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Tests of Capital market Integration/Segmentation: The Case of the European Equity Markets

By

Antonis M. Violaris

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Submitted for the Qualification of Ph.D. in Economics

University of Durham

Department of Economics and Finance

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Abstract

Tests of Capital market Integration/Segmentation: The Case of the European Equity Markets

By Antonis M. Violaris

Given the globalisation of the financial markets and the importance of the European equity markets this thesis seeks to correct an imbalance in the literature. Effectively, it tries to examine whether the European equity markets are integrated/segmented. Following the investigation by *Koch,Koch(1991)*, this issue becomes even more important in the European context given the economic integration of the member countries.

The main findings of the research carried out in this thesis show at first that these markets have become mildly integrated, with the mispricing error being reduced over time and thus suggesting that they are moving towards perfect integration. Secondly, both the first and second moments are time varying implying that these should be directly incorporated in methodologies that seek to analyse the issues of segmentation/integration. Moreover, these results propose that in the context of analysing international equity markets, the multifactor model is preferable to the single index model. Furthermore, it is evident from the results that the process towards integration is brought about by the removal of the restrictions to trading and harmonisation of policies. Finally, evidence has been produced that although these markets are more or less driven by common factors they share the information generating process.

Overall, the thesis presents results which contribute to our understanding of how the equity markets in general and the European ones in particular become more integrated through time and the current information transmitting mechanism.

The material contained in this thesis has not been previously submitted for a degree in this or any University.

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Chapter 1

Introduction

Over the past few years, financial markets have become increasingly global. This process began with the relaxation of controls on capital movements in 1960's and was followed, especially during the past two decades by the formal relaxation of exchange controls. This has been further enhanced by the major advancements in technology and the development of financial techniques and hedging instruments that facilitate domestic and cross-border trading in marketable financial instruments. Taking as an example some figures from the European markets, this is evident from the flow of equity capital around these markets. In 1989, equity flows to continental Europe and the UK, were calculated to be around £242.3 billion compared to £93.6 billion in 1986[1].

These developments are welcomed so far as the increased level of competition is expected to lead to a more efficient allocation of capital, both nationally and internationally, lower-cost financial services and new means of hedging risk. In the globalised security markets, the main challenge for both investors and policy makers is to take advantage and promote efficiency enhancing aspects of market interaction, while containing and controlling the undesirable destabilising effects. However, they also present a new regulatory challenge in securing financial stability. It was the 1987 world-wide stock market crash in particular which highlighted the inadequacies of a regulatory framework which in several cases, was still based largely on old institutional divisions and national jurisdictions.

[1] Source : Salomon Brothers Inc., "International Equity Flows", 1990

In response, and as a complement, to these market developments, a substantial body of research has attempted to establish the extent of integration of national stock markets along with other empirical issues - namely (i) whether markets are integrated or segmented and (ii) if there is identical asset pricing across markets. Additionally they considered some theoretical implications of the issue, these being (i) the effects of institutional and other barriers to trade and (ii) the interrelationships and linkages between markets. Early literature though, has concentrated solely on the issue of the benefits of international diversification pointing out that there is a change in investors' wealth as a result of lifting barriers to investment across national frontiers, without giving any direction for these changes. This literature, however, ignored the issue of how the degree of capital market integration may actually affect these diversification benefits.

Whilst this debate was going on, another group of literature concentrated on evaluating the core issue, that of the prevailing market structure upon which investments are held. In other words, they were looking at whether markets around the world behave as a single financial market, integrated, or independently, segmented.

The implementation of this has been carried out using both the international version of the single index model and the less restrictive multifactor model. As far as the first analytical technique is concerned, the derivation of the underlying model had two main empirical drawbacks. These were identified as the restrictive nature of the underlying assumptions and its inability to establish the actual cause of the rejection of the main hypothesis, that markets were integrated. Together these suggested that rejection of the hypothesis could either be due to rejection of the model, rejection of market integration hypothesis or even presence of an inefficient market[2].

This leads to the inference that the uniqueness of the covariance risk is questionable and alternative approaches should be used for testing for the joint hypothesis that the underlying model is valid and markets are integrated. In this respect, the international

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[2] *Harvey(1991)* gives a good example of the difficulty in interpreting this joint hypothesis.

version of the APT was used. In effect, studies in this strand of literature have chosen to test explicitly for the hypothesis that assets with the same risk characteristics were identically priced in different markets. Once more, as in the previous strand of literature, results were mixed and in certain cases conflicting.

A possible cause of these conflicting results might lie on the fact that (i) the market structure is in the grey area between the two extremes and (ii) the time variation in the risk measure. While it is obvious and not true that financial markets are completely segmented, nearly all of these studies under both specifications were concerned with the extreme cases of complete the segmentation / integration hypothesis. On these grounds the issue was re-addressed, by *Errunza,Losq(1985)*, in a more general context which allowed for the market structure to lie between the two extremes. The application of this model produced plausible results, suggesting the presence of a middle market structure and forming a major step forward in finance theory. At the same time another group of authors expressed concerns about time invariance of moments in asset pricing theory which has a direct effect on the reliability of results. These observations called for a reconsideration of the issue of integration in a time varying framework with results supporting to the introduction of a time varying testing environment.

Alongside the empirical work that addressed the empirical aspects of the integration/segmentation hypothesis, we find another group of studies which shares a common base, *Fang(1991)*, *Bonser-Neal,Brauer, et al(1990)*, *Alford,Folks(1996)*, and *Korajczyk(1996)*. In fact these studies attempted to investigate the qualitative aspects of this hypothesis. Specifically, they looked at the causes of the acceptance/rejection of the integration/segmentation hypothesis and the possible interrelationships resulting from this hypothesis testing results. Although at limited number, a group of studies focused on the first aspect and attempted to identify the possible causes of acceptance of the integration hypothesis. Almost all of these studies have suggested the impact of government controls on the results of earlier empirical work.

In another group of studies attempts were made to establish the nature and the extent of the interdependence between national stock markets, *Eun,Shim(1989)*,

Lee,Tehodossiou(1995), *Koutmos,Booth(1995)*, and *Koutmos(1996)*. The main finding from this line of research was that there is a substantial amount of bi-directional interactions between markets. It was also suggested that stock markets have become more interdependent in recent years and that the transmission of information between markets prevents the existence of arbitrage opportunities.

Despite this vast body of literature, both theoretical and empirical, there are still certain aspects of these issues which need further investigation. In this respect, and following the success of these studies in advancing the theoretical background and the acquisition of further knowledge about the empirical aspects of these issues, we re-address almost all of them in a rather different context along with the introduction of new issues.

The objective of this thesis is to contribute to the literature by examining the above mentioned issues with respect to the European markets. In particular the thesis seeks to address the following questions:

- Are the European markets integrated to a Pan European Financial Market, and if so to what degree?
- What is actually causing the markets to be integrated/segmented?
- How much of the movement in one stock market can be explained by innovations in another market?
- How rapidly are the price movements in one market transmitted to other markets?

The formation and expansion of the EEC has been a landmark in the creation and development of a growing degree of interdependence because the member countries have been in the process of institutional integration[3]. Effectively, most of the legal barriers in the member states have either been removed or are scheduled to be removed in the near future. Furthermore, the EU has adopted a stronger form of harmonisation for its financial services - a policy of mutual recognition whereby

[3] This has been the main objective of the EEC code of liberalisation adopted in 1961 'to progressively abolish.... restrictions on movements of capital , to the extent necessary for effective economic cooperation'.

member states within the EU have agreed to allow financial intermediaries from other states to operate under home country rules and supervision.

However it would be unfair to give the impression that these markets are completely interlinked and unregulated and that everything goes as planned. Although, as a result of this progressive attitude, cross border investment opportunities have increased, accelerating the flow of equity capital between markets and towards the European continent in general. An earlier empirical study[4], clearly points out that within a very short period of time, the net equity flows to continental European Stock Markets and the United Kingdom have tripled. In 1986, it was around £11.2 billion compared to £33.2 billion in 1989. This could be termed as evidence of the increased importance of European equity markets in world financial activities.

In an attempt to answer these questions, Chapter two of the thesis provides a detailed and thorough review of both the theoretical and empirical literature. While the review is not intended to be exhaustive, it focuses on the main questions that this thesis tries to address. This chapter is split into two parts. Part one reviews the literature relating to the empirical aspects of the integration hypothesis and their evolution through time. Furthermore, it examines the attempts made in the literature to identify the possibilities that led to the acceptance/rejection of the integration hypothesis. Part two could be termed as complementary to this as it looks into the other aspect of the qualitative implications of the integration hypothesis, that of possible interdependencies and linkages amongst national markets. Finally, this chapter provides the motivation for the techniques and methodologies adopted in the subsequent chapters.

Chapter three, uses as a basis the testing environment of *Errunza,Losq, Padmanabhan (1992).* Taking information on all available companies in each of the European countries, revised on an annual basis, it sets up the framework in which the integration/segmentation hypothesis is tested. Within this framework, markets are allowed to retain some independence, i.e. be mildly segmented, thus departing from the restrictive setting of the two extreme cases.

[4] Salomon Brothers Inc , "International Equity Flows", 1990

Recent evidence, *Harvey (1991),* suggests though the importance of the time variation of the moments in the return distribution,. In line with this, chapter four sets up the theoretical and empirical environment for addressing the issue of capital market integration. It also takes account of the changes in market conditions and institutional structures, central to this strand of literature, in addition to the belief that the single index model is too restrictive. Firstly, as in *Korajczyk(1996)*, we introduce a model in which moments are allowed to vary through time, to evaluate the integration/segmentation hypothesis as in the earlier chapter. However, the issue of whether a particular market is integrated is much less important than the question of what it is that leads markets to be integrated/segmented. Hence, the second part of the chapter establishes a direct test of the effect of exchange controls present in each sample country. Another possible source of segmentation is the individual attitudes but since it is extremely difficult to account for them, we evaluate the qualitative implications of the hypothesis based on the first possibility.

The existence of such exchange controls may impede the unrestricted functioning of financial markets, suggesting that investors could be able to make a profit, mainly because assets are separated into distinct markets and are not uniformly priced. This gives rise to an equally important question concerning the presence of an information transmission mechanism and hence the examination of volatility transmission in these markets. These are in fact analysed in chapter five, with the use of the VAR-EGARCH methodology, similar to *Koutmos(1996).* This methodology contributes to the literature because unlike earlier work in the area it encompasses the leverage effect which introduces an asymmetric pattern in the transmission mechanism in the sample markets.

Lastly, in an attempt to examine the robustness of this methodology and driven by the fact that the internationalisation process does not limit itself within continental boundaries, the thesis addresses the same questions as in the main text by introducing the Japanese market. The selection of this country is based on its relationships with the European markets and consequently its importance in the world financial

activities[5]. In addition, it is in another geographic region with maximum time zone difference. This means that the inferences from the application of this methodology will provide insights into the overnight transmission mechanism, which may yield information to all market participants in both markets although they are geographically segmented, i.e. different time zones.

Having set the basic framework of the thesis we can summarise its structure as follows: Chapter two provides a review of literature relevant to the issues. Chapter three provides an investigation of the integration/segmentation hypothesis in a European context. Following concerns about the restrictive environment of the single index model and time variation in moments, chapter four re-addresses the whilst also identifying the source of segmentation , thus supplementing the previous chapter. Chapter five then attempts to identify the information transmission mechanism behind these markets and quantify these interrelationships. Conclusions and further research proposals are included in chapter six.

[5] From published statistics Japan is found to be the main receptor of cross border equity flows in addition to being the highest in capitalisation market.

Chapter 2

Review of the Literature

Recent economic and political reforms in various international institutions, together with the introduction of better communications and trading systems, have actually brought people of different nations much closer. Investments across nations have become quite common place, the participants note via their behavioural patterns that certain world markets are well connected and in effect integrated.

Conceptually, a country is integrated into world capital markets if capital is free to flow across the borders in either direction and the country's assets are substitutes for those of other countries. In empirical terms capital markets were defined to be integrated into a world market, " if assets with perfectly correlated rates of return have the same price regardless of the location in which they are traded" *(Gultekin, Gultekin, Periati(1989)).*

In another plausible definition, *Bekaert, Harvey (1995)* have suggested that markets are completely integrated if assets in these markets have the same exposure to some common world factors.

Segmentation on the other hand is the isolation of the national financial market mechanism from the rest of the world. In this respect the individual country will act independently, trying to achieve short-term national interests. Research in the area has actually supported the notion that this is connected with the imposition of exchange controls by individual authorities in an attempt to control trading activities.

Testing for capital market integration is possible by examining the returns on portfolios of securities from different countries, which are perfectly correlated. However, construction of this type of portfolio is not feasible in practice mainly because of the individual features which are inherent in each market. As a

consequence all tests in this field of research rely on a pricing model to indicate which proportion of the variation in returns commands risk premium

Following these observations and the seminal work of *Solnik(1974a)* several empirical studies were carried out in an attempt to establish the structure of financial markets, with modelling approaches being classified in two categories. The main approach investigated financial market integration from the perspective of the CAPM, incorporating in certain cases specific barriers which lead to the segmentation of capital markets. The second approach examined the issue via the arbitrage pricing theory. Both approaches provided somewhat consistent empirical results, suggesting that markets are mildly segmented – neither perfectly segmented nor integrated.

Given these results, which imply that national markets are econometrically behaving more or less as if there is one perfect multinational capital market, investors will automatically adjust their portfolio to changes in relative rates of returns in different parts of the capital market.

This creates the need of identification and quantification of the possible routines of share price adjustments in this environment. Theoretically, the presence of any routine of share adjustment will influence the activities in different financial markets via two channels. At first it will act as a tool for policy regulators. Under normal circumstances, policy regulation primarily targets the elimination of the undesirable side effects of these interdependencies whilst at the same time aims to promote market efficiency, subject to the size and sophistication of the national equity market.

Secondly, a better understanding of the nature of these interactions may increase the effectiveness of investment and hedging strategies. Different rewards for investment risk amongst national markets would imply that shifting investment to countries with higher returns could increase expected returns.

At first studies used simple econometric techniques and have suggested that countries are highly independent, with foreign information having little and sometimes no influence on asset prices.

The occurrence of certain world-wide events has urged the re-examination of the issue in another framework using more robust techniques which reflected these events and the empirical characteristics of returns. Results were both conflicting and supportive of the interdependence hypothesis, the bottom line being that markets are intimately related.

Having said this it is evident that these issues are central to the investment and financing decisions. In particular, if markets are termed to be segmented, the cost and corresponding value of an investment will generally depend upon the market in which it is financed as well as the information generating mechanism that affects this market.

Part A

Assessing Capital Market Segmentation

A.1 Testing for Capital market Segmentation

In theory testing for capital market segmentation can be pursued by simply examining the returns of two perfectly correlated portfolios from two countries. If capital is free to flow across countries' boundaries, arbitrage should equalise the prices of financial assets with identical payoffs. However this is a difficult task given the presence of idiosyncratic and country specific sources of variation.

Consequently, all tests in this field depend upon the pricing model, which propounds that part of the variation in portfolio returns which commands risk premium. Within this strand of literature, empirical work which dealt with the test of capital market segmentation, can be placed into two different categories. In the first set of studies, empirical work has been carried out using the Capital Asset Pricing Model (CAPM), whilst in the other group, conclusions on the issue were derived via the Arbitrage Pricing Theory (APT).

A.1.1 Using the Capital Asset pricing Model

In the first group, studies have generally adopted the single factor model (equation 1) to test whether a purely domestic factor (β_{im}) – usually the part of the domestic market

$$E(R_i)=R_f + \beta_{im}\left[E(R_m)- R_f\right] \qquad (1)$$

portfolio which is orthogonal to the world portfolio – has explanatory power in a regression of stock returns on a world market index.

Within this framework *Solnik(1974a),* acknowledging the fact that there was little intuitive reason to expect the simple CAPM to be applied in an international context mainly because of the limitations it imposes, proposed an alternative model. In fact, he put forward a model derived in a continuous time variance framework which integrated the features required for such a model to be applied to different countries' asset returns[6].

This was viable by assuming, in addition to the basic CAPM assumptions and the standard portfolio theory assumptions, that investors were strictly limited to their home country stocks in an environment where capital was allowed to move freely across countries. Under these circumstances, individuals were expected to maximise their utility by investing in their domestic risk-free asset and common stocks, in addition to foreign stocks and risk-free asset which were purely exchange risk assets.

By using data from several countries around the world the proposed model was tested for the identification of the risk factor relevant to asset prices. Solnik's results actually gave evidence of strong effects from domestic information. However, it was also apparent that international events had some influence both on the domestic market as

[6] *Wallinford(1974)* however has criticized this approach by stating that the empirical evidence given by the study was 'consistent with a variety of alternative specifications of the IAPM'(pp.393). He justified his view by supplying a radically different model specification, which implied complete segmentation of markets, and moved on to characterise this work as inconclusive and unsupportive to the authors theory.

a whole and on selective stocks, suggesting the existence of an international market structure for price behaviour.

Later, *Stehle (1977)* pointed out that prior studies in this field, have been testing in isolation the hypothesis that assets are priced in a segmented/integrated market against the null hypothesis of no relationship. However, this approach to asset pricing, could not be used to identify whether or not the assets were priced in either of the market structures. The main reason behind this argument has been the fact that if the wrong measure of risk was utilised, this would have led to a residual distribution which was dependent on the independent variable, leading to inconsistent least square estimates. Taking as a basis the single factor model, the author derived a model that identified the variation in return which was exclusively generated domestically, and the proportion of the diversifiable risk that was attributable to international events. Using monthly data, the author has actually tested whether the NYSE securities, formed into a portfolio to avoid any measurement errors in the independent variables, have been priced on a national or international environment[7].

The empirical implementation of the model revealed that neither of the two polar market structures could be rejected in favour of the other, indicating that the US based portfolio pricing on a world market portfolio could not be rejected, i.e. the market was integrated.

In a rather different framework, *Errunza,Losq(1985)* approached the problem of segmentation from a different angle. In fact, their approach was based on earlier recommendations made by *Solnik(1977),* who criticised the current approach for testing for segmentation. The author has in fact proposed that 'the efficient way to test for segmentation would seem to be, to specify the type of imperfection which might create it and study its specific impact on portfolio optimality and asset pricing'(pp.505).

In this respect, *Errunza, Losq(1985)* defined the imperfection as the inability of a group of investors to have trading access in a set of securities, thus forming the

[7] The author has created a world portfolio by merging the indices of the several countries, on a GNP basis.

foundation for the development of their theoretical model. This approach basically assumed that investments were carried out based on the real return and variance of an asset. Furthermore, this theory was based on a perfect and frictionless market context with unequal access to securities by investors i.e. discriminating between local and foreign investors. Additionally, the expected utility of investors was considered to be represented by a function of the expected value and the variance of the real returns, which were normally distributed, on the investment portfolio (mean-variance assumption). Furthermore, there were unlimited financial transactions by the investors, at the same interest rate.

As a consequence of the basic distinction of the methodology, this being the trading rights of investors, securities had to be classified into eligible and ineligible ones. Under these circumstances all eligible securities were priced as if the market was fully integrated. Ineligible ones commanded a super risk premium, depending on the risk aversion coefficient and the conditional market risk. If, however, by any means, unrestricted investors became risk lovers willing to bear more risk, prices would go up beyond what restricted investors are willing to pay, giving the false belief that markets are perfectly integrated even though barriers may exist. Secondly as the correlation coefficient between the returns on eligible and ineligible securities moves to one, there would be no distinction between diversification and hedge portfolio because diversification benefits will decline, implying that the conditional market risk will be negligible for all securities wiping out any super risk premiums.

This risk premium should exist to act as a motive to the risk averse unrestricted investors to supply diversification services, by offering a proxy of foreign securities which have comparatively low return and no super risk premium to restricted investors. This will demand that unrestricted investors should buy the ineligible securities otherwise required by restricted investors and at the same time supply eligible ones to them, so as to keep the market at equilibrium. Alternatively, the presence of this risk premium will encourage foreign firms, whose stocks are included in the ineligible set, to take a step and list their stock on the segmented market if the host country exchange control allows it and thus minimise this premium.

The authors have put their theoretical model into test by conducting a cross-sectional analysis, using a sample of monthly observations for a set of heavily traded securities from markets around the world. Their results were in line with their mild segmentation hypothesis. This is further supported by the fact they have used two different portfolio formation techniques with consistent results.

In his study, *Wheatley(1988)* assumed that markets were completely integrated and developed a pricing model to evaluate the joint hypothesis that tests for the appropriateness of the pricing model and the prevailing risk generation process. The actual model used was the discrete time version of the consumption based asset pricing model, which shared similarities with *Stulz(1981)* because it explicitly incorporated a tax rate with similar properties. Under this model specification, representative individuals across countries were allowed to hold different beliefs but display a constant relative risk aversion.

Empirically this model predicted that there was an asset pricing line for each country which related the individual country's expected return to the covariance of the return with the growth in real consumption. This meant that testing for equity market integration will be a test that will involve plotting foreign equities and measuring the deviation they have with the individual market line[8]. The joint hypothesis, that the model holds and the markets are integrated, will then be statistically evaluated based on the magnitude of the deviation.

In the empirical application of the methodology, the author considered 17 representative individuals around the world who made their decisions, measured in a single currency, on a monthly basis. Test results provided weak evidence against the joint hypothesis, suggesting the statistical validity of a statement that postulates that equity markets are internationally integrated given that the utilised model is valid too[9].

[8] This distance will represent the difference between expected real return and the required expected real return of a domestic asset with similar risk.

[9] However according to the author this is a low power test mainly because of the statistically significant relationship between consumption and real asset returns and he suggested an alternative testing environment to increase this power.

Based on their earlier work's recommendations for improving the power of their tests, *Errunza,Losq et al (1992)* have modified their hypothesis for testing for the presence of the intermediate case of "mild segmentation". This emerged from the fact that there are economies with rather underdeveloped capital markets, fearing that a rapid move towards full liberalisation of portfolio flows may prove to be extremely difficult with significant costs in the short-run. In such a case they prefer to utilise controls on international portfolio operations, which freeze investment by foreign capital as part of government measures designed to achieve specific and fundamental policy adjustments and national objectives.

The testable hypotheses of the study were constructed to implicitly reflect the presence of such factors. In a two-country environment, as outlined in their earlier study, there are two classes of investors and securities. A set of investors, termed as unrestricted, could trade in all available stocks whereas the rest of the investors could only trade on domestic stocks, eligible securities.

Within the same framework as the previous study and following the recommendations made by *Stehle(1977),* the authors derived the study's testable hypotheses. The empirical application of the study utilised data from markets around the world and the US as a proxy of the world market to test for a bilateral segmentation hypothesis. Test results strongly suggested that domestic factors, i.e. innovations generated within the market, have some explanatory power for asset pricing, postulating that markets are actually mildly segmented.

Later, as in the previous study but to a greater extent, *Buckberg(1995*) considered the case of emerging markets and their return behaviour. In this study the author concentrated on modelling the behaviour of returns in developing countries using a model adapted for the situation, the ICAPM. The empirical validity of this model was given in *Harvey(1991*).

In addition to testing the main hypothesis of capital market integration, the author also attempted to check whether these markets had actually become more integrated with the world during the same period of time. Under these circumstances if emerging markets are part of a global market, then each market's returns should be proportional

to that market's covariance with a capitalisation-weighted world portfolio. This suggests that under the model, investors with optimising behaviour care only about covariance risk with the market and not other forms of risk. Following previous work by *Harvey(1989,1991)* the author conditioned the ICAPM on an information set, allowing for proper testing of the model as a relationship between expected returns and ex-ante-risk.

Returns in the markets were calculated as the excess return in dollars over the holding yield on the US Treasury bill closest to thirty days to maturity on the last trading day of the month, assuming that each market index was a portfolio. In the empirical section of the study, tests suggested that the model cannot be rejected in almost all cases. This meant that the same model was eligible to be applied using both the local and common instruments in order to ascertain the level of integration of these markets in global asset markets. Evidence from this test suggested that the markets under consideration have over time, become more integrated into a world capital market.

In separate work looking at the effects of market structure on asset pricing models in terms of measuring risk, *Bekaert,Harvey (1995)* extended the mild segmentation hypothesis of *Errunza,Losq et al (1992)* within the single factor framework. In this framework expected returns in the country were affected by their covariance with the world benchmark portfolio and by the variance of the country returns, in an integrated and segmented market respectively. The full model equation could be viewed as an unchangeable, one-factor, partially segmented, world asset-pricing model, allowing for the identification of the degree of market integration through a probability that may be regarded as a policy weight which is subject to the integration policy effects.

The empirical section of the study used a sample that included data on both developed and emerging capital markets, for a period spanning over 15 years. The authors first provided a wide range of descriptive statistics which suggested that in almost half of the emerging markets the hypothesis of no predictability is turned down.

At the second stage an estimation of the proposed regime-switching model was carried out for all the countries on an individual basis, with interesting results. However concerns were raised by the authors, following a referees comment, that the

application of this model might have been capturing changes in foreign exchange regimes rather than the capital market integration itself. Thus, they conducted a check on this comment and found that there was little or no evidence of any interrelationships between the two possibilities. Following this, the authors safely concluded that the main observation was a time varying, negative degree of conditional market integration for a number of sample countries, within a single factor framework.

Conclusively, although the application of the capital asset pricing model (CAPM) and its variates for testing of capital market segmentation have flourished, their implications are difficult to defend on theoretical grounds in the presence of exchange risk and market imperfections. As a matter of fact, under certain forms of market segmentation, the simple asset pricing relationship becomes more complex. Specifically, the risk premium depends primarily on the form of market imperfection, the relative wealth of investors, and the parameters of their utility. Additionally, some of these constraints cannot be incorporated easily in an equilibrium asset pricing relationship, hence making impossible the modelling of their precise influence on the resulting optimal portfolio holdings. Moreover, this strand of literature faces all the criticisms that the domestic CAPM has received over the past years. A further problem encountered is the inability of the model's theoretical background to provide guidance as to the choice of instrumental variables which will form the information set.

A.1.2 Using the Arbitrage Pricing Theory

The observation of the above evidence, that the uniqueness of the covariance risk is questionable, suggested that studies within this field of research should consider alternatives, with multiple risk factors. The most appropriate model within this context has been an extension of the APT. Within this framework, researchers that have been engaged in examining this issue have tested the hypothesis that securities with the same risk characteristics should have the same expected returns in different markets.

Looking at early literature in the area, two independent studies, that of *Ross, Welsh(1983)* and *Solnik(1983)*, have actually conceived the idea of an international version of the APT, which was first inspired by *Ross(1976)* as a successful alternative of the CAPM.

This approach to international asset pricing requires perfect capital markets and that a real deflator be applied to nominal returns of investors who homogeneously believe that returns follow a k-factor generating model (equation 2).

$$E(R_i) = \lambda_0 + \sum_{j=1}^{K} b_{i,j} \lambda_j \qquad (2)$$

This overcomes the problem of aggregation when asset demands are summed over the universe of investors who use different numeraires for their return calculation. This is because the portfolios defined under ICAPM represent weighted averages of individual assets whereas the factors in this framework are theoretical constructs, which are not constructed to be portfolios of original assets. On the other hand, despite the fact that it is not a utility based approach it requires the definition of a riskless investment, to be used for real return measurement matters.

Cho, Eun, Senbet (1986) explored the bilateral relationships of different national financial markets by applying this methodology. They tested the joint hypothesis that the markets were efficient and the underlying model was valid in addition to the hypothesis that markets are integrated. Under these circumstances an inference about capital integration could not be made just by considering the factor or correlation structure. What is actually needed, given that the IAPT is valid, is a test to evaluate the possibility that factors are identically priced across markets. Within this context, the authors have selected a group of companies from eleven different countries and have used both the US Dollar and the Japanese Yen as numeraires to conduct the study's empirical tests. At first a factor analysis was conducted to estimate the pervasive factors which were used in the second stage to perform a validity test for the IAPT.

This validation test was based on three hypotheses: (i) equal intercept terms across countries; (ii) equal risk premia; and (iii) a joint test for both of them. If any one of these was rejected then the whole set would be rejected. Empirical results led the

authors to reject the joint hypothesis that the markets were integrated and that the APT holds internationally, under both numeraires. In conclusion, the authors suggested that these results restricted them from determining whether the rejection of the joint hypothesis reflected segmented financial markets or a failure of the IAPT. In such an event the authors concluded that the APT does not hold on a global framework but they did not exclude the possibility that the model could be applied successfully on a regional basis within in a segmented market.

The same principal was applied by *Abeysekera,Mahajan(1990),* to jointly test the validity of the model and the integration of international capital markets. In empirical terms this study was differentiated from the previous one on the grounds that it utilised domestic factors common to all countries, rather than the international ones previously used. As such, this provided a direct test on Solnik's model which stated that a valid APT model should be independent of the numeraire chosen so that the K-factor model holds from any currency.

The factors common to all sample countries that generated returns, were derived using factor analysis. As no optimal number of factors has been suggested by theory, the authors used past experience and set a limit of eight factors, upon which the returns of each formed portfolio , translated into two different currencies, were regressed.

The empirical section of the paper set out to test the joint hypothesis of the IAPT being a valid model and globally integrated markets. Firstly, the equality of the intercept term was tested in addition to the invariance of the number of factors, to the used currency. As an additional test the authors validated whether the computed currency-asset covariances were equal, using observed data and data from the model. Results obtained in the study supported, albeit weakly, the equality of risk free rates but at the same time rendered some support to the factor invariance. However, risk premia were found not to be significantly different from zero. Overall these results are more or less similar to those of the previous study which tends to reject the validity of the IAPT without distinguishing what causes this rejection.

Later on, *Campbell,Hamao(1992)* with their study, added to the ongoing debate of the identification of the market structure by considering the case of Japan and US over a

nineteen-year period. In their view the process of identification could have been carried out either by looking directly at evidence of barriers, or by testing the hypothesis that assets which share identical risks have the same expected return across countries. In the light of these, the authors have excluded the first alternative because of the possibilities available to investors that pass round these measures.

By adopting the second procedure the authors acknowledged that within their desired framework, the single pervasive factor , there was still a major problem, that of identification of a benchmark mean variance efficient portfolio. Consequently, by making further assumptions and moving from the restrictive CAPM framework, they identified within the IAPT environment a single- latent variable, changes of which were assumed to influence the expected returns on all assets within the integrated national markets. Evidence from the study proposed that similar types of variables could assist in stock return predictability in both countries. In addition, evidence was given suggesting that movements in expected returns in both markets were not adequately explained by a single factor model, using an international factor proxied by a world stock index return, whose risk price changes over time.

This result confirmed earlier work by *Harvey(1991)* and others who suggested that risk premia are time varying and the strand of literature that postulated the inefficacy of the single factor model and suggested that the multifactor equilibrium model would enhance predictability.

Comparing these results to those of earlier studies it is clear that they are contradictory, mainly because earlier work failed to ensure the validity of the model used. Overall, the common movement observed in the expected excess returns within the markets was suggestive of at least partial integration of the markets on the grounds that domestic events have, to a certain extent, some influence on the returns of other countries.

In the same context, *Heston,Rowenhorst,Wessels(1995)* examined the issue of capital market integration by looking at the US and European markets. Their approach was twofold, demonstrating at first, as *Ferson,Harvey(1993,1994),* that international equity markets share multiple factors. This was a result of an application of factor

analysis, which also revealed some features unique to the different countries. At this point the authors turned to the question of capital market integration, which in the normal pattern involved the joint hypothesis of a valid international asset pricing model.

Within their testing environment the authors considered whether world factors could be used to price country index returns. Following the results of some preliminary tests the authors suggested the use of two further hypotheses in their attempt to robustly diagnose the form of market segmentation. First they tested for the law of one price - whether risks are priced equally across markets - and secondly they evaluated the role of the firm size in going round any capital market barriers and increasing the level of integration.

Results were mixed, providing 'widespread international evidence of pricing segmentation in capital markets for small and large firms or the existence of country specific premiums for size risks, which are uncorrelated across countries'(pp194). Effectively, these results rejected the full integration hypothesis but with no indication of any systematic mispricing pattern and in this respect markets appeared to be integrated.

Most of the above studies, especially those that used factor analysis, suffer from some methodological problems associated with the identification of the factors to be used in hypothesis testing[10]. This, in addition to the inefficiency of the single factor model, has urged *Koutoulas, Kryzanowski (1994)* to address the issue of stock market integration using an alternative approach. This evaluated the earlier study by *Jorion, Schwartz(1986)* who used the same sample countries, in a different pricing environment, to test for the integration hypothesis and the empirical validity of the multifactor models.

The authors approached the issue by assuming that domestic factors have some explanatory power, thus extending the original *Solnik(1983)* framework. This meant that the authors were moving away from the two extremes and were seeking a

[10] See *Burmeister,McElroy(1988)* for an analysis of these problems.

possible middle solution, of mildly integrated markets, as outlined and tested by *Errunza,Losq(1989,92).*

In search of the appropriate factors the authors made use of the set of bi-national factors introduced by *Frankel(1979)* which they then marginalised using techniques similar to the earlier study by *Chen,Roll,Ross(1986).* In the process of selecting these variables the authors concluded that the inclusion of macroeconomic variables, as in other studies such as *Ferson,Harvey (1993,1994),* captures to a great extent, the time-variance of volatility of market indices.

After these rather encouraging results the authors moved on to address the issue in question, this being the identification of the market structure, using both the domestic and international factors. Consequently, the testable hypotheses were associated with the pricing of these factors, suggesting that if markets were classified as completely integrated then only all international factors should be priced.

Over the whole sample period that extended between 1/68 and 3/88 results suggested that markets were not completely integrated because at least one of the domestic factors was priced. In order to model the path markets had followed over the years, the authors sub-divided the sample period to two segments and conducted the tests once more. For both sub-periods it was found that the Canadian market was mildly integrated with the other North American markets, with time varying risk premia confirming the findings of *Harvey(1991).*

These results contradicted the earlier empirical study by *Jorion,Schwartz(1986)* who found that the market was actually segmented, in addition to casting doubts about the reliability of the earlier studies' results which used similar methodology.

A.2 Explaining the Sources of Segmentation

As demonstrated above, both strands of literature have in a way identified the structure of capital markets around the world. While there is a rich body of research on international market integration, very few studies have attempted to identify what

is the actual cause of the rejection of the hypothesis that international capital markets are integrated. In this respect, literature suggests that the causes of segmentation and to an extent rejection of the hypothesis can be nested in two major categories, either because of the different controls imposed by governments to control capital flows or due to individuals' investment attitudes - see for example *Gultekin, Gultekin, Penati(1989)*. The latter cause is however, very difficult to be empirically evaluated, suggesting, indirectly, the importance of the government impediments. This is further supported by the fact that empirical studies which where carried out and analysed below, suggest that government imposed barriers have been effective in segmenting international capital markets.

A.2.1 Restrictions to international movements

There are many countries around the world which impose restrictions on the investment activities of individuals and companies within their jurisdiction. This in turn implies that market forces and government regulations influence the world's supply of stock exchanges and the nature of the securities traded therein. Consequently, stock exchanges will range from those that are highly regulated to those that are largely unregulated. As the tightening of regulations increases, international capital flows are discouraged because they "make it costly to hold foreign securities as opposed to domestic" *(Stulz (1981a),pp.923)*. Actually, there is a perception that these restrictions are the key to capital market integration because they are set out with the purpose of increasing segmentation, causing differences in risk-return relationships between the capital markets.

According to *Bekaert (1995)*, these measures could be arranged into three distinctive categories. First, there are legal barriers which deal with the rights of domestic and foreign investors. In the second category there are the indirect barriers which arise mainly from information availability differences, accounting standards and protection of investors' rights. In the last form of barriers, one could include liquidity risk, economic policy risk and even currency risk.

The nature of these barriers to international investments can take any form ranging from those that attempt to influence market conditions and affect the investment actions, to regulations of certain aspects of such transactions. The choice and the means of implementation of these controls, on either outstanding or new issues of capital, appear to have a direct relationship with the size and sophistication of the domestic capital market. In general, temporary controls are linked with developed markets, whereas countries, which have underdeveloped markets with narrow choices, prefer permanent restrictions.

A.2.1.1 Temporary controls

Temporary measures are normally imposed in an emergency situation such as capital flight. One form of these allows only the reinvestment amongst local traders of the proceeds from international investments. This prevents a net increase in foreign portfolios held by domestic investors and at the same time allows for diversification of portfolios, at a higher cost of uncertainty.

It is also possible to introduce a tax which can be applied on all securities purchased, with minor exceptions, and can vary with the maturity of these securities. The scope of this measure is to restrain foreign purchasing activity but at best it will only reduce the level of foreign purchases. In effect this will allow domestic investors to diversify the composition of their holdings if they are willing to pay the predetermined tax and thus it could not be considered as a prohibitive measure but rather a discretion measure.

However, these measures require some time to produce the desired results and in addition, they fail to distinguish between the different forms and levels of stock. Consequently, they are viewed as supplementary to other measures which are designed to correct the market disequilibria but at the same time they offer some breathing space. Finally, these will be more effective in cases where interest rate differentials are ultimate determinants of stock selections.

The major problem of such measures is fraud, especially as time passes, thus any measure should be constantly enforced and extended in scope to maintain its effectiveness. On the administration side these will be costly and burdensome to economies with a relative developing market, depending on the degree of enforcement by existing institutional structures in the country. In general, these restrictions are effective in the narrow technical sense of restricting recorded transactions. Furthermore, the anticipation of the imposition of such controls encourages investors to alter their holdings in advance and consequently avoid the effects of the imposition of such measures.

A.2.1.2 Permanent Controls

Several capital markets around the world virtually maintain permanent systems of controls both on new and existing issues of foreign securities. These systems can be applicable with certain flexibility or prohibition.

The scope and the sharpness of the flexible controls applied in certain cases create diverse conditions. Take for example the case of two countries which are mutually related, an exchange market is formed, ensuring complete freedom of capital circulation which will be free of domestic liquidity and foreign exchange reserves. The dual exchange market as outlined is permanent yet allows complete flexibility of inflows, thereby safeguarding the domestic capital market's efficiency.

In addition an individual authorisation system could be used as a flexible measure. The central bank, which is the head of the procedure, retains the right to refuse or issue authority subject to certain conditions. These conditions include technical requirements such as the maturities, size and place of issue of the foreign securities.

Other measures include the flexible allowance in buying foreign securities with a ceiling of a proportion of the total investment, given that the issuing side is a fellow-

member of an organisation. Furthermore, this is restricted to buying only quoted foreign securities.

The second form of measures mainly applies to countries which have persistent economic difficulties. Barriers could be imposed due to the limited size and nature of the domestic capital market and block the flow of capital depending on the problem. Motivation for this arises from the fear of arbitrary action by foreign governments leading to refusal of foreign exchange for the profit transfer or repatriation of capital. As far as the inflow of capital is concerned there is a belief that foreign investment may lead to loss of independence and additionally give rise to excessive profits.

This form of measures includes amongst others the deliberate maintenance of low rates of return on capital by governments, which will favour high rates of capital accumulation and for countries which eventually pass the transition phase, this will reduce the vulnerability of the basic economic policies to external factors.

A.2.2. Empirical implications from the imposition of such barriers

Approaches to model these financial market characteristics could be grouped into two main classes. In the first group, studies such *as Black(1974), Stulz(1981)* amongst others, attempt to model the issue as an incremental tax which reduces the return on foreign investments , thus changing the investors objective function coefficient. In the second group of studies, a selection of which is *Errunza,Losq (1989), Eun,Janakiramanan(1986), Hietela(1989), Fang(1991), Bonser-Neal,Brauer, et al(1990), Alford,Folks(1996),* and *Korajczyk(1996),* investors face explicit ownership restrictions for foreign equities.

In effect, the empirical difference of these two classifications is a conceptual one. This is mainly due to the fact that the first considers the barriers as tariffs, which increase the price of the security, whereas the second group of studies quantifies this as a quota, limiting the quantity of an asset in an investors' portfolio. However, within the context of international trade theory there is always a quota for a given

tariff that will yield the same effect. This implies that in the empirical estimation of the effects of these barriers, researchers are developing either a tariff or a quota to represent the cumulative effects of all barriers to international investment. The implications of either would be the same but on a differential scale.

The efficiency of the imposition of such controls could be twofold. Firstly, in a technical sense, they could be evaluated on their capability to block certain transactions and secondly, on their contribution to the attainment of the economic policies. In practice, it is almost impossible to raise a clear distinction between these two forms, mainly because there is no modelling technique which captures the behaviour of the individual barriers. Under normal circumstances even when controls succeed in blocking certain operations, their contribution towards the policy objectives may be minimal and costly thus making it hard to be distinguished.

According to *Dumas,Solnik(1995)* 'empirically, the severity of market imperfections which tend to produce segmentation'(pp 473) is a challenge to be resolved. Thus several researchers have supported this view and argued that there are effective barriers to capital movements which determine the degree of world market integration, amongst which are the poor credit ratings, high and variable inflation and the limited size of such markets. However, it has been argued that it could be wiser and more reliable if researchers were to isolate and quantify a barrier, which in their perception could affect the portfolio mixture and asset pricing, rather than speaking about them in general [11].

