it is assumed that the value of beta is unity and the value of the constant zero. The aim of these tests is to observe the extent to which the beta's of those countries tested converge towards unity, or some other value. If past information is relevant then some movement to unity should be apparent. Using such tests should also show if there has been any movement of the beta's to their predicted value over the 1980's as capital controls have been eased and international capital markets have become more widely traded by foreign investors. It should in addition illustrate the effects of specific events such as the stock market crash or effects of the EMS on the exchange rate (See Hall and Haldane 1991)[2] .

[2] There is a more detailed discussion of the relevance of the Kalman Filter to the formation of expectations ,especially the formation of adaptive expectations, in Cuthbertson (1988).

Due to the previous set of results, in this section of the chapter it is the risk premium differential that continues as the main area of analysis. Again both monthly and quarterly data is tested and as before the results are quite different for each. Another trend which has appeared before is that tests with Germany tend to give different results, and the reason that this occurs could be partially due to the marked changes experienced by the parameters after 1990, a factor which this method makes particularly evident. Graphical representation of the results is contained in Appendix B, for both monthly and quarterly results.

In the monthly data, all the parameters are positively signed as predicted. Until 1990 all the beta's tend to follow a similar pattern suggesting a degree of correlation between the risk differentials and that the strength of these risk premiums as regards the exchange rate tends to be controlled by world factors as much as domestic. Also the parameters tend to follow similar values with the exception of the Canada\USA test in which the value of the parameter is about a third of that for the other countries. This suggests a large change in the risk differential is needed to effect the exchange rate suggesting risk is not so important between these countries, perhaps because of the similarity between the two economies.

It is assumed that the parameter should be unity, as with the conventional UIP, such that a unit change in risk equally affects the change in the exchange rate. During the early 1980's and up to roughly the end of 1988 there is a strong trend towards this situation such that around the world the risk differential parameter approaches unity. Thus the risk differential over this period of time is becoming steadily more important as a means of determining the expected movement in the exchange rate.

There is one exception to this trend and this involves the Japan\Germany tests in which the convergence towards unity occurs up until mid 1990, when it reaches a value of one. Having peaked at this point it fairly rapidly declines during 1991, reaching a value of 0.2 by the beginning of 1992. The reunification of Germany is the most likely explanation and reduces the role of risk in determining the German exchange rate. One exception to the positive sign on the parameters is that for the UK\USA test up until mid 1984 when it is negative. This may be due to the role of North sea oil in appreciating Sterling despite the problems this caused to the underlying strength of the UK economy.

In the case of the other countries the parameter reaches its peak in 1988 then gradually falls back until it is roughly half its previous level. In the exchange rates involving Germany the fall is far more marked. The rise in the parameter towards unity is as would be expected because capital markets became more integrated due to deregulation and changes in the financial sector about this time. It is also due to the removal of capital controls especially in the early 1980's and the increasingly reduced prospect of their reintroduction at a later date.

However the reason for the fall in the parameter after the late 1980's is less clear other than the world recession which occurred in the late 1980's. This in part was related to the problems in Germany due to the need for high interest rates, which had an effect on other economies and their interest rates. So the use of the stock market risk premium as a measure of risk could have started to break down due to the unusual behaviour of world interest rates. Alternatively it may be concerned with the fall in the stock market at the end of 1987.

In many respects the Japanese results are the best with the exception of the Japan\Germany result as their reduction in the beta parameter after 1988 is less than in other countries. This suggests that the problems associated with German reunification and the subsequent world recession had a lower impact on Japan than the other countries. Another feature of the Japanese results is that the changes in the parameters are more gradual which is a little unexpected considering the volatility of the Japanese stock market. This observation is supported by the smoothed parameters in which these three tests produce a constant parameter level of between 0.3 and 0.4. In contrast to this with the exception of the German\Canada test, all the German tests when smoothed are non-constant and still produce a high degree of volatility.

The tests using quarterly data, from 1974 quarter 1 to 1993 quarter 4, are with a few exceptions much better than the monthly results, which are from 1982 month 1 to 1993 month 12, which is the opposite to those results in the previous section. Overall the beta's are much closer to unity, especially during the 1980's. However again the results with Germany are generally worse than for the other countries, although the Germany\Canada result is reasonable with all the parameters being about unity with a few exceptions, up until 1990 when again German reunification causes the parameters to decrease sharply. As before most of the parameters are correctly signed, the notable

exception on this occasion being the German\Japan test which is negatively signed on occasions in the 1970's and early 1980's. In most of the other tests negative parameters are exclusively in the early 1970's which is primarily due to the existence of capital controls which all countries retained at this time.

A particularly unusual case is the UK\USA test in which the parameters are negatively signed up until 1981, after which all capital controls had been removed. After this there is a gradual increase in the parameter until 1985 when it reaches a value of unity which remains until 1991, after which it gradually decreases. In this case there is a particularly sharp fall after the end of 1990 and also the end of 1992 which roughly correspond to the times just after the UK's entry into the ERM and immediately following their withdrawal from it. This again shows how it is past information which affects these results.

As before the best results are those with Japan except the Germany\Japan test which is particularly volatile as noted earlier. Also as mentioned before in the previous section the UK and Japan have a particularly close relationship with the parameter values being consistently unity from the 1970's onwards. Looking at the results from the smoothing process the parameter has a constant value of 8.99. Both the Canada\Japan and Japan\USA results are good with the smoothing process producing a constant result for both which exceeds 6.5 in all cases and most interestingly does not fall in the 1990's unlike the monthly results.

As with the monthly results the Canada\USA test gives consistently lower parameter values than the other tests and never exceeds a value of 0.4. But again the value is consistent from the early 1980's onwards. As mentioned the Canada\UK test is also particularly good from the 1980's onwards, although in the 1990's the parameter value dips slightly, again the break seems to occur when the UK left the ERM. Overall Canada's tests are the most effective as the Canada\Germany test is reasonably good relative to the other German tests. As is evident from tables 8.23 and 8.24, there is very little sign of any serial correlation with the Kalman Filter.

In many respects these results are the exact opposite to those from the earlier section as the quarterly results offer much more consistent parameter values from the early 1980's onwards and in addition they are much closer to unity. A possible explanation could be that the results from the earlier section suggest rational expectations held for

the majority of the monthly tests as the explanatory variable was reasonably significant. However the quarterly tests produced less powerful evidence of the relationship perhaps due to the failure of rational expectations over three months. As Kalman filters incorporate a different form of expectations to purely rational expectations, it could be that this combination is not appropriate for monthly data.

It may be that the type of expectations incorporated into the Kalman filter works much better with quarterly data, where the majority of the tests failed with only rational expectations. When agents form their opinions on what the exchange rate will be in three months time, according to an analysis conducted by Frankel and Froot (1987), they use a mixture of adaptive and rational expectations as represented by the Kalman filter, which fits with evidence that expectations in the foreign exchange markets tend to be formed in a variety of ways (Frankel and Froot 1987). It may be that the relevant information is not available for three months into the future or that agents do not trust it, so they form their judgement on these future values using the information that is available as well as past experience.

Table 8.23 Box-Pierce statistics, testing for serial correlation with the Kalman Filter (quarterly data)

Countries	(1)	(4)	(8)
UK/USA	0.65	6.59	19.17
Germany/USA	0.16	8.81	13.17
Japan/USA	0.01	2.86	7.79
Canada/USA	0.18	6.65	9.39
Germany/UK	0.50	1.81	3.39
Japan/UK	1.99	6.72	8.71
Canada/UK	0.76	3.54	13.29
Germany/Japan	2.23	2.35	23.72
Germany/Canada	0.01	0.75	2.11
Japan/Canada	0.01	0.75	2.11

All statistics follow a chi-squared distribution, with the following critical values at the 5% level (1) 3.841, (4) 9.488, (8) 15.507.

Table8.24 Box-Pierce statistics, testing for serial correlation with the Kalman Filter (monthly data)

Countries	(1)	(4)	(8)
UK/USA	0.52	1.42	7.53
Germany/USA	0.03	0.39	3.85
Japan/USA	0.57	1.53	7.46
Canada/USA	1.41	2.29	6.24
Germany/UK	2.48	3.08	5.18
Japan/UK	2.02	3.79	6.56
Canada/UK	0.01	2.18	6.87
Germany/Japan	0.08	3.97	6.61
Germany/Canada	0.01	0.47	2.79
Japan/Canada	0.11	0.75	3.50

All statistics follow a chi-squared distribution, with the following critical values at the 5% level (1) 3.841, (4) 9.488, (8) 15.507.

8.6 Conclusion

These results indicate that the risk premium on the foreign exchange market is positively related to the risk premium on the domestic stock market and negatively related to the risk premium on the foreign stock market. This implies that with monthly data, these two markets use the information available to them in an almost equally efficient way to determine the levels of risk in the foreign exchange market and stock market. It is also evident that the relationship holds in the long and short term as well as between non-US currencies. Following an innovation, the adjustment back towards equilibrium is very quick and can involve some overshooting.