Black (1974) suggested that barriers to trade could be anything between transaction costs, information costs or differential taxation, and proposed a model which included a form of tax, modest in amount, as a fraction of the value of the asset. The use of taxes as representatives of barriers stands as a direct control on capital movements and even set a maximum percentage for foreign owned assets. The derivation of this model was based on the assumption of short sales presence, implying that investors who are short will pay negative tax, meaning that they will get a subsidy on their sale

[11] See *Solnik B.*," Testing international asset pricing some pessimistic views", *Journal of finance*, Vol. 32 ,Iss. 2, 1977.

equal to the tax paid by the buyer. Surprisingly enough, an increase in taxes under these circumstances will lead the market towards integration rather than isolation because local investors will increase their short positions but at the same time their long ones will not reach zero. In a study similar to this, *Stulz(1981)* argued that a different form of taxes, taxing both long and short positions, will prevent domestic investors from holding foreign securities, and thus can, albeit imperfectly, represent the barriers.

Both models agree on the prediction that a foreign asset which is domestically held, will have a higher rate of return than a domestic asset which is similar in terms of risk. This prediction ensures that the expected after tax returns on these assets will be equal. Under normal conditions, any binding restriction of this form will push up the price-net asset value ratio, ceteris paribus.

Furthermore, a study, which was carried out to account for the effectiveness of capital controls, was that of *Eun,Janakiramanan (1986).* The authors more or less based their work on previous studies, *Errunza,Losq(1985),* and set the scenario of "mild segmentation" with the allowance of some foreign investment by domestic investors. This approach was followed in an attempt to understand better the effects of legal restrictions imposed by the governments. They have concluded that foreign securities which are limited in amount are differentially priced by being offered at two different prices. This reflects the premium that domestic investors are willing to pay and the discount demanded by foreign investors. The size of this will depend on the covariance matrix of returns and investors preferences and will increase as the restrictions are tightened, thus increasing the price-net asset value ratio of the fund investing in the country.

Jorion,Schwartz (1986), suggested that segmentation could be a result of several barriers by classifying imperfections into two categories[12]. However, documenting barriers to investment is not sufficient to prove segmentation, since prices are determined by marginal investors who may find innovative ways of getting around these controls.

[12] In the first category there are the legal barriers, tax regimes, restrictions on ownership. In the second are the indirect ones such as information, disclosure requirements.

In order to pinpoint the source of segmentation the authors have split the study sample into inter-listed and pure domestic securities. The first group of securities was actually subject to the same listing requirements as the host country stocks, thus limiting the power of the indirect barriers imposed in the country of origin.

Considering the alternative source of imperfection, inter-listed stocks would carry the features of integrated stocks whereas domestic stocks would carry those of segmented ones. However if both types of securities are segmented then effective barriers are the legal ones. Nevertheless the equality of prices of the two may not indicate integration because some factors may be priced in one market and not in another. In an attempt to identify the possible cause of segmentation, the authors have run a test which showed that coefficients were the same in the two groups indicating that the legal barriers are most probably the cause.

In the same framework as the previous authors, *Hietela (1989)* focused on the effects of legal barriers but at the same time admitted that other barriers such as informational asymmetry, language and different accounting standards, in addition to the illiquidity of certain stocks, could affect the pricing of stocks. Ignoring these imperfections, his evidence generally supported the implications of another independent study, *Errunza,Losq(1989),* which in a different but relevant framework to the issue of effectiveness of capital controls, derived similar results. The authors of the latter study have suggested that the future wealth of investors who are restricted to trade in domestic securities only is directly affected by these measures, through selecting a set of assets that will minimise their welfare loss. However, as the authors argue, should these impediments be removed, at best there will be an increase in the number of available stocks to trade, which will benefit some but not other traders in terms of welfare[13]. Both studies provided evidence that domestic securities return, is kept below that of the unrestricted securities.

Within this context *Gultekin,Gultekin,Penati(1989)* attempted to answer the same empirical question. The authors believed that segmentation may arise as a

[13] This is contrary to the findings of an earlier study by *Subrahmanayam(1975)* which strongly suggests that an enlargement of the data set will unambiguously benefit investors.

consequence of either the imposition of government impediments to capital flows or because of individuals' attitudes or irrationality. Given that the second possibility is rather difficult to be assessed in practice, they focused on the issue of the effectiveness of capital controls. In this respect, the authors devised an event study, with which they considered a period of reforms in the controls of Japan against the US to evaluate the effectiveness hypothesis. Under these circumstances, the price of risk was expected to be differential across countries whilst the country was highly regulated and identical following the abolition of controls.

The empirical implementation of this hypothesis was carried out using a multifactor model in which equilibrium returns were set by APT. In an attempt to identify the relevant priced factors, the authors have considered two rival methodologies. First they utilised factors that were originally suggested by *Chen,Roll,Ross(1986)* and *Hamao(1988)*, as having a systematic effect on stock prices, as well as the alternative of factor analysis.

Test results under both alternatives where similar, with minor discrepancies, suggesting that risk determination is a domestic affair when the market is highly regulated against the case of a universal risk generating process, at times of liberalisation. An argument could be raised suggesting the robustness of this evidence, given the similarities shared by the two methodologies, in suggesting the effectiveness of the controls imposed by the different governments in an attempt to monitor capital flows.

In a rather similar environment *Bonser-Neal,Brauer,Neal,Wheatley(1990)* tested the efficacy of the controls imposed by governments on international investment. In their view if these controls were binding they would affect the ratio of a country's funds to its net asset value.

Under these circumstances the authors have proposed an event study, which in effect tested whether certain announcements of a change in restrictions are related to the premiums and discounts on close end country funds[14]. In particular, what the authors

[14] They have selected this approach based on two arguments. Firstly, earlier study tests require measures of the effectiveness of the prevailing barriers which is difficult to assess because investors

were looking for was to evaluate whether a relaxation of policy was associated with a decline (increase) in the premium (discount) and vice versa.

In empirical terms their results were consistent with the hypothesis that postulates a relationship between the events. This evidence could be translated as an indication that for this specific case the government-imposed barriers have been successful and met their requirement, i.e. segmenting international financial markets.

Fang (1991) has also suggested the presence of several controls in the international capital markets. He pointed out that information on foreign assets is not as readily available as on domestic stocks, in addition to the fact that accounting standards vary across countries. Furthermore, foreign transactions involve costs both in the foreign security market and the foreign exchange market.

In this context he pointed out the importance of not modelling the barriers in a "catch-all" manner, as in *Jorion,Schwartz (1986),* who recognised the two categories of controls. However he cast doubts about the latter study on the grounds that they used a doubtful model in their study and proposed an alternative testing environment based on the foundations of the APT.

The study's empirical tests were based on the assumption that the two forms of barriers are independent. Results have in fact supported this assumption, lending support to the independence between the two forms of barriers and their combined effectiveness on asset pricing.

In another study, using a completely different approach, *Bekaert(1995)* has attempted to evaluate the effect that several predefined capital flow controls have on markets returns. Using some predefined indices by the International Financial Corporation and information on the individual countries' policies, the author constructed some measures which he then interpreted economically. He suggested, contrary to the earlier work, that exchange control barriers imposed by the governments are either circumvented or are not binding. In his opinion what caused markets to be termed as

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often find ways round explicit restrictions. Secondly, these studies require some auxiliary model to explain the tendencies in close-end funds, which are not yet empirically justified.

segmented was the lack of useful information on markets and companies together with the low regulation regarding investors' protection and company information disclosure, confirming in a way *Fang(1991).*

Recently *Alford,Folks(1996),* acknowledged the fact that "some formal and informal barriers to cross-border investments remain in place"(pp.1) and proposed a measure of integration within this context. Their model was similar to that of *Black(1974)* and *Stulz(1981),* , in allowing an infinite number of counties in the world. Furthermore, their approach resembled earlier work in the assumption that investors seek to minimise the variance of the portfolio they hold subject to the portfolio return and barriers in operation.

The development of the coefficient of integration, i.e. effectiveness of controls, was based on the ratio of the return per unit of risk for the security and the return per unit of risk for the market portfolio. The derivation technique for the coefficient has been consistent with *Jorion,Schwartz's (1986)* remark , that when markets are fully integrated the world portfolio is mean variance efficient.

This measure provided a direct estimate of the severity of capital controls, modelled as a shadow cost on the purchase of a security and allowed for an analysis of bilateral integration and inter-temporal changes in the level of integration. Results from this application were consistent with and supportive of earlier studies such as *Jorion,Schwartz(1986)* and *Errunza,Losq(1989)*, confirming the importance of the impediments to international investment, suggesting also that these have declined over time.

In a similar study *Korajczyk(1996)* has taken into account the difficulty in comparing directly the effects of official controls across countries and proposed a measure that could be consistently applied to countries around the world, in an attempt to measure the level of segmentation. In this respect the author has utilised the arbitrage pricing theory to develop a general multi-factor equilibrium model, in a fully integrated environment. Given that the normal procedures of factor selection were followed and the model has actually identified the risk factors important to the investors, any

deviations from the returns depicted by the model would be considered as an indicator of the effectiveness of the official barriers to capital flows.

In an attempt to shed light on the debate of the appropriateness of such controls in assisting the economic development of the individual countries and controlling capital flows, the author has selected an expanded set of countries around the world, both in terms of geographical position and size and sophistication of institutions

In the empirical application of the proposed model the author concluded that there is a time variation in the measure and it "tends to be larger for the emerging markets than for the developed"(pp.285). This comment implied that legal barriers are actually larger for emerging markets postulating some relationship between the degree of regulation and the size of the market.

It is prominent from this study which uses an expanded dataset that these controls are effective, especially in developing countries. Furthermore, the measure often tended to decrease through time which was an indication of an increase in market integration. Thus along several dimensions this study's proposals were consistent with and confirmed prior studies in the same field.

In conclusion, these studies provided an insight into the effects and viability of the controls imposed. Their main observation was that the presence of barriers deprives domestic investors of the ability to diversify their country risk via the purchase of foreign securities.

Overall, it is very difficult to assess the cost-benefit contribution of these controls mainly because of the time trade-off involved. On the one hand the costs of these controls, which are imposed in most cases to provide autonomy from external disturbances, are realised in the long term but on the other hand the benefit becomes significant in the short-term. Additionally, given the awesome way of capital growth, controls could only be assessed after considering alternative capital flow channels and simultaneously applicable policy instruments.

Furthermore, this approach poses a problem in terms of inability to identify the specific barrier that drives the results. This is mainly because it is impossible to decompose the impact of either temporary or permanent barriers on asset pricing, thus limiting the modelling powers of the univariate models just to the determination of the level of segmentation created by all barriers to investment.

A.3 Summary

Evidence from capital markets around the world, postulates that, subject to the asset pricing model, there are some risk factors which are shared between different countries.

Errunza,Losq(1985,1992), using the ICAPM, found that markets around the globe are bilaterally integrated , implying that to an extent these markets share some common factors. However, *Wheatley(1988)* in the same framework provided weak evidence for the complete integration hypothesis. In a separate work which also shared the use of the single factor model, *Harvey(1995)* proposed that the level of integration of capital markets actually changes over time and surprisingly he found that this has negatively changed over the sample period.

During the same period of time, given the inadequacies of the single factor with respect to the exchange risk and market portfolio identification, empirical work was also carried out using the alternative IAPT developed by *Solnik(1983)* . Results from the application of this model were again mixed , with *Cho et al (1986)* and *Abeysekera,Mahajan(1990)* suggesting that there are different factors influencing asset returns in different countries.

On the other hand *Koutoulas,Kryzanaowski(1994)* have confronted earlier attempts to validate the joint hypothesis of integrated markets and a valid model. Their point of reference was that earlier work has used a problematic approach to define factors and secondly that they were limited to identify whether or not market structure complies with complete integration/segmentation hypothesis, i.e. all common/local factors are the sole determinants of expected returns in the markets. Their results strongly

suggested that the model was in fact valid and that the prevailing market structure was a middle one, thus converging to earlier studies' results which used the ICAPM and proposed a similar market structure.

However, studies under both model specifications have been mostly concerned with the theoretical implication of the hypothesis, pushing to the margin the attempts to identify what actually was the cause of these results. Few empirical studies, such as *Gultekin,Gultekin et al(1989),Bonser-Neal et al(1990), Alford,Folks(1996), Korajczyk(1996)* amongst others, have actually considered the cause of segmentation and have, in their concluding remarks, fortunately suggested that certain barriers imposed by governments to control capital flows are effective in isolating the regulated markets.

Overall, the literature, part of which is analysed here, provides an insight to the shifts in the financial markets around the world and the changes in the level of segmentation which is inherent in the world's capital markets.

Part B

Equity Market Interdependence

B.1 Modelling these mechanisms: Early Empirical evidence

Since the early 70's the establishment of the lead-lag relationship in the national stock exchanges, has been a main issue of empirical work. An early study by *Granger,Morgenstern (1970)* examined these relationships by applying spectral analysis on a dataset comprising of weekly prices, for eight markets. Their results led to the main conclusion that, contrary to widespread beliefs, different stock exchanges around the world showed little or no interrelationship between them. However they noted, that this scenario might not be viable in the case of a major world-wide crisis, economical or political.

Another study, which attempted to throw some light on the issue during the seventies, was that of *Aagmon(1972).* He used a simple econometric technique to conduct a lead-lag analysis, using a monthly dataset for four developed countries. His main results showed there were no significant signs of lagging in these countries and that responses were mostly immediate.

Further to this study and contrary to the earlier work by *Granger, Morgenstern (1970)* who used similar methodology to his, *Hilliard(1979)* found some expected[15] lead-lag relationships in the market indices around the world. The author supported these observations by the fact that the study actually analysed a period which encompassed a world-wide crisis, the OPEC Oil Embargo in 1973. Under these circumstances the embargo should have operated as a common external factor which introduces a comovement in world equity markets. Additionally, this observation might have been a result of the use of a daily dataset, which most probably captured some short-lived events, not captured in earlier studies. These results, using cross sectional techniques add considerable analytic support to the earlier study by *Aagmon(1972).*

Overall, despite the fact that the above studies have in general used different empirical methods, they tend to agree that the correlations between countries are low. Consequently, they confirm the notion, that nationally generated information has the most and in certain cases exclusive, effect on the asset prices. This in effect suggests that independence of price movements is more prominent within each market rather than contemporaneously.

However, by looking at recent events in market movements it can be suggested, at least for equity markets, that there is actually a substantial degree of interdependence amongst national markets. Within this framework and in the absence of any market imperfection, a market stock index should reflect all available information including that impounded in any other country's index. This implies that there should be no systematic lagged inter-market adjustment long or large enough to be exploited.

[15] The author argues that these were expected in the sense that there is non-synchronous trading, and he suggests that this appears to be consistent with the implications of efficient markets with respect to real time lags.

Effectively this suggests that performance in one country should only be reflected in the opening prices of another, thus leaving any subsequent changes to be random. In addition, he correlation of the two markets open to close returns to be zero. If, however, the open to close returns of the individual countries are found to be highly correlated, this will constitute violation of the efficient market hypothesis on the grounds that public information about the performance in one market could be used as a profitable trade strategy in another market.

A major problem though, with establishing and evaluating this relationship, is the fact that return observations across countries are matched by calendar date, creating a possibility of a real time discrepancy. This discrepancy mainly arises from the fact that different national markets operate in diverse time zones without any overlapping hours and as a result have non-synchronous return observations. The absence of any common operating interval between markets increases the feasibility of predictable actions by traders.

This means that earlier results should be carefully assessed prior to any conclusion. In this respect *Eun,Shim(1989)* have explicitly considered these time discrepancies in the interpretation of their results. The authors attempted to answer certain questions, which in their opinion form the basis for the identification of the transmission mechanism. The data set comprised daily rates of return on the country indices[16], from 1/80 until 12/85, contrary to most of the previous work which used weekly and monthly data. Additionally, the selected data set excluded the multi-listed companies, thus alleviating the possibility that any observed interdependence in national stock markets arises from the activity in these stocks. Results from this study provided several useful insights into the transmission mechanism within the sample countries, suggesting that there is a substantial amount of interaction with an approximately 48 hour post-shock response. A result consistent with the notion of informationally efficient markets, given the differential time zones.

A later study by *Becker,Finnetry,Gupta(1990)* focused exclusively on the synchronisation of stock price movements in the US and Japan, using daily opening

[16] Dataset was made up of Australia, Canada, France, Germany, Hong-Kong, Japan, Switzerland, UK, USA

and closing data. The authors chose this form of data to complement their main investigation for the presence of any influence between the two markets, by checking the correlation of closing prices in one market and the next working day opening of the other market[17].

Their motivation for this has been the fact that the absence of overlapping trading hours between markets, creates a perfect ground for traders and analysts to use information from the previous trade market as a predictor of performance in the other market. Such an event could, as mentioned earlier, be considered a violation of the principles of the efficient market hypothesis. In effect, this hypothesis expects the flow of new information in the market to be random and any news from the previous market to be reflected in the opening price of the next.

The dataset comprised of the daily opening and closing prices for NIKKEI and S&P 500 between 10/85 and 12/88. The authors justified the short period chosen on the grounds that this was more "meaningful than a longer period because of the structural changes"(pp.1299) in both markets. Their results suggested that the performance of the US in the previous trading day has a major impact on the Japanese current day returns. Surprisingly enough, they discovered that the Japanese performance had no impact on the US overnight return, although there was a slight impact of the Japanese daily return on the subsequent daily US return. Additionally, as far as the US effect on the Japanese market was concerned, the authors suggested that the inclusion of the transaction costs and taxes eliminated the profits and predictive ability of the US market[18].

The authors have been concerned about the validity of these results, mainly because they were based on a data set that included a very unusual period in the recent history of stock markets, the October 1987 crash. On this basis, they as well as using the data with the observations which corresponded to this period, they have also run their tests without the respective crash observations. Interestingly enough, by excluding the relevant observations, the authors found that the lagged US returns have more impact

[17] As a matter of fact there is an eight and a half-hour gap between the trading hours of the two stock exchanges.
[18] This is mainly because of the fact that trading costs are higher in Japan than in the US

on the overnight Japanese returns, than on the following open to close returns. This challenged the statement by other authors[19], amongst whom were *Granger,Morgenstern(1970),* that in the case of an international crisis, markets are more interrelated.

In a somewhat different approach *Koch,Koch(1991),* motivated by the fact that over the years there have been advances in communications and relaxation of various governmental policies leading to the reduction of international markets imperfections, once more addressed the issue of interdependencies but in a rather different framework. In fact they have developed a procedure which involved a dynamic simultaneous equation model which could reveal any contemporaneous and lead-lag relationships amongst the national market indices. Further to this, the proposed estimation technique was capable of identifying the change in magnitude and statistical significance of each response over time.

Consequently, this study extended existing literature in several fields. First, the proposed model specification allowed for the estimation of the magnitude and significance of these market relationships, making a distinction between contemporaneous and lagged effects in real time. This set-up was also capable of incorporating the effects of non-synchronous trading of stocks because of the differential opening times. Furthermore, the proposed model included dummy variables to account for day of the week effects and the inclusion of a time trend.

Results were similar to those of *Eun,Shim (1989)*, suggesting an increasing level of market interdependence, by presenting several clusters of markets that had substantial interaction and unidirectional impacts within a 24 hour interval. This relationship was found to be in countries with overlapping trading hours, on top of the fact that they are within the same geographical region. In addition, test results have indicated that there are several over 24-hour lapse lagged responses in markets, suggesting that these relationships are quite efficient as markets adjust rapidly to relevant

[19] Authors such as *Roll(1988)* , have actually exclusively focused on the relationships around the international market crash in October 1987. In their comments these studies have pointed out that actually inter-market relationships have intensified for a brief period after the crash, but then quickly resumed to the normal pre-crash levels .

information, minimising the possibility of exploiting this information for earning abnormal returns.

The above mentioned studies could be classified as literature which discusses the complexities that may arise from non-synchronous trading. Based on this and to an extent, on the failure of these studies to identify the form of effect, *Aggarwal,Park(1994)* claimed that results of past studies examining daily and overnight transmissions of equity prices between markets with no overlapping trading hours, specifically between USA and Japan, may be unreliable. The authors also contended the results of *Becker, Finnetry, Gupta (1990)*, although they used opening and closing prices. They in fact, pointed out that the opening value used is unlikely to reflect the opening values of many of the stocks that make up the indices because few of these stocks are traded by the time the value is calculated. This has been the main finding of *Stoll,Whaley(1990)*, who reported that stocks begin to trade on average, 5-7 minutes after the stock exchange opens. Furthermore, they raised the issue of differential time intervals between the closing of one market and the opening of the second and the differential effects that information release has on the equity value.

Trying to alleviate these shortcomings, the authors proposed the use of the "transaction based opening prices for the nearest future contracts"(pp.761) on the market indices under examination, which act as the best alternative to the use of the "unreliable" spot equity index. The bottom line was that according to their test results previous studies that used opening values are highly unlikely to be a reliable source for describing the prevailing market conditions. However, they confirmed previous results on the nature of the index opening prices, these being very noisy compared to closing prices. What the authors have suggested, based on their results, was that US (Japan) overnight returns reflect earlier Japanese (US) trading period returns. Furthermore, they infer that the statement by *Becker,Finnetry,Gupta (1990)*, suggesting that US equity prices on the previous day have some explanatory power on the Japanese overnight returns, is questionable given their significant results of bi-directional reflection of overnight price changes[20].

[20] Consequently, their results can be viewed as a confirmation of *Gultekin,Gultekin, Periati (1989)*, finding of increased capital market integration between the two markets following the relaxation of some controls in Japan.

Overall, it can be concluded from all of the above studies that, despite the attempts made to model the transmission mechanism with interesting and considerable results, this strand of literature overlooked certain empirical characteristics of index returns, which through years of research have been found to be of importance.

B.2.1 Alternative Testing Methodologies

B.2.2.1 The Structure of International Stock Returns

The shortcoming of the above studies, in accounting for the long standing empirical characteristics of financial series and especially the stock indices, is evident by looking at an early study by *Merton(1980).* The author suggested that these studies should consider the presence of heteroscedasticity – non-stationarity of the second moment of the distribution of returns - and so account for the temporal dependencies in the series[21].

These suggestions have also been confirmed recently, by *Schwert, Sequin(1990)* who pointed out that heteroscedasticity is a pervasive phenomenon in stock returns. They have even moved a step further to prove that failure to account for predictable heteroscedasticity can actually lead to the misleading conclusion of accepting the fact that the conditional distribution of returns is much more fat tailed than a normal distribution.

In this context, *Engle(1982)* introduced the ARCH model based on what has been previously considered as nuisance, modelling second order moments. In effect, the author, by using these moments, has managed to explicitly incorporate these suggestions and brought a change in financial time series modelling. These models are quite similar to the first moments time series techniques, with the emergence of

[21] His suggestions have been made on the premise that the absence of serial correlation does not in fact imply statistically independent returns. Heteroscedasticity has been acknowledged as a stylised fact for stock prices since *Mandelbrot(1963)* whose study results suggested that large changes tend to be followed by large changes of either sign and small changes to be followed by small ones.

deeper and richer understanding of the underlying dynamics of conditional variances and covariances.

Statistically, they are zero mean and serially uncorrelated processes which allow for a time invariant unconditional covariance matrix but at the same time permit dependency of the conditional variance on past states of the world. Early empirical application of the simple ARCH(p) model suggested a rather arbitrary lag structure in the conditional variance equation, to take account of the long memory of events. This led to an extension of the model to allow for a more flexible lag structure, the GARCH(p,q) due to *Bollerslev(1986)* - see equation (3)- which then formed the basis for further extensions in literature.

$$y_t = \xi\ x'_t + \varepsilon_t$$
$$\varepsilon_t / \Psi_{t-1} \sim \mathrm{N}(0, h_t)$$

$$h_t = \alpha_0 + \alpha_1 \varepsilon^2_{t-1} + \ldots\ldots + \alpha_p \varepsilon^2_{t-p} + \beta_1 h_{t-1} + \ldots\ldots + \beta_q h_{t-q} \qquad (3)$$

The inclusion of the time varying variance in these models could actually explain the high level of kurtosis and could in some cases be relevant in explaining the presence of skewness in the return series.

A study that has empirically shown that these models can reasonably capture the individual stock return series and their distributional characteristics is that of *Akgiray(1989).* In this study stock market returns and squared stock returns series[22] were analysed. Contrary to previous empirical work, based on a wide range of statistics, this paper gave evidence of temporal behaviour of stock market returns that challenged the common assumptions of independence and linearity.

The author suggested that there are no compelling theoretical reasons for assuming that the lack of serial correlation does imply statistical independence of returns in

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[22] Dataset was the CRSP value weighted portfolio covering the period from 1963-1986, The sample is analysed as a single time series, in addition to the four equally split series. The breaking up is motivated by the observation that the series might not exhibit homogeneous behaviour over the entire sample period, which is then confirmed in addition to the fact that the whole series may not be represented by a stationary process with constant parameters

addition to the fact that the necessary assumptions are questionable. Additionally, he suggested that expectations should tend to accept that there are non-linearities and intertemporal dependence in the returns series.

A verification of these expectations provided evidence that neither the actual nor squared stock returns were made up of independent variates suggesting the presence of linear and non-linear dependencies in the series, especially in the daily one. These results were similar to those of *Fama(1965),* giving a conclusive rejection of the hypothesis that returns are strict white noise processes, thus proposing the presence of linear and non-linear dependencies in returns.

In conclusion, it can be argued that the use of these models, which allow for the correlation between the first and second moments is far better than the hypothesised risk return relationship of the simple asset pricing models. Additionally, the results of this study re-enforce the empirical popularity of these models based on their features.

Based on this supportive evidence and in an attempt to evaluate the applicability of these models in 'smaller' markets, *Poon,Taylor(1992)* have considered the case of the United Kingdom. In this respect the study used different forms of data - daily, weekly, fortnightly, monthly - for the market in an attempt to point out the best model in the family[23], for each frequency.

Following the indications from the simple plot of the series, the authors concluded that the series demonstrated fatter tails than those implied by a normal distribution, proposing the estimation of the models under both the normal and t-distribution specification. In effect, this approach allowed for the distinction between conditional heteroscedasticity and conditional leptokurtic distribution, either of which could generate the fat-tailness in the data set.

[23]The authors were mainly concerned with the issue of the nature of the relationship between return and volatility in the market, following the contradicting empirical evidence, in earlier studies in this area.

Within the context of both distributions the authors have estimated a wide range of models including the simple generalised form and a GARCH in mean model , GARCH-M, proposed by *Engle, Lilien, Robins (1987)*, which implies mean reversion. Reference has been also made to an exponential specification of the model, based on *Nelson (1991),* which incorporates the 'leverage effect' , identified by *Black (1976)* and *Christie (1982).*

Although the GARCH-M model, under both distributions, provided better estimates these were not statistically significant at a 5% level, suggesting that the GARCH(1,1) was the most appropriate model in comparison with other time series models, within the group.

Similarly, *Corhay,Rad(1994),* motivated by this study and using an expanded data set made up by a group of European markets, applied this type of model on the individual series. This could be considered as an interesting extension basically because it could provide further evidence in either direction, in favour or against the validity of such models in capturing the return dynamics in smaller capitalisation markets.

The study results, generated by the estimation of several combinations of GARCH models out of which the authors have selected the best fitting model[24], indicated that European markets are primarily characterised by conditional heteroscedasticity, exhibiting non-linear dependence which cannot be captured by a random walk model. In this respect the authors have empirically confirmed the adequacy of this class of models, and not surprising the GARCH(1,1) model , for studying the behaviour of returns in smaller markets.

Moreover, a recent study by *Theodossiou,Lee(1995)* using weekly data combined both sets of literature in terms of markets used by dealing with a large set of major international stock markets for the main index of each country. Their preliminary results revealed that stock index returns around the world exhibit strong second

[24] The authors in addition to assessing the validity of the models using the likelihood function specification under normal distribution, have estimated the models using a t-distribution (*Bollerslev*

moment dependencies, thus supporting earlier evidence and invalidating the use of a white noise linear process for modelling the series.

Given these results, the authors turned to the use of the GARCH-M, which allowed for the conditional mean and volatility of returns to be predictable using past available information on returns and volatility at a given point in time. In search of the optimal representation, the authors estimated the model using the linear, square root and logarithmic specification of the mean equation. The statistical results were similar to those of earlier studies, suggesting that the model under all mean equation specifications is a viable approximation for the statistical features exhibited in the series of stock market returns.

The main point raised by this group of studies, amongst others, is in effect a favourable result for the ARCH based models in two aspects. Firstly, this class of models demonstrated that it can be used to adequately model the return series of countries and secondly it could be applied to almost all markets irrespective of the size and trading volume.

Additional to these positive remarks, recent developments in finance, which implied the importance of predicting volatility in many financial decisions, have motivated the empirical work by *Engle,Ng(1993)*. After confirming that the leverage effect is present, the authors used a data set which comprised of the daily data of the Japanese TOPIX index between 1/80 to 12/88 to investigate and identify the asymmetric model that fits data best. Effectively, this result prompted the inadequacy of the simple GARCH model and provided evidence in favour of the asymmetric volatility models suggested - EGARCH, GJR-GARCH.

In summary, the above study and to a greater extent all of the previous mentioned studies suggested that the development of a process which falls within the ARCH specification, corrects for the skewness and reduces the excess kurtosis. Consequently, these processes tend to describe stock price fluctuations much better than a normal process with constant variance and with or without time varying mean.

(1987)). Results actually demonstrated that GARCH models under this specification are better fitting processes than the original specification, which is in line with *Poon, Taylor(1992)* study.

In addition to these favourable features , studies have also pointed out that they can be successfully applied to a wide range of markets, irrespective of their size and trading volume.

B.2.2.2 The Transmission Mechanism

The empirical evidence presented above demonstrates, that the ARCH type class of models is an interesting and popular approach for modelling equity market financial series and to an extent their empirical features. As a consequence several researchers re-addressed the issue of the mechanics behind the transmission of information around the world's capital markets within this framework.

In fact, empirical studies attempted to establish the influence stock returns of one market have on those of another market and the implications these transmissions have on asset pricing, hedging, other trading strategies and regulatory policies within these financial markets. In econometric terms this is achieved by modelling the dynamic relationship between the markets, for return and volatility.

Hamao,Masulis,Ng(1990), is one of the studies in which the short-term interdependencies in stock prices and volatility across national markets are modelled. They examined the transmission mechanism of the conditional first and second moments in common stock prices across international markets by allowing a time variation in the mean and variance. The dataset consisted of daily opening and closing returns over a three-year period and unlike previous studies, was divided into close-to-open and open-to-close returns. This was in contrast with previous work, which under similar conditions used only close-to-close returns to examine the spillover effects in the markets. Furthermore, this separation helped to distinguish between the different causes of correlation, created by the presence of overlapping returns in different markets. Effectively, this allowed for the isolation of the overnight effects within the correlation measure, by examining the impact of the open-to-close returns of the previous market to trade onto the close-to-open returns of the domestic market.

They used a two-stage technique, utilising the univariate GARCH-M model introduced by *Engle,Lillien,Robins (1987)*. The model was then modified by an inclusion of a dummy variable to capture any holiday and weekend effects.

Additionally, it was extended further by the inclusion of an exogenous variable into the conditional variance, intended to capture the potential volatility spillover effect from the previously opened foreign market on the domestic one. The variable was proxied by the most recent squared residual, using open-to-close returns, termed as "volatility surprise" from the foreign market last to close. Application of this principle has revealed a statistically significant effect of the previous to trade market on domestic for all sample markets.

The main finding of the study was the successful approximation of the daily stock returns both in close-to-open and open to close format by a GARCH(1,1)-M model. Empirically the application of the model documented some price and volatility spillovers amongst the markets in question. In fact results suggested an 'overnight' information transmission routine in the next market to trade from the proceeding trading markets. The inclusion of the October 1987 crash in the sample created significant mean spillovers in almost all directions. This could be viewed as a confirmation of *Eun,Shim(1989)* results and as evidence of informational efficiency in these markets during the crash period.

The identification of the price and volatility spillovers between a group of countries, basically consisting of markets in the Asia basin, has also been the main issue in *Liu,Pan(1997)*. The structure of these markets and the differential capital controls in each one made the investigation interesting and allowed the authors to evaluate the impact of these controls on the spillover effects. Under these circumstances it is reasonable to expect that a market which has fewer restrictions will actually show a greater degree of influence by foreign shocks.

In search of a good representation of the spillover effects the authors have used the daily closing prices of the market indices in the sample countries and the two stage GARCH model approach. At first they modelled the stock returns of each country using a modified ARMA (1)-GARCH model, including a dummy variable to capture

the day of the week effect, if present. In the second stage they used the standardised residuals and their squared value to estimate the mean and volatility spillover effects from the US and Japanese market to the other sample markets.

Results revealed significant mean-return spillovers especially for the innovations originating in the US market. On the other hand the Japanese innovations were not statistically significant in terms of creating a spillover effect. Furthermore, volatility spillovers were found to be unimportant for both information centres. This is an interesting result because the power of the Japanese innovations was insignificant despite the geographical proximity of the sample due to earlier comment by *Koch,Koch(1991)* that interdependencies are highly likely to arise in markets in the same geographical region.

These results of *Liu,Pan(1997)* suggested that the openness of the market has no relation with the identification of spillover effects. The generality of this suggestion has led authors onto investigating further the presence of a connection between the two by considering the case of a sample country, which has actually transposed its financial policy within the sample period. This scenario required splitting the sample into two periods, representing the prior and post transition period for the country. Following the same estimation technique they confirmed the fact that the spillover effects have intensified since the liberalisation of policy. Effectively, these results proposed that after liberalisation the spillover effects tend to increase and in general there are some time varying interdependencies in terms of mean and volatility across markets.

Prior to this study , *Lee,Theodossiou(1993)* also directed their interest in this area, in an attempt to provide some additional understanding into the level of coherence amongst the national stock markets. They considered several markets around the world – USA, Japan, United Kingdom, Germany and Canada – using their most representative stock index, on a weekly basis between January 1980 and December 1991.

Using the multivariate extension of the GARCH-M model, introduced by *Bollerslev(1990)*, the authors have generated some results which could be termed as

signals of weak, but statistically significant, positive mean spillovers amongst sample markets, proposing a violation of the martingale hypothesis for stock prices. The presence of such a relation created the possibility of predictability of stock market returns, an action which allows investors to reap above normal returns, thus violating the weak form of the efficient market hypothesis. An evaluation of this possibility showed that the explanatory power of the mean equations was limited and could not be used for generating predictions. Additional to this the empirical results of the model rejected the presence of a time varying risk premia, depicted by the insignificant volatility coefficients in the mean equations. This result confirmed *Baillie,DeGennaro(1990)*, who disclosed little evidence for a statistically significant relationship between return and own volatility.

Furthermore, the results for the conditional variance equations sustained the presence of significant and persistent conditional heteroscedasticity in the sample market series. It was prominent, that past own innovations were statistically significant in almost all cases, in addition to the fact that there was a cross border transmission mechanism which created significant but at varying degrees of intensity spillover effects.

These results, provided the motivation to *Karolyi(1995),* who attempted to model, in a dynamic framework, the shortrun dependencies in price movements for stocks traded in the stock exchanges of Canada and US. The selection of this sample was made, based on earlier literature, such as *Jorion,Schwartz(1986) and Koutoulas, Kryzanowski(1994)* amongst others, which suggested that the two markets are increasingly affected by unified factors, i.e. integrated, and thus share certain market structure similarities.

Within this framework, the sample period was extended between 4/81 and 12/89 using the fully aligned daily closing prices of the most representative country index. This specification attenuated the problem of non-synchronous trading, arising from the non-overlapping trading hours, present in several earlier studies. Further to this, the author was concerned about the fact that the sample period selected included the October 1987 crash which had dramatic effects on the distribution of returns around

the world and removed these days by opening a four-day window around the crash day[25].

Moreover, the sample was conditioned by splitting it into the pure domestic companies and the ones that were inter-listed, given that several Canadian companies were listed in the Canadian as well as the American exchanges in question. This effect, allowed for the derivation of an indirect test to ascertain the effect of barriers to trade on the price and volatility relationship of these markets. A dummy was also introduced in the sample to account for the weekends and the non-identical holidays, thus converting the dataset into a fully aligned one.

The empirical model used was the bivariate GARCH model[26]. The main study results, suggested that conditional volatility is an important feature of the return series, and that innovations were rapidly transmitted between markets, speed of which was subject to the modelling technique used and time interval. Nevertheless, the interrelationships were present, and when the two sub samples were separately examined the inter-listed stocks showed higher immediate response to foreign shocks.

The bottom line of the study was that the employment of the bivariate GARCH process to capture the transmission mechanism was successful, with inferences about the transmission mechanism in terms of magnitude and persistence of return innovations depending extensively on this modelling technique. It is also evident from these that the there was a time varying relationship in these markets, this not being a result of a common shock - as the main international shock has been removed. Furthermore, evidence was given for the importance of investment barriers in understanding the dynamics of comovements in stock prices around the world as in *Liu,Pan(1997)*.

Engle, Sumsel(1994), have also re-examined the issue of spillovers in international equity markets. Their sample consisted of the hourly observations for the most

[25] This has been carried out by actually removing the respective observations for the period between 16/10-21/10.

[26] The author was concerned about the sensitivity of his results and he has introduced another model based on the VAR methodology. Results under this specification has actually shown consistency with

representative and well diversified indices in United Kingdom and United States, for the period between 2/1/87 and 29/2/89. In the empirical section, the framework was almost identical to that of an earlier study by Hamao,Masulis,Ng*(1990).*

Their results suggested no inefficiency, as depicted by the estimated coefficients for the sample countries, even if the October 87 crash was included in the dataset. This rejected and challenged the results of earlier studies, which reported statistically significant spillover effects in these markets, especially for innovations originating in the USA. The authors attribute this to the fact that earlier studies are based on standard t-statistics which might be misleading.

Despite the apparent success of these simple parameterisations[27], in dealing extensively with the linkages and interactions in the major stock markets around the world, they failed to explicitly examine the possibility that the size of innovation, quantity of news, as well as quality, sign of the innovation, i.e. leverage effect, are relevant and important determinants of the degree of volatility spillovers across markets.

In this context *Nelson(1991)* developed a new model, within this family of models, known as the exponential GARCH model, EGARCH, which could capture the asymmetric impact of stocks on volatility. At the same time other authors such as *Engle(1990)* have proposed competing models - Quadratic-GARCH, VGARCH - which targeted the adequate modelling of the series given these asymmetries. However, evidence given by *Engle,Ng(1993)* suggested that the modelling capabilities of the EGARCH model were superior to these, especially when modelling the predictable volatility associated with 'bad news', i.e. negative innovations.

An early study, in terms of using this model in this framework, was that of *Booth, Koutmos (1995*), in which they attempted to explicitly account for the potential

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those of the earlier study by *Eun,Shim(1989)* but with the latter methodology overestimating the dependence in certain cases and suggesting significant higher order lags.

[27] These studies could be viewed as an illustration of the extant literature, part of which is referenced in *Bollerslev et al (1992),* who surveyed the use of these models in explaining the behaviour of

asymmetries that may exist in the volatility transmission mechanism within three 'major markets'. The authors looked at the daily behaviour of the New York, Tokyo and London stock exchanges over the period between September 1986 and December 1993[28]. However they have ignored the fact that there is no concurrent trading between the markets in question and used the open-to-close series of returns. This in effect does not allow for the explicit determination of the cause of coherence, which may arise under conditions contrary to the efficient market hypothesis requirements.

Study results suggested the existence of first and second moment spillover effects. In particular they proposed the presence of an asymmetric transmission mechanism in terms of volatility spillovers, which are more prominent for news originating in the last market to trade.

In the empirical section of the study, the authors extended the EGARCH model to a multivariate form. In effect they were seeking to simultaneously model the series considering both the price and volatility spillovers between markets. This increased the power of their tests and at the same time avoided the two step estimation procedure of the earlier studies by *Hamao, Masulis,Ng(1990)* and *Liu,Pan(1997).*

In terms of first moment interdependencies the tests revealed that there were significant price spillovers between markets and that the London market was actually a recipient of shocks originating in both the other markets in question. Taking the analysis to second moments the authors found that the countries were, in addition to their past innovations, influenced by innovations which originated in the last two markets to trade, in an extensive and reciprocal manner which was higher than the first moment dependencies. Moreover these were found to be asymmetric for all countries confirming that both the sign and size of innovations were important determinants of volatility spillovers.

Following the suggestions made by *Bollerslev et al(1992),* that outliers are highly likely to be the cause of the asymmetric volatility, and the fact that the sample period

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volatility over time, and refer to more than 200 studies that applied the ARCH and the related models in financial series

included the October 1987 crash, the authors estimated the model using two sub-samples. At first, the pre-crash period was examined and revealed some spillovers in price, also present in volatility but with no asymmetric pattern. However, when the post-crash period was examined, the picture was different. Results were quite similar to those of the full sample period, giving evidence of significant leverage effect.