The results offer support for the view that the exchange rate contains a risk premium and that it is related to the risk premium in the stock market. This implies that UIP will not hold, as investors are risk averse. This result supports the various tests on UIP, which suggest it is not an effective mechanism for determining exchange rate dynamics (Macdonald and Taylor 1992). To overcome the problem of risk and UIP, it

seems appropriate to attempt to adapt the UIP condition such that it takes into account the risk averse nature of agents.

The results of the tests on the alternative version of UIP offer some evidence that there is an effective alternative to the UIP condition, and this involves the use of a risk premium relationship In addition the results show that rational expectations may be relevant for monthly data, but a different type of expectations may be required when using quarterly data. However there is an important difference between the monthly and quarterly data, as the quarterly data covers some of the 1970's when capital controls were more evident. So It could be that the failure of many of the quarterly results is due to the influence of capital controls in the 1970's, as much as by the different time periods. However it was not possible to test the quarterly data on just the 1980's alone due to the lack of observations.

Appendix A

The Kalman Filter

The Kalman filter is an example of a time varying parameter model, and is primarily used to test for the way in which one variable moves relative to another, over a set period of time. The method was originally developed by engineers in the 1900's, but has recently been used by economists. The main application for the technique is in the area of tests for levels of convergence amongst both macroeconomic and microeconomic variables. Prior to the use of the Kalman filter, tests for convergence were relatively uncoordinated, whilst the use of this technique did not become popular until the late 1980's. In particular Hall and Haldane (1991) used it to test for convergence amongst exchange rates.

There has also been a second reason for applying the Kalman filter, which relates to the ways in which it incorporates a learning process into the model. It can be viewed in a general sense as a form of adaptive expectations, in which the parameters are being continually adjusted each time period as new information becomes available. Unlike adaptive expectations, the Kalman filter is optimal not just under a specific data generating process, and so can be applied to more general situations. In addition agents in the market do not commit systematic forecast errors, given a particular set of information, which is reflected by the Kalman filter as it gives minimum mean square estimations under normality.

This technique offers a way around the more stringent assumptions of the rational expectations hypothesis. As although most accept agents use all information efficiently, it is harder to believe that information becomes available immediately to all market participants. With the Kalman filter it is not necessary for agents to know of all available information and thus the true model of the economy, but it does assume they use that information efficiently. In this way the Kalman filter is acting in the alternative form of rational expectations;

$$y_t = \beta x_t + u_t \tag{8.13}$$

The Kalman filter developes this basic principle to allow the beta to vary stochastically and also assume that agents have some previous knowledge of beta at time t=0. This

latter developement is one complication that the Kalman filter suffers from, as these initial estimates either need to be provided, or else the first few observations are used to generate this initial position, which means the first few data points have to be ignored.

Apart from the benefits of the Kalman filter associated with expectations formation, and deriving the time path of a particular parameter, it also has a variety of statistical advantages over OLS estimation. For instance the problem of omitted variables can be a serious problem using OLS however with the Kalman filter the presence of the stochastic constant overcomes such a problem as it proxies these variables. On the other hand such models tend to require information on the model's structure, and to an extent information on the variance and covariance of the errors, which in more complicated models can be difficult to obtain. However this is less of a problem with the more basic tests, such as a relationship between interest rates.

The derivation of the Kalman filter technique is relatively complicated, but in this section it is introduced in a simplified format concentrating on it's relevance to expectations formation models and its advantages over OLS. In essence it expresses an equation in state space form, whereby the model is expressed in two separate equations called the measurement and transition equations. Applying the Kalman filter to such a set of equations produces a set of recursive equations which can be used to produce a series for the one-step ahead prediction errors as well as their variances.

Following this maximum likelihood (ML) methods are used to generate estimates of the as yet unknown parameters produced by the recursive equations. It is possible to view a general form of the Kalman filter in terms of Bayes theorem. This allows the integration of previous information with the data, to produce an optimal posterior estimator, which acts as an updating process.

To begin with, there is the linear model where parameters are fixed, and the usual assumptions apply;

$$Y = \beta X + u$$

Where β^* is the estimated coefficient by OLS, that produces BLUE, and is defined as; (8.14)

$$\beta^* = (X'X)^{-1} X'Y$$

This then gives the following variance-covariance matrix;

$$Var\beta^* = \sigma^2(X'X)^{-1} \tag{8.15}$$

If the last two equations are estimated during a specific time period, then the introduction of new observations on X, can be incorporated to create new predictions of Y, without the need to change the structural model. These new observations give;

$$Y_1 = \beta X_1 + u_1 \tag{8.16}$$

Assuming u and u_1 are uncorrelated, the predicted values of Y_1 called Y_1^* give;

$$Y_1^* = \beta^* X_1 \tag{8.17}$$

With the one-step ahead forecast called;

$$V_1^* = (Y_1 - Y_1^*)$$

This has a covariance matrix given by;

$$\mathrm{Cov}(v_i^*) = (X_1 P_0 X_1' + v_1) \tag{8.18}$$

Where $P_0 = Cov(\beta^*)$

This value represents the uncertainty in estimating the beta parameters. Also the variance of both Y and it's predicted value are a function of the covariance of the estimated betas, as well as the original uncertainty of the first equation.

The next step is to produce a measurement equation, transition equation, prediction equation and the updating equations. The measurement equation is defined by;

$$Y_t = \beta_t X_t + u_t \qquad u_t \approx N(0,\Omega_t) \tag{8.19}$$

So the error term is predicted by a n*1 vector and the usual assumptions about the mean. To measure the betas requires the following transition equation;

$$\beta_1 = T_t \beta_{t-1} + R_t \eta_t \qquad \eta_t \approx N(0,\Omega_t) \tag{8.20}$$

T and R are m*m matrices, the error term is defined as before. In addition it is assumed that the betas and error terms in both equations are uncorrelated.

Using initial estimates of β_{t-1} called β_1^* at time t - 1, and initial estimates of P_{t-1}.
The unbiased predictor of β_t at t - 1 is β_1^*, derived from the transition equation;
$\beta_{t/t-1} = T_1\beta_{t-1}$

Based on information at time t-1, the estimate of the covariance matrix takes the following form;

$$\mathrm{Cov}(\beta_{t/t-1}) = (T_t P_{t-1} T_t' + R_t \Omega_t R_t') \tag{8.21}$$

These two equations comprise the prediction equations, and both beta and its covariance, which was calculated without requiring any reference to the Y observations. So at time t-1, this information can be used to predict Y at time t, as well as the covariance matrix of one step ahead prediction errors. The one step-ahead prediction error is defined as;

$$V_1^* = Y_t - Y_{t/t-1}$$

This gives a covariance matrix of the form; (8.22)

$$\mathrm{Cov}(V_t^*) = (X_t P_{t/t-1} X' + \Omega_t)$$

Finally there is the updating equations for the covariance matrix and beta, which are given by;

$$P_t = P_{t/t-1} - P_t X_t'(F_t)^{-1} X_t P_{t/t-1}$$

and (8.23)

$$\beta_t = \beta_{t/t-1} + P_{t/t-1} X_1'(F_t)^{-1}\{Y_t - X_t\beta_{t/t-1}\}$$

To produce the smoothing equations requires that in the last round of the Kalman filter, a recursive process works back from the betas and covariance matrix, thereby obtaining the best estimates at t-1,t-2...t-n. However it is difficult to interpret these smoothed estimates in an economic sense, But they can be viewed as the best possible estimates available with regard to the data set, but still allowing the parameters to vary over time.

Appendix B

The following is a graphical representation of the coefficient on the risk premium differential in the alternative representation of the UIP condition. The letters cnp-Canada/USA, bdp-Germany/USA, bcp-Germany/Canada, jpp-Japan/USA, ukp-UK/USA, jup-Japan/UK, bup-Germany/UK, jbp-Japan/Germany.

Figure 8.1 The Kalman Filter coefficients for the risk premium form of UIP (monthly)