Looking at these results, it is apparent that the model is actually a good approximation of the transmission mechanism of spillovers. Furthermore, they suggest the increase in the interdependencies of markets, with information being generated in a rather global environment.

In another study but within the same framework, *Koutmos(1996)* focused exclusively on European markets. The study sample selection has been inspired by the fact that research interest in European markets did not reflect the interest which is shown by international investors. The data set consisted of daily close returns of the aggregate stock price indices of several European countries[29] between January 1986 to December 1991.

The empirical section of the study although it shared similarities with *Booth,Koutmos(1995)*, utilised an extended model specification. As a matter of fact, it extended the previous study's model to identify the lead/lag relationships between the market as depicted by their stock market indices. Consequent to this, was the specification of the contemporaneous relationship between the returns of the sample markets.

This relationship was captured by the constant conditional correlation specification, introduced by *Bollerslev(1990)*. This is a simplified estimation and inference procedure, compared to *Baba,Engle,Kraft,Kroner(1989)*, based on conditions that are very easy to impose and verify. This specification implied that the observed increased comovement in the stock indices was due to changes in the covariance rather than changes in the correlation structure. In particular, the increased volatility magnitude

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[28] Useful statistics about these stock exchanges could be found in the earlier study by *Hamao,Masulis,Ng(1990)*

[29] The study markets were United Kingdom, Germany, France and Italy

was offset by an equivalent magnitude in the covariance structure, leaving the correlation structure unchanged.

Prior to the assessment of the importance of the market interdependence in the sample countries the author carried out a simple check, through descriptive statistics, which revealed that if dependencies were present in the series , second moment ones were of greater magnitude. These preliminary results have, in effect, signalled the importance of dependencies requesting a further evaluation of the transmission mechanism. In this respect, tests were then carried out by estimating a VAR-EGARCH model. Estimates of the autoregressive coefficients of the restricted model suggested according to *Conrad, Kaul(1988)* that expected returns were actually time varying.

Furthermore, it was evident that the short-term dynamics of the markets had conditionally heteroscedastic errors, additional to the presence of asymmetric volatility interactions across these markets. Evidence was also given to support volatility persistence in these markets and suggests that their unconditional variances are finite (not integrated). The main model estimation results highlighted the presence of several multi-directional lead-lag relationships suggesting that no market plays a significant role in the information generating process. What is important from these relationships is the assessment of whether these are economically significant. This required further detailed work on the transaction costs as well as measures of the foreign exchange risk. Initially, when these were taken into account, the markets complied with *Fama(1970)* 'weak form' efficiency.

Further tests, for the presence of second moment interdependencies revealed that they were equally extensive and reciprocal. It was evident that in addition to its own volatility spillovers the markets were also affected by innovations generated in other markets[30] with the exception of Italy. The transmission mechanism was mostly asymmetric with the exception of innovations originating in France. Both results confirmed *Sand,Schollhammer(1985)* suggestions of an Italian autonomy and the French passive role.

[30] 'Own volatility spillovers' is used to indicate a one way causal relation between past volatility shocks and current volatility in the same market. 'Imported innovations' is used to indicate the same pattern but with past volatility in the market affecting current volatility in another.

These findings supported the notion that both the size and sign of the innovations are important determinants of the volatility transmission mechanism. On average, it was found that a negative innovation in a market increases volatility within and across markets twice as much as a positive innovation as found also in earlier studies. A comparison of the volatility persistence estimates between a restricted and unrestricted VAR-EGARCH process confirmed *Lastrapes(1989)* suggestion that a high degree of volatility persistence estimate may be due to omitted variables.

Conclusively, these results suggested the presence and significance of the first and second interdependencies implying that European markets are integrated in the sense that news affecting asset pricing is not purely a domestic one. Overall results, unlike previous studies, accounted for the possibility that bad news in one market has a greater impact on the volatility of returns in another market. Evidence was supplied for multidirectional lead-lag relationships and significant second moment (volatility) interactions. Finally it is once more obvious that the interactions across markets can be represented by the multivariate EGARCH in a satisfactory manner.

B. 3 Summary

It is quite evident from what has been put forward in the literature, selection of which has been considered above, that forecasting financial market volatility is an important aspect of asset pricing.

Over the years this has become an important empirical feature of stock markets, as new evidence accumulated, suggesting that the occurrence of certain drastic episodes, such as the OPEC Embargo and the October 1987 crash, had a world wide impact. These 'events' have prompted a number of empirical researchers to search for and evaluate the short-run mechanisms through which stock market volatility was transmitted around the world during these periods of time and during normal periods.

At first studies in this area focused on interactions and interdependence of the national financial markets in terms of first moments. *Eun, Shim(1989)* for instance, attempted in this framework to model contemporaneous and lagged correlation changes in several markets. Results documented dynamic responses to innovations that are generally consistent with the notion of informationally efficient international stock markets. Furthermore, *Koch,Koch(1991)* investigated the lead-lag relationship between markets, and pointed out a growing regional interdependence over time. *Becker,Finnetry,Gupta(1990)* gave evidence of profitable trade on information raised in another market, under certain conditions, which effectively contradicts the efficient market hypothesis.

However, during the same period of time studies such as *Merton(1980)* and *Schwert,Seguin (1990*), have identified an important empirical feature of asset prices, that of changing conditional volatility known as heteroscedasticity. This observation has led to the reconsideration of the facts and the introduction and development of a group of models - the ARCH family of models by *Engle(1982), Bollerslev(1986), Engle, Lilien, Robins(1987), Bollerslev(1990)* amongst others.

Since then, literature that utilised this type of model has been accumulating very rapidly, confirming the empirical success of them and the presence of the empirical features in the stock market series, *Akriray(1989), et al.*. Furthermore, studies such as *Poon, Taylor(1992), , Corhay, Rad(1994),* and *Lee, Theodossiou(1995)* have considered with favourable results the applicability of these models in markets which are considered to have low turnover and trading.

The empirical success of these models in the univariate form, i.e. dealing with markets in isolation, has created a new dimension for testing for the stock market interactions and interdependencies , for both the first (price) and second (variance) moments, by extending them to a multivariate form. *Hamao,Masulis,Ng(1990)*, demonstrated the different dynamics for spillover effects in price and volatility changes between three major stock exchanges. Furthermore their results gave evidence for a substantial effect of international shocks, such as the October 1987 shock, on the relationship between markets. This sort of result has also been suggested by *Lee,Theodossiou(1993)*. On the same wavelength *Engle,Sumsel(1994)*

concluded that there are some spillovers, which at their best, are very short in duration. Following up studies such as *Karolyi(1995, Liu,Pan(1997)* gave evidence similar to these studies.

However the presence of the 'leverage effect' in stock returns has urged studies to re-consider the case of interdependencies within this context. This in effect implied that simple parameterisations of the ARCH models that have been used in several studies were inadequate mainly because they failed to take account of this fact explicitly. In this respect authors such as *Nelson (1991), Engle (1990), Engle, Ng (1993),* introduced new augmented models classified as non-linear models, to deal with this shortcoming.

Within this framework, *Booth,Koutmos(1995), Koutmos(1996)* accounted explicitly for the potential asymmetries that may exist in this mechanism, and provided new evidence on price and volatility spillover transmissions and the statistical importance of the asymmetry.

Conclusions

In recent years capital markets have undergone numerous changes that led to the increment of cross-border equity investment. In this context investors gained by reducing the unsystematic risk of investing in a single market, by enlarging their opportunities both in terms of individual companies and across countries. Literature that examined the implications of such an expansion of opportunities has given conflicting results. At first it was suggested that this unambiguously benefits investors but at a later stage it was confronted by the suggestion that this benefits some but not other traders.

Effectively the globalisation of the financial services and the dismantling of capital controls meant that the difference between national and international risk exposure should be reduced or even disappear and thus the markets become more integrated.

Over the years this has become central to most theoretical developments in international finance and indeed lay behind much of the international policy discussion. As a practical matter, testing for capital market integration relies on the pricing model to identify the portion of the variation in asset returns which command a premium and inversely relate it to the level of integration.

In this framework, although studies used the two basic models advanced by finance theory in an international context, they could be classified in three broad categories: segmented markets, integrated, mildly segmented. In the first group of studies it was assumed that markets were segmented by considering the asset-pricing model, namely the CAPM, using only one country's data.

The second class of studies was built upon the assumption that markets were fully integrated. This included studies, which used the CAPM and the APT in their international context both in simple form and their extensions. However, several of these attempts to empirically investigate the structure of the world capital markets have led to inconclusive and at times conflicting, results. The conflict was mainly created by the fact that they only tested for the polar cases, complete integration/segmentation. At times of rejection of the hypothesis this was interpreted as proof of segmentation. In effect this excluded the possibility that the fundamental asset-pricing model was invalid or the market was inefficient.

Yet, the third class of studies falls between the two polars – the so called mild segmentation hypothesis. At first a model was put forward using the theoretical background of the CAPM, and results suggested that the model reasonably captured the real world and gave evidence in support of the mild segmentation hypothesis. However, the fact that this model had at first a restricted measurement of risk and secondly it introduced a fixed level of segmentation through time, led to the development of alternatives. Following this a model in the APT environment was introduced. Results from the application of this model enforced earlier results in a more general framework, by suggesting that national markets are influenced by both domestic and international innovations. Furthermore, in the second extension when the level of integration was allowed to be time varying, results also suggested that markets have been moving towards integration.

While there is a rich body of research on international market integration few studies tried to identify the source of segmentation. Traditionally researchers have assumed that segmentation arose either because of individual attitudes, irrationality or because of the government impediments to capital movements. Given that measuring the individual attitudes is a rather difficult task and especially in an international context, the analytical approaches to modelling the barriers, were again in the context of the basic asset pricing models. Studies under both model specifications provided an insight to the effects of the official barriers imposed. This could be viewed as success of these barriers in impeding international investments.

Moreover, another empirical implication of the inference that markets are mildly integrated is the possibility that these markets are interdependent. Under these circumstances, individuals may look at information generated in other markets and adjust their investment strategies accordingly and gain excess returns.

Early literature in the area, although it used mostly divergent methodologies has agreed that the correlation between countries is low. Consequently, it confirmed the notion, that nationally generated information has the most and in certain cases exclusive effect on the asset prices. Looking at the motivation of these studies though, this is questionable, mainly because they were concerned with the justification of the belief that independence of price movements is more prominent within each market rather than contemporaneously.

However the generality of these early methodologies and the occurrence of certain world-wide events, OPEC 1973 Oil Embargo and the October 1987 Stock Market Crash, have urged researchers to re-examine the issues in a different framework. Moreover, the importance of the presence of non-synchronous trading which has been actually overlooked at earlier stages of literature has also been recognised and incorporated in the testing approaches.

In this strand of literature results were mixed, and in several cases conflicting, *Becker, Finnetry, Gupta(1990), Malliaris, Uruttia(1992)*. In effect some of them found that the world-wide crises were not as important in affecting the information

transmission mechanism across borders, whilst others found that markets were more interrelated during and after these periods of time.

Despite the increase in volume of studies, which provided similar conclusions and improved empirical findings, this strand of literature suffered from a number of shortcomings. Most notably, they failed to account for the long-standing stylised facts of speculative price changes - that is the presence of heteroscedasticity and to an extent the presence of temporal dependencies in the series.

As a consequence, this has called for a re-examination of the empirical representation of this issue by the employment of conditional heteroscedastic models , along with the other already established methodologies. First phase results from the application of this group of models revealed that they can be adequately used for modelling return series in different countries, irrespective of size.

The empirical success of these models in a univariate form, i.e. dealing with markets in isolation, has created a new dimension for testing for the stock market interactions and interdependencies , for both the first (price) and second (variance) moments, by extending them to a multivariate form. Within this framework , results suggested the presence of linkages and interactions amongst stock markets around the world and in a way confirmed earlier results , which suggested the creation of significant spillover effects in countries around the world.

In conclusion, all of the reviewed literature from early stages to current status tends to converge on the inference that markets are intimately related, with this degree growing over time. News that originates in one market seems to influence the short-run volatility of stock prices in foreign markets. Furthermore, these have important implications for the global pricing of securities within these markets.

Chapter 3

Are National Stock Markets integrated in terms of risk?

3.1 Introduction

Recent increases in cross-border investments, following the progressive policies which several governments are continuously adopting, have effectively escalated interest in the examination of the implications of such events on the structure of international capital markets.

In this context markets are considered to be integrated if assets, which have the same exposure to a risk factor, have identical returns regardless of their trading location. Segmentation on the other hand may arise either because of some official restrictions imposed by the government, or by any other form of impediment resulting from sources such as individual's attitude or irrationality.

Most of the existing literature that addressed this issue has been developed in a two period mean variance framework[31] and within this compilation of work it is possible to identify two major categories of studies. At one end, studies are concerned with fully integrated markets assuming that all markets are part of a major world market. Empirical models, á la *Sharpe-Lintner* pricing model, which were previously used in the purely national framework, have been extended to reflect the assumption of the presence of a single world market which has a prevalent influence on the individual national markets (*Jorion,Schwartz(1986), Stehle(1977), Solnik(1977), Harvey(1991), Stulz(1995)* and references thereafter). Departing from this rather restrictive framework of a single factor, authors such as *Wheatly(1988), Cho,Eun,Senbet(1986), Koutoulas Kryzanowski(1994)* have fruitfully used the principals of *Solnik(1983)*

[31] Chapter 2 of this study offers a more detailed explanation of extant literature.

multi-factor model in testing for the hypothesis of internationally integrated markets.

Under both of these specifications, studies approached the issue by considering the testable hypotheses which involved a joint test that the model was valid and that the markets were integrated. Sometimes the rejection of the hypothesis of financially integrated markets led to a *cul-de-sac* conclusion, this being that either the model was invalid or the markets under consideration were inefficient, in addition to the possibility of rejecting the capital market integration hypothesis in favour of the segmentation hypothesis[32]. This result arose mainly due to the fact that almost all of the studies, of which both of the above specifications are part, formally restricted the market structure to be either of the polar cases - completely integrated, segmented markets - in their hypothesis procedure.

Examples of these results can be drawn from *Wheatley's(1988)* study which used a sample of developed markets and the simple consumption based asset pricing model and failed to discriminate between the two extremes. Additionally, *Jorion,Schwartz(1986)* rejected the integration hypothesis, using an international capital asset pricing model. However, it was recently confronted, for conceivably rejecting integration in times that the markets were integrated, by *Koutoulas,Kryzanowski(1994)* who tested the same hypothesis for the same markets using the alternative multifactor model, IAPT.

On this basis, which suggests that there are considerable difficulties surrounding the issue of establishment of the prevailing market structure, the study makes use of a model that was theoretically developed by *Errunza,Losq (1985)*[33] and empirically tested by *Errunza,Losq,Padmanabhan(1992)*. The model set-up allowed for the presence of a structure other than the two polar cases, resulting from the inability of a group of investors to access a set of securities. This imperfection 'appears to be quite prevalent in the international arena'(*Errunza,Losq(1985)*,pp106), given that in many cases non-resident investors face restrictions in foreign markets. In asset pricing terms, if this sort of discrimination is present, stocks which are restricted to be traded

[32] See *Harvey(1991)* for a good example

only by locals demand a premium which is proportional to the market risk. The value of any premium on the restricted securities in conjunction with the other testable hypotheses will define the level of integration of the two markets.

The twist in this testing methodology is the fact that the established relationship can take any form between complete segmentation / integration, thus allowing for a moderate, in between, structure. The present study, will actually examine the issue of capital market integration using this model but in a different framework, i.e. testing for the relationship in a European context

Under this scenario, the utilised European capital markets, and their constituents, are considered to form two groups. The first group contains the eligible securities, represented by the British stocks, which are accessible to all investors given that there are no severe controls in foreign ownership[34]. At the other end we have the individual European markets - Netherlands, France, Germany, Switzerland - which are termed as ineligible and under this specification are only available to resident investors. This classification is further justified by the fact that these markets, at the beginning and at least for much of the covered period of time, had some controls in place that impeded local investors to access other markets. Take for example France which up to late eighties was considered to be ' a country with severe foreign exchange controls' (*Korajczyk, Viallet (1990)*, pp.557). In terms of numerical data the study will use a time series of stock prices for this group of European countries , obtained from Datastream International Database from July 1987 to April 1997.

3.2 Data Requirements

The source of the data for this empirical section is Datastream International Database. The selected sample countries do in fact account for almost three-quarters of the European market capitalisation and thus could be considered as representative of the European Equity Market.

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[33] The model has been developed based on *Solnik(1977)* proposal that 'the efficient way to test for segmentation would seem to be to specify the type of imperfection which might create it and study its specific impact on portfolio optimality and asset pricing' (pp 505).

Our sample consists of mid-month estimates and spans from July 1987 to April 1997. It is evident that this period encompasses the influential period of the October 1987 stock market crash. However, since these events occurred during the third week of October their effects on our sample are somewhat remote.

The data set is comprised of the prices of the individual stocks listed on the National Stock Exchanges together with their respective market capitalisation. The data is extended by the Morgan Stanley Capital International, MSCI, European Stock Index together with the ECU-30 Day Deposit rate. These were selected as proxies of the European Equity return and the European risk free rate, respectively. Additional to this are monthly observations of the Sterling exchange rate, used to measure excess returns in a common currency, since the study involves the examination of the risk premium differentials.

Table 3.1 presents the distribution of stocks across countries. It is evident that these markets have demonstrated a pattern of steady expansion over the sample period. The French market has in fact, over the ten-year period, increased six times in size.

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Country										
UK	948	1043	1111	1159	1184	1210	1264	1393	1480	1699
Netherlands	149	154	158	166	171	173	176	182	189	203
France	129	197	546	567	686	695	709	791	843	923
Switzerland	171	191	208	218	220	226	230	238	244	256
Germany	229	241	583	628	659	685	694	714	736	757

Table 3.1 Available companies on the National Stock Markets as at July annually

The British market dominates the sample by contributing around 52% of all the securities. The predominance of the British listed Stocks indirectly suggests, further to the regulatory characteristics of the market, that they should be used as the proxy of the European Equity Market eligible security set.

The monthly returns of these firms are calculated as being the difference in natural log of the price for two consecutive months and mathematically presented as $R_t = \log(P_t)$-

[34] In theory the UK equity market is an open market in terms of accepting foreign equity investments, after the abolition of the exchange control in 1979.

$\log(P_{t-1})$. It is obvious from this that we are dealing with a large number of companies, making study calculations a complex procedure. In an attempt to alleviate this problem we reduce the data to manageable proportions, by using portfolio instead of security returns.

The thesis makes use of two competing portfolio formation techniques, the equally weighted and the market value weighted one. The sole purpose of following this is to check the robustness of our results by ensuring that they are not conditional on the formation procedure.

The different asset portfolios are formed at the beginning of the sample period and then are rebalanced on an annual basis. This implies that at the beginning of each time interval the stocks, which have price and market value information available for the preceding quarter[35] to the rebalancing point, are considered in the formation of portfolios. If in the mean time any company is taken over, merges or goes bankrupt, it will be dropped from the sample at the next rebalancing point. The same applies for new companies, which had no information at the time of rebalancing. Available stocks will then be ranked in ascending order in terms of their market capitalisation. This forms the basis of calculating the deciles which will be the boundaries of the portfolios, and will be fixed between rebalancing points. This means that there will be ten (10) portfolios of stocks, starting from the low capitalisation stocks and moving on to the high ones, in each time interval. The attribute of each security to the individual portfolio price will then be calculated either according to the total number of securities (n) in the portfolio, i.e. (1/n) or the capitalisation of the specific security (i_{mv}) in relation to the total portfolio capitalisation (Σi_{mv}) , i.e. ($i_{mv}/\Sigma i_{mv}$).

[35] This has been used by LSE, as a selection criterion, for an inclusion of a stock in the FTSE indexes.

3.3 The model

3.3.1 Theoretical background

Following the normal channels of hypothesis testing we should first build the theoretical basis for the empirical model used. In the first instance we should be looking at a model developed in an environment which introduces an imperfection to the main assumption of previous studies, that of complete integration. According to Errunza,Losq*(1985)* this imperfection could be introduced by constraining a group of investors for having access to a subset of stocks. Under these circumstances in a two-country framework, investors are pooled into two categories, with differential trading rights. In the first group, restricted investors are limited to trade domestic securities only whereas in the other group unrestricted investors are allowed to trade on their domestic securities which are available only to them, termed as 'ineligible', in addition to the ones of the other country which comprise the 'eligible' set.

Effectively, this introduces a scenario of one way integration in the sense that unrestricted investors can form portfolios on an expanded set of securities, domestic and foreign, whereas the restricted can only use domestic securities for their portfolio strategies.

In every other aspect of modelling the standardised assumptions which are applied in asset pricing model derivation prevail, these being perfect capital markets, free lending and borrowing. Further to these assumptions there are the mean variance expression of expected utility and the assumption of normal distribution of returns. Additionally, returns are denominated in a single currency implying that there are no differential demands for foreign currencies amongst investors, translating to ineffective deviations from the purchase power parity and optimal portfolio choice, see for example *Adler,Dumas(1983), Stulz(1995).* In other words the explicit treatment of the exchange rate risk is made rather unnecessary. This has been a desirable feature of the testing methodology and model, for the sake of tractability. In the event of large price differentials between countries in addition to the consumption preferences, the problem of the exchange rate risk could not be conveniently

dismissed, *Dumas, Solnik(1995).* Furthermore, the study deals only with the demand side and a single imperfection to international capital markets.

An important implication of the framework of unequal access to securities, is the fact that the eligible securities are priced as if the two markets are fully integrated[36]. On the other hand, ineligible ones, demand a 'super risk premium' which should onbe positive on average, and will represent the compensation required for supplying ineligible securities in a segmented market. In this set-up, unrestricted investors will provide a proxy for the market portfolio of the ineligible stocks, for which they will require an implicit remuneration. However this becomes negligible, when the unrestricted investors have a comparatively low risk aversion, or when there is a suitable proxy of the market portfolio of the ineligible securities in the eligible segment. In such a case, the expected returns of any security in either group would be proportional to its covariance with the world portfolio.

3.3.2 Derivation

Within this framework, the degree of effective market integration could be expressed as a function of price discrepancy between the two classes of securities, depicted by the risk premium. However, because the estimation of the risk aversion coefficients is a formidable task, the alternative of cross sectional regressions for the estimation of the effective degree of segmentation will be used. This requires the specification of a particular return generating process, which could be represented by a two-factor model for testing the hypotheses.

The methodology used for the generation of the testable hypothesis parallels that of *Jorion, Schwartz(1986), Stehle(1977).* This requires the adjustment of the general two-factor model to derive two different return generating processes. These will in effect encompass the characteristics of both the eligible and ineligible securities, in the first case under complete/mild integration structure and in the latter under

[36] This could be contradicted with the results of Stulz(1981a) who stated that under these circumstances the domestic common stocks will actually plot on a line which a smaller slope than the one depicted by the Sharpe-Lintner relationship.

complete segmentation. Thus, in the case of testing the null hypothesis of complete integration and mild segmentation the model is assumed to be

$$\widetilde{R}_e = \alpha_e + \beta_{e1}\widetilde{R}_{EU} + \beta_{e2}\widetilde{V}_E + \widetilde{\mu}_e \qquad (1)$$

and,

$$\widetilde{R}_i = \alpha_i + \beta_{i1}\widetilde{R}_{EU} + \beta_{i2}\widetilde{V}_I + \widetilde{\mu}_i \qquad (2)$$

In this model specification $R_{e(i)}$ are used to denote the individual securities, in the eligible and ineligible segment respectively, which if accumulated they will create the respective market return (E,I). The European equity market return is represented by R_{EU} where the tilde denotes randomness. For both endogenous variables returns are assumed to be in excess of the 30-day rate of return.

Equations (1), (2), also include the term $V_{E(I)}$ representing the variance-covariance matrix which is orthogonally generated by estimating the equation

$$\widetilde{R}_E = \alpha_E + \beta_E\widetilde{R}_{EU} + \widetilde{V}_E \qquad (3)$$

and,

$$\widetilde{R}_I = \alpha_I + \beta_I\widetilde{R}_{EU} + \widetilde{V}_I \qquad (4)$$

assuming that by construction,

$$\text{cov}\left(\widetilde{V}_E, \widetilde{R}_{EU}\right) = \text{cov}\left(\widetilde{V}_I, \widetilde{R}_{EU}\right) = 0$$

an assumption which severely limits the sources of covariability between the returns of the two sets of stocks. The inclusion of this term is due to *Stehle(1977)* who suggested that prior tests were deficient in the sense that they used the alternative risk measures, under any market structure, as a single independent variable. This means that the total market return has to be decomposed[37] without loss of generality , into a component perfectly correlated with the return on the European market portfolio and a component which is uncorrelated with the rate of return of the domestic securities market portfolio.

[37] Testing for integration of markets cannot be done either by the use of univariate regression, due to the correlation between the domestic and international market, or a multiple regression because of the presence of collinearity.

As a result of this and the general assumptions discussed in the previous section, about the structure of returns in the two segments of the market, the risk-return relationship can be expressed as

$$E(\widetilde{R}_e) = \gamma_{E1}\beta_{e1} + \gamma_{E2}\beta_{e2} \qquad (5)$$

$$E(\widetilde{R}_i) = \gamma_{I1}\beta_{i1} + \gamma_{I2}\beta_{i2} \qquad (6)$$

where γ_{E1} , γ_{I1} and γ_{E2} , γ_{I2} are the unconditional and conditional market risks respectively. In these models and under the expectations of the complete integration hypothesis, the unconditional market risk γ_{E1} , γ_{I1} should be equal in both segments and different from zero. Additionally, in both segments the conditional risk is expected to be equal to zero. In the case of the mild segmentation hypothesis the unconditional risk of the ineligible segment is expected to be larger in magnitude that that of the eligible, $\gamma_{E1} < \gamma_{I1}$, in further to a statistically significant γ_{I2}.

In addition, the presence of formal and informal barriers to capital transactions imply that the assets in different countries are not priced according to the model of an integrated capital market as developed above. The use of the incorrect risk measure in the regression, will imply that the least square estimates will be inconsistent, mainly because of the non-independent distribution of the residual from the independent variable. This requires the derivation of an alternative general process, to the earlier specifications. In the same framework the process in a completely segmented market can be expressed as:

$$\widetilde{R}_e = \eta_e + \delta_{e1}\widetilde{R}_E + \delta_{e2}\widetilde{VE}_{EU} + \widetilde{\mu}_e \qquad (7)$$

$$\widetilde{R}_i = \eta_i + \delta_{i1}\widetilde{R}_I + \delta_{i2}\widetilde{VI}_{EU} + \widetilde{\mu}_i \qquad (8)$$

However in this case the decomposition process will attempt to break down the European market portfolio return, into the component which is directly related to the respective domestic market portfolio and a second component which is independent to the local market portfolio. In this setting,

$$\widetilde{R}_{EU} = \alpha_{eW} + \beta_{eEU}\widetilde{R}_E + \widetilde{VE}_{EU} \qquad (9)$$

and

$$\widetilde{R}_{EU} = \alpha_{iW} + \beta_{iEU}\widetilde{R}_I + \widetilde{V}E_{EU} \qquad (10)$$

and once more,

$$\text{cov}\left(\widetilde{V}I_{EU}, \widetilde{R}_{EU}\right) = \text{cov}\left(\widetilde{V}E_{EU}, \widetilde{R}_{EU}\right) = 0$$

With the same logical sequence as the derivation of the model in the previous case, under this market structure the risk-return relationship can be expressed as,

$$E\left(\widetilde{R}_e\right) = \theta_{E1}\delta_{e1} + \theta_{E2}\delta_{e2} \qquad (11)$$

$$E\left(\widetilde{R}_i\right) = \theta_{I1}\delta_{i1} + \theta_{I2}\delta_{i2} \qquad (12)$$

This implies that the under a fully segmented market, the conditional risk coefficients are expected to be different from zero but not equal across market segments. Furthermore, for both sets of stocks the international risk coefficient is not expected to be different from zero.

The derived models under both scenarios, relate the ex-ante expected excess returns on a security to its ex-ante covariances, based on market probability assessments. However, since the risk aversion coefficients and distribution of wealth across investors are not directly observable this theory should be extended to accommodate the relationship of these ex-ante variables with the ex-post returns. These are considered to be random outcomes of the stationary ex-ante probability distributions which are in turn assumed to be efficient and unbiased estimates of the underlying distributions[38]. This effectively, implies that expectations are replaced by historical returns given that consensus expectations are unbiased and change the process into:

$$\widetilde{R}_e = E\left(\widetilde{R}_e\right) + \beta_{e1}\left[\widetilde{R}_{EU} - E\left(\widetilde{R}_{EU}\right)\right] + \beta_{e2}\widetilde{V}_E + \widetilde{\mu}_e \qquad (13)$$

$$\widetilde{R}_i = E\left(\widetilde{R}_i\right) + \beta_{i1}\left[\widetilde{R}_{EU} - E\left(\widetilde{R}_{EU}\right)\right] + \beta_{i2}\widetilde{V}_I + \widetilde{\mu}_i \qquad (14)$$

[38] Justification for this could be found in an early study by *Kraus,Litzenberger(1975)*

Alternatively, in an environment which considers markets to be fully segmented the return generating process will be presented as,

$$\widetilde{R}_e = E(\widetilde{R}_e) + \delta_{e1}\left[\widetilde{R}_E - E(\widetilde{R}_E)\right] + \delta_{e2}\widetilde{V}E_{EU} + \widetilde{\mu}_e \qquad (15)$$

$$\widetilde{R}_i = E(\widetilde{R}_i) + \delta_{i1}\left[\widetilde{R}_I - E(\widetilde{R}_I)\right] + \delta_{i2}\widetilde{V}I_{EU} + \widetilde{\mu}_e \qquad (16)$$

As a consequence of the assumption of rational expectations, certain substitutions can be made in equations (5) and (6) for complete and mild integration and in (11) and (12) for complete market segmentation. The return generating process will now take the form of

$$\widetilde{R}_e = \gamma_0 + \beta_{e1}\left[\gamma_{E1} - E(\widetilde{R}_{EU})\right] + \gamma_{E2}\beta_{e2} + \beta_{e1}\widetilde{R}_{EU} + \beta_{e2}\widetilde{V}_E + \mu_e \qquad (17)$$

$$\widetilde{R}_i = \gamma_0 + \beta_{i1}\left[\gamma_{I1} - E(\widetilde{R}_{EU})\right] + \gamma_{I2}\beta_{i2} + \beta_{i1}\widetilde{R}_{EU} + \beta_{i2}\widetilde{V}_I + \mu_i \qquad (18)$$

for testing the hypothesis of a completely and mildly integrated market and,

$$\widetilde{R}_e = \gamma_0 + \delta_{e1}\left[\theta_{E1} - E(\widetilde{R}_E)\right] + \theta_{E2}\delta_{e2} + \delta_{e1}\widetilde{R}_E + \delta_{e2}\widetilde{V}E_{EU} + \mu_e \qquad (19)$$

$$\widetilde{R}_i = \gamma_0 + \delta_{i1}\left[\theta_{I1} - E(\widetilde{R}_I)\right] + \theta_{I2}\delta_{i2} + \delta_{i1}\widetilde{R}_i + \delta_{i2}\widetilde{V}I_{EU} + \mu_i \qquad (20)$$

for the segmented market.

The dependent components of the return generating process (equations 17-20) will be proxied, as mentioned earlier, by the total number of domestic stocks traded in the individual major national stock exchange. The size of the markets under consideration, implies that there will be a large number of stocks involved, translating to an analogous number of parameter estimates. To avoid the computational difficulties that may arise in the implementation of the hypotheses testing, and yet still benefit from the same properties as if individual stocks are considered, we will use the constructed portfolios, following the earlier techniques discussed. However as pointed out by *Gibbons(1982)* this procedure may overlook some information specific to the company but since the main target is to model a relationship which concerns the national market as a whole, this is not a problem.

At this stage the distinction between the two classifications of securities should be introduced. As mentioned earlier the British stocks will form the eligible set which is expected to be priced as if the markets were completely integrated. This is because these stocks are traded in a market which is open to all nationals. In addition, stocks traded in the other sample markets will be termed as the individual ineligible set, mainly because over the sample period there were certain regulations in place that controlled the capital flows.

The empirical evaluation of the testable hypothesis, first requires the acquisition of parameter estimates for equations 1,2 and 17,18 which will be used for the tests of complete integration and mild segmentation and for the test of complete segmentation, respectively.

After the acquisition of these two components we can proceed to the next step of a proper hypothesis test, that is the acquisition of the parameter estimates as depicted by the testable hypothesis model. Under this specification there will be some shared parameters within each segment further to the common restrictions that will be imposed on both market structures. This implies that the disturbances of these equations, given time, are highly likely to reflect some common, unmeasurable or omitted, factors and hence could be correlated. In the event of the presence of contemporaneous correlation, the individual parameter estimation might lead to inefficient estimates.

Consequently, it is more appropriate and efficient in this framework, to consider all equations jointly, rather than estimate each one separately. The appropriate joint estimation technique is known as seemingly unrelated regression (SUR) estimation, due to Zellner*(1962)* and considers that each portfolio has different fixed coefficient vectors. The application of the technique however, is subject to some basic assumptions. First, all the disturbances are assumed to have a mean of zero and be constant over time, with differential variance across equations. Furthermore, the disturbances of equations corresponding to the same time period, are allowed to be correlated but no correlation is allowed , either in the same equation or acrossequations, through time, i.e. no autocorrealtion.

Efficiency of estimators is again an issue for consideration. Under certain circumstances, i.e. if any assumption is violated, this technique offers no improvement in efficiency. If suspected correlation is actually equal to zero and all parameters are identical , the use of a system of equations will actually yield reults that are actually efficient to applying non-linear least squares individually on each stock. Thus it is useful to test whether contemporaneous covariances are equal to zero. In the context of this system of equations the null and alternative hypotheses for this test are,

$$H_0: \sigma_{12} = \sigma_{13} = \ldots = \sigma_{ij} = 0 \text{ for } i=j=1..20 \text{ and } i \neq j$$

$$H_A: \text{at least one covariance is nonzero}$$

An appropriate test statistic is the Lagrange multiplier statistic , suggested by *Breusch,Pagan(1979)*. This statistic is asymptotically distributed as chi-squared with M(M-1)/2 degrees of freedom where M is the number of equations. This statistic is given by

$$\lambda = T \sum_{i=2}^{M} \sum_{j=1}^{i-1} r_{i,j}^2 \qquad for \quad r_{i,j}^2 = \sigma_{i,j}^2 \Big/ \sigma_{ii}\sigma_{jj} \qquad (21)$$

Therefore, the null hypothesis and hence acceptance of the presence of contemporaneous correlation, is rejected if λ is greater than the critical value, at any significance level. Applying the test, (i.e. estimating equation 21, to assess the appropriateness of the selected modelling technique) the null hypothesis was rejected for all country pairs, because the estimated λ was actually well above the critical value of , 146.57, with 180 degrees of freedom and at a 95% level of significance. These results could be viewed as supportive evidence to the presence of contemporaneous correlation in the error terms, suggesting that the selected technique is efficient and appropriate for the proposed hypothesis testing.

Furthermore, in a less obvious way , this technique will yield the same results as the least squares, if the explanatory variables in each equation are identical. In terms of

the current case this condition clearly does not hold because the explanatory variables between the eligible and ineligible securities are not identical.

Given the validity of the proposed estimation technique, we can move onto estimating the system of equations and get the parameter estimates. In practice however, variances and covariances are unknown and must be estimated to form the basis for an estimated generalised least square estimate. To estimate $\sigma_{i,j}$ the equations will be estimated by least squares, yielding to obtain the least squares estimates of the residuals. This will then be used in the derivation of the variance covariance estimates, which are the input in the construction of a matrix[39] Σ which will be used for the derivation of the corresponding estimated generalised least square parameter estimators. Estimates of the parameters are obtained using the defined iteration procedure, minimising the objective function of

$$z(\beta)'\left(\hat{\Sigma}^{-1}\otimes \mathrm{I}_T\right) z(\beta) \qquad (22)$$

where $z(\beta)$ is the vector of stacked residuals, Σ^{-1} is the estimated covariance matrix of the disturbances and I_T is the identity matrix. The procedure is repeated until overall convergence, to the maximum likelihood estimator, is achieved.

3.4 Estimations and Discussion

Having set the theoretical framework of the empirical procedure we can proceed with the practical application. At first we should ensure that the proposed methodology is empirically a valid one , under all proposed scenarios. Effectively we will be looking to test whether the restricted model (eq. 1-4) is valid under the different scenarios and can be used to test the additional restrictions implied by each market structure.

[39] Notationally, the variance covariance matrix Σ^{-1} is given by stacking together the estimates of

$$\sigma_{ij} = \frac{1}{T-(K/M)}\sum_{t=1}^{T}\tilde{e}_{it}\tilde{e}_{jt}$$

This is a consistent alternative to the use of the T as a divisor which tends to bias the estimates. This divisor has the advantage of being constant for the whole system, and it leads to unbiased estimates when each equation has the same number of coefficients. The asymptotic properties of the estimated GLS estimator of β remain the same irrespective of which divisor is used.

Notationally, under each scenario this could be assessed by considering the null hypothesis (H_0) ,

$$\alpha_e = \gamma_0 + \beta_{e1}\left[\gamma_{E1} - E\left(\widetilde{R}_W\right)\right] + \gamma_{E2}\beta_{e2}$$

$$\alpha_i = \gamma_0 + \beta_{i1}\left[\gamma_{I1} - E\left(\widetilde{R}_W\right)\right] + \gamma_{I2}\beta_{i2}$$

against the alternative hypothesis (H_A) of inequality - unrestricted model eq 17-20.

These hypotheses can be conveniently tested using the likelihood ratio test (LRT), calculated by taking the difference in the natural logarithm of the absolute value of the objective function (22) of each of the models and multiplying it by the number of observations. In mathematical terms this could be presented as

$$LRT = T^*\left[\ln(Obj_R) - \ln(Obj_{UR})\right] \sim \chi_m^{\ 2} \qquad (23)$$

where Obj_{UR} is the value of the objective function when the restrictions (m), five in this case, do not apply while Obj_R represents the same value when the restrictions do apply.

The calculation of this statistic using the appropriate values suggested the acceptance of the hypothesis, that the two-factor model methodology could be used to economically reflect the different market structures. In light of this result the procedure could then be taken a step further onto the hypothesis testing of the appropriate structure. At first we concentrate on the statistical test for the presence of a completely integrated market structure. This could be carried out by considering the validity of the complete integration hypothesis, reflected by $\gamma_0=0$, $\gamma_{I1} = \gamma_{E1} \geq 0$, $\gamma_{I2} = \gamma_{E2} = 0$, against the alternative that the ineligible segment, is not completely integrated to a world financial market. The rationale of these hypotheses is that in the case of a fully integrated market the expected excess returns on any security , in both segments, would only be proportional to its covariance with the world market portfolio, as depicted by γ_{I1} and γ_{E1}.

In addition, testing for the presence of a mildly segmented market structure, requires the identification of an alternative set of hypotheses which will in effect present the unequal access restriction. In financial terms this restriction could be reflected in the set of ineligible securities which would command the payment of a premium, expected to be positive on average. Presence of this, the magnitude of which depends on the risk aversion[40] of the unrestricted investors, indicates that the market is actually mildly segmented. In other words, this risk premium should exist as a motive to the risk averse unrestricted investors to supply diversification services by offering a proxy of foreign securities, which however have comparatively low return and no super risk premium, to restricted investors. This infers that unrestricted investors should buy the ineligible securities otherwise required by restricted investors and at the same time supply eligible ones to them, so as to keep the market at equilibrium. In terms of the underlying model this could be tested by considering the hypothesis that $\gamma_0=0$, $\gamma_{I1}>\gamma_{E1} \geq 0$, $\gamma_{I2} \geq 0$, $\gamma_{E2}=0$, which effectively incorporates the presence of the super risk premium, against the alternative, that the markets are not mildly segmented.

Lastly, in the case that the market structure is suspected to be described by the notion of segmented markets, then a set of different hypotheses should be derived to evaluate the possibility. Under this circumstance the markets will price their assets in a purely domestic pattern, without any effect from economic forces outside the country, thus the international markets coefficients should be equal to zero. Thus the appropriate hypotheses to be tested, using equations 17-20, should be that $\gamma_0=0$, $\theta_{I1}\geq 0$, $\theta_{E1}\geq 0$, $\theta_{I2}=0$, $\theta_{E2}=0$.