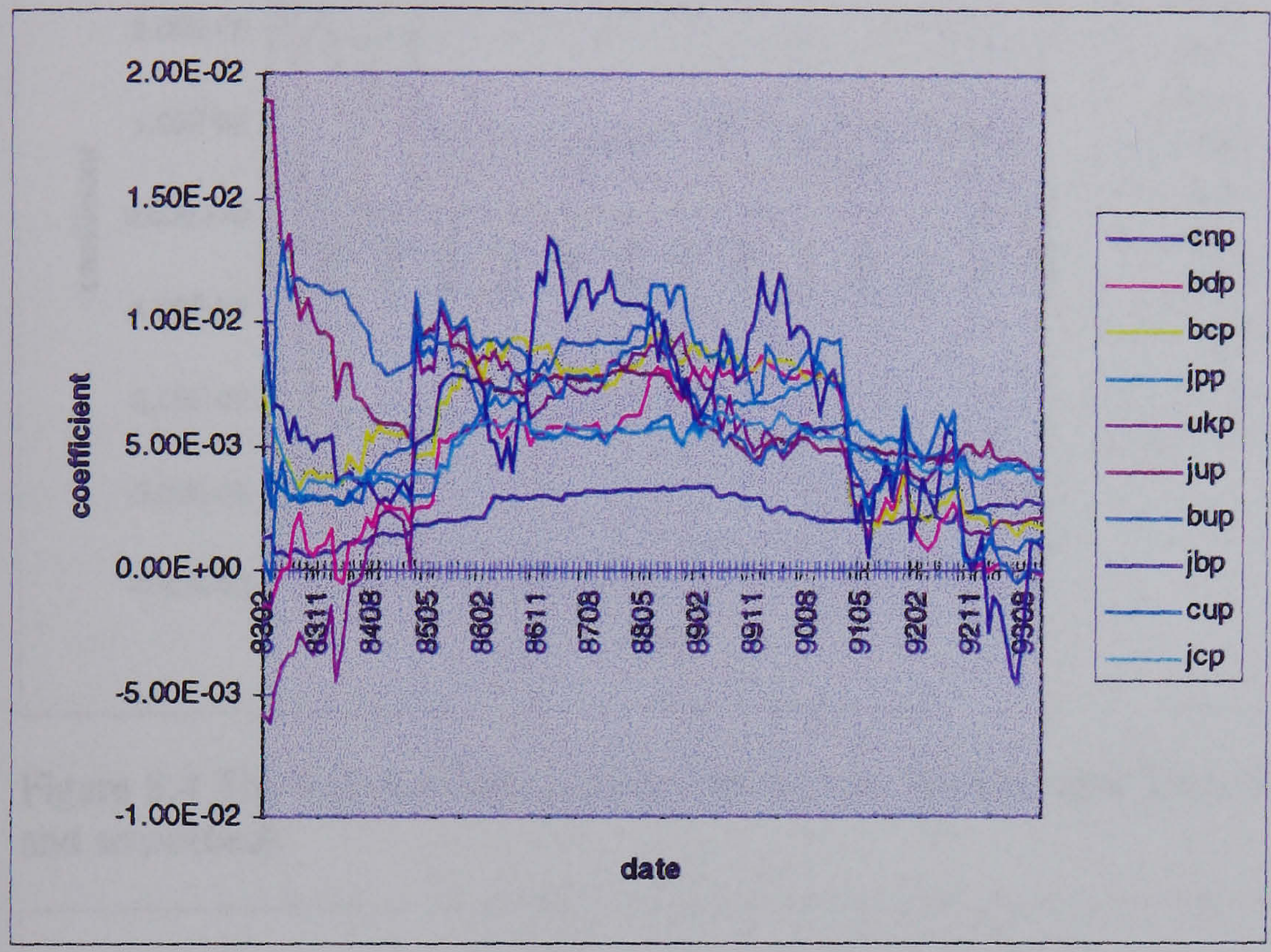
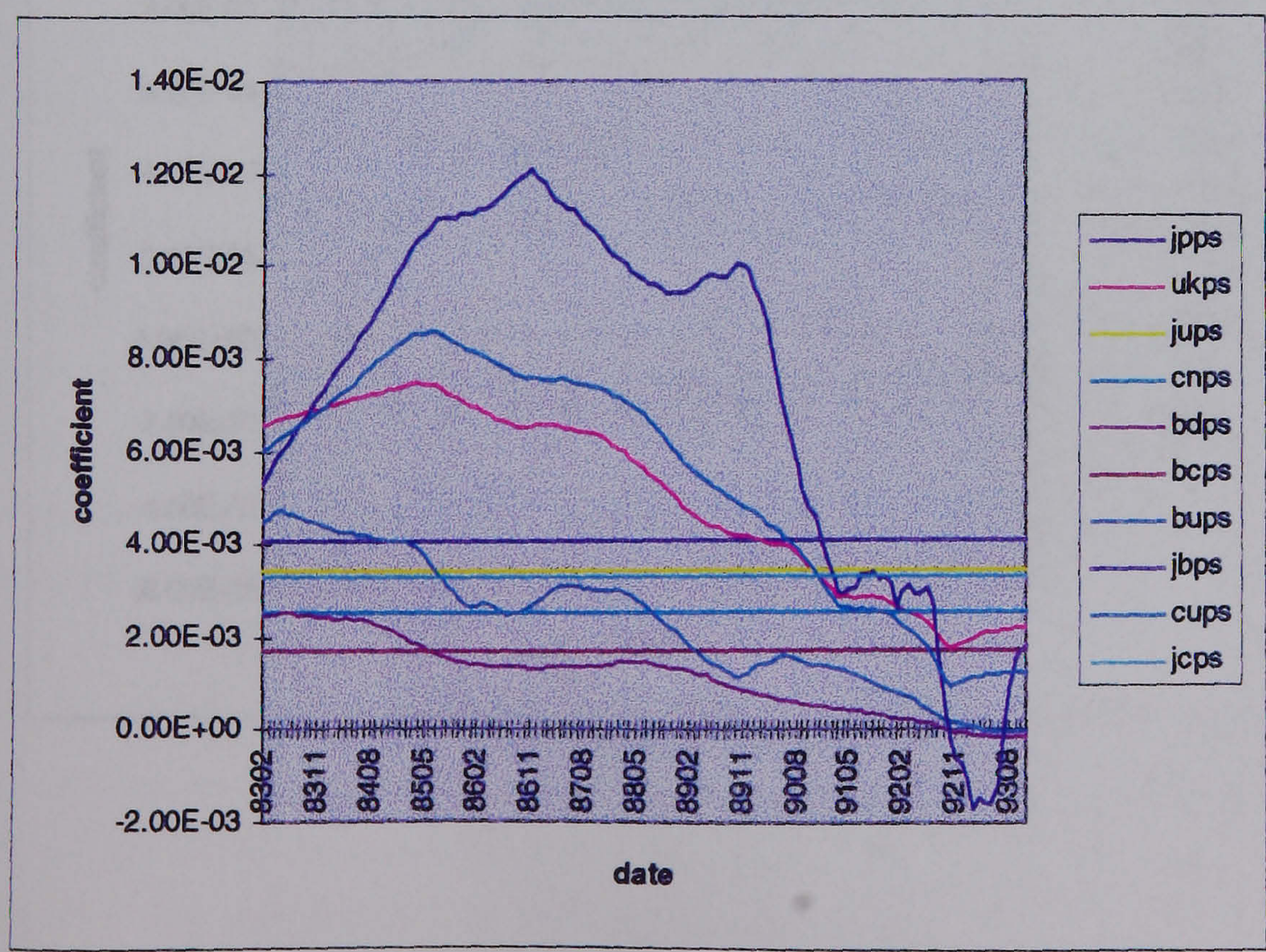


Figure 8.2 The Kalman Filter coefficients for the risk premium form of UIP (monthly and smoothed)



The following is a graphical representation of the coefficient on the risk premium differential in the alternative representation of the UIP condition.

Figure 8.3 The Kalman filter coefficients for the risk premium form of UIP (Quarterly)

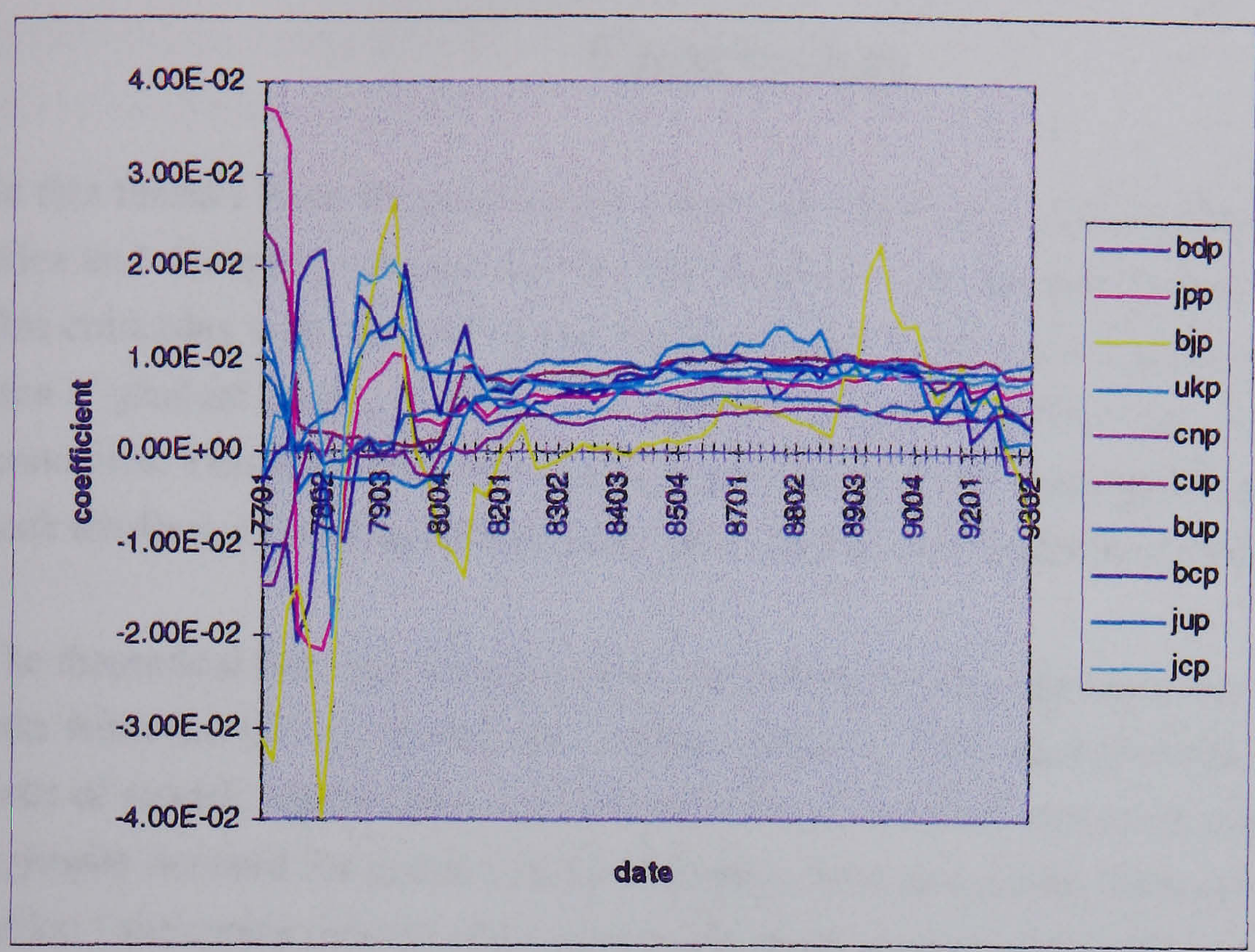
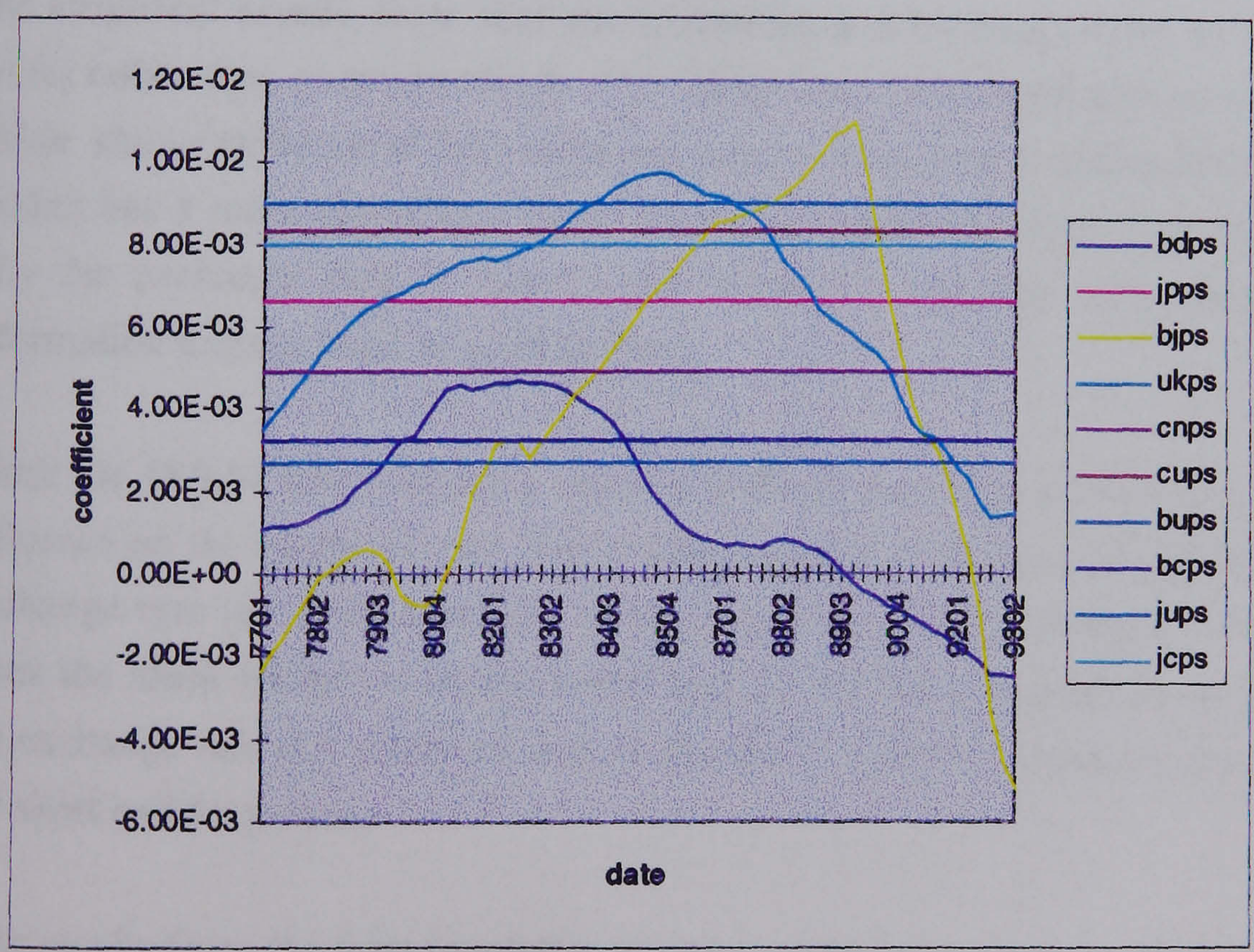