The nature of these hypotheses relatively implies that all conditions should be met otherwise the overall hypothesis should be rejected. The relativity of this statement is based on the fact that an average non-zero risk free return ($\gamma_0 \neq 0$) cannot constitute a reason for a rejection of the overall hypothesis. In this respect, all tests

[40] If by any means unrestricted investors become risk lovers willing to bear more risk, prices will go up beyond what restricted investors are willing to pay, giving the false belief that markets are perfectly integrated even though barriers may exist. Secondly as the correlation coefficient between the returns on eligible and ineligible securities tends to one, there will be no distinction between diversification and hedge portfolio because diversification benefits will decline, implying that the conditional market risk will be negligible for all securities wiping out any super risk premiums

require only that this return is equal across the two segments, which in turn has no affect on the overall conclusions.

Econometrically, the first component of the hypotheses to be tested for the case of complete integration can be represented by $\gamma_{E1} = \gamma_{I1} = \gamma_1$ where the terms γ_{E1}, γ_{I1} in the respective equations are replaced by γ_1 thus forming the restricted model. This will then be evaluated against the unrestricted, e.g. 17,18, using the LRT with one degree of freedom. The other components are just evaluated using their t-statistics from the unrestricted model estimation.

Secondly, mild segmentation hypothesis is validated against the alternative of not mildly segmented markets. Acceptance of the null hypothesis here depends on the validity of certain relationships, $\gamma_{I1} > \gamma_{E1} \geq 0$ in addition to $\gamma_{E2} = 0$, $\gamma_{I2} = 0$. Testing for $\gamma_{I1} > \gamma_{E1} \geq 0$ under the mild segmentation hypothesis actually requires the introduction of a new parameter in the ineligible segment equations, due to *Chernoff(1954)*. On these grounds γ_{I1} will be replaced by $\gamma_{E1} + \omega$ in the unrestricted model and the significance of ω will imply whether the hypothesis is true or not, using - as in the earlier cases - the t-statistics of the parameters.

Similarly, using the t-statistics of the estimators, we can test for complete segmentation against not completely segmented. This hypothesis requires that $\theta_{I1} \geq 0$, $\theta_{E1} \geq 0$, $\theta_{I2} = 0$, $\theta_{E2} = 0$, which denotes that assets are domestically priced within the segments.

At this stage the empirical implementation of the respective hypotheses in each market structure could be carried out using the iterative, variance correction, procedure. Taking the twenty portfolios, in pairs, formed under two different arrangement techniques and using their returns in place of securities returns as required by the model we get the appropriate results in each case.

The estimated 2SLS risk premia and factor loadings given by the respective equations are reported in Tables 3.2.A and 3.2.B - under both portfolio construction methods - with the respective t -statistics in parentheses. Additionally, the far right

i.Complete Integration and Mild Segmentation hypothesis							
Test pair	γ_0	γ_{E1}[1]	γ_{E2}	γ_{I1}[1]	γ_{I2}	df[2]	$x^{2(3)}$
UK-BD (1)	1.041 (9.41)*	-1.1746 (-2.11)*	0.112 (1.41)	-0.963 (6.00)*	-0.094 (-1.78)	15	12.66
(2)	0.993 (2.014)*	-0.93 (-2.95)*	-0.079 (-1.53)	-0.994 (-4.72)*	-0.0031 (-0.33)	15	10.99
UK-FR (1)	1.031 (2.95)*	-1.1453 (-4.44)*	0.0979 (1.45)	-1.036 (-9.44)*	-0.038 (-2.64)*	15	8.56
(2)	0.942 (3.59)*	-0.814 (-10.22)*	-0.131 (-2.14)*	-0.9743 (-4.69)*	0.102 (2.10)*	15	8.36
UK-SW (1)	1.044 (6.56)*	-1.2476 (-7.59)*	0.174 (1.13)	-1.012 (-3.76)*	-0.0942 (-1.78)	15	9.84
(2)	1.08 (23.79)*	-1.27 (-8.08)*	0.170 (1.45)	-0.917 (-11.33)*	-0.154 (-1.58)	15	10.72
UK-NL (1)	1.004 (4.65)*	-1.549 (-1.18)	0.54 (0.42)	-1.001 (-10.1)*	0.0113 (1.09)	15	7.06
(2)	0.93 (17.08)*	-0.782 (-4.33)*	-0.161 (-1.29)	-1.014 (-29.73)*	0.1322 (1.20)	15	10.2

Table 3.2.A Parameter Estimates for the sample countries under Complete / Mild Integration environment

Equally weighted portfolio formation technique is denoted by (1). Similarly (2) denotes the market value weighted formation
'*' indicates a significance at 95%. Values in parentheses are the t-statistics for testing the individual hypotheses
$\gamma_0=0$, $\gamma_{E1}\geq 0$, $\gamma_{E2}=0$, $\gamma_{I1}\geq 0$, $\gamma_{E2}=0$ respectively
1 The estimate is obtained by adding back to γ_{E1} γ_{I1} Θ_{E1} Θ_{I1} the sample mean of $E(R_{EU})$ in the first two instances and $E(R_E)$, $E(R_I)$ in the latter two respectively.
2 Degrees of freedom are calculated using df=(E+I)-5, critical value
3. This represents the LRT calculated statistic

ii. Complete Segmentation Hypothesis								
		γ_0	θ_{E1}[1]	θ_{E2}	θ_{I1}[1]	θ_{I2}	df[2]	x^{2} [3]
UK-BD	(1)	1.03 (9.21)*	-1.02 (-46.32)*	-0.149 (-1.71)	-1.069 (-35.02)*	0.0711 (1.64)	15	13.00
	(2)	1.04 (62.8)*	-1.02 (43.53)*	-0.153 (-1.68)	-1.075 (-30.58)*	0.0814 (1.57)	15	12.96
UK-FR	(1)	1.059 (21.01)*	-1.046 (-17.74)	-0.211 (-1.05)	0.178 (0.056)	-0.81 (-0.40)	15	6.58
	(2)	0.941 (41.90)*	-0.96 (-46.08)	0.181 (2.29)*	-0.977 (-16.43)*	-0.019 (-0.10)	15	8.38
UK-SW	(1)	1.037 (4.52)*	-1.01 (-42.73)*	-0.156 (-1.65)	-1.08 (-26.07)*	0.079 (1.54)	15	14.02
	(2)	1.08 (23.27)*	-1.04 (-29.72)*	-0.24 (-1.61)	-1.09 (20.22)*	0.153 (1.38)	15	10.26
UK-NL	(1)	1.00 (7.245)*	-0.923 (-6.74)*	-0.503 (0.486)	-0.994 (-7.94)*	-0.011 (-0.95)	15	7.22
	(2)	0.928 (14.28)*	-0.9605 (20.75)*	0.227 (1.16)	-0.862 (-7.00)	-0.134 (-1.06)	15	10.58

Table 3.2.B Parameter Estimates for the sample countries under Complete Segmentation environment

Equally weighted portfolio formation technique is denoted by (1). Similarly (2) denotes the market value weighted formation

'*' indicates a significance at 95%Values in parentheses are the t-statistics for testing the individual hypotheses $\theta_{E1} \geq 0$, $\theta_{E2}=0, \theta_{I1} \geq 0, \theta_{E2}=0$ respectively

1 The estimate is obtained by adding back to γ_{E1} γ_{I1} Θ_{E1} Θ_{I1} the sample mean of $E(R_{EU}$ in the first two instances and $E(R_E)$, $E(R_I)$ in the latter two respectively.

2 Degrees of freedom are calculated using df=(E+I)-5, critical value

3. This represents the LRT calculated statistic

column represents the test for the validity of the utilised model specification. The statistic is χ^2 distributed with 15 degrees of freedom, which is equal to the total number of equations minus the restrictions. It is actually clear from the presented results that the deviation between the two models' objective functions is below the critical value. This supports the conjecture that the cross-sectional restrictions imposed by the two factor model are valid and that the model can be used as a tool for testing the particular constraints imposed by the market structure models.

The results from the application of the hypothesis testing for all market structures are nested in Table 3.3. It should be noted once more that the rejection of any of the elements of the appropriate hypotheses will mean the rejection of the overall hypothesis.

Test statistics for complete integration are disclosed in Panel A. It is clear from the results that certain features, which denote that markets are fully integrated, are statistically significant, whereas others are not. Overall these results translate into a rejection for almost all pairs of the hypothesis of completely integrated markets in favour of the fact that markets are not completely integrated. It is evident that under one form of portfolio formation the hypothesis can not be rejected for Germany and the United Kingdom. Under the alternative portfolio specification, results also reject the null hypothesis of completely integrated markets. This will mean that the expected returns on assets are not solely proportional to their covariance with the world portfolio.

Panel A. Complete integration							
Test pair	H_0: $\gamma_{I1} - \gamma_{E1} = 0$ H_A: $\gamma_{I1} - \gamma_{E1} \neq 0$		H_0: $\gamma_{E2} = 0$ H_A: $\gamma_{E2} \neq 0$		H_0: $\gamma_{I2} = 0$ H_A: $\gamma_{I2} \neq 0$		**Overall Hypothesis**
	x^2(df)	R/CR	t	R/CR	t	R/CR	R/CR
UK-BD (1)	5.56	R	1.41	CR	-1.78	CR	CR
(2)	8.76	R	-1.53	CR	-0.33	CR	R
UK-FR (1)	9.06	R	1.45	CR	0.47	CR	R
(2)	15.86	R	-2.14	R	2.10	R	R
UK-SW (1)	6.18	R	1.13	CR	-2.64	R	R
(2)	8.64	R	1.45	CR	-1.58	CR	R
UK-NL (1)	10.0	R	0.41	CR	1.09	CR	R
(2)	14.5	R	-1.29	CR	1.207	CR	R

Panel B. Mild Segmentation							
	H0: $\gamma_{I1} - \gamma_{E1} \geq 0$ HA: $\gamma_{I1} - \gamma_{E1} > 0$		H0: $\gamma_{E2} = 0$ HA: $\gamma_{E2} \neq 0$		H0: $\gamma_{I2} \geq 0$ HA: $\gamma_{I2} < 0$		**Overall Hypothesis**
	t	R/CR	T	R/CR	t	R/CR	R/CR
UK-BD (1)	1.9	CR	1.41	CR	-1.78	CR	CR
(2)	-1.87	CR	-1.53	CR	-0.33	CR	CR
UK-FR (1)	1.48	CR	1.45	CR	0.47	CR	CR
(2)	-2.29	R	-2.14	R	2.10	CR	R
UK-SW (1)	1.34	CR	1.13	CR	-2.64	R	R
(2)	1.68	CR	1.45	CR	-1.58	CR	CR
UK-NL (1)	0.41	CR	0.41	CR	1.09	CR	CR
(2)	-1.22	CR	-1.29	CR	1.207	CR	CR

Panel C. Complete Segmentation									
	H0: $\theta_{E1} \geq 0$ HA: $\theta_{E1} < 0$		H0: $\theta_{I1} \geq 0$ HA: $\theta_{I1} < 0$		H0: $\theta_{E2} = 0$ HA: $\theta_{E2} \neq 0$		H0: $\theta_{I2} = 0$ HA: $\theta_{I2} \neq 0$		**Over hypo.**
	t	R/CR	t	R/CR	t	R/CR	t	R/CR	R/CR
UK-BD (1)	-46.32	R	-35.02	R	-1.71	CR	1.64	CR	R
(2)	43.53	R	-30.58	R	-1.68	CR	1.57	CR	R
UK-FR (1)	-17.74	R	0.056	CR	-1.05	CR	-0.4	CR	R
(2)	-46.08	R	-16.43	R	2.29	R	-0.10	CR	R
UK-SW (1)	-42.73	R	-26.07	R	-1.65	CR	1.54	CR	R
(2)	-29.72	R	20.22	R	-1.61	CR	1.38	CR	R
UK-NL (1)	-6.74	R	-7.94	R	0.486	CR	-0.95	CR	R
(2)	20.75	R	-7.00	R	1.16	CR	-1.06	CR	R

Table 3.3 Test results for the competing market structures

The columns with 'R/CR' refer to tests of the corresponding hypothesis indicating whether it is rejected ('R') or not ('CR')

Further to these hypotheses , the validity of $\gamma_{I1} \geq 0$ and $\gamma_{E1} \geq 0$ should be considered, for the tests of full integration and mild segmentation. The hypotheses are actually rejected for all the country pairs(see table 3.2)

[1] Critical value at 95% significance and 1 degree of freedom 3.84

[2] Critical value at 95% significance and 115 degrees of freedom equals to 1.98

By taking a look at Panel B of the same table, it can be suggested that in almost all cases , the hypothesis that the ineligible securities actually command a premium is accepted. The exceptions are France and Switzerland for one of the two formation techniques. In the first instance , under the market value weighted portfolio formation,

it is suggested that there is no risk premium attached to the ineligible securities, a result which might have arisen for reasons which have been discussed earlier. In the latter case, although there is a super risk premium, the local factor premium is negligible, suggesting that for both cases the hypothesis of mild segmented markets is rejected in favour of the substitute of not mildly segmented markets.

Lastly, considering the hypothesis of completely segmented markets, it is quite evident that the statistical significance of the hypothesis that excess returns on assets are determined in a closed economy , i.e. only pervasive risk is the covariance with the domestic market, cannot be accepted.

Overall, the rejection of the latter hypothesis combined with the results on the first one , point towards the acceptance that the markets are most likely described by the structure defined as mildly segmented markets. This is confirmed in almost all pairs by the acceptance of the relevant hypotheses under the mildly segmented market structure setting. Consequently, it is suggested that there is an international, unified, risk premium in the pricing of securities in addition to the national risk premium, which creates a demand for a positive super risk premium in a group of assets.

3.5 Concluding Remarks

In this study a formal model of international asset pricing has been derived. Primarily the model has a distinctive feature, the unequal access assumption, which has been identified as the imperfection which proxies the reality of a mildly segmented world capital market. Under these circumstances the required return of the eligible securities will be satisfactorily depicted by the CAPM. However when it comes to the ineligible ones, the acceptance of the mild segmentation hypothesis will suggest the presence of a risk premium which arises as a proportion of the differential risk aversion and the conditional market risk.

In the empirical application of the model, results were consistent with the theoretical background of the model, lending support to the mild segmentation hypothesis. The most striking feature of these results was their consistency and similarity of estimates

across the two portfolio construction procedures. In cases where results were weak, i.e. the two procedures were conflicting, this may be attributed to the kinds of restrictions imposed by different countries in the real world framework.

Finally, although the procedure recognises the presence of an imperfection in world capital markets and corrects for problems in previous work, it does not recognise the fact that the level of integration has a time varying pattern. The importance of this, cited in earlier empirical work calls for the development of a testing methodology which will incorporate the time variance of the measure.

CHAPTER 4

A measure of national stock market integration in a time varying environment

4.1 Introduction

The results of the previous chapter indicate the presence of a relationship between national markets in terms of risk pricing and have important implications for the pricing of securities. The statistical significance of these results, heightens the need to take greater account of them whilst examining the mechanism of pricing securities within the broader European context.

It is evident however, that most of the existing literature and in particular the testing methodology which identifies this relationship, has been developed in a static, mean variance framework[41] under both models specification - single and multiple factor.

This is the basic shortcoming of the literature which in fact is twofold. At one extreme it is the time-invariance of the moments and at the other it is the degree of integration, which is set at the beginning and fixed through the sample period. This ignores any structural changes which might have taken place in the markets considered, after relaxation of policies such as monetary and exchange control.

Under these circumstances, a conclusion can be made that this has important implications on the results of empirical studies. Previous chapter results are a clear indication of this, supporting the need to establish an alternative way for testing for the risk integration of financial markets.

At first, studies such as *Harvey (1991), Ferson, Harvey (1993) (1994)* , *Dumas,Solnik (1995),* focused on the time variation of moments, which proved to be important in this area of research. These studies indicated that investors have common expectations

[41] A good example is the model developed and applied in the previous empirical chapter

on the moments of future returns which are conditional and therefore random rather than constant.

It was up until *Bekaert,Harvey(1995)* suggested the presence of and constructed a measure which allowed for, the time variation in the degree of integration. Their specification of the testing environment corrected for the drawbacks present most of the previous empirical work, by allowing both the measure of integration and moments to be time variant. Their basic framework allowed the conditional expected returns of country A to be determined by their covariance with the world benchmark portfolio and the variance of country A's assets alone. Under this structure, if the markets are perfectly integrated, only the covariance would be priced. On the other hand, if the markets are segmented the relevant portfolio would be the country's own assets. They then proposed a regime-switching model in which national stock markets are expected to move between integrated and segmented regimes.

Even if these basic problems have been corrected using different techniques, a problem which still remains is that most of these studies actually provide an incomplete picture of the issue, by just testing for the integration hypothesis at a theoretical level. They don't attempt to answer the empirical question of what actually has caused the rejection of the hypothesis.

Very few studies, such as, *Bonser-Neal, Brauer et al (1990), Errunza, Losq (1989), Eun, Janakiramanan(1986), Gultekin, Gultekin et al (1989), Stulz(1981a), Alford,Folks(1996)* , have been concerned with this issue and tried to establish the actual cause of rejecting the theoretical hypothesis. All of these published studies, in their concluding remarks, tend to converge on the fact that government imposed barriers act as an impediment to the integration process.

Given the current status of the international asset pricing models along with the difficulty in assessing an array of official capital controls, operating within the sample countries, a measure is required to account for deviations from capital market integration. This study proposes , as in *Korajczyk(1996),* such a measure which can be consistently applied across countries.

The procedure implemented here estimates the divergence from integration by calculating deviations of national asset returns from an equilibrium model, on the presumption, that by default the national markets are fully integrated. Returns will be proxied by the equally weighted market portfolio of all outstanding and trading companies in each market, between July 1987 and April 1997

This type of test could be classified as a test of the law of one price (LOP), in a multi country context. In this framework, the model to be used should identify the risk factors that are important to the investors in each market. This indicates that there is a multifactor relationship, making it clear that the utilised model should be an APT-type one, within the international setting. In this context, the model will use a set of economic factors, extracted from earlier studies. Effectively, actual deviations from LOP will be accounted for and thus incorporating all effective impediments, regardless of their source. At the second stage an attempt will be made to assess the effectiveness of the different controls which were in place in the sample countries over the period studied.

4.2 Methodology

Given evidence from previous studies, which indicates that there are several important sources of return variation, a number of European risk factors may be important in the determination of the individual national stock market index returns. In an attempt to price the most important of these risk factors , factor model regressions of the form

$$r_{i,t} = \beta_0 + \sum_{j=1}^{K} \beta_{i,j} F_j + u_{i,t} \qquad (1)$$

are estimated for the sample countries, using GMM estimation.

In this model specification, excess returns, r_{it} , are measured in a common currency and follow this K-factor structure. Following common practice in the finance literature, the returns are calculated by subtracting from the national market equity returns the 30-day European risk free rate proxy. The $\beta_{i,j}$'s, are the betas

corresponding to returns on the K risk factors, F_j. Consequently, an application of this model will provide information about the usefulness of the different global risk factors for measuring variation in the national market excess returns.

However, the main feature of the study is the identification of any cross-sectional differences in the expected returns from the sample countries' equity markets. In asset pricing models these cross-sectional differences are considered to be captured by the differences in betas. Thus in general, under this setting, the difference will be accounted by the risk premiums (λ) in the model,

$$E(R_{it}) = \lambda_{0t} + \sum_{j=1}^{K} b_{i,j}\lambda_j \qquad (2)$$

where λ_0 is the return on the riskless asset and λ_j is the risk premium on the jth source of risk. The b_{ij}'s are the coefficients derived from the projection of the national market returns, not excess returns, on the significant world risk factors identified earlier using equation (1). As a normal consequence, we then take the excess returns and we get a relationship of the form

$$E(r_{it}) = \sum_{j=1}^{K} \beta_{i,j}\lambda_j \qquad (3)$$

which is restricted by the assumption that the constant term is equal to zero.

From this stylised representation of the beta pricing model, we can derive the correct form applied to this study, targeting the identification of the cross country differences in expected equity returns. The estimated model will then become,

$$r_{i,t} = \alpha_i + \sum_{j=1}^{K} \beta_{i,j}\left(\int_{j,} + \lambda_j\right) + u_i \qquad (4)$$

where f_{jt} are the priced risk factors.

The intercept term, which is present in (4), contains the price deviations. If individual markets are actually integrated and the model using the prespecified risk factors depicts the expected returns , then this coefficient should be insignificant in value, i.e. equal to zero. However if risk factors carry different prices and premiums, this will lead to a non-zero value of the intercept which could be termed as a direct measure of segmentation.

Under this model specification, it is assumed that there is a fixed level of integration as depicted by the pricing error,α_i, set at the beginning of the sample period. However following the suggestions of previous studies which acclaim the statistical importance of the time variation in the measure, see *Bekaert,Harvey (1995)*, supported also by the progressive policies that the sample countries have adopted through the period, the estimation of eq. 4 requires the adoption of a time varying estimation technique. For this purpose the rolling regressions technique is adopted as it considers past information, depending on the length of the window, to update the coefficient estimates. Admittedly, this is a crude method of accounting for the non-stationarity in the integration measure but it is a step towards measuring the level of integration.

4.3 Data sources

4.3.1 Asset returns

The dataset is similar to that of the earlier chapter and consists of the end of month share price, available for the outstanding companies listed on the individual stock exchanges, from July 1987 to April 1997. This allows for the entry of new companies and also the deletion of companies which ceased trading either because of bankruptcy, merging or acquisition.

This will involve a large number of companies which should then, at each point in time, be aggregated to form a single portfolio, which will represent the total market returns[42]. The value will then be converted into sterling pounds using the appropriate end of month exchange rate, retrieved from the Datastream international database. Excess returns will then be proxied as the difference between the monthly compounded returns and the proxy for the European 30-day risk factor.

[42] Forming a portfolio will in fact rearrange the risk and reward associated with the original assets but fortunately it doesn't alter the underlying forces and characteristics in the economy.

4.3.2 Pervasive Risk Factors

4.3.2.1 Direct Selection of Macroeconomic Variables

Empirical evidence - see for example *Chen,Roll,Ross(1986), Priestley(1996)* - supports the theoretical aspect of financial theory, that a wide variety of unanticipated events have an effect on asset prices. However, theory remains silent about the factors which will affect the stock market returns. In the context of this study the primary target should be merely to model equity returns, in different national markets, as a function of common macro variables and non-equity returns. An earlier study by *Chen,Roll,Ross(1986)* found that certain variables from a set of predetermined innovations in macroeconomics 'were found to be significant in explaining expected stock returns' (pp402).

On these grounds, the set of predetermined risk factors for this study will be similar to those used by *Chen, Roll, Ross (1986), Burmeister, McElroy(1988), Ferson, Harvey (1993,1994), He,Ng (1994), Priestley (1996), Koutoulas, Kryzanowski (1994),* and other studies. These will include the excess equity return, the spread between short and long term interest rate,, expected and unexpected components of inflation, oil price risk, industrial production and an exchange risk factor.

In brief, the first factor will be the European Equity Return, EER, in excess of the short-run interest rate. In addition to the main studies from which the factors are extracted , other studies - *Cumby,Glen(1990), Fama,French(1992)*- although in a different framework, have successfully included this risk factor in their asset pricing models. Alternatively, *Harvey(1995)* suggested that the inclusion of the world market portfolio will not have much to offer on the explanation of the national equity returns. However the significance of this factor in most of the earlier work, suggests the use of the European market portfolio risk factor to shed light on the ongoing debate and assess its usefulness in the European context.

Secondly, an exchange risk factor, ERI, is included in the set. Going back, *Adler,Dumas(1983)* were the first to identify this form of risk in theory. Under their specification its pricing proved to be a complex task in empirical terms. One possible

successful simplification used in other studies , *Dumas,Solnik(1995), Harvey,Solnik,Zhou(1994)* , has been the aggregation of this exchange risk factor. In line with this, the factor will be nested into a single European exchange risk factor.

As factors should reflect only unexpected changes in economic factors , so it should be in the case of inflation. The unexpected component of the monthly inflation rate, UIF, could form the third factor in the model given that inflation has real effects which lead to national markets being exposes differently to changes in the global inflation rate.

Similarly, a measure of the changes in the long-term inflationary expectations, LIR, could prove useful in the model. This could be termed as a replication of *Chen Roll, Ross(1986)* who, in their study for the US, included a measure of the changes in the US inflationary expectations as well as the unexpected inflation component.

Eurocurrency deposits are, as a matter of fact, a major means of carrying out trade and investment activities and they reflect the short term interest paid on a deposit outside the national system. The spread between this rate and the domestic short-term interest rate, encompasses the premium paid relative to the other series. Unexpected changes in this spread can then be termed as a proxy of the world credit risk, WCR.

It is common in economic models to include a real interest rate return, RIR, as a means of capturing the state of investment opportunities. On this premise and following the suggestions made by earlier empirical work, the same factor will be tested in a European context.

Other studies, such as *Hamao(1988),* have considered the different exposures that countries have on the oil price changes and have concluded that this could be a potential source of risk . Under these circumstances a proxy of this risk, OIL, will also be included.

Lastly, the industrial production growth rate could be used as a risk factor. Early studies, such as, *Bodurtha,Cho,Senbet(1989), Hamao(1988), He,Ng (1994),* examined this in a domestic context, with positive results. Recent studies, in a world context,

actually rejected its relevance but it is worth taking it into consideration, to either confirm or just oppose this conclusion.

4.3.2.1.1 Derivation of the pervasive risk factors

Having theoretically identified the possible sources of risk that the series will capture, the unexpected component of such factors should be derived. This is in line with the fact that agents form expectations of the factors commanding risk premiums in the asset markets.

However, a condition which should be met for these series to qualify as unanticipated components, is that they should have a mean of zero and be serially uncorrelated white noise processes. Over the years, empirical studies have extensively used two techniques, namely the rate of change and autoregressive models, in their attempt to generate this components.

All the same recently acquired evidence by *Priestley(1996)* has highlighted the weakness of these techniques[43] and proposed an alternative expectation formation technique which is based on a learning process and avoids the inherent problems of the earlier techniques. Take for example *Chen,Roll,Ross(1986)*, who assumed that the spread between the longrun interest rate and shortrun interest rate is relatively uncorrelated, mainly because they are both interest rates and the difference between them is considered to be innovation. However, these are not zero mean because the term structure is mostly upward sloping and there is a positive risk premia for holding the long-term government bonds. Similar arguments could be addressed in *Burmeister, McElroy (1988).*

Additional evidence for the appropriateness of an alternative measurement technique was also given by the independent study of *Koutoulas, Kryzanowski (1994).* They

[43] He has suggested that the process based on the rate of change , actually ignores information which is not embodied in the most recent observation. Furthermore, he concluded that the latter technique is incapable of providing a process which is free of systematic forecast errors because of the time

proposed a measure of innovations in the macroeconomic variables based on *Akaike(1976)* state space modelling, which shares similarities with the extraction procedure applied here, in the sense that it is a learning mechanism.

The innovations in the macroeconomic variables of this study will be extracted using the technique which was originally put forward by *Priestley(1996)* and is based on a Kalman Filter. This postulates that agents actually update their expectations as new information becomes available. It can be expressed as a simple model, with unobserved components, of the form

$$X_t = X_t^* + u_t \qquad (5a)$$

$$X_t^* = X_{t-1}^* + \gamma_{t-1} + v_t \qquad (5b)$$

$$\gamma_t = \gamma_{t-1} + \omega_t \qquad (5c)$$

where X_t is the variable of interest with expectations embodied in X_t^* which is time varying. If the error term u_t is 1st order uncorrelated then we have a series of unexpected components. If however, this application does not provide a series with the required properties, lags of the variable of interest are included in the measurement equation (eq.5a) and a time varying model is estimated to generate a series of uncorrelated observations. In equation form this could be represented by

$$X_t^* = \delta_{t-1}^* + \varepsilon_t \qquad (6a)$$

$$\delta_t = \delta_{t-1} + \omega_t \qquad (6b)$$

This more generalised procedure will then provide the innovations for the risk factor unanticipated components.

Following the specification of the decomposition procedure , the appropriate input series should be derived. Within the framework of this study, the input series should be constructed in a such a way so as to identify the individual country characteristics but still be common to all countries. However, in certain cases the retrieval of a series which is measured on a common base, is difficult because of the different

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invariant coefficients. His study results in general suggest that these inherent problems invalidate these techniques.

measuring techniques applied in the individual countries . avoidance of this difficulty requires the use of a database which is independent and deals with different countries.

At first, the European excess equity return, EER, will be proxied by the GDP-weighted MSCI European stock index[44], including dividends, minus the short term interest rate proxy, ECU Deposits for 30 days. These were selected from the available series because they had the highest correlation with the competing series, indicating that they reflect more or less the pattern in any series (see Table 4.1).

Following the suggestions of earlier studies, the ERI will be proxied by the aggregate measure of the weighted sterling price of the foreign exchange rate of the countries in the stock index, excluding the United Kingdom.

Additionally, ECR can be accommodated in the fluctuations of the spread between the most representative European Country Eurocurrency, the 90-day interest rate and the national short-term interest rate, constructed by aggregating the individual European markets short term interest rate. The selection criterion for the representative European rates under both classifications is again the correlation coefficient. Results indicate that the ECU 3-month deposit rate and the equally weighted Eurocurrency rate have the highest correlation with the other rates[45] making them the most appropriate to be used as proxies of the European national short term interest rate and the Eurocurrency 3m rate respectively.

Furthermore, UIF, is the unexpected component of the European inflation rate. It is defined as the monthly percentage increase in the price level of the GDP weighted aggregate national inflation rates, as supplied by the International Monetary Fund.

The next factor, LIR, attempts to encompass changes in the long term inflationary expectations. The factor is constructed by projecting a 48 month moving average of

[44] According to the definition of the series it is constructed using the GDP of 15 European countries, namely Austria, Belgium, Switzerland, Denmark, Germany, Spain, Finland, France, United Kingdom, Netherlands, Ireland, Italy, Norway, Portugal, Sweden

[45] The first series has have been compared against the UK T-bill, 3m ECU Interbank rate, 3m Germany Interbank., and 3m UK Interbank rates, whilst the second GDP weighted 3m Eurocurrency rate, The DM-Eurocurrency and the UK-Eurocurrency rates.

the monthly inflation rate on a set of instrumental variables[46] and then extracting the unexpected component from the residuals.

Moreover the real interest rate factor, RIR, will be constructed, by taking the difference between the inflation rate and the short term interest rate as calculated previously, before the filtering procedure is applied.

The commodity risk factor OIL, which aims to evaluate the exposure of each country to the commodity oil, will be proxied by the unforeseeable price component, derived from the decomposition of the actual per barrel price using the technique outlined above.

	IR_1	IR_2	IR_3	IR_4	IR_5
IR_1	1				
IR_2	0.69675	1			
IR_3	0.99425	0.6753	1		
IR_4	0.91752	0.4885	0.91208	1	
IR_5	0.71676	0.999	0.69634	0.51166	1

	SI_1	SI_2	SI_3
SI_1	1		
SI_2	0.99369	1	
SI_3	0.99741	0.99041	1

SI_1, SI_2, SI_3 are M&S European Stock Index, FT-Actuaries European Index, and M&S GDP weighted European Stock Index
IR_1, IR_2, IR_3 IR_4, IR_5 are the ECU 1m Deposit rate, the UK 1m T-Bill, ECU Interbank Rate, German 1m Interbank Rate and the UK 1m Interbank Rate respectively

Table 4.1 Unconditional correlation matrix for the potential factor series : Stock Index , 1m Interest Rate

Lastly, the European industrial output risk, IPR, will be proxied by taking the unexpected component embodied in the GDP-weighted aggregate European industrial production, again provided by the IMF.

At this stage the series decomposition technique is applied and the potential risk factors are derived. Summary statistics for these factors are disclosed in Table

[46] See Appendix A for details of selection for the instrumental variables.

4.2.A and 4.2.B, showing clearly that this procedure is superior to competitive ones[47] in providing the required properties for the factors. The second section of the table contains the pairwise correlations of risk factors. It is evident that there is a high correlation between the unexpected inflation rate (UIF) and the real interest rate (RIR) but this is not a perfect correlation because the nominal interest rates are not part of the conditioning information that derives UIF and also RIR, components (nominal interest rates, inflation rates) are not corrected for serial correlation in advance.

Variable		Mean	Std Dev	ρ_1	Box-Pierce stat*
Excess European Return	EER	-0.00274	0.021257	0.15536	2.82
Exchange rate risk	ERI	1.88E-05	0.015818	0.008729	0.008
Credit Risk	ECR	-1.44E-05	0.001256	0.16793	3.29
Unexpected inflation	UIF	-9.09E-07	0.001888	-0.07128	0.594
Commodity price risk	OIL	-9.42E-04	0.096131	0.16348	3.12
Longrun Inflation expectation changes	LIR	-2.29E-05	0.001276	-0.11729	1.6096
Real interest rate	RIR	6.08E-06	0.001099	-0.12184	1.7369
Industrial Output	IPR	1.56E-04	0.006492	-0.16198	3.06

*** The test for 1st order serial correlation is distributed $\chi^2(1)$ and has a value of 3.84 at 95%**

Table 4.2.A Descriptive Statistics for the Economic factors

	EER	ERI	ECR	UIF	OIL	LIR	RIR	IPR
EER	1							
ERI	0.07025	1						
ECR	0.1809	-0.12023	1					
UIF	-0.11264	0.04168	-0.01874	1				
OIL	-0.12985	0.1625	-0.04039	0.24736	1			
LIR	-0.17415	0.1083	-0.01527	0.67438	0.221	1		
RIR	0.12732	0.003979	0.009177	-0.94218	-0.26555	-0.62818	1	
IPR	-0.07306	0.035761	-0.07738	0.0295	-0.03029	0.12259	0.01226	1

Table 4.2. B Pairwise correlations of the factors

4.3.2.1.2 Measurement of the Deviations

As discussed earlier, in the estimated pricing model, the intercept term (a_i), in equation (4), is the measure of segmentation. Firstly though, the risk factors should be reduced to those that are actually important in controlling the variance of returns and have an expected return premium. This does not mean that non-priced risk factors

[47] This conclusion has been reached after the derivation of the factors using the rate of change and

are not as important as the priced ones in an individual's investment decision but they are irrelevant for return predictability.

The trimming procedure starts by projecting the monthly national market excess returns on all eight prespecified variables. Table 4.3 below provides the results from applying the unrestricted factor model, as defined by equation 1 using the GMM.

These results provide some information about the usefulness of the European risk factors and the relationship between the sensitivities, β_{ij} and the expected returns in the sample markets. However, these are only preliminary results which confirm that these are significant factors. What we actually require is that only economically significant factors, in the sense that they have a premium, are priced for all sample markets. In other words, we will be testing the hypothesis that the individual risk factors are statistically significant across countries. If their beta is actually equal to zero then the specific factors should be dropped on the premise that they have nothing to offer to the analysis.

However, qualifying for this hypothesis does not imply that the factors should be retained in the model estimating pricing errors. Furthermore, the factors should have different coefficients across countries, if they are to be left to be left in the final model equation. This is because the unconditional version of the model implies that the variation of expected returns is dependent on the different sensitivities the individual countries have for that specific factor.

The lower part of the table contains the results of the application of both hypotheses. It is evident from the test statistics, at the bottom of the table, that EER, OIL, LIR,

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autoregressive model techniques where applicable to construct the factors. Results could be provided.

	Factors (i)*									R^2		
	Constant	EER	ERI	ECR	UIF	OIL	LIR	RIR	IPR	All factors	Priced factors	only EER
United Kingdom	0.002718	0.708353	-0.21184	0.146478	-4.45968	0.005651	12.81518	-4.10544	0.25661	0.188	0.154	0.106
	0.95466	3.32362	-1.26307	0.0681	-0.75367	0.14821	4.29193	-0.49016	0.721			
France	0.006014	1.059022	0.293637	3.074153	-19.5786	0.023389	14.05938	-21.4191	-0.92285	0.24	0.211	0.142
	1.65691	8.39744	1.1666	1.19131	-3.09211	0.65043	4.25608	-2.155	-1.09503			
Germany	0.009135	0.740168	-0.51307	0.523534	-4.93929	0.00146	4.40452	2.759227	-0.39785	0.189	0.156	0.138
	2.52335	4.91047	-2.76813	0.20162	-0.78823	0.0406	1.22885	0.28531	-1.0012			
Netherlands	0.009205	0.651637	-0.32158	0.677938	-4.84547	0.116979	4.591723	0.153419	-0.29769	0.095	0.0685	0.053
	3.23335	4.23941	-1.82329	0.24626	-0.90681	3.13557	1.42054	0.01758	-0.95565			
Switzerland	0.013451	0.028233	0.011966	4.83605	0.273301	-0.05562	-2.49133	-0.72979	-2.03273	0.201	0.166	0.127
	3.31985	0.16406	0.05722	1.84361	0.0389	-1.10034	-0.66199	-0.06488	-1.94264			
$F_i=0$ **		23.72	9.74	8.76	8.54	15.08	34.2	4.3	24.92			
$F_i=\beta$ **		21.22	7.62	8.76	10.56	12.92	11.08	4.2	24.40			

* T-stats are included under coefficients.

** The tests are distributed $\chi^2(5)$ and $\chi^2(4)$ and have a critical value of 11.07 and 9.49 respectively at 95% interval

Table 4.3 Regressions of the asset returns on the European Risk Factors Aug. 1987 - April 1997 (117 0bs) using GMM.

IPR are signifigally different from zero at a 95% level of significance. The last line presents test results for the hypothesis that a given factor has an equal loading across the national markets. The hypothesis is again accepted for ECR, ERI, UIF, RIR which suggests in conjunction with the first hypothesis, that these factor loadings are jointly equal to zero and therefore equal.

Following some concerns about the principal of these hypotheses the same hypotheses have been carried out under an alternative scenario. Results of which are disclosed in Table 4.4. In this, contrary to the original framework, factors were added instead of deleted at each stage. For example, in order to test for the significance of the coefficient of the exchange risk (F2) the unrestricted model included the constant (F1), and F2 whilst the restricted model included the constant and F1 only. In the second hypothesis, the models were run incorporating only factors that had a statistically significant coefficient. It is evident from these results that under both scenarios the factors selected are almost identical, indicating that the selection is robust and it does not depend on the selection technique used.

		β1	β2	β3	β4	β5	β6	β7	β8
Adding	Hyp1	13.88**	1.78	10.46**	3.22	4.52	13.28**	4.36	24.92**
Variables	Hyp 2	16.44**		1.23			15.06**		17.08**
Deleting	Hyp1	23.72**	9.74	8.76	8.54	15.08**	34.2**	4.3	24.92**
Variables	Hyp2	21.22**	7.62	8.76	10.56**	12.92**	11.08**	4.2	24.4**

Table 4.4 An alternative testing scenario

It can be also argued that nesting national markets into a group, might repackage the risk and the associated risk premium. Given that we have the same set of statistically significant factors, the second hypothesis is carried out using pairs of countries. The aim here is to investigate whether or not we miss any important features present in some of the countries which are cancelled out by nesting them into larger groups. The matching criterion is again the unconditional correlation coefficient for the Stock Index Returns of the national markets, Table 4.5 Taking the highest correlation coefficient of each country, in addition to the UK-BD pair, we can form five pairs. The selection of the UK-BD pair has been done irrespective of the correlation coefficients based on the fact that the German economy is considered to

be the strongest mainland European economy and the UK is the main market upon which conclusions are to be drawn.

	United Kingdom	France	Germany	Netherlands	Switzerland
United Kingdom	1				
France	0.415	1			
Germany	0.623	0.443	1		
Netherlands	0.495	0.261	0.400	1	
Switzerland	0.626	0.489	0.734	0.425	1

Table 4.5 Unconditional pairwise correlations of the Sample Countries Returns

Factor Loadings	SW- UK	SW-FR	SW-BD	UK-NL	UK-BD
β_{1t}	12.2**	0.12	2.30	0.52	0.16
β_{5t}	2.76*	8.02**	3.76*	5.28**	0.08
β_{6t}	28.76**	18.66**	5.56**	3.56*	4.86**
β_{8t}	21.00**	10.48**	17.0**	5.26**	21.56**

significance at **=95% *=90%

Table 4.6 Test results for the equality of the significant risk factors

Carrying out the same hypothesis test, of potentially equal premiums within the pair of countries, we can conclude with some confidence that for most factors in each country pair, the reward is differential and significant (see Table 4.6). The European index returns are, according to the results, universally priced but with the other risk factors being priced differently we can say that overall we have actually selected a set of factors that are universally generated but differently priced in each market.

Having identified the pervasive factors in the European markets considered, and the evaluated their selection, we can move forward and estimate the mispricing of securities in these markets, as captured by the error term (α_i).

However, the estimation of the model in equation (4) treats the errors as constant over the sample period which, as mentioned earlier, is incorrect in certain aspects. This is because, of the significant liberalisations of capital controls that have taken place over the sample period in some of these countries. A second challenge which might be considered a result of the first, is the fact that the moments are found empirically to be time varying.

Accounting for the changes in policies, however, will require an econometric technique which is based on a form of learning mechanism, thus adapting the model estimates to the changes. The best procedure for this has been proposed by *Bekaert,Harvey(1995)* and it allows for shifts around the regimes of integrated or segmented markets at any time, conditional on certain calculated probabilities.

However, the empirical implementation of such a methodology is complicated and very delicate, calling for the use of an alternative, more general, methodology with similar properties. As a matter of fact, the rolling regression methodology may be used which might account for the time variation of the coefficients. This will allow for the estimation of the pricing errors over a sequence of subperiods, creating a series of mispricing errors.

Therefore, for each national market, equation 4 is estimated over a rolling period of 12 months, giving reasonable time to the returns to incorporate the changes in regimes. The estimates yield a vector of coefficients, which will then be augmented[48] and plotted against time , in an attempt to characterise the time series behaviour of the mispricing parameters and relate this behaviour to the changes in governmental policies.

The sample period should theoretically embrace a further liberalisation of international capital movements which has been the trend around the world for several years. The motivation for such a progressive attitude has been, on the one hand an attempt of individual countries to promote capital outflows and reduce their current account surplus and, on the other hand the desire to increase the efficiency and competitiveness of the domestic market.

The plots of the mispricing coefficients, as seen in Figure 1, render support to the clause of the Rome Treaty which required the member states to abolish all restrictions on the movement of capital between them in a progressive manner .

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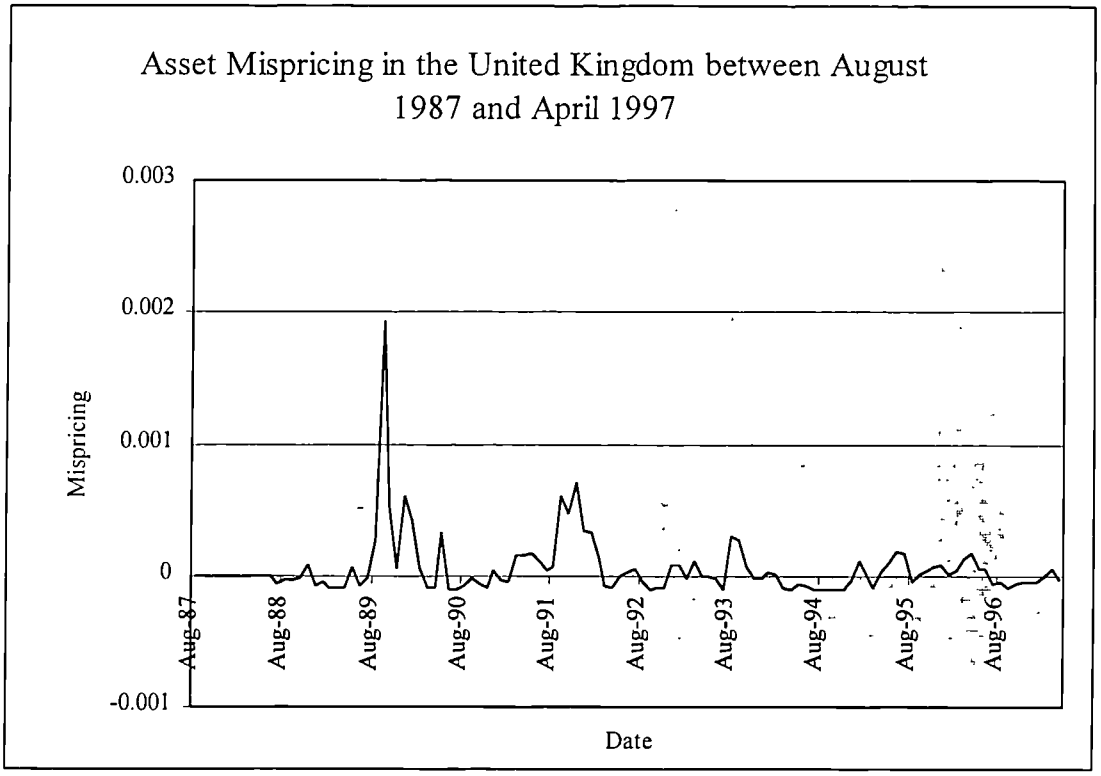
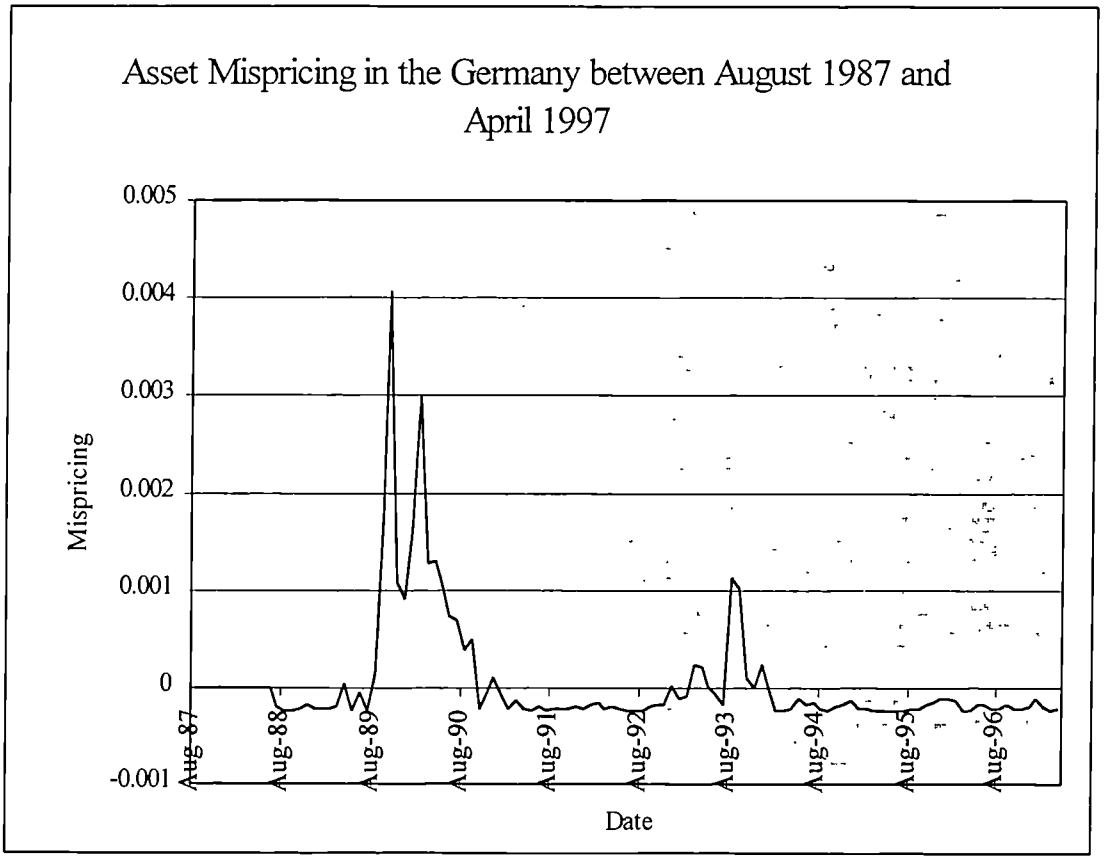
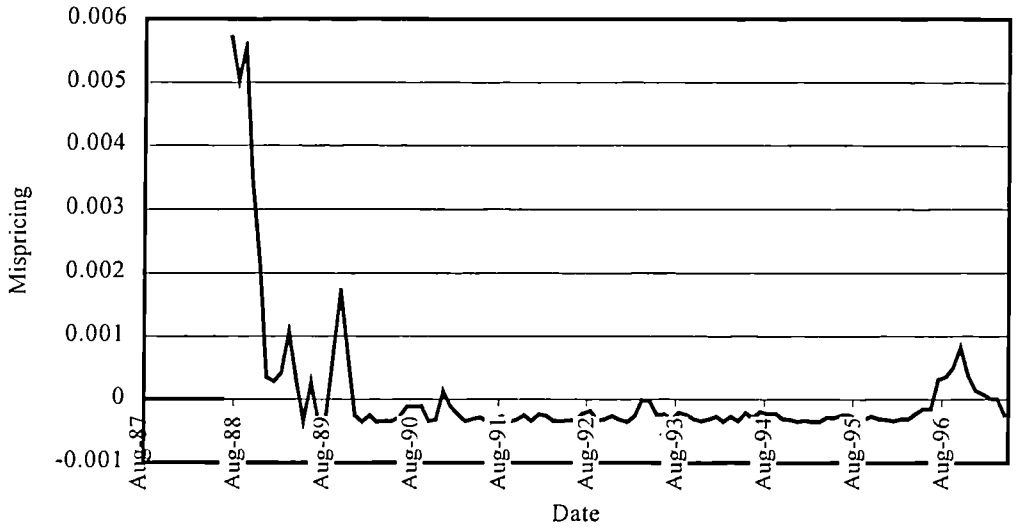
[48] In a study similar to this *Korajczyk(1996)* has introduced an adjustment for the derived mispricing error, which effectively is biased upwards by the square of the estimation error. This means that the expected value of the bias, between the estimated and the true value, will be equal to the variance of the coefficient. If V_α is the variance of the estimated, then the adjusted measurement will be equal to the difference between the squared coefficient and V_α.

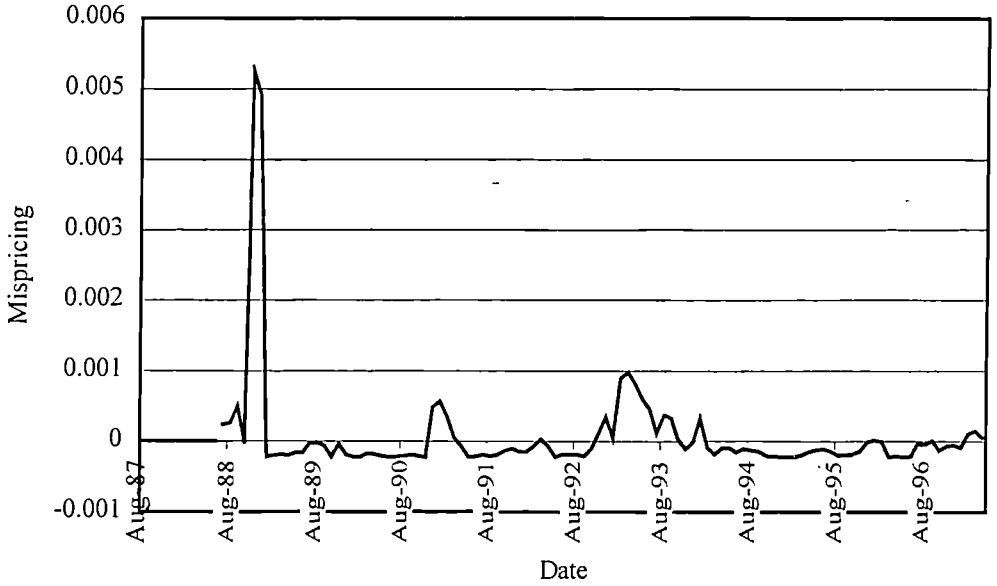

Asset Mispricing in the United Kingdom between August 1987 and April 1997
0.003
0.002
0.001
0
-0.001
Mispricing
Aug-87
Aug-88
Aug-89
Aug-90
Aug-91
Aug-92
Aug-93
Aug-94
Aug-95
Aug-96
Date


Asset Mispricing in the Germany between August 1987 and April 1997
0.005
0.004
0.003
0.002
0.001
0
-0.001
Mispricing
Aug-87
Aug-88
Aug-89
Aug-90
Aug-91
Aug-92
Aug-93
Aug-94
Aug-95
Aug-96
Date

Asset Mispricing in France between August 1987 and April 1997



Asset Mispricing in the Netherlands between August 1987 and April 1997



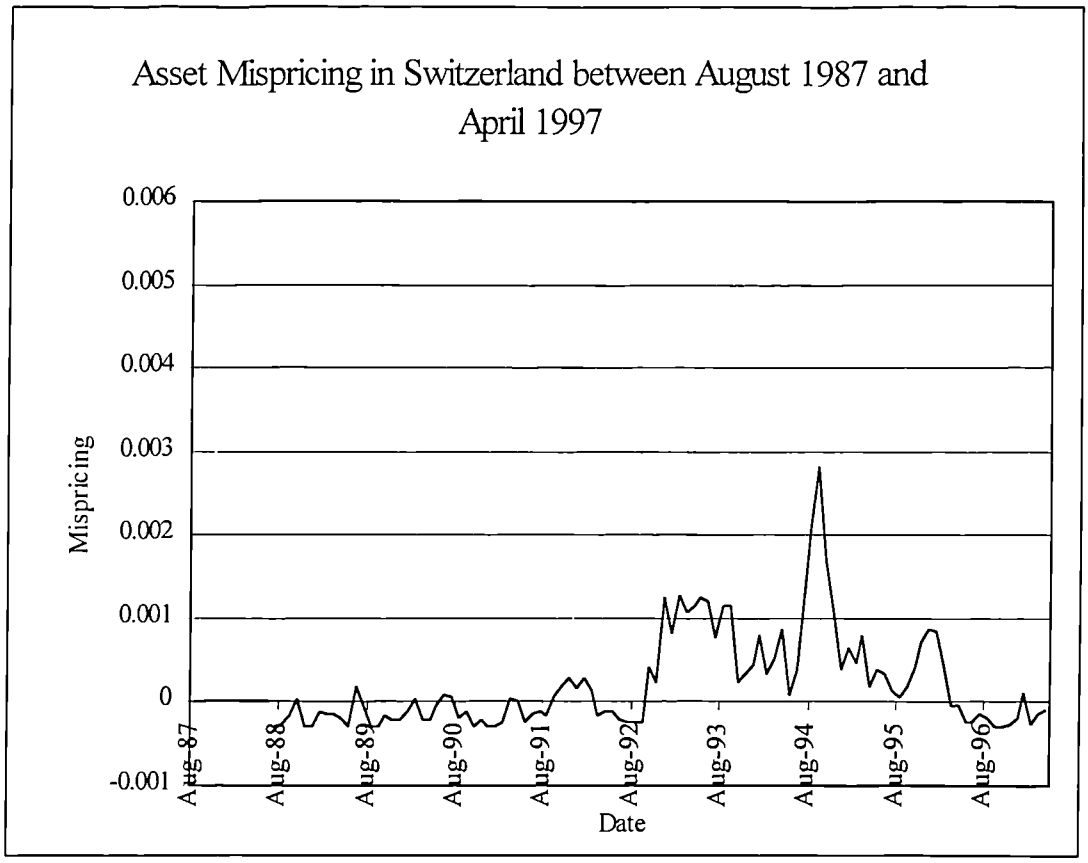


Figure 4.1 Asset Mispricing in Sample Countries

In early stages France shows high mispricing errors which coincide with the principal reforms in the capital market, 1988-89, and the dismantling of several capital controls - such as the allowance of foreign borrowing and the exchange restrictions applicable to capital transactions by banks and enterprises engaged in international trade. Effective from January 1990, all remaining exchange restrictions, relating to capital transactions, were abolished with the consequence of having very low mispricing errors for the reasons discussed above.

Germany, exhibits an overall smooth distribution of errors. This may be attributed to the fact that there is a completely free movement of capital, within domestic and foreign securities without the need for official approval. Turbulence is shown

between late 1989 and early 1990 which may be termed as the period of political instability and economic reforms affecting the capital markets. It is during this period that talks for the reunification of Germany started increasing speculation of instability and economic failure.

Switzerland shows at the beginning shown that it had no major mispricing errors in its equity market. However, in the second quarter of 1992 this is not the case. The pattern becomes uneven and this coincides with that changes the European Community member countries needed to make in order to comply with the requirements of the single market. Since Switzerland is not part of the EC, such a mispricing pattern is expected in one way or another.

4.3.2.2 Principal component Analysis

Following concerns about the robustness of these results, a similar procedure has been implemented using the alternative modelling technique of principal components analysis. This alternative technique has been used, but not extensively, in empirical studies for modelling the expected returns of risky assets (see *Connor, Korajczyk (1986,1988)*) . The empirical unpopularity of this method lies in the fact that it lacks the ability to interpret of the estimated risks in an economic context, as compared to its alternatives.

As the main objective of this study is not the identification of the pervasive macroeconomics variables as such , we can use it for the derivation of the pricing errors within each country. Basically, this analytical technique is to provide a representation of a variable Θ_i in terms of several hypothetical constructs which can only be constructed from observed data (n variables). Ultimately, these constructs will aim to reproduce the sum of the variances of the observed data series. Algebraically this could, in its simplest form, be represented by the linear factor model

$$\Theta_{ij} = \sum_{c=1}^{m} \alpha_{jc} F_{ci} \quad (7)$$

where F's are the constructed variables and α's are the loadings, also termed as the maximum contribution of the specific variable towards the variance explanation. It is possible that not all of the observed factors are retained, especially if the sum of the explanatory power of first m coefficients is very high, $m<n$. The method[49] involves the simultaneous iterative specification which yields the maximum eigenvalue for the characteristic equation and the loading of the associated factor, α_{jc}. This should then be orthogonal, with mean zero and unitary standard deviation. Effectively, the procedure will be followed until the sum of the individual factors' explanatory power, reaches the prespecified degree of accuracy. However, this is subject to the fact that the observed correlations between the original series are reproduced in the derived components.

Carrying out an analysis which tries to uncover the driving forces in the national economies, by examining the covariance of asset returns for all the assets in the sample, will be expensive in terms of time and computations. Once more, the compressed data set will be used for the derivation of the common features of the national equity returns. In order to compare this with the main results, the market weighted portfolio will be used to unveil the common forces and indicate how their pricing influences the level of integration of national stock markets.

The principal of this technique may be criticised as it may produce many different structures depending upon the selected sample from which the components are derived and indirectly on the portfolio formation technique. Furthermore, it is argued that this statistical tool can no longer detect the pervasive factors. This is prominent when a sample is used, especially when it is small and unrepresentative of the total market structure, for the derivation of the components. Fortunately in the context of this study this is a remote possibility because there is a single portfolio encompassing the entire population of securities within each market at every point of time, for the estimation of the deviations from the common features of the group.

The procedure of decomposition and identification of the common features in the series, with the required statistical properties, is carried out with the assistance of the

[49] A detailed development of the technique can be found in *Judge et al.* , 'Introduction to the theory and practice of Econometrics'.

Time Series Processor (TSP) econometric package. The series derived from the analysis (Q_t), are required to reflect the fact that stock markets react only to the arrival of news. This implies that what we need to extract is the unexpected components of the variation in the series, identified by a mean value of zero and a serially uncorrelated white noises process (see table 4.7).

Variable	Mean	Std Dev.	r_1	Box-Pierce statistic*
Q_1	3.25E-07	3.8443	0.15974	2.985
Q_2	-1.32E-07	0.034969	-0.0564	0.3721
Q_3	1.28E-07	0.21164	0.067464	0.5325
Q_4	4.27E-08	0.018982	-0.19313	3.46

* The test for 1st order serial correlation is distributed $\chi^2(1)$ and has a value of 3.84 at 95%

Table 4.7 Summary statistics for the derived Principal Components

Implicit to this procedure is the fact that the extracted components are actually statistically significant in the sense that they are important to the investment decisions. Furthermore, to complete the test environment we should consider whether or not the constructed risk premiums are different across countries.

The estimates of the full factor model suggest that all but one (Q_2) carry a premium, which is in line with the implication of unconditional pricing, that expected returns differ across countries depending on their sensitivities to the specific variable. Take for example the case of Q_3, here it is clear that the UK is negatively related whereas France is positively related. Table 4.8 includes the arithmetic results which supports the fact that almost all of these constructs are actually significant and differentially priced across countries.

As under the main estimation technique in this chapter, equation (4) is estimated over a rolling period of 12 months for each national market. The estimates yield a vector of coefficients, which will then be plotted against time , to show the deviations of the asset prices from the principal common features of the series and thus integration.

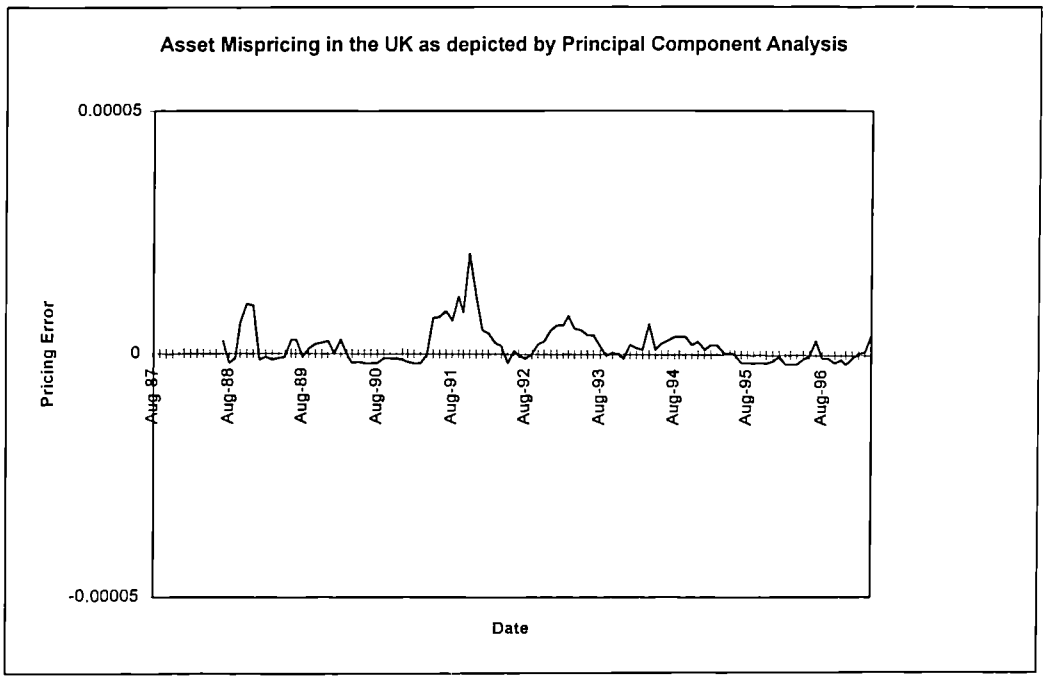
Results augmented using the same technique applied previously, as seen in Figure 2 are encouraging in the sense that they resemble the methodology of the main study methodology by picking up the pattern of variation.

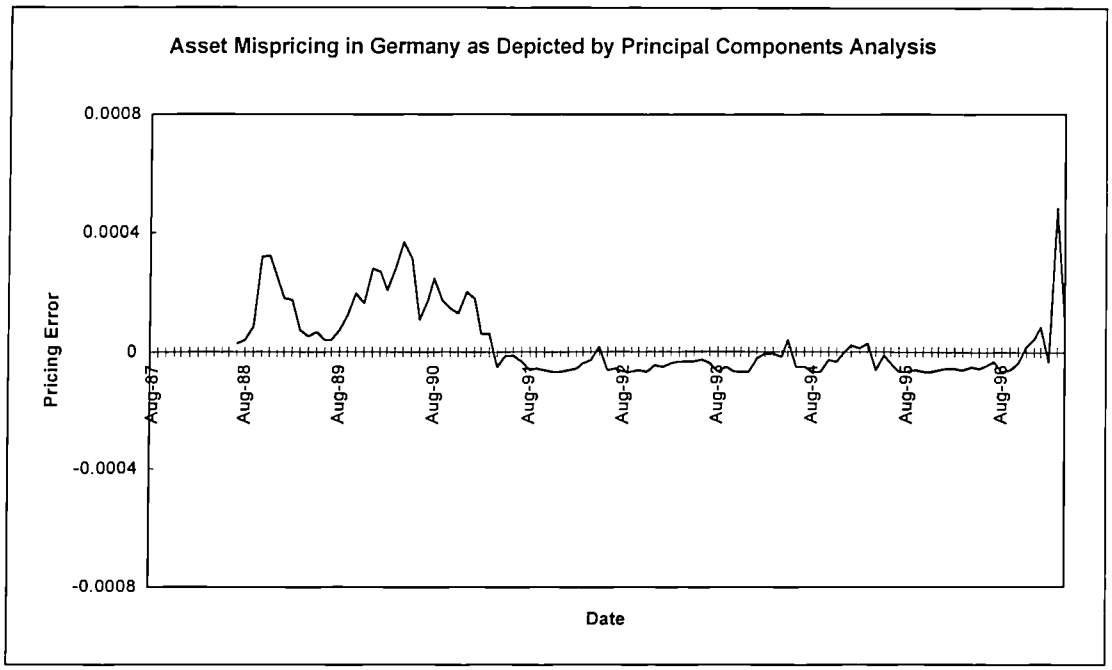
Although, this technique offers no economic interpretation to the results, as rival ones do, it can still capture the trends in each of the markets under consideration. It can be more or less concluded that the results under both procedures suggest that the level of integration is very volatile and for at least a third of the sample period both procedures agree on the direction of the integration level. This could be termed as confirmation of the validity of the main methodology of the chapter.

	Components (i)				
	C	Q_1	Q_2	Q_3	Q_4
United Kingdom	0.002011	0.011181	0.215586	-0.03041	-1.44056
	.00006*	0.00002*	0.003*	0.0006*	0.00288*
France	0.004595	0.011369	-1.07835	0.171955	-0.05355
	.00023*	0.00007*	0.001088*	0.0023*	0.0100*
Germany	0.001678	0.012419	-0.32209	-0.02467	0.668386
	0.00187	0.0006*	0.0875*	0.0185	0.0809*
Netherlands	0.00885	0.010639	1.160597	0.119102	0.553405
	0.0001*	0.00004*	0.006*	0.00127*	0.00556*
Switzerland	0.015444	0.014211	-0.00045	-0.14186	0.583054
	0.0020*	0.00068*	0.0962	0.0204*	0.088*
$\beta_{ij} = \beta_i^{\alpha}$		24.48	2.36	10.44	20.3

α –The test for equality of risk premia is distributed $\chi^2(4)$ and has a value of 7.81 at 95%

Table 4.8 Regression of the National equity returns on principal components




Asset Mispricing in Germany as Depicted by Principal Components Analysis
0.0008
0.0004
0
-0.0004
-0.0008
Pricing Error
Aug-87
Aug-88
Aug-89
Aug-90
Aug-91
Aug-92
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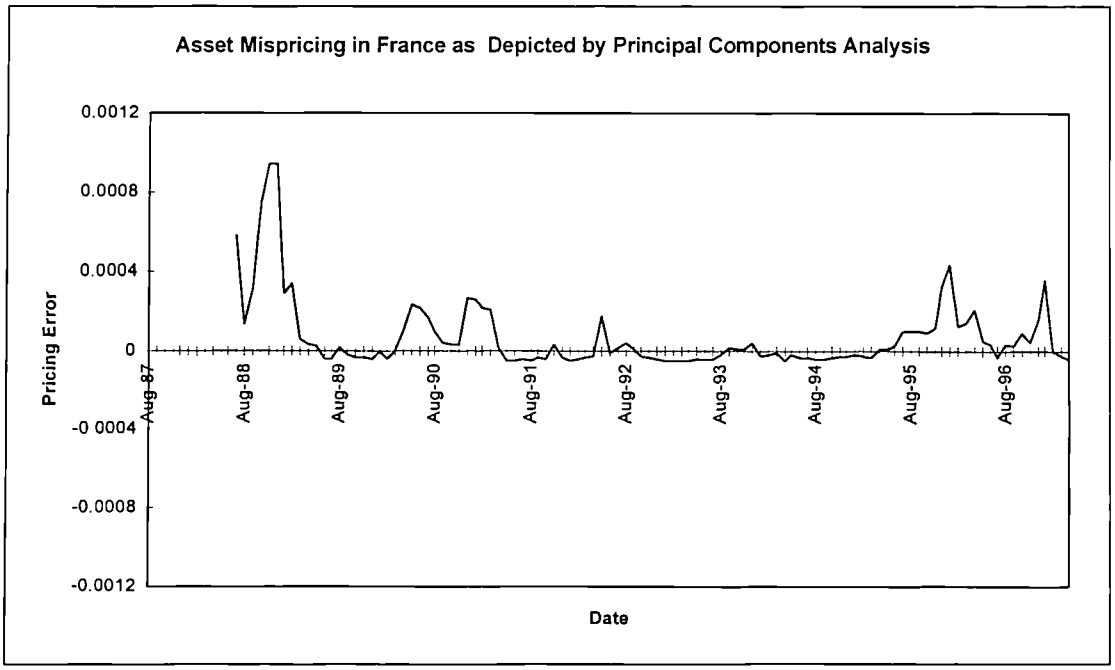
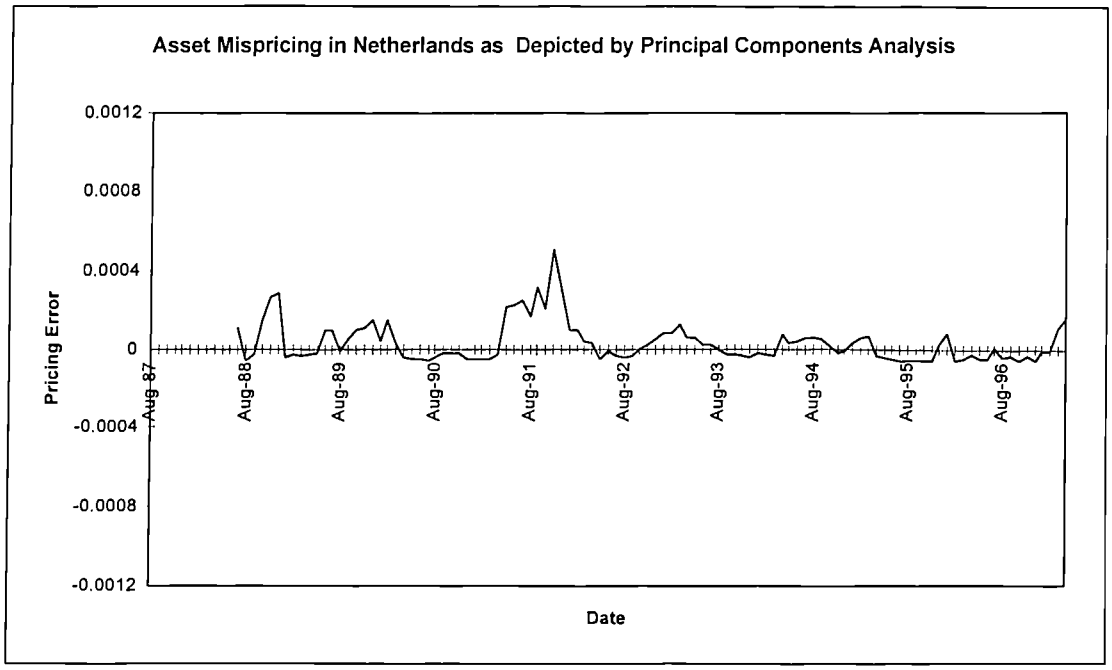
Aug-95
Aug-96
Date


Asset Mispricing in France as Depicted by Principal Components Analysis
0.0012
0.0008
0.0004
0
-0 0004
-0.0008
-0.0012
Pricing Error
Aug-87
Aug-88
Aug-89
Aug-90
Aug-91
Aug-92
Aug-93
Aug-94
Aug-95
Aug-96
Date



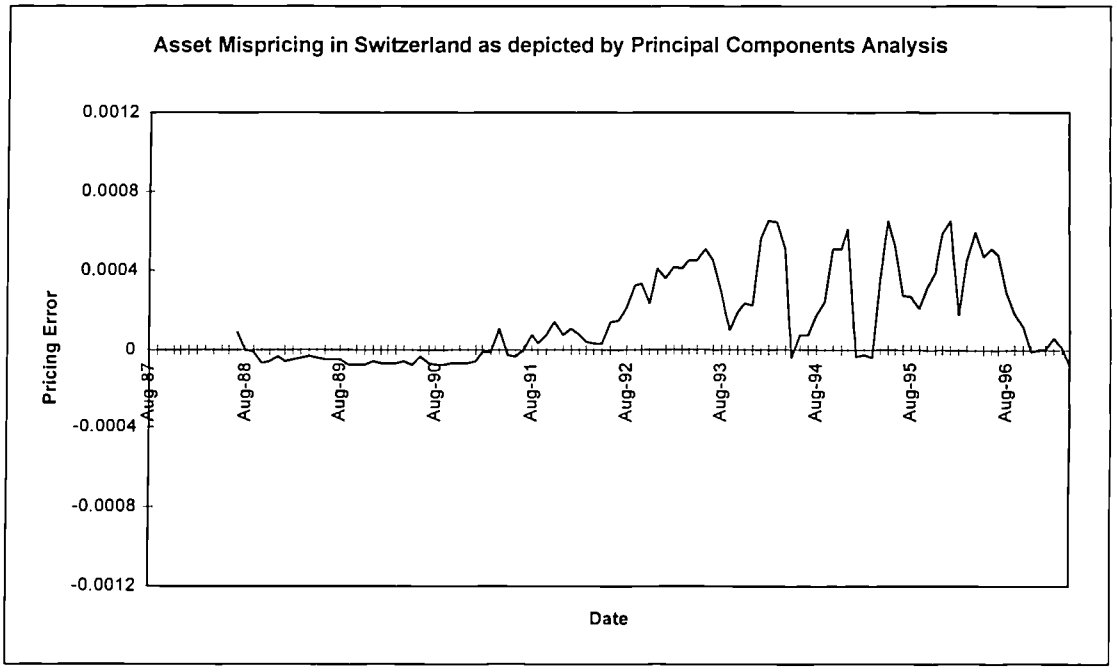


Figure 4.2 Asset Mispricing Plot using Principal Component Analysis

4.4 Relationship between National Stock market integration level and the prevailing Capital Controls

Results in the previous section establish the theoretical conditions for European equity markets, in terms of asset pricing. These results, as in other empirical work, are limited to simply identifying the pricing error and in this respect fail to answer

the empirical question of what has caused the acceptance or rejection of the theoretical hypothesis.

Earlier studies, which attempted to answer this empirical question , suggested that the outcome of the hypothesis depends extensively on the barriers to capital flows imposed by the different governments[50]. On this premise, this section will try to evaluate the significance of the barriers which were present over the sample period in the different countries, as in *Levine,Zervos (1996)*.

The empirical implementation of this will require the identification of the dates on which the sample countries have "significantly" changed their policy on capital movements. In search of these events, using IMF publications, we have reviewed the prevailing market conditions in the sample countries over the period under investigation. Based on this report , the appropriate information was extracted and is summarised in Table 4.9.

Country	Date	Significant Policy Changes
France	9/3/89 (A)	All exchange restrictions applicable to capital transactions by banks and enterprises engaged in international trade were abolished
	1/1/90 (B)	Restrictions which prohibited individuals and enterprises other than those engaged in international trade to have monetary assets abroad or accounts in France denominated other than the ECU were abolished. OECD countries were permitted to issue foreign securities in France
	15/1/90 (B)	Simplified the administrative procedures for acquisition of existing French companies, from EC based companies, but authorisation procedures were still in operation for investments from companies outside the EU for an amount over 10m FFr
	13/3/91 (C)	Abolished the requirement for permission for direct investments in South Africa
Germany	1/3/93 (A)	Reduced the minimum reserve requirement on all liabilities
	1/1/94 (B)	Abolished system of 'cash advances' by the Bundesbank to the central and regional authorities
	1/3/94 (C)	Reduced minimum reserve requirement to 5%
Switzerland	7/10/94 (A)	Liberalised the ownership of real estate
	1/2/95 (B)	New law was announced at first and then put into practice abolishing the permit requirement for an issue of foreign and domestic bonds over 10m SWF
United Kingdom	21/2/90 (A)	The ban on foreign direct investment in South Africa was lifted.
	16/9/92 (B)	Suspended intervention obligations with respect to the exchange and intervention mechanism of the EMS

Table 4.9 Policy Event Dates 1988-1997

To start with, a simple examination of the behaviour of the pricing error measure would involve a basic comparison of the sample mean before and after the event date. Using the estimated measure (108 Observations) the sample is split into two sub-samples, the cut-off point being the policy change date. It is evident from the results included in Table 4.10, that the mean tends to be lower following the adoption of progressive new policies. This is in line with previous studies in this area which depict the negative relationship between the barriers and the level of integration. Further evidence in support of this is viewed when the UK imposed the restrictive 'temporal measure'[51], following the ERM incident, thus suspending the intervention obligation with respect to the exchange rate and the intervention mechanism of the EMS[52].

However the simplicity of this test , may create misleading conclusions. Consequently, an additional test given by Dickey Fuller which tests for the presence of a unit root in the series, is utilised to determine whether the data is trending upwards and hence biasing the indicator in favour of an improvement (i.e. reduction in mispricing) after the policy liberalisation date. While this test is not as

	Events	Up to the Event (1)	After the Event (2)	Result	ADF[53]	Break
United Kingdom	A	0.0092	0.0076	2<1	4.10	Y
	B	0.0077	0.008	2>1		N
France	A	0.061	0.006	2<1	4.45	Y
	B	0.0177	0.0068	2<1		Y
	C	0.0156	0.0071	2<1		Y
Germany	A	0.0106	0.0044	2<1	2.93	Y?
	B	0.0109	0.0039	2<1		Y?
	C	0.0123	-0.0003	2<1		Y?
Switzerland	A	0.1502	0.0147	2<1	1.88	Y
	B	0.1579	0.0123	2<1		Y

Table 4.10 Results assessing the importance of capital controls

[50] See for example the studies by *Bonser-Neal, Brauer et al (1990), Errunza, Losq (1989), Eun, Janakiramanan(1986), Gultekin, Gultekin et al (1989), Stulz(1981), Levine,Zervos(1995,1996), Alford,Folks (1996).*

[51] The measure is termed as temporary according to the OECD definition. Under this definition countries which are considered to be developed economies and have a large and sophisticated domestic capital market impose a temporary control as a result of an emergency situation .

[52] In accordance to this agreement the participant countries maintain the spot exchange rate between their currency and the other participants within a boundary, imposed by the European Union, above or below the cross rates based on the central rates expressed in European Currency Units (ECU).

[53] Statistics are for the absolute value of the test using regressions which include an intercept term but not a trend, at a 95% level of significance with the critical value being 2.88.

Powerful, it is used as a confirmation to the simple earlier tests. Results are also included in the table to suggest that Switzerland has a non-stationary series. This is a reason to be sceptical about earlier test results and suggest a further investigation.

Perron(1989) pointed out a shortcoming of this type of unit root tests[54] and has suggested an alternative set up for testing stationarity which allows a one-time break in the series on the event date (T_B). Following his methodology, three models are constructed to test for the effect of the time break under different circumstances. These models are specified as follows

$$M1x_t = a_1 + \beta t + (a_2 - a_1)DU_t + u_t \qquad (8a)$$

$$M2x_t = a + \beta_1 t + (\beta_2 - \beta_1)DT_t + u_t \qquad (8b)$$

$$M3x_t = a_1 + \beta_1 t + (a_2 - a_1)DU_t + (\beta_2 - \beta_1)DT^*_t + u_t \qquad (8c)$$

where $DU_t = 1$ if $t > T_B$ and zero otherwise, $DT^*_t = t - T_B$ and $DT = t$ if $t > T_B$ and zero otherwise. It is evident from this specification that the models actually incorporate the "change" under different scenarios[55] . A shortcoming of these basic models is their implication that the change in the trend function is a simultaneous one.

Since the aim of this study is not to model the series itself given the event dates but to justify whether these events were statistically significant, thus implying a change in the measurement, the basic rather than the generalised models which corrected for the drawback , will be used.

Testing the hypothesis requires assessing the statistical importance of dummy variables included in any of the three equations (7a,7b,7c) subject to white noise residuals, as based on *Perron (1989)* critical statistic values. These statistics do not depend on sample size but on the time of the break relative to the sample size, i.e. on the ratio T_B / T.

[54] In his study he has shown how these "standard tests of the unit root hypothesis against trend stationary alternatives cannot reject the unit root hypothesis if the true data generating mechanism is that of a stationary fluctuations around a trend function which contains one-time break" (Econometrica, Vol. 57, p 1361).

[55] In model (1) an exogenous crash effect is allowed in the model. Following up model allows as a matter of fact for an exogenous change in the rate of growth and the last one permits for the sudden change in the level to be followed by a different growth path.

In each case, we derive coefficients of the dummies and the series of residuals, by running the regressions using OLS with the appropriate variables. It is clear from the simple estimations of the coefficients , see appendix Table 4.A.2, that for almost all countries at least one of the dummies is significant. This indicates that the policy changes were actually significant.

This conclusion is however, subject to the condition imposed by the test, that of white noise residuals. It is evident from the results that almost all countries have white noise residuals, hence reinforcing the previous tests and the statistical significance of the "changes". An exception to these is the case of the UK and Germany. In the first case, although the residuals of the models are white noise there is no indication of significant changes in the mispricing measurement following the policy change, which is in contrast to previous test results. However, the robustness of the test leads us to the conclusion that in this case, the policy change has not affected capital flows in the market. As far as the first test is concerned which showed a higher mean in the second part, this might be attributed to investors' attitudes, which are rather difficult to take account of in this context. In the case of Germany, although there were some significant coefficients, the models failed to produce white noise residuals. This might be termed as evidence in favour of a more complex modelling of the series in order to supply the required series of residuals. The overall hypothesis test results are also included in the table above with "Y" indicating that the measurement has been positively affected by the policy changes, "N" indicates a negative effect or no effect and "Y?" for a questionable effect.