Figure 8.4 The Kalman Filter coefficients for the risk premium form of UIP (Quarterly and smoothed)



Chapter 9

Conclusion

In this thesis I have focused on the empirical relationship between the stock market index and the spot exchange rate for six countries over the time period 1974 to 1993. This coincides with the end of the 'Bretton-Woods' agreement, since when there has been a gradual move towards the removal of capital restrictions in all the main economies. This has inevitably produced a closer interrelationship between the worlds stock markets, as well as between the stock market and the exchange rate.

The theoretical linkages between stock markets and exchange rates are complex, with links from the goods, money and capital markets. This thesis has focused on three kinds of model, which have emphasised connections between stock markets and the aggregate demand for goods (IS/LM models), between money demand and the stock market (monetary model) and between the stock market risk premium and exchange rate risk premium.

The empirical results show that stock markets and exchange rates exhibit common cycles rather than common trends. The exception to this result occurs with Germany, which shows evidence of both common trends and common cycles. Overall the stock market has a more significant effect on the exchange rate than vice-versa, which is why the exchange rate is used as the dependent variable, reflecting the greater information incorporated in stock prices.

Both the IS/LM and Monetary models indicate the stock market has a significant influence on the exchange rate. The results support the theoretical conclusion that the exchange rate reacts in a variety of ways to changes in monetary or fiscal policy, when the stock market is incorporated into the analysis. In addition it is shown that the exchange rate risk premium and stock market risk premium are closely related, in the short and long term.

The results from the tests involving the time varying parameter technique suggest as expected the extent to which risk differentials affect the exchange rate has increased since capital controls were reduced. In addition using the quarterly data, there is evidence that expectations in the foreign exchange markets are formed adaptively,

rather than rationally. However over a shorter time horizon such as a month, adaptive expectations seem to be less evident.

The results of this thesis initiate a number of important policy implications, as regards the exchange rate. In general this study adds to the understanding of which factors determine the exchange rate. In particular in both models of exchange rate determination, stock prices have a significant effect on the exchange rate in the long and short run. This implies capital flows between markets are important in determining the exchange rate and as capital controls have been reduced and the worlds stock markets liberalised, so flows of capital between markets will become of ever increasing importance to the exchange rate. This indicates they will need to be considered by the policy makers when they attempt to manage changes in the exchange rate.

There is evidence that the expected change in the exchange rate is determined by risk differentials rather than return, which need to be considered in models which attempt to predict exchange rate movements. Additionally, this result suggests that when the authorities increase the interest rate, it does not automatically lead to an appreciation of the exchange rate. Sudden changes in the level of the stock market appear to significantly influence the exchange rate. For instance the fall in 1987, appears to have a significant effect on the exchange rate in a number of tests. In this case when there is a sudden movement in the worlds' stock markets, the authorities need to not only consider the effects on output and investment, but also take into account and if necessary intervene in the foreign exchange markets.

Throughout this study certain trends have become increasingly evident. For instance the countries that seem to have the strongest relationship between the exchange rate and the stock market are the UK and the USA. This is not surprising as they have the two largest stock markets, in terms of turnover and both stock markets have a dominant role in providing the finance for their country's industry. The contrasting situation occurs in the tests with Germany, which on occasions fail certain tests where all the other tests succeed. This highlights the different relationship between the German stock market and the rest of the economy, particularly as regards their industry. In Germany most of the finance is obtained from the banks, whom have a direct stake in the company.

This difference has an important implication for currencies such as Sterling and the DM, as there have been a number of attempts to link them over recent years. These two currencies are subject to fundamentally different influences, which make the

pound more volatile due to speculative capital flows. This is the reason for them acting in different ways and the consequent difficulty in trying to link them to each other. As long as the UK is a capital market based economy and the German economy is centred around the banks, their economies and exchange rates may never be completely compatible. This factor may need to be considered in the convergence criteria for the European economies as regards European integration.

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