In summary, the simple test results indicate, that the capital controls are negatively related with the level of integration in the sample countries. This indication is also prominent for most cases in the application of tests, which are considered to be more robust than the first one.

From these results, a general conclusion reached, is that they provide evidence that may be considered supportive of studies which have been carried out and suggested

that capital controls stand as an impediment to the integration of national financial markets.

4.5 Conclusions

Recent empirical evidence, in the field of asset pricing and especially in the capital market integration framework, has pointed out that the use of a single factor model has certain shortcomings. Furthermore, the evidence suggested that the use of a more general multifactor model would correct these problems. In another strand of literature, concerns were expressed about the characteristics of the moments and their effect on empirical results, suggesting that moments tend to vary through time.

Following these proposals, this study has introduced a measure of deviations from the law of one price in the sample markets and thus appraised the level of risk integration in these markets. The proposed measure was derived by using a multiple beta model in a time varying environment, for the expected returns of these European equity returns, along with a set of pre-determined factors which have been selected as a measure of the European economic risk factors.

Results have shown that for the sample countries the pricing error is at low levels, indicating that these countries are actually sharing the same source of risk when determining their asset prices. Relating this to earlier studies, this result resembles that of *Korajczyk(1996)* with regards to the United Kingdom which is common in both studies.

Furthermore, the study attempted to evaluate the relationship between impediments to free capital flows, represented extensively by governmental controls, and the level of integration as depicted by the calculated measure. Taking each country in the sample and analysing its position annually in terms of controls, confirmation of the theoretical result was obtained, the relaxation of the controls actually increases the level of integration. This was also the conclusion of earlier studies by *Bonser-Neal,Braumeret al (1990), Levine,Zervos (1995,1996),* who explored the effects of

liberalisation of capital controls and showed that their sample countries enjoyed improvements in their functioning, following the liberalisation of controls.

Overall, these results are in line with previous evidence, suggesting that the level of integration has increased in the sample countries, as required by the treaty of Rome and that in general capital controls are expected to have a negative relationship with the level of integration.

Appendix A

1. Assessing instrumental variables relevancy

Previous studies such as *Gultekin, Gultekin(1983)* have shown that January returns are higher than other months in certain industrialised countries. *Fama, French(1989)* demonstrated the considerable powers of the dividend price ratio and bond yield spread in explaining returns. Positive comments were also given in an international context by *Cutler,Poterba, Summers(1991)* for the dividend yield instrument. This is in addition to *Campbell, Hamao(1992)* who supported the use of the default risk.

Following these suggestions indirectly and the proposals of *Harvey(1994),* the complete list of instruments, that will be used in the determination of this factor is derived. This will include the lagged excess return on a January dummy (I1), the lagged value of credit risk (I2), European index (I3), the dividend yield on the European index (I4), one month treasury bill yield (I5) and the bond yield spread (I6).

A test for measuring these instruments' relevancy, is that suggested by *Nelson, Startz(1990)* which tests whether the "instrument is a poor one"(pp. S125) in the sense that it is weakly correlated with the explanatory variable, leading to spurious misleading results. This test directly considers the correlation between the two variables and tests whether

$$IV = 1 \Big/ \rho_{id}^{2} >> n \qquad (9a)$$

where ρ^2 is

$$\rho_{id}^{2} = \frac{n-1}{n-2} r_{id}^{2} - \frac{2}{n-2} \qquad (9b)$$

and r^2_{id} is the squared unconditional correlation of the instrument with the dependent variable.

	I1	I2	I3	I4	I5	I6
European Inflation	40.39787	10.35621	31166.02	7.131201	5.876427	12.66577

Table 4.A.1 Nelson,Startz test results

Relevant statistic results are listed in the table above, suggesting that in almost all cases the instrumental variables are not weakly correlated with the dependent variable, because calculated statistics are not larger than the sample size. In particular, I3 seems to have low correlation with inflation but due to the fact that this is an isolated case of this instrument, it is disregarded as a rejection of the specific instrument relevancy.

3. Perron Unit Root test results Tests

		Models*				Perron For Unit Roots			T_B/ T
		M1	M2		M3	M1	M2	M3	
Dummy Variables		DU	DT*	DU	DT				
United Kingdom	A	0.003	0.0003	**0.005**	**0.0004**	32.24	32.44	35.68	0.19
	B	0.004	0.0002	0.006	0.0002	33.06	32.38	32.86	0.48
France	A	**0.005**	**0.0009**	**0.008**	**0.0001**	64.21	62.17	69.6	0.08
	B	**0.006**	**0.0004**	**0.006**	**0.0004**	27.68	42.14	83.72	0.18
	C	**0.006**	**0.0003**	**0.006**	**0.0004**	26.92	37.18	58.45	0.2
Germany	A	0.006	**0.0002**	**0.012**	**0.0002**	22.40	21.87	23.06	0.51
	B	**0.006**	0.0002	0.013	0.0002	21.94	21.95	22.77	0.52
	C	0.005	0.0002	**0.021**	**0.0002**	23.19	22.01	23.05	0.63
Switzerland	A	**0.005**	**0.0001**	**0.017**	**0.0002**	10.27	45.09	44.98	0.71
	B	**0.004**	**0.0002**	**0.023**	**0.0003**	20.10	43.18	44.06	0.76

* Numbers are the standard errors of the variables, highlighted errors indicate significance at 95%

$\lambda=(T_B/T)$	0.2	0.5	0.6	0.7	0.8
Model					
A	26	25.25	25.56	25.99	25.82
B	27.16	29.65	29.51	28.68	27.24
C	29.95	33.79	33.19	33.11	30.70

Perron(1989) Critical values at 95% level of Significance, Econometrica, Vol 57(6), pp. 1376-1377

Table 4.A.2 Statistical Results for the Perron Unit Root Test

Chapter 5

Modelling National Stock Market Returns and Interdependencies using GARCH models

5.1 Overview

A series of empirical studies have been carried out since the early sixties to identify the distribution function that will empirically fit the observed return distribution. The majority of these studies have shown, in general, that the time series of returns exhibit short lag autocorrelation but with no prominent profitable trading opportunities[56]. An additional observation of these studies was the fact that stock returns are distributed as anything other than a normal pattern, mainly because of their fat tails and excess peakness, see *Nelson(1991), Booth et al (1992).*

Although studies confirm the above they do not reach a unanimous conclusion as to the distribution which will best represent these statistical properties. As a result individual authors propose different return generating models on the premise that they best fit observed distributions. These have been labelled as "empirical descriptions of fitted distributions" (*Bookstaber,McDonald(1987),*pp402) mainly because of the lack of empirical work which establishes a relationship between the empirical distributions and the actual return mechanism.

This has been the main description of most return generating processes up until Merton *(1980)* who suggested that studies in this field should consider the presence of heteroscedasticity[57] and basically account for temporal dependencies in the series. His suggestions were made on the premise that the absence of serial correlation does not in fact imply statistically independent returns. The introduction of the ARCH family of models by *Engle(1982)* and subsequent extensions, based on what has been previously considered as nuisance, has meant that the modelling of second order

[56] See *Fama (1963,65), Clark (1973), Blattberg,Gonedes(1974)*

moments began to explicitly incorporate these suggestions and so brought a change in financial time series modelling. These models are quite similar to the first moments time series techniques, with the emergence of a deeper and richer understanding of the underlying dynamics of conditional variances and covariances.

Statistically, these are mean zero and serially uncorrelated processes which allow for a time invariant unconditional covariance matrix but at the same time permit dependency of the conditional variance on past states of the world. The allowance of the variance to vary across time in these models could explain the high level of kurtosis and could in some cases be handy in explaining the presence of skewness.

The empirical use of the ARCH models has revealed that most of the applications required a large number of past values and consequently a lot of parameter estimates. This has called for an extension which could allow for a more flexible lag structure and reduce the number of estimated parameters. *Bollerslev(1986)* introduced the GARCH(p,q) model, which is the extension that generalises the process allowing for past conditional variances (q), to be included in the conditional variance equation.

However the set up of these equations is a general one allowing for a large number of functional forms to be accommodated by the models. The appropriateness of the selected model will depend exclusively on the understanding of the empirical regularities of returns to be captured. It will be expected to account for the features of serially uncorrelated series in addition to fat tails and skewness in stock returns, further to the requirement of modelling any dependencies present in the series.

All the same, the introduction of the informational asymmetries implied by non-trading periods and releases of important information on individual securities, *Harvey,Huang(1991),* in addition to the incorporation of the leverage effect, as noted by *Black(1976)* and later by *Christie(1982),* reduced the appropriateness of the basic GARCH model on the grounds that this model only considers the magnitude and ignores the parameter signs in the conditional variance equation. Furthermore, its

[57] This has been acknowledged as a stylised fact for stock prices since *Mandelbrot(1963)* study who suggested that large changes tend to be followed by large changes of either sign or small changes to be followed by small ones.

appropriateness was questioned on the grounds of the non-negativity constraints which are imposed to ensure positiveness of the conditional variance.

This requires the use of an alternative model which is a modification of the GARCH model and was put forward by *Nelson(1991)*. The EGARCH model accounts for these additional empirical complexities of the national stock returns, by taking into consideration both the size and sign of the parameters. It also relaxes the constraints in the conditional variance equation.

Follow up studies, such as *Engle,Ng(1993)* , have stressed the empirical success of this model, which could be said to stem from the absence of parameter restrictions. Furthermore, the authors have proposed this model specification as a relevant model to be used in the field of modelling the interaction mechanism, or alternatively the empirical implications of capital market integration on individual markets.

It is fairly established within the literature, see Chapter2, that there is an increase in the globalisation of financial markets, which stimulates the need to understand the ways in which the national markets interact. This understanding will permit investors and other groups of individuals to carry out their investment and policy strategies in a successful manner because as it stands now, their decisions should incorporate domestically generated information and information originating in other markets.

In empirical terms, this sort of testing requires the use of more than one data series because the relationship between two or more markets will be under consideration. This requires extending the basic EGARCH model to a multivariate form with similar properties but with different mean and variance equation specification. Additionally the model specification includes the constant covariance matrix which will outline the relationship of market returns.

This empirical chapter will initially attempt to model the individual stock indices using this class of models and will also provide an in-depth analysis of the interdependencies between the national stock markets, stressing the mechanism beneath these transmissions. In particular we will be looking to raise the issues of identifying the origin of influences within the European Union, their level and their

degree and speed of transmission. Furthermore, similar tests will be carried out to model the transatlantic mechanism which will involve the two major markets in Europe and Asia.

Daily closing price data will be used in order to capture any short-lived interactions between the markets. In the case of Japan both opening and closing prices will be used, because of the time differences in trading, to account for any overnight transmissions.

5.2 Data Description

A range of descriptive statistics for the sample countries' indices is reported in Table 5.1.A. Returns are positive on average in all markets and for Netherlands these are significantly different from zero, at the 5% level of significance. Taking a look at the third and fourth moments of the series it is evident that the third moment is non-symmetrical to the left, negatively skewed, whilst the dispersion of a large number of observed values is very small, i.e. leptokurtic frequency curve. Therefore it is evident from the sample, that returns follow a sharp peak and fat tail distribution, which is in line with the belief that returns in an empirical level follow a distribution other than a normal one. This is confirmed with the application of the Jaque-Bera test for normality. In fact, the test evaluates the hypothesis whether third and fourth moments actually have values which are consistent with the null hypothesis of normality. It is clear that none of the data series suffers from first order autocorrelation as indicated by the first order correlation coefficient.

Furthermore, an additional test which has further implications for the appropriate empirical model specification is included in the table. This is the Box-Pierce Q statistic which evaluates independence between the series values by considering the null hypothesis that the sum of the first K autocorrelation coefficients is equal to zero. An extension of the statistic is the adjustment for heteroscedasticity, according to *Diebold(1988)* suggestions. The test statistic equation is

$$Q(K)=\Sigma_{i=1}^{K}\left(\rho(i)/S(i)\right)^2 \quad (1)$$

where ρ(i) is the ith autocorrelation coefficient and S(i) is the estimate of the standard error, which in the extension is represented by the following equation where γ(ι) is the ith autocovariance of the squared data and σ is the standard deviation of the sample.

$$\sqrt{\frac{1}{N}\left(1+\gamma(i)/\sigma^4\right)} \quad (2)$$

The application of the simple statistic denotes that all countries except France are suffering from longrun dependencies in the return series. When the adjustment is made for heteroscedasticity, the calculated statistics are actually below the critical values up to the 25th lag for the sample countries, indicating that the adjustment for heteroscedasticity actually removes autocorrelation in the series of returns. When the same test is carried out using the squared series of returns it reveals that there are some non-linear longrun dependencies in the series which should be accounted for.

	Germany	United Kingdom	France	Netherlands	Japan
Sample	2558				
Mean (x 10^3)	0.345	0.243	0.223	0.367	0.0899
t-stat (μ=0)	1.46	1.34	0.95	2.22	-0.33
variance(x 10^3)	0.142	0.0839	0.139	0.0698	0.189
m_3	-1.12	-1.9	-0.59	-1.13	-0.18
m_4	15.78	30.09	8.32	27.12	12.98
1st Autocorrelation	-0.0178	0.0611	0.0274	-0.0237	-0.0013
Q(25) Unadjusted	39.53	52.24	28.67	56.24	66.04
Q(25) Adjusted	17.85	13.2	13.79	12.18	36.29
$Q^2(25)$	541.32	1406.2	1425.49	2614.35	311.77

Table 5.1.A Data Descriptive statistics

Lastly, Table 5.1.B reports the unconditional correlation structure of the European markets[58] under consideration. This is probably the most basic characteristic of the return series that investors will look into first because their hedging and diversification strategies will require a form of coherence measure. The estimates

[58] The table includes only European markets because the tests that will be carried out in later sections of the chapter will evaluate only the European relationship. A separate test will be carried out for the relationship of Europe with Japan and will involve the UK only.

vary from 0.694 between UK and Germany to 0.469 between the UK and the Netherlands.

	Germany	UK	France	Netherlands
Germany	1.0000	0.69425	0.62096	0.65337
UK		1.0000	0.55706	0.46959
France			1.0000	0.60556
Netherlands				1.0000

Table 5.1.B Pairwise unconditional European Country Correlations

5.3 Empirical model building

A combined conclusion from the above is that, contrary to the common assumption of empirical models, stock prices cannot be adequately represented by a linear white noise process with independent increments. This might be due to the existence of linear and non-linear dependencies. Linear dependencies, which partially contribute to the autocorrelation coefficient of the series, might be attributed to various market phenomena and anomalies, such as day-of-the-week trading and information processing. On the other hand non-linear dependencies are most probably created, as suggested in the empirical evidence, by time varying variances, variation of which is often related to the level of activity and information arrival. There is substantial literature on modelling non-linear dependencies but as reported by *Neftçi(1984)* and confirmed by *Akgiray(1989)*, the proposals could be challenged on the grounds of a lack of substantial theoretical basis to support their assumptions of linearity and independent successive observations.

Thus a realistic return generating process should be consistent with the properties premised in the return series, these being the absence of first order serial correlation and the observation that the series of squared returns is autocorrelated at very long lags. Given that the series are not found to suffer form 1st order autocorrelation we can move onto satisfying the second property.

The presence of long lag autocorrealtion in the squared series of returns of the sample countries is thought to be the cause of thick tails and peakness in the series. This calls for the development of a process of the form

$$R^2_t = \alpha + \sum_{s=0}^{\infty} \beta_s \varepsilon_{t-s} \quad (4)$$

which will be linear with non-normal innovations. This type of relationship, however, ignores information about dependence within the squared values and this has turned out to be of critical importance in many financial theories.

Yet the consideration of a linear process which will allow for the returns to be dependent on past innovations is often empirically intractable. This observation calls for the use of an alternative process in modelling stock returns , namely the ARCH family of models, developed by *Engle(1982)* as an approximation of the second order non-linear processes.

5.3.1 Description of Model

Essentially, the above mentioned modelling procedure imposes an AR structure on the conditional variance which allows for shocks to persist over time, thus incorporating successfully the presence of autocorrelation in the squared series of returns which is a long standing feature of stock return behaviour. In the context of the original model, the distribution of conditional errors is considered to be normal, with a conditional variance which is a linear function of past squared innovations. The model, denoted by ARCH(p), can then be represented by,

$$y_t = \xi\, x'_t + \varepsilon_t$$
$$\varepsilon_t / \Psi_{t-1} \sim \mathrm{N}(0, h_t)$$
$$h_t = \alpha_0 + \alpha_1 \varepsilon^2_{t-1} + \ldots\ldots + \alpha_p \varepsilon^2_{t-p} \quad (5)$$

where ψ is the information set currently available, ε_t are the residuals of the time series under consideration, which should be uncorrelated and mean equal to zero. Effectively this model specification implies that h_t is actually a function of the elements of the available information set.

In addition, the basic requirements of the model specification require that $\alpha_0 > 0$ and $\alpha_p \geq 0$ to safeguard positiveness in the conditional variance. Furthermore, by definition the conditional moments may be time varying. Hence large (small) errors of either sign tend to be followed by large (small) errors of either sign, with the order of p determining the length of time for which a shock is conditioning the variance of subsequent errors.

This type of model behaviour has proven useful in modelling different economic phenomena, because it states that apparent changes in time series may be predictable and a product of a specific non-linear dependence rather than exogenous change in the variance. Additionally, in distributional terms an ARCH process generates a density function which coincides with the frequently displayed feature of asset returns, this exhibiting heavier tails than a normal distribution.

However, because of the non-negativity assumption of the conditional variance a fixed lag is imposed on the model. This is contrary to the empirical requirements of a rather arbitrary lag structure in the conditional variance equation to take account of the commonly cited long memory of events.

This called for an extension of the process and at first *Engle(1983)* suggested a reparameterised conditional variance equation by introducing linearly declining weights for parameters. This parameterisation allowed researchers to specify large number of lags and yet restrict computations to a minimum. Although this has been a credible extension, this type of formulation has actually imposed restrictions on the dynamics of the process.

In the light of this shortcoming , an extension was required to allow for a more flexible lag structure and for a longer memory. *Bollerslev(1986)* proposed an extension of this kind, an extension which was also independently proposed by *Taylor(1986).* In fact, this was a generalised version of the original ARCH(p) model which, in addition to the past squared errors, included past conditional variances. Ultimately, the authors were aiming to represent a high order ARCH process by imposing a rational lag structure on the coefficients. Under these circumstances the

conditional variance equation, which could be termed as an adaptive learning mechanism, will be

$$h_t = \alpha_0 + \alpha_1 \varepsilon^2_{t-1} + \ldots + \alpha_p \varepsilon^2_{t-p} + \beta_1 h_{t-1} + \ldots + \beta_q h_{t-q} \qquad (6)$$

of which ARCH(p) is a special case, q=0. Under this specification the following inequality restrictions should be met $p>0$, $q\geq 0$ and $\alpha_0>0$, $\alpha_p\geq 0$, $\beta_q\geq 0$, so as to ensure that the conditional variance equation is strictly positive[59].

The basic feature of a GARCH model, the time variation of the variance, resulted in a fruitful empirical application of the methodology. However, this simple structure limits the empirical success of the GARCH models. Specifically, when the leverage effect is incorporated, as defined by *Black(1976)*, it is evident that the models only take account of the magnitude ignoring the sign of the parameters as determinants of the conditional variance. Furthermore, the imposition of the non-negativity constraint, which in certain cases is unrealistic, has turned out to create difficulties in the estimation of the models.

These objections to the basic methodology suggested that an alternative model should be presented to mitigate them. *Nelson(1991),* took the GARCH methodology as a foundation and based on the proposals by *Pantula(1986), Geweke(1986)*, has actually developed an alternative model by which these concerns have been mitigated. His model, the exponential GARCH model (EGARCH), similar to the previous versions of the GARCH models, assumes that the maximum likelihood estimator (MLE)[60] employed is consistent and asymptotically normal. In this model the variance (σ^2) depends on both the size and the sign of lagged residuals. In particular,

$$\log h_t = \alpha_0 + \sum_{i=1}^{q} \alpha_i \left(\gamma z_{t-i} + \gamma \left[|z_{t-i}| - \mathrm{E}|z_{t-i}| \right] \right) + \sum_{i=1}^{p} \delta_i \log h_{t-i} \qquad (7)$$

where $z_t = \varepsilon_t / \sqrt{h_t}$.

[59] Although these suffice in ensuring that the equation is positive , *Nelson,Cao(1992)*, under certain conditions, have reported studies which had negative coefficients and yet satisfy the conditions of a positive conditional variance. This implies that violation of the basic condition need not imply misspecification of the variance equation.

[60] Verification of these conditions proved to be extremely difficult.

The exponential form of the model comes as a solution for the first objection to the simple GARCH models. The unduly restrictive dynamics of the models and the inequality constraints which were violated in empirical application by the estimated coefficients, are accounted for by allowing terms to be of either sign.

This model specification is by definition superior to all prior models because of its ability to incorporate all the stylised facts about stock returns. On this basis the model will be evaluated along with other models of the family, in an attempt to confirm empirically its' theoretical superiority as an empirical description of the individual country indices.

Since there is extensive literature, part of which is discussed in previous chapters, which emphasises the growth of market integration, the methodology must be extended to account for any short-term events which may arise amongst countries. These are widely known as interdependencies and might be of importance to different groups of individuals or even the authorities themselves. As it stands, the univariate models are limited in characterising individual national stock market returns as they ignore the information that an innovation in one market might have with respect to the mean and variance of another market. Given the empirical characteristics of national stock returns that will have to be incorporated, the EGARCH model will have to be extended to a multivariate framework in an attempt to accommodate such innovations and model the structure of stock market movement transmission around the world *(Koutmos,Booth(1995), Koutmos(1996))*.

Such an extension is plausible because it improves the efficiency and the power of the empirical tests and it is methodologically consistent with the notion that interdependencies are essentially manifestations of the impact of global news on the national market.

Furthermore, the allowance of local and foreign innovations to create an asymmetric impact on the variance of a market by the EGARCH methodology makes it superior to competing methodologies and ideal for this sort of tests, i.e. modelling the innovation transmission mechanism.

This conclusion is reached based on the findings of *Engle,Ng(1993)* who, when comparing of the underlying methodology with the Quadratic GARCH model proposed earlier by *Engle(1990)* found that the latter tended to under-predict the volatility associated with negative innovations.

As a matter of fact, the proposed model extension will be a combination of the vector autoregressive analysis (VAR) by *Sims(1980)* and the EGARCH conditional variance equation. The VAR estimates a dynamic simultaneous four equation model which describes the returns in the individual national market (i)[61]. This model is expressed as

$$R_{i,t} = \alpha_{i,0} + \sum_{j=1}^{4} \beta_{i,j} R_{j,t} + \varepsilon_{i,t} \qquad (8)$$

Under this specification the individual national market returns are a function of their own past returns (R_i) as well as past returns of the other sample markets. This allows the identification of the multi-lateral relationships between the national stock markets, captured by b_{ij} for $i \neq j$. A significant b_{ij} will imply that current returns in market j could actually be used, under certain circumstances, to predict future returns in market i.

The conditional variance equation stems from the univariate EGARCH(1,1), equation (7) and is a function of its own past market (i) , in addition to cross market innovations. It is proxied by

$$ht = \exp\left(\alpha i,0 + \sum_{j=1}^{4} \alpha i,j,0 \left(\gamma j z j,t-1 + \left[|z j,t-1| - \mathrm{E}(|z j,t-1|) \right] \right) + \delta i \ \ln(hi,t-1) \right) \quad (9)$$

This functional form allows for the asymmetric influence of innovations on the conditional variance. The extent of the effect of each innovation is measured by the second term in the first component of the conditional variance equation. If the expected $E|z_{t-1}|$ is lower (higher) than the magnitude of z_{t-1} then the effect, given a positive a_{ij}, will be positive(negative). Similarly the direction of effect (sign) can be

measured with $\gamma_j z_{t-1}$ which in turn might reinforce or offset the magnitude effect. The interactions in terms of variance between stock markets can be measured by a_{ij} which, in conjunction with δ_j ,explain the asymmetric pattern in the volatility transmission mechanism.

Furthermore, as in the univariate model specification, δ_i measures the persistence of the volatility implied by the equation. Under this model specification, according to *Hsieh(1989)* it is highly unlikely that δ_i=1. This could be termed as a positive feature of the specification because if persistence, through the coefficient, is found to be equal to one, then the shock will persist indefinitely by conditioning the future variance with an infinite variance of the unconditional distribution of $\varepsilon_{i,t}$.

The conditional covariance specification is the last component of the multivariate model specification and it is modelled as,

$$\sigma_{i,j,t} = \rho_{i,j}\sigma_{i,t}\sigma_{j,t} \qquad (10)$$

This specification assumes that there is a constant contemporaneous correlation across the individual stock markets, or in other words, the covariance is proportional to the direct product of the standard deviations in the two markets (*Bollerslev(1990)*), given that no structural change has occurred over the sample period.

It is clear from this that the covariance specification is not robust when using non-overlapping data. However in the case of the European markets, this is inapplicable because the markets are simultaneously trading. When it comes to the case of Japan, which is obviously trading in a different time zone with no overlapping hours the measure should be augmented or the dataset should be made compatible[62]. This will ensure the statistical robustness of the measure but the cross market correlation coefficient of the market should still be interpreted with caution. Rather, it should be interpreted as measuring the intraday lead/lag relationships.

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[61] This methodology is free of a priori restrictions on the structure of relationships among variables and can be viewed as a flexible reduced form approximation of an unknown correctly specified economic structure.

[62] Compatibility arises by just splitting the compounded returns into open-close, close to open.

5.4 Empirical Findings and Discussion

5.4.1 Univariate Specification

Under this model specification the coefficient estimates of equations (5)-(7) for the individual countries require the maximisation of the loglikelihood function which is non-linear in ϕ.

Numerically, the maximisation of the likelihood function of the utilised models has been carried by employing the optimisation technique proposed by *Brendt, Hall, Hall, Hausmann(1974),* BHHH. Algebraically, the likelihood function to be optimised is,

$$L\left(\phi/_{p,q}\right) = -\frac{1}{2}T\ln(2\pi) + \sum_{t=1}^{T}\ln\left(\frac{1}{\sqrt{h_t}}\right)\exp\left(\frac{-\varepsilon_t^2}{2h_t}\right) \qquad (11)$$

The results for the different models are presented in Table 4.3.1. In empirical application of the ARCH process, fitting a higher order than required will give insignificant parameters corresponding to longer lags. This conforms with the successive application of likelihood ratio tests until improvement in the function is insignificant. Along with *Akgiray(1989),* who has suggested that a " maximum of five lags seem to give satisfactory fit to daily series"-pp.69- ARCH models in this study will be applied up to the fifth order.

If L_2 and L_1 are the likelihood function values under the null and alternative hypothesis, respectively then the test statistic will be equal to

$$LRT = -2\left[L_1 - L_2\right] \qquad (12)$$

and will be χ^2 distributed with the degrees of freedom being equal to the difference between the parameters under the two hypotheses. Calculations indicate, that the ARCH process is a better description of stock price fluctuations than the

Model	United Kingdom Likelihood *f*	LRT	SIC	Country France Likelihood *f*	LRT	SIC	Germany Likelihood *f*	LRT	SIC
Normal	10602.72			10066.5			10959.7		
ARCH(1)	10907.04	608.64	-21806.2	10134.82	136.64	-20261.8	11219.09	518.78	-22430.3
ARCH(2)	10965.35	725.26	-21915	10230.38	327.76	-20445.1	11337.53	755.66	-22659.4
ARCH(3)	10991.38	777.32	-21959.2	10260.77	388.54	-20498	11361.20	803	-22698.9
ARCH(5)	10997.15	788.86	-21955.1	10285.07	437.14	-20530.9	11391.71	864.02	-22744.2
GARCH(1,1)	11025.32	845.2	-22034.9	10088.33	43.66	-20161	11466.92	1014.44	-22918.1
GARCH(2,1)	11011.58	817.22	-21999.6	10322.46	511.92	-20621.4	11466.93	1014.46	-22910.3
GARCH(1,2)	10719.89	234.34	-21416.2	10073.6	14.2	-20123.7	-	-	-
GARCH(2,2)	-	-	-	10318.14	503.28	-20604.9	11465.37	1011.34	-22899.4
EGARCH(1,1)	**11046.96**	**888.48**	**-22078.2**	**10322.35**	**511.7**	**-20629**	**11488.4**	**1057.4**	**-22961.1**

Model	Netherlands Likelihood *f*	LRT	SIC	Japan Likelihood *f*	LRT	SIC
Normal	10007.16			9649.59		
ARCH(1)	10168.02	321.72	-20328.2	9883.04	466.9	-19758.2
ARCH(2)	10241.41	468.5	-20467.1	9923.18	547.18	-19830.7
ARCH(3)	10295.82	577.32	-20568.1	9956.31	613.44	-19889.1
ARCH(5)	10332.66	651	-20626.1	10015.58	731.98	-19991.9
GARCH(1,1)	10345.27	676.22	-20674.8	10062.79	826.4	-20109.9
GARCH(2,1)	10046.24	78.16	-20068.9	10096.98	894.78	-20170.4
GARCH(1,2)	-	-	-	9676.73	54.28	-19329.9
GARCH(2,2)	10349.92	685.52	-20668.5	10093.43	887.68	-20155.5
EGARCH(1,1)	**10361.11**	**707.9**	**-20706.5**	**10137.31**	**975.48**	**-20258.9**

Table 5.2. Maximum log-likelihood Values for the model

unconditional normal distribution, for all countries under consideration. In other words, these results indicate that the null hypothesis of a homoscedastic normal process is rejected in favour of the presence of significant ARCH effects. An improvement in the likelihood function may be the result of either an increment in the number of parameters or the use of a better model. An additional test which distinguishes between the type of improvement in the function is the Schwarz's order of selection criterion and it is calculated using

$$SIC = -2L(\phi) + (\ln \mathrm{T})K \qquad (13)$$

where K is the number of parameters in the model. Under this test the best model of fit is the one with the lowest SIC value.

Evidence provided in Table 5.3 indicates that the estimates of α_0 are positive for all countries and are significantly smaller than the sample variance which is presented in Table 5.1.A. Essentially this suggests that there is a time variation in the conditional variance of the series as well as the contribution to the unconditional variance.

	United Kingdom	France	Germany	Netherlands	Switzerland	Japan
α_0	0.034	0.061	0.0027	0.051	0.0038	0.052
	(16.06)	(18.15)	(44.72)	(20.04)	(41.66)	(25.19)
$\sum_{i=1}^{p} \alpha_i$	0.5733	0.5303	0.5303	0.7041	0.5925	0.8307

Table 5.3 ARCH model parameter estimates

Furthermore, when summing up the other ARCH parameters we note that these are substantially below unity which suggests two things. Firstly that fitted models are second-order stationary thus confirming Bollerslev *(1986)* who suggested that at least the second moment exists. Plus this is an indication of the fact that persistence of shocks is at normal levels.

The SIC value is for three of the countries, namely UK, France and Japan. It gives its lowest value for UK at GARCH(2,1) and for the other two at GARCH(1,1) indicating

that these models outperform the other (G)ARCH models. These results are partly in line with other applied work, which actually suggested that a GARCH(1,1) has the ability to represent the majority of financial time series.

Finally, given the objections arising from the use of the simple GARCH methodology an EGARCH(1,1) model has been applied to the return series. It is evident from the computed test statistics that the model is actually a better proxy for the return generating process within these markets[63].

Conclusively, results for the primary tests that have been carried out first suggest that European indices, along with the Japanese, can be termed as conditional heteroscedastic. Furthermore, the application of different ARCH models which allow for autocorrelation between first and second moments and primarily deal with this phenomenon, provided evidence indicating that fluctuations in the daily national stock prices, represented by the indices, could be empirically proxied using the EGARCH(1,1) .

5.4.2 Multivariate Specification

In the preceding section the individual national stock markets have been modelled using a univariate EGARCH(1,1) model which proved to be the best fit model, in the ARCH family of models. However the introduction of the foreign factors that may influence the national stock market, volatility surprises, will require the model applied previously to be extended to a multivariate specification, thus allowing for the estimation of the parameters that proxy these surprises. The model will have a vector autoregressive form, allowing for a variation in the first moments and will require the maximisation of the log likelihood function. Algebraically, under the assumption of joint normal distribution of returns, the function could be written as

[63] It has been suggested that the assumption of normally distributed errors which has been made in most of the applications may in fact be inappropriate because these are actually leptokurtic, thus rendering t-statistics unreliable. In the light of this the model residuals density function is plotted. From the plots it is obvious that the residuals are normally distributed, suggesting that the normality assumption made in this study is valid. The plots can be found in the appendix at the end of the chapter.

$$L(\Phi) = -0.5(\mathrm{NT})\ln(2\pi) - 0.5\Sigma_{t=1}^{T}\left(\ln|S_t| + \varepsilon_t' S_t^{-1}\varepsilon_t\right) \qquad (14)$$

Under this notation N represents the number of equations (four in this case), and T is the number of observations used. The 44X1 parameter vector to be estimated is represented by Φ , together with the 4X1 vector of innovations ε_t'. Finally, S_t represents the time varying variance covariance matrix, elements of which are given by the basic model equations. Maximisation of the system of equations which is highly non-linear in Φ will be carried out using the *BHHH(1974)* algorithm.

Implementation of the economic model of coherence of national stock markets requires the estimation of a model which excludes such an event. In other words, the system of equations as presented by equations (8)-(9) should be altered into a purely domestic system by restricting the cross-market coefficients measuring price and volatility spillovers, namely $\beta_{i,j}$ and α_{ij} for $i \neq j$, to take the value of zero. Contemporaneous correlation coefficients, equation (10), are not restricted by this hypothesis , thus the restricted benchmark model, an AR(1)-EGARCH, is not equivalent to four univariate models. This specification is similar to *Bollerslev (1990)* with a slight difference in the empirical model used. The estimates of the particular model specification are disclosed in table 5.4.A.

It is evident from the estimations that the autoregression coefficients $\beta_{i,j}$ are insignificant, thus concluding that the concept of market inefficiency, amongst other causes of linear dependencies, do not infect the return series , i.e. no autocorrelation.

On the contrary, it is apparent that what describes short-run dynamics of the series is conditional heteroscedasticity as shown evidenced by the significant coefficients α_{ij} and γ_i which make up the conditional variance equation.

A useful finding is the significance of the impact of past innovations on current volatility, for all countries. In this respect the coefficients for α_{ij} are positive and statistically significant where as the coefficients of γ_i , which measure the sign effect, are negative and statistically significant. This implies that market declines are most likely to be followed by higher volatility than market advances of an equal magnitude.

Numerically this asymmetry, at a local level when restricting foreign effects to zero, can be measured using the estimated γ_i coefficients in the ratio

$$\frac{\left|-1+\gamma_i\right|}{1+\gamma_i} \qquad (15)$$

It is clear that in the Netherlands negative returns increase volatility approximately 2.85 time more than a positive innovation, followed by France (approx. 2.41 times), UK (1.68 times) and Germany (1.31 times). Judging from the estimated coefficients for δ_i, volatility persistence is very close to unity with the highest persistence shown in Germany.

Germany		United Kingdom		France		Netherlands	
$\beta_{1,0}$	0.0003	$\beta_{2,0}$	0.0001	$\beta_{3,0}$	0.0001	$\beta_{4,0}$	0.00025
	(.00012)*		(0.00015)		(0.0002)		(0.0002)
$\beta_{1,1}$	0.0103	$\beta_{2,2}$	0.00293	$\beta_{3,3}$	-0.0051	$\beta_{4,4}$	0.0031
	(0.0138)		(0.017)		(0.0153)		(0.017)
$\alpha_{1,0}$	-0.2355	$\alpha_{2,0}$	-0.3024	$\alpha_{3,0}$	-0.2983	$\alpha_{4,0}$	-0.2806
	(0.023)*		(-0.038)*		(0.053)*		(0.0281)*
$\alpha_{1,1}$	0.1328	$\alpha_{2,2}$	0.1502	$\alpha_{3,3}$	0.097	$\alpha_{4,4}$	0.1058
	(0.0095)*		(0.0097)*		(0.011)*		(0.0071)*
γ_1	-0.1342	γ_2	-0.2552	γ_3	-0.4138	γ_4	-0.4815
	(0.0554)*		(0.0508)*		(0.0907)*		(0.0805)*
δ_1	0.9755	δ_2	0.9678	δ_3	0.9664	δ_4	0.9681
	(0.0023)*		(0.0039)*		(0.0058)*		(0.003)*

Standard errors are in the parentheses and * denotes significance at 95%

Table 5.4.A Close-to-Close returns AR(1)-EGARCH(1,1) model for European Union

	Germany	United Kingdom	France	Netherlands
$E(z_{i,t})$	0.0131	0.0163	0.0119	0.0123
$E(z^2_{i,t})$	1.004	1.004	1.003	1.002
LB(20) $z_{i,t}$	19.07	23.79	16.92	20.56
LB(20) $z^2_{i,t}$	35.59*	22.96	22.03	4.71

Table 5.4.B Residual descriptive statistics for the AR(1)-EGARCH(1,1) model

Looking at the results in Table 5.4.B of the standardised residuals, it is evident that in almost all cases the benchmark specification is statistically valid. Residuals exhibit the expected properties of zero mean and unitary variance and furthermore, the LB statistic for dependency at 20 lags, with a critical value of 31.41, indicates that there is no dependency in the standardised residuals.

Finally, it is noticeable, in Table 5.4.C, that the pairwise correlations are lower than the unconditional ones presented in Table 5.1.B. This suggests that the failure to account for conditional heteroscedasticity, evidently characterising the return series, may inflate the correlation estimates.

	Germany	United Kingdom	France	Netherlands
Germany	1.0000	0.638	0.6156	0.6172
		(0.0095)*	(0.113)*	(0.0113)*
United		1.0000	0.566	0.44
Kingdom			(0.0131)*	(0.0142)*
France			1.0000	0.566
				(0.0116)*
Netherlands				1.0000

Table 5.4.C Pairwise Conditional Country Correlations

The estimates of the unrestricted multivariate model are reported in Table 5.5.A. This full econometric model considers the impact of an innovation in market j on both the conditional mean and variance of market i, known as price and volatility spillovers respectively. In terms of first moment interdependencies there are significant price spillover effects, i.e. economically significant $\beta_{i,j}$ coefficients. Factually, there is a bi-directional effect for the case of Germany and UK in addition to their individual effects on France and the Netherlands. Furthermore, returns in the Netherlands seem to be correlated with French returns.

The multi-directional nature of these relationships suggests that no European market acts as a sole information producer. The only conclusion that can be drawn from this is that Germany and UK are information generation centres in the European Union.

However, the presence of these relationships, gives rise to the possibility that information in one market influencing the others could be used in an attempt to earn abnormal returns. An evaluation of this possibility requires a detailed consideration of the costs involved, such as transaction and exchange rate risk, which is a difficult task. Instead, an attempt to measure the explanatory power of past innovations in each market using the uncentered R^2 estimate will evaluate this possibility. The statistic is calculated using $R^2 = 1 - (VAR(\varepsilon_i)/ VAR(R_i))$. Results reveal that past innovations can only explain a small percentage of the returns, ranging from 0.4% for France to

3.3% for Germany[64]. In addition to this, the introduction of any transaction and other related costs will ensure that there is no economic significance in this information, giving grounds to the belief that these markets comply with weak form market efficiency under *Fama*(1970) terminology, in th every least.

Germany		United Kingdom		France		Netherlands	
$\beta_{1,0}$	0.0003	$\beta_{2,0}$	0.00014	$\beta_{3,0}$	0.00003	$\beta_{4,0}$	0.0001
	(0.0001)*		(0.0001)		(0.002)		(0.0002)
$\beta_{1,1}$	-0.0372	$\beta_{2,2}$	0.0981	$\beta_{3,3}$	0.0758	$\beta_{4,4}$	-0.108
	(0.0261)		(0.0253)*		(0.0245)*		(0.0255)*
$\beta_{1,2}$	0.0813	$\beta_{2,1}$	-0.0747	$\beta_{3,1}$	-0.0972	$\beta_{4,1}$	-0.0268
	(0.0204)*		(0.0301)*		(0.0406)*		(0.0426)
$\beta_{1,3}$	0.0215	$\beta_{2,3}$	-0.0237	$\beta_{3,2}$	0.033	$\beta_{4,2}$	0.139
	(0.0149)		(0.0175)		(0.0345)		(0.0337)*
$\beta_{1,4}$	-0.0176	$\beta_{2,4}$	0.009	$\beta_{3,4}$	-0.00191	$\beta_{4,3}$	0.1497
	(0.0153)		(0.0179)		(0.025)		(0.0236)*
$\alpha_{1,0}$	-0.2546	$\alpha_{2,0}$	-0.3508	$\alpha_{3,0}$	-0.370	$\alpha_{4,0}$	-0.227
	(0.0305)*		(0.0452)*		(0.0583)*		(0.0272)*
$\alpha_{1,1}$	0.1239	$\alpha_{2,2}$	0.1311	$\alpha_{3,3}$	0.0761	$\alpha_{4,4}$	0.075
	(0.122)*		(0.0130)*		(0.0133)*		(0.012)*
$\alpha_{1,2}$	0.0504	$\alpha_{2,1}$	0.008	$\alpha_{3,1}$	-0.0197	$\alpha_{4,1}$	0.02
	(0.0115)*		(0.0159)		(0.0154)		(0.0139)
$\alpha_{1,3}$	-0.0006	$\alpha_{2,3}$	0.085	$\alpha_{3,2}$	0.0529	$\alpha_{4,2}$	0.082
	(0.0105)		(0.0101)*		(0.0133)*		(0.0128)*
$\alpha_{1,4}$	0.0147	$\alpha_{2,4}$	-0.007	$\alpha_{3,4}$	0.038	$\alpha_{4,3}$	-0.0255
	(0.0103)		(0.01012)		(0.0121)*		(0.01)*
γ_1	-0.075	γ	-0.1009	γ_3	-0.399	γ_4	-0.5455
	(0.066)		(0.0589)		(0.0929)*		(0.0978)*
δ_1	0.9734	δ_2	0.9628	δ_3	0.9582	δ_4	0.9741
	(0.0031)*		(0.004)*		(0.0064)*		(0.0029)*

Table 5.5.A Multivariate VAR-EGARCH(1,1) model estimates

	Germany	United Kingdom	France	Netherlands
$E(z_{i,t})$	0.0166	0.0202	0.0195	0.0191
$E(z^2_{i,t})$	1.0044	1.004	1.001	1.001
LB(20) $z_{i,t}$	16.68	14.60	12.94	18.02
LB(20) $z^2_{i,t}$	20.22	19.76	12.16	4.12

Table 5.5.B Residual descriptive statistics for the VAR-EGARCH(1,1) model

	Germany	United Kingdom	France	Netherlands
Germany	1.0000	0.633	0.616	0.6187
		(0.0116)*	(0.0118)*	(0.0120)*
United Kingdom		1.0000	0.569	0.447
			(0.0133)*	(0.0162)*
France			1.0000	0.571
				(0.0124)*
Netherlands				1.0000

Table 5.5.C Pairwise Conditional Country Correlations

[64] In the other two countries, UK and the Netherlands the variation is only explained by 0.7% and .14% respectively.

Turning to second moments, it is clear that past innovations, both domestic and foreign, significantly affect current conditional variance – with minor exceptions- and hence translate into conditional variance predictability in terms of past innovations.
As with the restricted model, the volatility transmission mechanism is mostly asymmetric, based on the significant $\alpha_{i,j}$ and δ_j estimated coefficients, in the sense that bad news seems to increase volatility at a higher rate than a positive one of equal magnitude. The effect of the asymmetry will exclusively depend on the sign and magnitude of these coefficients which will either enforce or offset the effect. From the results it is evident that negative innovations in the French and German markets tend to have a lower effect than positive ones in either market. Similar effects are observed in the contribution of UK market innovations on the Netherlands and between the Netherlands and France.

The contributing factor of a negative innovation in market i on the volatility of market j is proportional to $| -\alpha_{i,j} + \alpha_{i,j}\gamma_j |$ whereas a positive innovation will affect the market in $(\alpha_{i,j} + \alpha_{i,j}\gamma_j)$ proportion. A basic illustration of this asymmetry could be derived by measuring the impact of $\pm$ 5% innovation in market i at t-1 on current variance of market j, given that innovations generated at t-1 in other markets have a negligible effect on market's j current variance. The results of this illustration can be found in Table 5.6, which indicates that a -5% (5%) innovation in Germany at time t-1 will actually increase the volatility by 0.2774% (0.2225%) in UK, by 0.0019% (0.0042%) in France, and lastly by 0.1136% (0.0335%) in the Netherlands, at time t.

The main conclusion from this analysis is the fact that there is some asymmetry in the transmission mechanism of volatility shocks between countries. However, a more robust procedure should be used, in addition to this simple measure, to identify the persistence of these shocks, given the existence of a transmission mechanism as depicted in the above table. The following section, actually utilises the process of generating the responses that the individual countries will have to these shocks.

It is useful at this point to compare the coefficients obtained within the restricted model, under the assumption of no coherence between national stock markets and

within the unrestricted model which allows for national market interactions. It is evident that the degree of volatility persistence in the markets, implied by the restricted model, denoted by δ_i is in most occasions higher than that of the unrestricted model. This finding is in line with what *Lastrapes(1989)* claimed to be the cause of high degree of volatility persistence. As a matter of fact he suggested that this might be caused by the omission of certain variables, which in this case are the cross-border effects.

Innovation at t-1 from	% Δ Volatility in Germany at t	% Δ Volatility in UK at t	% Δ Volatility in France at t	% Δ Volatility in Netherlands at t
+5% Germany	0.5730	0.2225	0.0042	0.0335
-5% Germany	0.6660	0.2774	0.0019	0.1136
+5% UK	0.0370	0.4384	0.4081	0.0540
-5% UK	0.0430	0.5706	0.5945	0.0160
+5% France	0.1059	0.2379	0.2287	0.0864
-5% France	0.0911	0.2912	0.5323	0.2936
+5% Netherlands	0.0925	0.3687	0.1784	0.1705
-5% Netherlands	0.1075	0.4514	0.0767	0.5795

Table 5.6 Impact of Innovations on volatility

Finally, the joint significance of the spillover effects in price and variance within the European Union, as illustrated by the sample countries, can be assessed using a likelihood ratio test. Mathematically, this test can be carried out by applying the respective maximum likelihood values of the two models considered in equation(12), L_1 will be the AR(1)-EGARCH model and L_2 the VAR-EGARCH model. The test statistic has the same properties as the one applied in the previous section, the difference being there are 24 restrictions because under AR(1)-EGARCH a 34X1 vector is estimated whereas under the full model, there is a 54X1 vector estimate. The calculations give a statistic of 252.564 which is well above the critical value,thus accepting the hypothesis that there are first and second moment interactions within the European Union Markets.

The results from modelling the dynamic coherence of the major European stock markets reveal that past innovations affect current volatility in the European markets. Estimates of these coefficients reveal a multi-directional relationship between the markets , suggesting a sensitivity to news originating in other markets but no single market acting as the major information producer. Turning to second moment relationships the results are more extensive and reciprocal. The 'volatility surprises' transmission mechanism which carries information from market j onto i is asymmetric, subject to $\alpha_{i,j}$ and γ_i coefficients which determine the asymmetry. This is in line with previous studies such as *Koutmos (1996), Booth,Koutmos (1995)* which both used a similar methodology. On the other hand, they are also in line with studies which use different methodologies but still confirm that there is a ' substantial amount of interdependence among national markets' (*Eun,Shim(1989*), pp 254) by revealing that 'most of the significant impacts appear within blocks of countries in the same geographic region'(*Koch,Koch(1991*), pp245).

A common hypothesis arising from these results is that information from a leading market could form the basis for outperforming the following markets. An empirical evaluation of this hypothesis reveals that past innovations, although statistically significant, have very little economic significance which then vanishes when transaction and other trading related costs are introduced.

Furthermore, the introduction of the heteroscedastic property of stock index returns leads to a reduction in the correlation structure indicating that hedging strategies which ignore the time variation of the covariance structure are likely to be less than optimal.

Overall, this section's results come as confirmation of the empirical perception that European national markets are integrated in the sense that the news generation process is not purely a domestic one.

5.4.2.1 Impulse Response Analysis

Looking at the results from the previous section, it can be concluded that there is an asymmetry in the transmission of shocks between countries. What remains though, is

to establish the persistence that these shocks will have in the original market and in the others. In this framework impulse response functions trace the response of variables to a one period shock in that variable and in every other endogenous variable[65], filtered through the underlying model, thus making it a common tool for investigating the interrelationship among variables.

In an attempt to obtain additional insight into the international transmission mechanism of stock market movements, as presented in Table 5.6, the pattern of direct responses for each of the four markets to shocks originating in one of them, is examined. This is done using the impulse response procedure due to *Sims(1980)*.

Although a lot of literature has been published in this area[66] , its application in the popular class of GARCH models has not been considered up until recently when *Karolyi(1995), Lin(1997)* applied the concept to this family of models. The latter study actually derived the properties of the procedure and concluded that the nonlinearity of the process imposes no complications in the analysis due to the linearity of the conditional variance. Thus the linear specification of the process would be applicable.

Within the framework of the VAR-EGARCH(1,1) model the impulse coefficients can be obtained by adopting a procedure which generates a moving average representation of the form

$$r_t = \sum_{s=0}^{\infty} R_s v_{t-s} \quad (16)$$

where r_t is a linear combination of current and past period forecast errors, which are filtered for time varying conditional heteroscedasticity. The innovations are then orthogonilised using Choleski factorisation which selects a lower triangular matrix to compute new innovations, $v_t=V^{-1}e_t$. In this respect, R_s will represent the response of the ith market in s periods to a shock of a standard error in the jth market.

[65] This does not exclude the possibility of future greater effects on the originally shocked variable mainly because of feedback effects through the other variables.
[66] See for example *Koop(1996), Perasan,Shin(1998)* and references thereafter.

Table 5.A.1, in the appendix at the end of the chapter, provides the impulse responses of the sample markets to a typical shock which originated in either the market itself or a foreign market. To facilitate the interpretation of these results, the time paths of the responses are plotted, together with the confidence bands[67]. The columns display the response each individual market had on the introduction of a shock in one of the sample markets.

It is evident from Figure 5.1 , that there is a persistent effect of shocks on volatility for all countries. It can also be observed that domestic stocks are actually higher on average higher than those originating in another sample country, *Eun,Shim(1989), Karolyi(1995)*, and take longer to be digested by the market.

Although responses indicate, that in almost all cases innovations are transmitted quickly amongst countries and die out through time, those originating in the United Kingdom , show an inverse effect.

Overall, the results suggest that there is a mechanism of volatility shock transmissions, indicating that the predicted future volatility dies out slowly following the introduction of a shock in the series. On the other hand, in view of the findings many shock responses tend to arise in a time period of 1-2 days after the shock and increase through time.

5.4.2.2 The transatlantic transmission mechanism: the case of UK and Japan

In this section, shortrun interdependencies between the two largest stock markets in Europe and Asia, namely UK and Japan are examined. This will be an extension of the previous analysis in the sense that it will try to capture any translantlantic price and volatility spillover effects.

[67] Impulse responses are highly non-linear functions of the estimated parameters, with a huge number of terms. This makes calculating confidence bands by linearisation infeasible. Thus in the context of this study a monte carlo simulation is used to create them, by taking draws for the coefficients and seeing how the response changes.

The methodology used will match that used in the examination of cross border interactions within Europe with certain amendments in the data series used. Given that the two markets comply with weak form efficient market hypothesis in the very least, close-to-close returns are divided into close-to-open and open-to-close compounded returns.

Essentially, effect this separation aims to alleviate the absence of overlapping trading hours between the two markets, which will possibly create a problem in the

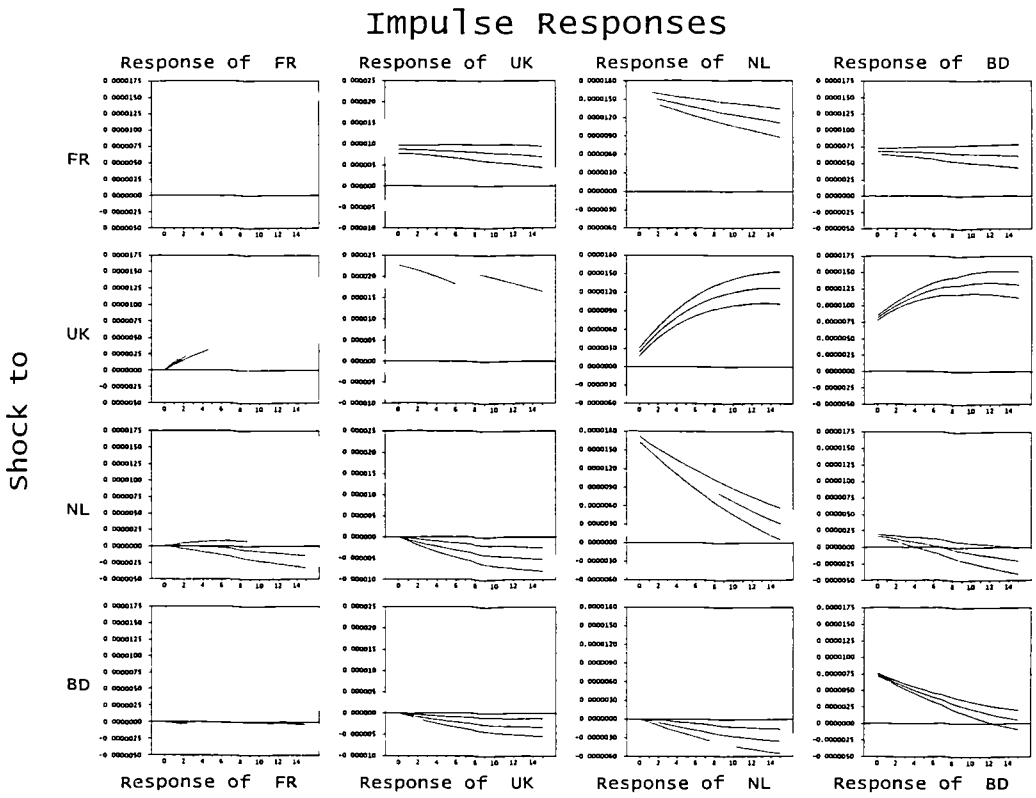


Figure 5.1 Impulse response coefficients for Stock Index returns for European sample countries

information release and update of the markets, since the trading times and more importnatly the time gap between the closing of the one market and opening of the other vary.

Consequently, this section will differ from earlier work in two ways. First through the sample countries used, *Becker,Finnetry,Gupta(1990), King,Wadhani(1990)* and others, and second by the data series used, *Eun,Shim(1989), Koch,Koch(1991)*. These

studies mainly considered Japan and US as their sample countries and used closing price data to examine the relationship of national markets. However, the adoption of such a data set limited these studies from examining the effects of information generated by the active market on the next market to trade, as well as overestimating the relationship between the two markets.

Thus, the empirical tests of this section will give evidence on the extent to which price changes in one market influence the opening price of the next market to trade - price spillovers – and also provide an assessment of any positive correlation in terms of price volatility in the two markets.

At first the benchmark-restricted model, which limits cross border spillovers to be zero, is estimated with results as shown in Table 5.7. Panel A of the table is associated with the close to open returns. Estimations of the $\beta_{i,j}$ coefficients reveal that the UK return series is first order autocorrelated, which according to *Conrad, Kaul (1988)* suggests the presence of time varying expected returns. In addition to this, it seems that the shortrun dynamics of the series are described by conditional heteroscedasticity, as disclosed by the significant $\alpha_{i,j}$ and γ_i coefficients which are the basic components of the conditional variance equation. In this context it seems that within the UK market there is an asymmetric impact of past innovations on current volatility, as shown by the negative significant coefficient of $\gamma_{i.}$. Whereas the Japanese market, although it has a past innovation effect on current volatility, is not asymmetric. As a matter of fact a negative innovation in the UK will increase volatility by approximately 1.27 times where as in the Japanese market volatility will be increased by 0.51 times only.

On the other hand, the results scene changes when the open to close returns, Panel B, are used for the assessment. Both markets seem to have time varying expected returns as shown by the significant AR(1) coefficients , in addition to volatility asymmetry. Interestingly enough taking account for conditional heteroscedasticity has reduced the pairwise correlation coefficient, to 0.187 from 0.2194, suggesting that it is highly possible that conditional heteroscedasticity inflates the estimate. Judging from the δ_i estimates, volatility persistence is high in both cases - almost near unity.

Once more the table includes the diagnostics for standardised residuals. It is clear from the calculated statistics that there is no substantial evidence against the benchmark specification of the model, with the expected properties. It could be argued though , that in certain cases the significance of the LB statistic suggests that there is some dependence in the residuals but this could be blamed on the imposed restriction of zero mean and variance interactions. All the same, the feature of the model which allows for contemporaneous correlation makes it superior to its alternatives.

Panel A: CLOSE-OPEN RETURNS UK-JP AR(1)-EGARCH(1,1)				Panel B: OPEN-CLOSE RETURNS UK-JP AR(1)-EGARCH(1,1)			
United Kingdom		Japan		United Kingdom		Japan	
$\beta_{2,0}$	0.00016	$\beta_{5,0}$	0.0002	$\beta_{2,0}$	-0.0003	$\beta_{5,0}$	0.0008
	(0.000009)		(.00016)		(0.0002)		(.00038)*
$\beta_{2,2}$	-0.06732	$\beta_{5,5}$	0.0346	$\beta_{2,2}$	0.3438	$\beta_{5,5}$	0.399
	(0.0288)*		(0.0253)		(0.0213)*		(0.0220)*
$\alpha_{2,0}$	-0.4672	$\alpha_{5,0}$	-0.352	$\alpha_{2,0}$	-0.2213	$\alpha_{5,0}$	-0.204
	(0.0699)*		(0.0866)*		(0.0745)*		(0.0866)*
$\alpha_{2,2}$	0.2446	$\alpha_{5,5}$	0.124	$\alpha_{2,2}$	0.1769	$\alpha_{5,5}$	0.168
	(0.0136)*		(0.0188)*		(0.0172)*		(0.021)*
γ_2	-0.1192	γ_5	0.332	γ_2	0.1328	γ_5	0.509
	(0.0303)*		(0.098)*		(0.0620)*		(0.089)*
δ_2	0.9542	δ_5	0.9642	δ_2	0.9757	δ_5	0.9740
	(0.00644)*		(0.0087)*		(0.00808)*		(0.0046)*
Statistics for the standardised residuals							
$E(z_{i,t})$	0.0001		0.0116		0.003		-0.013
$E(z^2_{i,t})$	1.0018		1.0012		1.0009		1.002
LB(20) $z_{i,t}$	19.06		23.11*		63*		101.25*
LB(20) $z^2_{i,t}$	8.32		11.54		56.60*		14.78

Table 5.7 AR(1)-EGARCH(1,1) model estimates for United Kingdom and Japan

Moving on, the second leg of the testing methodology requires the estimation of the unrestricted model which accounts for any price and volatility spillover effects across the two markets. Results for this model are presented in Table 5.8 which again is separated into two panels to accommodate estimations using both return series.

Looking at the parameters that build up the conditional mean equation in both markets, it is evident that, using the close-to-open returns, there is no spillover effect

between the markets. In other words information on the last market to trade has no effect on the opening price of the next market to trade. Turning to second moment interdependencies, it can be seen that in the UK the conditional variance, in addition to own past innovations, is affected by innovations generated within the Japanese market. Furthermore, the volatility transmission mechanism is asymmetric in the case of the British market, with a negative innovation affecting the volatility of the market 1.09 times more than a positive one. It is noticeable that the correlation coefficient of the market is lower than the unconditional estimation indicating that conditional heteroscedasticity in conjunction with the introduction of the cross border effects actually increases the potential of diversification between the two markets.

On the contrary, when the open-to-close returns are used the conditional mean return exhibits a bi-directional spillover effect from the last market to trade. A high return in the Japanese market is followed by a lower return in the UK whereas at the same time a high return in the UK is inversely proportionate to a return in the Japanese market. This in contrast with the conditional variance indication which, as with the close-to-open returns, suggests an impact of the British market on the Japanese but with no asymmetric impact. Volatility persistence is at levels close to unity in both markets and the pairwise correlation is again lower than the conditional restricted one, indicating that the introduction of foreign effects in the mean equation reduces the pairwise correlation estimation.

The use of impulse response functions to trace the dynamic effect of a shock introduced in either country on the volatility of the country returns, revealed that, as in *Eun,Shim(1989),* the magnitude of responses to domestic shocks are on average larger than and similar in pattern to those of a foreign shock, for both data series. The cross border effects are mirror reflections between the two series. For instance a shock in the UK, using close-to-open returns, will affect the Japanese market whilst the same shock in the Japanese will not have a significant effect on the British market volatility. The opposite result is given when the open-close returns are used. This indicates that there is a counter-cyclical effect by foreign markets on the volatility of the domestic market which arises mainly from the absence of concurrent trading.

Panel A: CLOSE-OPEN RETURNS UK-JP VAR-EGARCH(1,1)				Panel B: OPEN-CLOSE RETURNS UK-JP VAR-EGARCH(1,1)			
United Kingdom		Japan		United Kingdom		Japan	
$\beta_{2,0}$	0.0002 (.00016)	$\beta_{5,0}$	0.0001 (0.00009)	$\beta_{2,0}$	0.00103 (0.003)*	$\beta_{5,0}$	-0.00027 (0.00022)
$\beta_{2,2}$	0.026 (0.0263)	β_{52}	-0.0206 (0.011)	$\beta_{2,2}$	0.3621 (0.0231)*	$\beta_{5,2}$	-0.0386 (0.0123)*
$\beta_{2,5}$	-0.0054 (0.0380)	$\beta_{5,5}$	-0.0822 (0.0304)*	$\beta_{2,5}$	0.2493 (0.0354)*	$\beta_{5,2}$	0.3801 (0.022)*
$\alpha_{2,0}$	-0.3499 (0.093)*	$\alpha_{5,0}$	-0.379 (0.0601)*	$\alpha_{2,0}$	-0.225 (0.0433)*	$\alpha_{5,0}$	-0.1731 (0.0638)*
$\alpha_{2,2}$	0.1261 (0.0194)*	$\alpha_{5,5}$	0.2373 (0.0121)*	$\alpha_{2,2}$	0.1768 (0.0227)*	$\alpha_{5,5}$	0.1343 (0.0194)*
$\alpha_{2,5}$	0.03425 (0.0185)	$\alpha_{5,2}$	-0.0736 (0.0113)*	$\alpha_{2,5}$	0.033 (0.0203)	$\alpha_{5,2}$	0.0593 (0.01503)*
γ_2	0.1699 (0.0793)*	γ_5	-0.04606 (0.0348)	γ_2	0.5059 (0.0895)*	γ_5	0.1849 (0.086)*
δ_2	0.9639 (0.0093)*	δ_5	0.9626 (0.0055)*	δ_2	0.971 (0.005)*	δ_5	0.98 (0.0069)*
$\rho_{2,5}$	.1195 (0.0248)*			$\rho_{2,5}$	0.1826 (0.0229)*		
Statistics for the standardised residuals							
$E(z_{i,t})$	0.004		0.0157.		-0.00264		-0.0144
$E(z^2_{i,t})$	1.00013		1.00016		1.0001		1.0018
LB(20) $z_{i,t}$	16.85		24.71		58.68*		96.51*
LB(20) $z^2_{i,t}$	9.64		11.53		42.89*		14.26

Table 5.8 VAR-EGARCH(1,1) model estimates for United Kingdom and Japan

Lastly, a simple test to evaluate the significance of these spillover effects is performed. Taking into consideration the appropriate likelihood values of both the unrestricted and restricted models and using both return series, it is evident that under all scenarios the spillover effects are statistically significant. In the case of using close-to-open returns their calculated statistic is equal to 14.2 with 4 degrees of freedom, the calculated statistic using the open-to-close returns is 71.59.

In this section the importance of any relationship in terms of exploiting the national market and earning abnormal returns is more prominent. This stems from the fact that there are no concurrent trading hours in the two markets and there is a possibility

that traders and analysts in the next market to trade may use information from the previous market and so exploit their security market in any trading day[68].

In order to evaluate this possibility, the uncentered R^2 is calculated for both countries. The formula is the one used previously which reveals that under close-to-open returns only 2.6% and 0.7% of the returns, for the UK and Japan respectively, could be explained using past innovations. Furthermore, using the alternative data series, UK and Japanese returns could only be explained by 12.75% and 19.02%. The implications of this finding are twofold. At first information in either market, embodied in the close-to-open returns has very little economic significance, especially for the case of Japan, implying that it is not worth using Japanese information to outperform the British market. Furthermore, the introduction of transaction costs, exchange risk, and taxes will actually eliminate the profits and predictive ability of the filters, hence the markets are weak form efficient, in the very least.

These empirical results reveal an intraday relationship, mainly because of the differential trading hours between the two markets. These are similar to the results of an earlier study by *Hamao, Masulis, Ng (1990)*, which claims 'the existence of price changes and volatility effects from one market to the next'(pp 306).

Specifically, in terms of price spillovers, unexpected changes in the foreign market have significant spillover effects on the other market's conditional mean equation, when open-to-close returns are used. Also these results, as in *Booth,Koutmos (1995)*, document significant volatility spillover effects from Tokyo to London of an asymmetric pattern, when close-to-open returns are used. These results actually suggest that the UK market is informationally sensitive to the Japanese market, especially when news is adverse. This could be explained by the fact that the Japanese market is trading before the British and therefore any relevant information is transmitted overnight.

[68] Such an event will constitute a violation of the EMH which predicts that information about the trading activity in the market should be fully reflected in the opening price of the other, assuming that the markets are financially integrated.

5.5 Conclusions

The econometric tests of this empirical chapter can be separated into two phases. First, tests were carried out in search of a model which will empirically represent the individual stock indices for the main European stock markets as well as for the Japanese. Results indicated that it is conditional heteroscedasticity which primarily describes daily returns in the sample markets, along with the fact that the series exhibit non-linear dependencies. However, existing linear models , such as the random walk model, are incapable of capturing these non-normal innovations.

This called for the development and use of an alternative process which is an approximation of the second moment non-linear process. Different forms of the ARCH family of models, as originally proposed by *Engle(1982)* and later extended *(Bollerslev(1986), Nelson(1991)),* have been estimated in an attempt to proxy second order non-linear processes in the series. Results have suggested that the exponential GARCH actually models the empirical regularities of the European and Japanese stock market indices best.

Second, the univariate EGARCH model, which was found to be the best fit model has been extended to a multivariate form as proposed by *Koutmos(1996)* in an attempt to model the joint distribution of stock returns for the sample countries.

The rationale behind this empirical testing is the growing economic interdependence amongst countries and the broad awareness of the advantages which internationally diversified portfolios offer. Earlier studies which mostly used mostly other markets, have given mixed empirical results suggesting that a minimal to very weak correlation exists between national stock markets. This would mean that stock prices in one country are essentially unaffected by stock price movements in another.

In contrast to these findings, this study led to different results, based on the application of the VAR-EGARCH model. First, it has suggested that within Europe there are multi-directional relationships between the markets, suggesting a sensitivity

of markets to news originating in another market but no single market acting as the main producer of information. Furthermore, it provided significant and reciprocal results, of coherence in terms of volatility. The 'volatility surprises' transmission mechanism which carries information from market j onto i is asymmetric, subject to $\alpha_{i,j}$ and γ_i coefficients which determine the asymmetry and persistence. The identification of this persistence has revealed, as in previous studies, that locally generated shocks are actually more persistent that those originating in other markets. Furthermore, an analysis of the response of the individual country's variance to shocks originating in the other sample markets suggested that innovations are quickly transmitted amongst countries but with information absorption occurring at different rates.

These results provide evidence of the existence of possible exploitable profit opportunities, stemming from the awareness of price developments in other countries. An empirical evaluation of this hypothesis actually suggested that past innovations, although statistically significant, have very little economic significance and even vanishes when transaction and other trading related costs are introduced.

Furthermore, the introduction of the heteroscedastic property of stock index returns led to a reduction in the correlation structure this indicating that hedging and diversification strategies that ignoring the time variation of the covariance structure are likely to be less than optimal.

An application of the model to capture shortrun interdependencies between the two largest stock markets in Europe and Asia, revealed an intraday relationship between the two , mainly because of the differential trading hours. In terms of price spillovers, unexpected changes in the foreign market have significant spillover effects on the other market's conditional mean equation when open-to-close returns are used. Also, these results document significant volatility spillover effects from Tokyo to London in an asymmetric pattern when close-to-open returns are used. In line with to the main study results, they confirmed that the failure to account for major factors, such as heteroscedasticity, creates biased estimations, see *Lastrapes(1989),* in this case an

inflated correlation structure which reduces the potentials of transatlantic portfolio diversification.

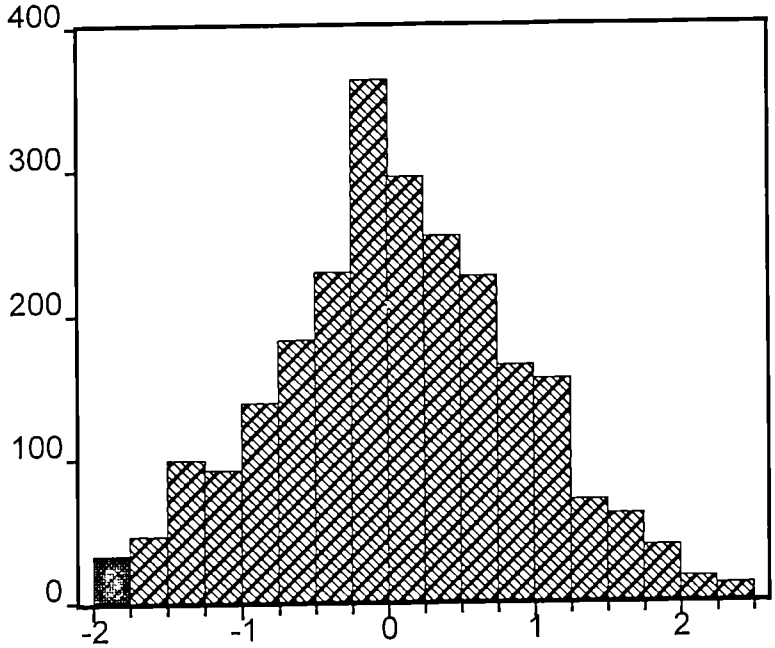
In general the empirical representation of the return series using the univariate EGARCH model is of prime importance because it confirms that this class of models can be successfully used to model both large and small capitalisation markets.

Overall, these results come as confirmation of the empirical perception that European national markets are integrated in the sense that the news generation process is not purely a domestic one. They are also in line with previous studies such as *Koutmos(1996), Booth,Koutmos(1995)* ,which use a similar methodology. On the other hand, the results share similarities with previous studies which used different methodologies, thus confirming that there is a ' substantial amount of interdependence among national markets'*(Eun,Shim(1989*), pp 254) by revealing that 'most of the significant impacts appear within blocks of countries in the same geographic region' (*Koch,Koch(1991*), pp 245).

Within the transatlantic context, findings are similar to those of an earlier study by *Hamao, Masulis, Ng (1990)* who claim 'the existence of price changes and volatility effects from one market to the next'(pp 306). It is actually suggested in the results of the last section of empirical tests that the UK market is informationally sensitive to the Japanese market, especially when news is adverse. This could be explained by the fact that the Japanese market is trading before the British market and any relevant information is transmitted overnight.

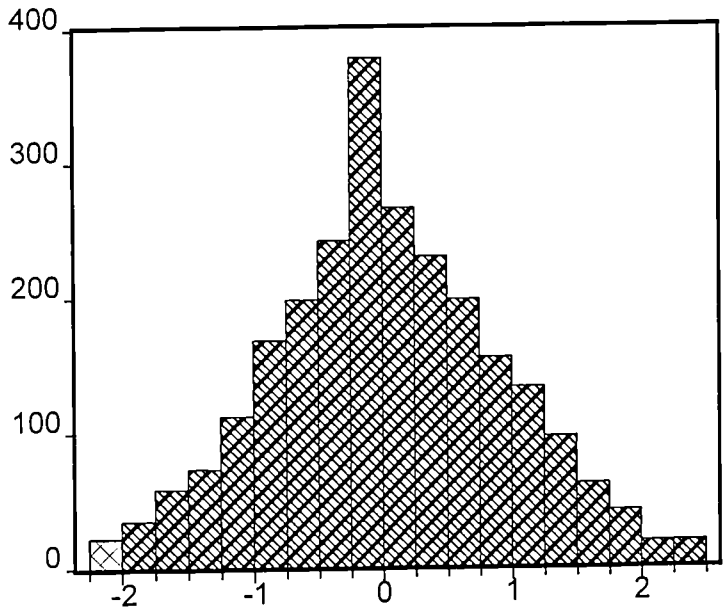
APPENDIX A

1. Density functions for the residuals



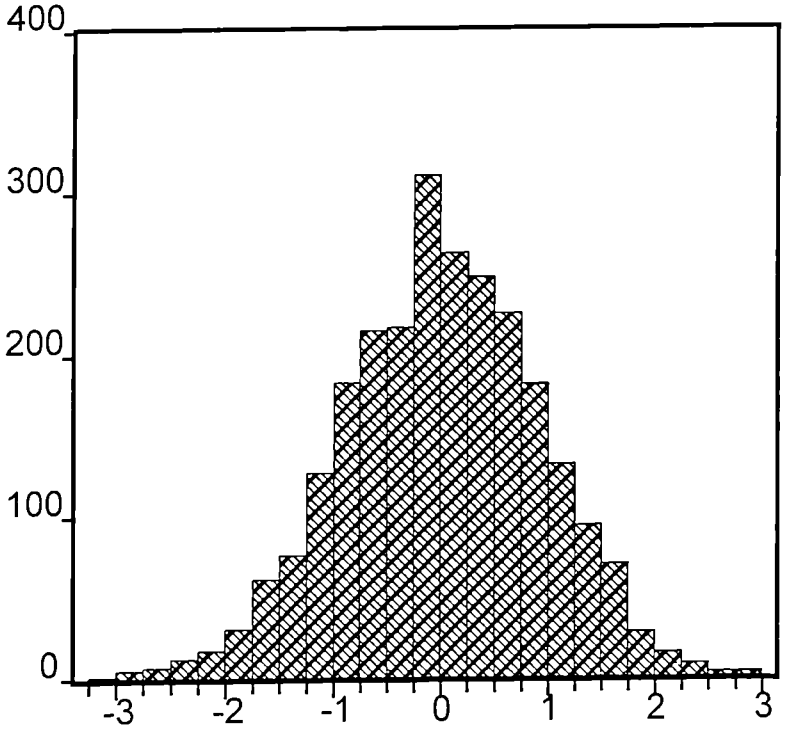
Series: STDBD
Sample 1 2556
Observations 2556

Mean	0.073399
Median	0.046329
Maximum	2.488374
Minimum	-1.991430
Std. Dev.	0.837743
Skewness	0.039448
Kurtosis	2.820074
Jarque-Bera	3.972375
Probability	0.137218



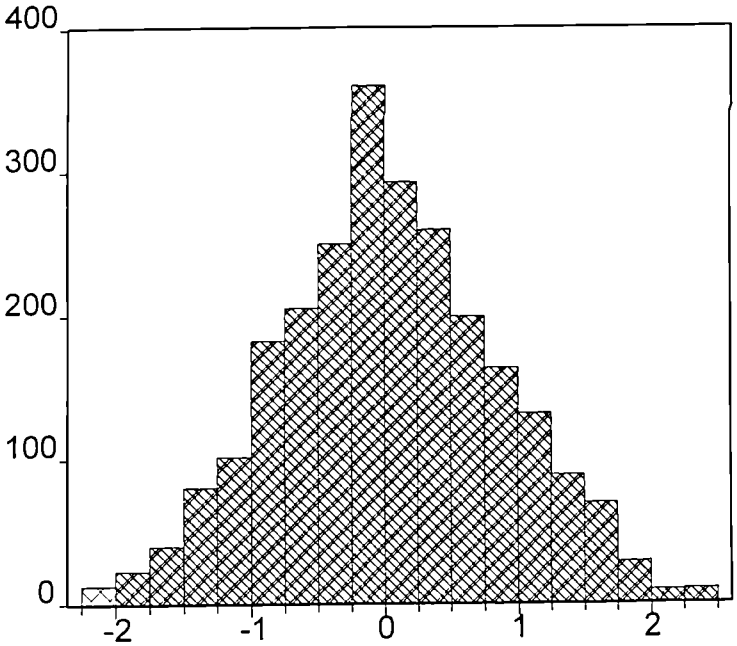
Series: STDFR
Sample 1 2556
Observations 2556

Mean	0.035516
Median	-0.017360
Maximum	2.497986
Minimum	-2.199560
Std. Dev.	0.885009
Skewness	0.080441
Kurtosis	2.835672
Jarque-Bera	5.513438
Probability	0.063500



Series: STDUK
Sample 1 2556
Observations 2556

Mean	0.009500
Median	0.001863
Maximum	2.834855
Minimum	-3.060460
Std. Dev.	0.914135
Skewness	-0.110483
Kurtosis	2.970199
Jarque-Bera	5.248935
Probability	0.072478



Series: STDNL
Sample 1 2556
Observations 2556

Mean	0.041993
Median	-0.003580
Maximum	2.462745
Minimum	-2.180340
Std. Dev.	0.825487
Skewness	0.068520
Kurtosis	2.805917
Jarque-Bera	5.877640
Probability	0.052928

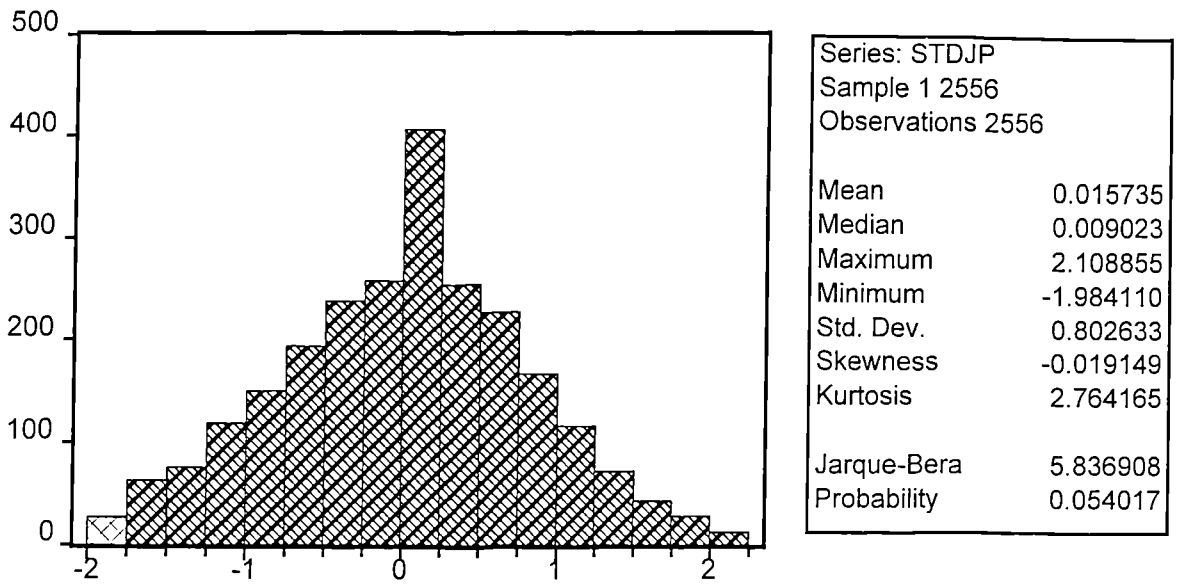


Figure 5.A.1 Distribution of the Conditional Residuals

2. Variance decomposition of the sample countries to impulses

Panel A: Responses to a Shock in the UK				
	Impulse response in			
Day after shock	France	United kingdom	Netherlands	Germany
1	0	4.56E-06	-1.6E-07	1.87E-07
2	1.49E-07	3.06E-06	1.51E-06	-3.07E-07
3	-4.3E-07	2.06E-06	2.03E-06	-3.58E-07
4	-8E-07	9.29E-08	1.79E-06	-4.84E-07
5	-1E-06	-1.4E-06	8.17E-07	-4.69E-07
6	-9.3E-07	-2.2E-06	-4E-07	-3.74E-07
7	-6.3E-07	-1.8E-06	-1.4E-06	-2.22E-07
8	-2.4E-07	-7E-07	-1.7E-06	-7.85E-08
9	1.02E-07	7.26E-07	-1.4E-06	8.51E-09
10	2.61E-07	1.84E-06	-5.9E-07	1.42E-08

Panel B: Responses to a Shock in the France				
	Impulse response in			
Day after shock	France	United kingdom	Netherlands	Germany
1	5.79E-06	-7.6E-08	9.42E-08	1.72E-06
2	3.89E-06	4.8E-06	2.25E-06	2.36E-06
3	3.23E-06	1.99E-06	4.67E-06	1.54E-06
4	1.94E-06	-1.1E-06	4.88E-06	1.22E-06
5	1.1E-06	-4.8E-06	3.46E-06	9.64E-07
6	7.65E-07	-7.1E-06	9.47E-07	9.69E-07
7	1.02E-06	-7.3E-06	-1.5E-06	1.13E-06
8	1.63E-06	-5.4E-06	-3E-06	1.35E-06
9	2.29E-06	-2.4E-06	-3.1E-06	1.5E-06
10	2.69E-06	6.2E-07	-1.8E-06	1.5E-06

Panel C: Responses to a Shock in the Germany

	Impulse response in			
Day after shock	France	United kingdom	Netherlands	Germany
1	0	0	0	1.61E-06
2	1.31E-06	-4.1E-06	1.47E-07	5.62E-07
3	1.02E-06	-2.5E-06	-8.2E-07	9.26E-07
4	1.33E-06	-1.9E-06	-9.3E-07	8.64E-07
5	1.43E-06	-7E-07	-6.8E-07	8.9E-07
6	1.45E-06	7.61E-08	-8E-08	8.23E-07
7	1.31E-06	3.61E-07	5.69E-07	7.23E-07
8	1.07E-06	6.64E-08	1.01E-06	6.03E-07
9	7.98E-07	-6E-07	1.08E-06	5E-07
10	5.91E-07	-1.3E-06	7.94E-07	4.35E-07

Panel D: Responses to a Shock in the Netherlands

	Impulse response in			
Day after shock	France	United kingdom	Netherlands	Germany
1	0	0	2.81E-06	5.18E-07
2	-5.07E-09	-3.6E-06	1.79E-06	1.01E-07
3	-1.70E-07	-4.4E-06	-1.4E-07	2.82E-07
4	2.03E-07	-4.2E-06	-1.7E-06	4.17E-07
5	7.04E-07	-2.5E-06	-2.4E-06	6E-07
6	1.17E-06	-2.8E-07	-2E-06	6.96E-07
7	1.38E-06	1.56E-06	-8.8E-07	6.79E-07
8	1.27E-06	2.38E-06	5.51E-07	5.52E-07
9	9.02E-07	1.97E-06	1.68E-06	3.66E-07
10	4.23E-07	6.11E-07	2.08E-06	1.91E-07

Table 5.A.1 Impulses resulting from the introduction of a shock[69]

3. Impulse response variance decomposition and plots for United Kingdom and Japan

Table 5.A.2 Impulses resulting from the introduction of a shock[70]: The case of United Kingdom and Japan

	Responses to a shock in the United kingdom		Responses to a shock in Japan	
Close-open returns				
Day after shock	United Kingdom	Japan	United Kingdom	Japan
1	5.20E-06	0	-1.14E-07	2.94E-06
2	2.04E-06	-8.83E-07	4.60E-07	1.33E-06
3	6.49E-07	-7.40E-07	4.09E-07	5.15E-07
4	1.27E-07	-4.41E-07	2.49E-07	1.60E-07
5	-2.59E-08	-2.18E-07	1.26E-07	2.92E-08
6	-4.77E-08	-9.30E-08	5.43E-08	-8.28E-09
7	-3.47E-08	-3.34E-08	1.99E-08	-1.29E-08
8	-1.94E-08	-9.01E-09	5.58E-09	-9.14E-09
9	-9.16E-09	-7.28E-10	6.19E-10	-5.03E-09
10	-3.72E-09	1.23E-09	-6.23E-10	-2.35E-09

[69] The entries on the table represent the normalised impulse response of the column market on the row day to a unit shock in each of the markets, represented by the different panels.
[70] The entries on the table represent the normalised impulse response of the column market on the row day to a unit shock in each of the markets, represented by the different panels.

Open-close returns				
1	1.67E-05	0	8.5E-06	0.000136
2	1.19E-05	2.64E-05	6.57E-06	0.000119
3	8.54E-06	3.92E-05	5.13E-06	0.000103
4	6.23E-06	4.39E-05	4.04E-06	8.77E-05
5	4.6E-06	4.39E-05	3.21E-06	7.44E-05
6	3.44E-06	4.13E-05	2.57E-06	6.27E-05
7	2.61E-06	3.75E-05	2.07E-06	5.27E-05
8	2E-06	3.32E-05	1.67E-06	4.41E-05
9	1.55E-06	2.89E-05	1.36E-06	3.68E-05
10	1.21E-06	2.48E-05	1.11E-06	3.07E-05

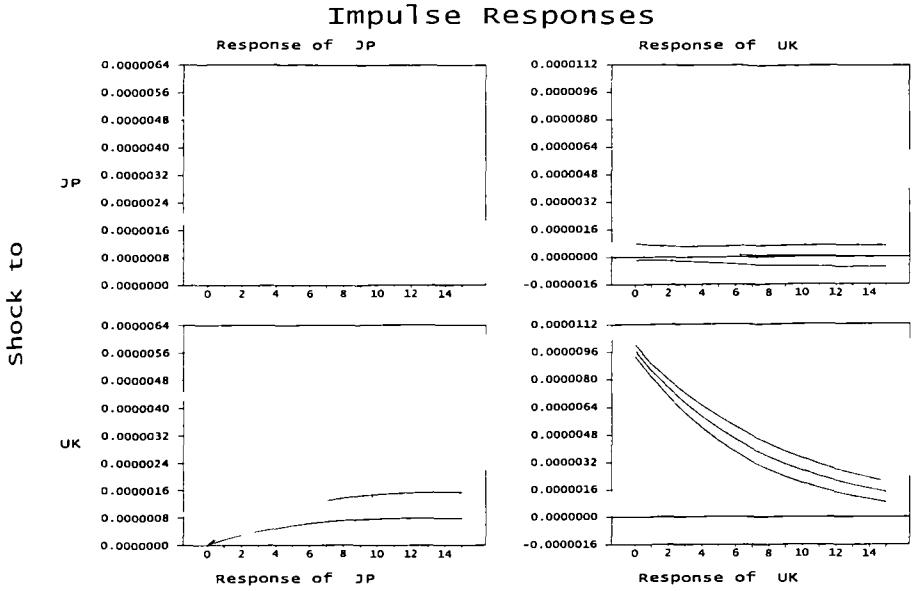


Figure 5.A.1 Impulse response coefficients for United Kingdom and Japan for close to open

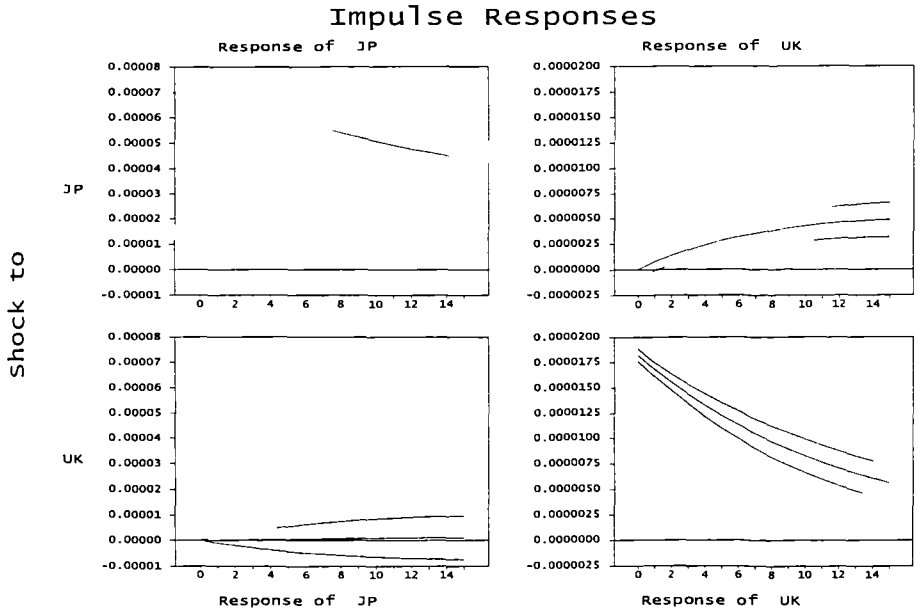


Figure 5.A.2 Impulse response coefficients for United Kingdom and Japan for open to close returns

Chapter 6

Conclusions, Implications and Further Research

This thesis has attempted to empirically verify the theoretical questions which have been set at the beginning of this study. On these grounds, a group of European countries were selected to form the sample upon which the relevant econometric tests were carried out.

At first an attempt to establish the presence of a unified European equity market was made in the context of chapter three. In this chapter we developed a formal model of international asset pricing, different from almost all earlier work, based on earlier suggestions and the current status of the financial markets. The difference, or rather the uniqueness, of the model lies in the fact that it allowed for an unequal access assumption, following the understanding that certain restrictions were still in place in countries around the world.

The empirical evaluation of the model revealed that the environment upon which it is built is viable and that it provides an adequate measurement of the current status of the equity markets. Moreover, the most striking feature of the application results is the fact that they are consistent and similar under both scenarios of portfolio formation, suggesting the presence of mildly integrated European markets. These are somewhat contrary to the inconclusive evidence provided by earlier studies, such as *Solnik(1974a), Stulz(1981)Wheatley(1988),* , with respect to the capital market structure and hence provides evidence which favours the presence of the non-polar formation.

Although the introduction of this modelling technique, which explicitly takes account of the presence of an imperfection, has successfully corrected for the earlier studies caveat , we had to face some further problems, cited in previous work. In general earlier work suggested that the single factor model is rather inappropriate within this

framework, in addition to the importance of time variation in the moments. The latter is prominent in this sort of study given the rapid reforms in institutions and market structures around the world.

Following these, we have introduced a multifactor model in the APT framework, which could, by measuring the deviations from the law of one price, appraise the level of integration in the sample markets. Results from the application of this model, in a time varying environment, indicated that for the sample countries the pricing error, that is the level of segmentation, is at low levels suggesting that these countries are sharing common risk factors in the determination of their asset prices and hence markets are moving towards complete integration.

The use of two competing techniques in the empirical tests of this chapter have proven the robustness of our results because both of them converged on the fact that mispricing has reduced over time. Comparing these with an earlier study by *Korajczyk(1996)*, which shares methodological and sample similarities, it is clear that they are consistent and in line with expectations.

In brief both of these empirical chapters have successfully addressed and verified the question of whether or not the sample markets are integrated, and concluded that markets are mildly segmented and that the level of integration is time varying.

However, as in almost all of the earlier work in this area, the approaches undertaken have indicated only which portion of the variation in portfolio returns command a risk premium, leaving unanswered a more important empirical question which is related to the source of segmentation.

In this respect given the possible causes of segmentation - either the presence of official controls or the individuals attitudes and irrationality - a test has been developed to investigate this question empirically and thus identify the main source of segmentation. Given though that it is widely accepted in financial theory, that the identification and quantification of the individual attitudes is a rather difficult task to execute, we are left with assessing solely the effect of the official barriers.

Taking each country in the sample and analysing its position in terms of controls, on an annual basis, we confirmed that the relaxation of controls increases the level of integration. This has also been the conclusion of earlier studies by *Bonser-Neal,Braumeret al (1990), Levine,Zervos (1995,1996),* who explored the effects of liberalisation of capital controls and showed, that their sample countries enjoyed improved functioning following the liberalisation of controls.

These results imply that because markets are not completely integrated there is a possibility that certain arbitrage opportunities may arise. Under these circumstances, we have set up a framework to address and examine, the two final issues, that is the identification and quantification of the information transmission mechanism in the sample countries.

The empirical implementation of this question included a two-stage estimation process. First the individual country returns were modelled on the basis of the empirical features of their series. Given the indications of the first stage, which suggest that the main underlying feature of daily returns is conditional heteroscedasticity in addition to the presence of some non-linear dependencies, we moved onto the second phase of the implementation. At this stage, in search of the transmission mechanism the model used in the first part was extended to a multivariate form to encompass the possible interactions, if any, between markets. In contrast to earlier work, the application of this model led to different results. They have in fact demonstrated that there are multi-directional relationships between the markets, translating into a sensitivity of markets to news originating in another market but with no major information producer. Furthermore significant coherence was evident in terms of volatility, results of which were more extensive and reciprocal. The 'volatility surprises' transmission mechanism which carries information from one market to the other proved to be asymmetric at different degrees. This also revealed, as in previous studies, that locally generated shocks are actually more persistent that those originating in other markets.

These results provide evidence of the existence of possible exploitable profit opportunities, stemming from the awareness of price developments in other countries. An empirical evaluation of this hypothesis suggested that for past

innovations, although they are statistically significant, their economic significance is very little and vanishes when transaction and other trading related costs are introduced.

Overall, these results are a confirmation of the empirical perception that European national markets are integrated in the sense that the news generation process is not a purely domestic one. Additionally, they are in line with previous studies such as *Koutmos(1996), Booth,Koutmos(1995)* who used similar methodology. On the other hand, results share similarities with previous studies that used different methodologies and still confirm that there is a ' substantial amount of interdependence among national markets'*(Eun,Shim(1989)*,pp 254) by revealing that 'most of the significant impacts appear within blocks of countries in the same geographic region' (*Koch,Koch(1991*), pp 245).

At this stage, after identifying the behaviour of the European markets and based on the rationale that European markets are not isolated from the rest of the world , the same tests were carried out by introducing the Japanese market which is thought to be an advanced economy as well as being a main centre to which capital flows.

An application of the model to capture short-run interdependencies between the two largest stock markets in Europe and Asia revealed an intra-day relationship between the two , with the unexpected changes in the foreign market having significant spillover effects on the other market.

Similar to the main chapter results, it is confirmed that failure to account for the major empirical characteristics of returns, such as heteroscedasticity, creates biased estimations, see *Lastrapes(1989),* which reduce the potential for transatlantic portfolio diversification. These findings are similar to those of an earlier study which also claimed 'the existence of price changes and volatility effects from one market to the next' (*Hamao, Masulis, Ng (1990), p 306)*. It is suggested from these results, that the UK market is informationally sensitive to the Japanese market, especially when news is adverse. This could be explained by the fact that the Japanese market is trading before the British market and any relevant information is transmitted overnight.

In conclusion, it could be argued that over the years the internationalisation process led to increased substitution of domestic and foreign assets and brought about increased interdependence of financial markets. Unrestrained , this process will lead to what would essentially be a single European market, accessible to all individual nations.

In theory this is achievable by removing all restrictions on offshore transactions and by introducing centralised institutions. Recent developments in Europe, the creation of the European Central Bank and subsequently the introduction of the Euro have in practice taken the process one step further. However, the day when investors will have no incentive to look outside their domestic market to take advantage of the risk return opportunities is not yet here and it may indeed never arrive, but markets are alert and ready to adapt to any moves that facilitate internationalisation.

Hand in hand with the technology, the innovations occurring in the financial markets lead to a situation whereby all participants treat the whole of Europe and to an extent the world, as their market place. Consequently, these results have rather important implications for the global pricing of securities, hedging and other trading strategies, in addition to the regulatory policies within these countries.

If we accept the viability of the cross-market short-term dependencies in security returns, then we need to assess the impact of these spillovers on the degree of integration or segmentation in the pricing the securities within the European context. In this respect future research needs to evaluate how sensitive conclusions are about the extent of integration within these markets, in the context of models that allow for the dynamics uncovered in this thesis.

In terms of hedging and other trading strategies, given the understanding of the short-term dynamics of the markets, we can examine the viability of cross-hedging trading strategies using derivative contracts in one market for traders with exposure in another market.

Finally, measuring the degree of integration has implications beyond explaining why returns across countries do differ. In the regulatory framework , these results may provide useful guidelines for regulatory policies in the individual countries' securities industry. Furthermore, this could also be related to the stage of financial market development and consequently to economic growth.

Moreover, following the recent major developments in the European context and the introduction of the single currency, the questions set in this thesis should be re-visited and be re-examined in the light of these changes.

Chapter 7

References and Bibliography

1. Aagmon T. (1970), ' The relations among equity markets: A study of share price co-movement in the United States, United Kingdom, Germany and Japan', *Journal of Finance,* Vol. 27,pp 839-855
2. Abeysekera S., A. Mahajan(1990), 'International Arbitrage Pricing Theory: An Empirical Investigation', *Southern Economic Journal,* pp 760-773
3. Adler M., B. Dumas(1983), ' International portfolio choice and corporation finance : A synthesis', *Journal of Finance*, Vol. 38 , Iss. 3, pp 925-984
4. Adler M., R. Horesh (1974),' The Relationship among Equity Markets : Comment, *Journal of Finance*, Vol. 29, Iss 4, pp1311-1317
5. Aggarwal R., Y. Park (1994), ' The relationship between daily and US and Japanese equity prices : Evidence from spot versus futures markets', *Journal of Banking and Finance,* Vol. 18 , pp 757-773
6. Akaike, H. (1976), 'Canonical correlations analysis of time series and the use of an information criterion', *Advances and Case Studies in System Identification, ed. R. Mechra and D.G.Lianiotis* , New York: Academic Press.
7. Akgiray V. (1989), ' Conditional Heteroscedasticity in time series of stock returns : Evidence and Forecasts', *Journal of Business*, Vol. 62, Iss 1, pp 55-80
8. Alford A., W. Folks (1996), ' A test of increased capital market integration' , The Financial Review, Vol. 31, Iss 1,pp 1-23
9. Baba Y, Engle R., Kraft D., K. Kroner (1989), ' Multivariate Simultaneous Generalised ARCH', Working Paper, University of California at San Diego
10. Baillie R., R. De Gennaro (1990), ' Stock Returns and Volatility', *Journal of Financial and Quantitative Analysis,* Vol. 25, Iss 2, pp 203-214
11. Basak S. (1996), 'An intertemporal Model of International Capital market Segmentation', *Journal of Financial and Quantitative Analysis,* Vol. 31, Iss 2, pp. 161-188
12. Becker K, J. Finnetry, M. Gupta(1990), 'The Intertemporal Relation between the US and the Japanese Markets', *Journal of Finance,* Vol. 45 , Iss 4, pp 1297-1306

13. Bekaert G, C. Harvey (1995), 'Time varying world market integration', *Journal of Finance*, Vol. 50, Iss 2,pp 403-444
14. Bekaert G(1995)., "Market integration and investment barriers in emerging equity markets", *The World Bank Economic Review*, Vol.. 9, Iss. 1, pp 75-107
15. Bera A., M. Higgins(1993),'ARCH models: Properties, Estimation and Testing', *Journal of Economic Surveys*, Vol. 7, Iss 4, pp 305-362
16. Black F. (1976), 'Studies of Stock market Volatility changes', *Proceedings of the American Statistical Association, Business and Economics Studies Section,* pp 177-181
17. Black F (1974), "International Capital Market equilibrium, with investment barriers", *Journal of Financial Economics*, Iss 1,
18. Blattberg R., N. Gonedes(1974), 'A comparison of the Stable and Student distribution as statistical models for stock prices, *Journal of Business*, Vol.. 47, pp. 244-280
19. Bodurtha J., D. Cho, L Senbet (1989), ' Economic forces and the stock market : An international perspective', *Global Finance Journal*, Vol. 1, pp 21-46
20. Bolerslev T, R. Chou, K. Kroner (1992), ' ARCH modelling in finance : A review of theory and empirical evidence' , *Journal of Econometrics*, Vol. 52, pp. 5-59
21. Bollerslev T. (1990), 'Modelling the coherence in short-run nominal exchange rates : A multivariate generalised ARCH model', *Review of Economics and Statistics, Vol. 72*, pp 498-505
22. Bollerslev T.(1986), 'Generalized autoregressive conditional heteroscedasticity', *Journal of Econometrics*, Vol. 31,pp 307-328
23. Bonser Neal C. , G. Brauer, R. Neal, S. Wheatley (1990), ' International investment restrictions and closed end country funds prices', *Journal of Finance,* Vol.. 45, Iss 2, pp 523-547
24. Bookstaber R., J. McDonald (1987), ' A general Distribution for Describing Security Price Returns', *Journal of Business*, Vol.. 60, Iss.3, pp 401-424
25. Booth G, G. Koutmos (1995), 'Asymmetric volatility Transmission in international stock markets', *Journal of International Money and Finance,* Vol. 14, Iss 6, pp 747-762
26. Booth G, T. Matikainnen, I. Virtnanen, P Yli-Olli (1993), 'On the existence of common factors in the Arbitrage pricing model: international evidence from US

and the Scandinavian stock markets', *Applied Financial Economics,* Vol. 3, pp.189-200

27. Booth G., J. Hatem, P. Ylli-Olli (1992),'Stochastic model of the security returns: Evidence form the Helsinki Stock Exchange', *European Journal of Operational Research*, Vol. 56, pp 98-106
28. Bowden R., D. Turkington, *Instrumental Variables*, Cambridge University Press, USA, 1984.
29. Brendt E., B. Hall, R. Hall, J. Hausmann (1974), 'Estimation and inference in Nonlinear structure models', *Annals of Economics and Social Measurement*, Vol. 3, pp 653-665
30. Breusch T., S. Pagan (1979), ' A simple test for heteroscedasticity and, and random coefficient variation', *Econmetrica,* Vol.. 49, pp 1057-1072
31. Buckberg E. (1995), 'Emerging Stock markets and international asset Pricing', *The World Bank Economic Review*, Vol. 9, Iss 1, pp 51-74
32. Burmeister E. M McElroy (1988), ' Joint estimation of factor sensitivities and risk premia for the Arbitrage Pricing Theory', *Journal of Finance*, Vol. 43, pp 721-735
33. Campbell J. , Y. Hamao(1992), 'Predictable stock Returns in the United States and Japan : A study of long-term Capital Market Integration', *Journal of Finance,* Vol. 46 , Iss 1, pp 43-69
34. Chen , R. Roll, S. Ross (1986), ' Economic forces and the stock market', *Journal of Business,* Vol. 59, Iss. 3, pp 383-403
35. Chernoff H.(1954), 'On the distributions of the Likelihood Ratio', *Annals of Mathematical Statistics,* Vol. 25, pp 573-578
36. Cho C., C. Eun, L. Senbet (1986), 'International arbitrage pricing theory: An empirical investigation', *Journal of Finance*, Vol. 41, Iss.2, 313-329
37. Choudhry T (1995), 'Integrated-GARCH and non-stationary variances: Evidence from European stock markets during the 1920s and 1930s', *Economics Letters,* Vol. 48, pp 55-59
38. Christie A.(1982), 'The Stochastic behaviour of common stock variance : Vol., Leverage and Interest rate effects', *Journal of Financial Economics,* Vol. 10, pp 407-432
39. Clark P. (1973), 'A subordinate stochastic process model with finite variance for speculative prices', *Econometrica*, Vol. 41 , pp. 133-155

40. Connor G., R. Korajczyk (1986), ' Performance measurement with arbitrage pricing theory , a new framework of analysis', *Journal of Financial Economics*, Vol. 15, pp 373-394
41. Connor G., R. Korajczyk (1988), ' Risk and return an equilibrium APT, Application of a new methodology', *Journal of Financial Economics*, Vol. 21, pp 255-289
42. Conrad J., G. Kaul (1988),' Time Variation in Expected Returns', *Journal of Business,* Vol. 61, pp. 409-425
43. Corhay A, Rad A. (1994), 'Statistical properties of daily returns : Evidence from European Stock Markets', *Journal of Business Finance and Accounting,* Vol. 21, Iss 2, pp 271-282
44. Cumby R, J. Glen (1990), ' Evaluating the performance of international mutual funds, *Journal of Finance*, Vol. 45 , Iss 2, pp 497-521
45. Cutler D., J. Poterba, L. Summers (1991), 'Speculative dynamics', *Review of Economic Studies,* Vol. 58, Iss 3., pp 529-546
46. Diebold F.(1988), 'Testing for Serial Correlation in the presence of ARCH', *Proceedings from the American Statistical Association*, pp323-328
47. Dumas B., Solnik B. (1995), 'The World Price of foreign exchange risk', *Journal of Finance*, Vol. 50, Iss.2, pp 445-479
48. Engle R, D. Lillien, R. Robins (1987), 'Estimating time varying risk premia in the term structure : The ARCH-M model, *Econometrica,* Vol. 55, pp 391-407
49. Engle R, R. Sumsel (1994), 'Hourly volatility spillovers between international equity markets', *Journal of International Money and Finance*, Vol. 13, pp 3-25
50. Engle R (1982), ' Autoregressive conditional heteroscedasticity with estimates of the variance of UK inflation, *Econometrica*, Vol. 50, pp 987-1008
51. Engle R (1990), 'Discussion: Stock Volatility and the crash of '87', *The Review of Financial Studies,* Vol. 3, Iss 1, pp 103-106
52. Engle R., *ARCH: Selected readings,* Oxford University Press, Oxford, 1995
53. Engle R.,W. Lin, T. Ito(1994), 'Do bulls and Bears move across boarders? International Transmission of Stock Returns and Volatility', *The Review of Financial Studies,* Vol. 7 , Iss 3, pp 501-538
54. Engle R. V. Ng(1993), ' Measuring and testing the impact of news and volatility', *Journal of Finance*, Vol. 48, Iss 5, pp 749-1778

55. Engle R.(1983), 'Estimates of the Variance of US inflation Based on the ARCH model', *Journal of Money ,Credit, Banking,* Vol. 15, pp 286-301
56. Errunza V, E Losq (1985), 'International Asset Pricing under mild Segmentation', *Journal of Finance*, Vol.. 40 , Iss 1, pp105-124
57. Errunza V, E Losq (1989), 'Capital Vol. controls, International asset pricing and Investor's welfare', *Journal of Finance*, Vol. 44,,Iss 4, pp 1025-1037
58. Errunza V, E. Losq, Padmanabhan P. (1992), 'Tests for Integration, mild segmentation, and segmentation hypothesis', *Journal of Banking and Finance*, Vol. 16, Iss 5, pp 949-972
59. Eun C, S. Shim(1989), 'International Transmission of Stock market movements', *Journal of Financial and Quantitative Analysis,* Vol. 24, Iss 2 , pp 241-256
60. Eun C., S. Janakiramanan (1986), ' A model of international asset pricing with constraint on the foreign equity ownership', *Journal of Finance,* Vol. 41, Iss. 4, pp 897-914
61. Fadner K., Grubel H.(1971), ' The Interdependence of International Equity markets', *Journal of Finance,* Vol. 26, pp. 89-94
62. Fama E., K. French (1992), ' The cross-section of expected stock returns', Journal of Finance, Vol. 47, Iss. 2, pp 427-465
63. Fama E. (1963), ' Mandelbrot and the stable Paretian hypothesis', *Journal of Business*, Vol. 36, pp 420-429
64. Fama E. (1965), ' The behavior of Stock Market Prices', *Journal of Business*, Vol. 38, pp 34-105
65. Fama E. K. French (1989), ' Business Conditions and expected returns on stock Bonds', *Journal of Financial Ecomonics,* Vol 25, pp 23-49
66. Fama(1970), "Efficient Capital Markets: A review of theory and empirical work", *Journal of Finance,* Vol. 25, Iss 1, pp 383-423
67. Fang H. (1991), "Foreign Investment barriers and international asset pricing", *Journal of Business finance & Accounting*, Vol.. 18, Iss. 4, pp 531-540
68. Ferson W, C. Harvey(1991), ' The variation of economic risk premiums', *Journal of Political Economy*, Vol. 99, Iss. 2, pp 385-415
69. Ferson W, C. Harvey(1993), 'The risk and predictability of international equity returns', The *review of financial studies*, Vol. 6, Iss 3, pp 527-566
70. Ferson W, C. Harvey(1994), 'Sources of risk and expected returns in global equity markets', *Journal of Banking and Finance,* Vol. 18, pp 775-803

71. Frankel J. (1979), ' On the mark: a theory of floating exchange rates based on real interest differentials', *The American Economic Review*, Vol. 69, pp 610-622
72. Geweke J.(1986), 'Modelling the Persistence of Conditional Variances: A comment', *Econometric Reviews,* Vol. 5, pp 57-61
73. Gibbons M. (1982), 'Multivariate Tests of Financial models: A new approach', *Journal of Financial Economics,* Vol. 10, pp 3-27
74. Gibbons M, S. Ross, J. Shanken (1989),' A test of the efficiency of a Given portfolio', *Econometrica,* Vol. 57, pp 1121-1152
75. Granger C., O. Morgenstern, *Predictability of stock market prices,* Lexington, 1970
76. Gultekin M., N Gultekin , A Penati (1989), 'Capital Controls and international market segmentation: The evidence of Japanese and American Stock Markets', *Journal of Finance*, Vol. 44, Iss 4, pp 849-869
77. Gultekin N., Gultekin M.(1983), ' Stock market seasonality: International Evidence', *Journal of Financial Economics*, Vol 12, pp 469-481
78. Hamao Y., R. Masulis, V Ng (1990), 'Correlations in price changes and volatility across international Stock markets, *The Review of Financial Studies*, Vol. 3, Iss 2, pp 281-307
79. Hamao Y. (1988), 'An empirical examination of arbitrage pricing theory: Using Japanese data, *Japan and the World Economy: International Journal of theory and Policy*, Vol. 1, pp 45-61
80. Harvey C. , B. Solnik, G. Zhou (1994), 'What determines expected international asset returns?', *Duke University*, Working Paper
81. Harvey C., R.Huang (1991), 'Volatility in the Foreign Currency Futures Markets', *Review of Financial Studies*, Vol. 14, Iss 3 , pp 543-569
82. Harvey C. (1989), ' Time Varying Conditional Covariances in tests of asset Pricing Models', *Journal of Financial Economics*, Vol. 24, pp 289-317
83. Harvey C. (1991), 'The World price of covariance risk', *Journal of Finance*, Vol. 46, Iss.1, pp 111-157
84. Harvey C. (1994), 'Conditional Asset Allocation in Emerging Markets', *Working Paper*, Duke University USA
85. Harvey C. (1995), ' Predictable risk and returns in emerging markets', *The Review of Financial Studies*, Vol. 8, Iss. 3, pp 773-816

86. Hawawini G.(1994), 'Equity Behaviour : Some Evidence from markets around the World', *Journal of Banking and Finance*, Vol. 18, pp. 603-620

87. He J. , L. Ng (1994), 'Economic forces , fundamental variables and equity returns', *Journal of Business,* Vol. 67, Iss 4, pp 599-609

88. Heston S., K. Rouwenhorst, R. Wessels (1995), 'The structure of international stock returns and the integration of Capital markets', *Journal of Empirical Finance,* Vol. 2, pp173-197

89. Hietela P. (1989), "Asset pricing in Partially segmented markets. Evidence from the Finnish market", *Journal of Finance*, Vol. 44, Iss 3, pp 697-718

90. Hilliard J. (1979), 'The relationship between equity indices on World exchanges', *Journal of Finance,* Vol. 34, Iss 1, pp 103-114

91. Hsieh D.(1989), Modelling Heteroscedasticity in Daily Foreign Exchange Rates, *Journal Business and Economic Statistics,* Vol. 7, Iss 3, pp 307-317

92. Hsieh D.(1995), ' Non-linear Dynamics in Financial Markets', *Financial Analyst Journal,* July-August, pp 55-62

93. IMF , *Annual Report on Exchange Arrangements and Exchange Restrictions,* various Issues, USA

94. Jorion P. , E. Schwartz (1986), 'Integration vs Segmentation in the Canadian Stock market', *Journal of Finance*, Vol.. 41 , Iss. 3, pp 603-616

95. Joy O., V. Lessig, D. Panton(1976), ' Comovements of International Equity markets : A taxonomic Approach', *Journal of Financial and Quantitative Analysis,* Vol. 11

96. Judge G., R Hill, et al, *Introduction to the theory and practice of econometrics*, 2nd Edition, John Willey and Sons, 1988.

97. Karolyi G. (1995) , ' A multivariate GARCH Model of International Transmissions of Stock Returns and Volatility : the Case of the United States and Canada', *Journal of Business and Economic Statistics*, Vol. 13, Iss 1, pp 11-25

98. King M., S. Wadhwani (1990), 'Transmission of volatility between Stock Markets', *Review of Financial Studies*, Vol. 3, Iss 2, pp 5-33

99. Koch P., T. Koch (1991), 'Evolution in dynamic linkages across daily national stock indexes', *Journal of international Money and Finance,* Vol. 10, pp. 231-251

100. Koop G. (1996), 'Parameter uncertainty and impulse response analysis', *Journal of Econometrics*, Vol.72, No.1-2, pp.135-149

101. Korajczyk R., C. Viallet (1990),'An empirical investigation of international asset pricing', *The Review of Financial Studies,* Vol. 2 , Iss 4, pp. 553-585

102. Korajczyk R. (1996), 'A measure of stock market integration for the developed and emerging markets', *The World Bank Economic Review*, Vol. 10, Iss 2, pp 267-289

103. Koutmos G. (1996), ' Modelling the Dynamic interdependence of major European stock markets', *Journal of Business Finance and Accounting*, Vol. 23, Iss 7, pp 975-988

104. Koutmos G. (1997), ' Feedback Trading and the Autocorrelation pattern of Stock Returns : further empirical evidence', *Journal of International Money and Finance,* Vol. 16, pp 625-36

105. Koutmos G. (1998), ' Asymmetries in the conditional Mean and the conditional Variance : Evidence from nine Stock markets', *Journal of Economics and Business*, Vol. 50, pp 277-290

106. Koutoulas G, L. Kryzanowski, (1994), " Integration or segmentation of the Canadian stock market: evidence based on the APT", *Canadian Journal of Economics*, Vol. 47, pp 329-351

107. Kraus A., Litzenberger R. (1975), 'Market Equilibrium in a multi-period state preference model with logarithmic Utility', *Journal of Finance,* Vol. 30, pp 1213-1229

108. Lastrapes W. (1989), 'Exchange rate Volatility and the Us monetary Policy : An ARCH Application', *Journal of Money Credit and Banking,* Vol. 21, pp 66-77

109. Lee U., P. Theodossiou(1993), 'Mean and Volatility Spillovers across major national stock markets: Further empirical evidence', *The Journal of Financial Research*, Vol. 16 , No 4, pp. 337-350

110. Lee U., P. Theodossiou(1995), 'Relationship between volatility and expected returns across international stock markets', *Journal of Business Finance and Accounting*, Vol. 22, Iss 2, pp 289-300

111. Lehnmann B., D. Modest (1988), 'The empirical foundations of the Arbitrage Pricing Theory', *Journal of Financial Economics*, Vol. 21, pp 213-254

112. Lessard D. (1976), 'World, Country and Industry relationships in Equity returns : Implications for risk reduction through International Diversification' , *Financial Analyst Journal* , Vol. 32, pp 2-8

113. Levine R. , S Zervos (1995), 'Capital control liberalisation and stock market development', World Bank, Policy Research Department, Washington D.C

114. Lin W.(1997), 'Impulse Response Function for conditional Volatility in GARCH models', *Journal Business and Economic Statistics,* Vol. 15, Iss 1, pp 15-25

115. Liu Y, M. Pan (1997), ' Mean and Volatility Spillover effects in the US and Pacific0-Basin Stock Markets', *Multinational Finance Journal,* Vol. 1 , No 1, pp 47-62

116. Malliaris A., J. Urrutia(1992), 'The international Crash of October 1987: Causality Tests', *Journal of Financial and Quantitative Analysis*, Vol. 27, Iss 3, pp 353-364

117. Mandelbrot B. (1963), ' The variation of certain Speculative prices', *Journal of Business,* Vol. 36, pp. 394-419

118. Merton R (1980), ' On estimating the expected return on the market : An explanatory investigation, *Journal of Financial Economics,* Vol. 8, pp 232-361

119. Neftçi S.(1984), 'Are economic time series asymmetric over the business cycle?', *Journal of Political Economy,* Vol. 92, pp 307-328

120. Nelson, Cao(1992), 'A note on the inequality constraints in the univariate GARCH model', *Journal of business and Economic Studies,* Vol. 10, Iss 2 , pp 229-235

121. Nelson C., R. Startz (1990), ' The distribution of the instrumental variables estimator and its T-ratio when the instrument is a poor one', *Journal of Business,* Vol. 63, Iss 1, pp 125-140

122. Nelson D. (1991), ' Conditional Heteroscedasticity in Asset returns: A new Approach', *Econometrica*, Vol. 59, Iss 2, pp 347-370

123. OECD, *Experience with controls on international portfolio operations in shares and bonds,* 1980

124. Pantula S(1986), 'Modelling the Persistence of Conditional Variances: A comment', *Econometric Reviews,* Vol. 5, pp 71-73

125. Perron P. (1989), ' The great crash, the oil price shock, and the unit root hypothesis', *Econometrica*, Vol. 57, Iss 6, pp 1361-1401

126. Pesaran H., Y. Shin (1998), 'Generalized impulse response analysis in linear multivariate models', *Economics Letters*, Vol.58, No.1, pp.17-29

127. Pindyck R., D. Rubinfield, *Economic models & economic forecasts*, 3rd edition, McGraw Hill International Editions,1991.

128. Poon S. , S. Taylor. (1992), ' Stock returns and Volatility : An empirical study of the UK Stock market', *Journal of Banking and Finance,* Vol. 16, pp 37-59

129. Priestley R. (1996), 'The APT, macroeconomic and financial factors, and expectation generating process, *Journal Of Banking and Finance,* Volume 20, pp 869-890

130. Ripley D. (1973), 'Systematic Elements in the linkage of National Stock market Indices', *Review of Economics and Statistics,* Vol. 55, pp. 356-361

131. Roll R. (1988), 'The International crash of October 1987', *The Financial Analyst Journal,* Vol. 44, pp 19-35

132. Ross S (1976), 'The arbitrage theory of capital asset pricing', *Journal of Economic Theory*, Vol. 13, pp 341-360

133. Ross S., S. Welsh (1983), 'A simple approach to the pricing of risky assets with uncertain exchange rates', *Research in International Business and Finance,* Vol. 3 , pp 39-54

134. Salomon Brothers Inc., *International Equity Flows,* 1990

135. Sand O., H. Schollhammer(1985), ' The Interdependence among stock markets of Major European countries and the US. An empirical investigation of interrelations among National stock price movements', *MIR,* Vol. 25, Iss 1, pp 17-27

136. Schwaiger W. (1995), 'A note on GARCH predictable variances and stock market efficiency', *Journal of Banking and Finance,* Vol. 19, pp 949-953

137. Schwert G. , P Seguin (1990), ' Heteroscedasticity in stock returns', *Journal of Finance,* Vol. 45, Iss. 4 , pp 1129-1155

138. Sims C. (1980), 'Macroeconomics and Reality', *Econometrica,* Vol. 48, pp1-49

139. Solnik B. (1977)., 'Testing international asset pricing: Some pessimistic views', *Journal of Finance*, Vol.. ,Iss. 2, pp 503-517

140. Solnik B., "International Investments", 2nd Edition, Addison-Welsley Publishing Co, USA : 1993

141. Solnik B. (1974), ' An equilibrium model of the International Capital market', *Journal of Economic Theory,* Vol. 8,pp 500-524

142. Solnik B. (1974a), ' The international pricing of risk: An empirical investigation of the world capital market structure', *Journal of Finance,* Vol. 29, pp 365-378.

143. Solnik B.(1983), 'International Arbitrage theory', *Journal of Finance*, Vol.. ,Iss. 2, pp 449-457

144. Stehle R.(1977), ' An empirical test of the alternative hypothesis of national and international pricing of risky assets', *Journal of Finance,* Vol. 32, Iss 2, pp 493-502

145. Steil B., *The European Equity Markets : The state of the Union and the Agenda for the millennium,* The Royal Institute of International Affairs, UK: 1996

146. Stewart J., *Econometrics*, Philip Alan, 1991.

147. Stoll H. , R. Whealy (1990), 'Stock market structure and volatility', *Review of Financial Studies*, Vol. 3, pp 37-71.

148. Stulz R (1981a), 'On the effects of Barriers to international Investment', *Journal of Finance*, Vol. 36, Iss 4, pp 923-934

149. Stulz R. (1981), 'A model of international asset pricing', *Journal of Financial Economics,* Vol. 9,pp 383-406

150. Stulz R. (1995)., 'The cost of Capital in an internationally integrated markets: The case of Nestle', *European Financial Management*, Vol. 1, No 1, pp 11-22

151. Subrahmanyam M (1975)., "On the optimality of international capital market integration", *Journal of Financial Economics*, Vol.. 2, pp 3-28

152. Taylor S., *Modelling Financial Time Series,* Chichester:Wiley 1986

153. TSP International ,*TSP Reference Manual Version 4.2*, 1991

154. Wallingford B. (1974), ' Discussion on B Solnik's model', *Journal of Finance,* Vol. 29, pp 392-395

155. Weatley S. (1988), 'Some tests of international equity integration', *Journal of Financial Economics*, Vol. 21, pp 177-212

156. White H.(1980), 'A heteroscedasticity-consistent Covariance Matrix Estimator and a Direct Test for Heteroscedasticity', *Econometrica* , Vol. 47, pp 817-838

157. Zellner A.(1962), 'An Efficient Method of Estimating Seemingly Unrelated Regressions and Tests for Aggregation Bias', *Journal of the American Statistical Association* , Vol. 57 , pp. 348-368