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VALUE, MONEY AND RISK: THREE ESSAYS

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Thesis submitted to the University of Dublin, Trinity College

in fulfilment of the requirements for the degree of

Doctor in Philosophy (Ph.D.)

October 2002

DECLARATION

I declare that this thesis, submitted to the University of Dublin, Trinity College, for the degree of Doctor in Philosophy (Ph.D.), has not been submitted as an exercise for a degree at this or any other university. All research contained herewith is entirely my own.

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SUMMARY

This thesis comprises of three essays which explore the theories of value, money and risk. The first essay takes a theoretical approach to study the background of and the relationship between value, money and wealth. The second and third essays examine empirically the issue of risk at both domestic and international levels.

The first essay (Chapter 1) aims to provide a comprehensive and analytical study of value, money and wealth. It consists of four parts. First we undertake a review of the development of value theory from the time of the classical and neoclassical schools to the more recent ordinal utility approach. The second part of this paper examines the theory of money. In addition to looking at the two situations that involve commodity money and no money, we also introduce David Hume's monetary economics. Part three of this paper examines the concept of wealth. To obtain a fuller picture of the notion 'wealth', we contrast the traditional consumption based approach of wealth with the modern view of the 'spirit of capitalism'. The last section of this paper presents two applications of the concepts of money and risk. In the first exercise we utilize an Arrow-Debreu type of model and in a general equilibrium framework with no risk we derive and prove the conditions under which the price of money will be positive. The second exercise introduces the facility of credit and its by-product of risk and bankruptcy. To add realism into our study, we construct an optimal bankruptcy law when government exemptions and social stigma are included in its construction.

The objective of the second essay (Chapter 2) is very specific. We attempt to answer the question of whether the gain and loss in property market speculations and rate of information flow play a significant role in stock market volatility in Hong Kong. To achieve this, we seek to examine the relationship between wealth, trading volume and stock market volatility. Hong Kong provides an ideal setting for studying this wealth effect as fluctuations in property prices have made many people rich beyond their wildest imagination within a short time. But does this newfound wealth and overconfidence, derived from property speculation success, reduce people's loss aversion with consequent impacts on stock market volatility? In this paper, we find evidence to support a positive relationship, in particular in the upper luxury property class of investment. The relationship between trading volume and price changes has long been an interesting topic on its own as relating to information. Hong Kong, as a small but well-commercialised city, offers us a good opportunity to look into how the extent of information flow affects stock prices. Although we fail to establish a volume-volatility relationship in our estimation, we offer additional dimensions to the explanation of our observation. To test for our hypothesis, two different measures of volatility: Absolute (absolute value of standard deviation from mean with monthly dimension) and conditional (EGARCH) are used and results are compared. In both measures we find evidence of a

positive wealth effect on stock market volatility, in particular in the investment of upper luxury class of property in Hong Kong.

Immediately following the tragic event of September 11th, many economists have expressed concern of a U.S. economic slowdown and its potential effect on the world economy. To verify their apprehension, in this final essay (Chapter 3) we test empirically the reaction of four international stock markets to the changes in U.S. interest rates, which frequently serve as signal of its economic condition. To achieve our aim, this paper attempts to quantify the relationship between the spot yield spread of the U.S. bond market and volatility of the stock market for the period of February 1979 to December 1998. The four major international stock markets, namely Hong Kong, Japan, U.K. and the U.S., are chosen for examination. The movements of U.S. interest rates have long played a significant role on the global economies and financial markets. Therefore, we try to capture and quantify this influence on these four countries. This paper is unique because, to the best of our knowledge this is the first attempt to expand the study of yield spread into three-dimensions in terms of multi-maturity spectrum, multi-horizon, and multi-country. Another distinctive feature of this paper is that in order to ensure our model captures all the dynamics, a Common Factor (COMFAC) approach is used for model selection. This paper finds that the U.S. spread-volatility relationship clusters around the short to medium maturity horizon. When this relationship exists, its performance varies from country to country. Finally, both Japan and the U.K. are shown to be the countries under the strongest influence of the U.S. interest rate movements. The U.K. case allows us to apply the business leverage effect to account for the event. In other words, we find evidence showing that the extent of U.S. economic influence on individual country is associated with the existing domestic firm structure: a country with many firms with high operating leverage tends to be more vulnerable. This paper also finds that investors are more sensitive to the future change in U.S. short rates than the risk premium term.

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CHAPTER 1

VALUE, MONEY AND WEALTH: THEORETICAL REVIEW AND TWO EXERCISES ON MONEY AND RISK

1.1 Introduction

The main objective of this paper is to tie three apparently independent theories (value, money and wealth) into a single coherent discussion through time. By examining how they have evolved over time, we hope to establish a theoretical relationship among them. In addition to the three core concepts that we endeavour to cover, we also incorporate a general equilibrium analysis of money and the notion of risk into the remaining parts of this paper.

The theory of value has long been an engrossing topic amongst economists. The classical school places great emphasis on the study of value because of its concern over wealth distribution within a nation, where the notion of wealth is frequently expressed in terms of material goods. Therefore, in order to facilitate the discussion of production, consumption, wealth and distribution, it has to first find a measuring rod for these material goods. Once this measuring rod is identified, a meaningful discussion of the changes in the wealth of a nation and its distribution among different social classes becomes possible. For the neoclassical school and the modern day utility-based economists, it is not value *per se* that is fundamental to the society, instead the evolution of market price forms the basis of their study of the value theory. In this utility-based framework, given fixed resources and technology, and individual consumption preferences, these economists are interested to find out how can these resources be allocated through a market system so as to maximize the satisfactions of both consumers and producers.[1] In other words, they endeavour to study how the consumers and the producers would react to the stimuli of given prices – market prices. Although on the surface the study of the theory of value seems to have shifted from the more direct approach of the classical school (the exchange value of goods) to the more indirect discussion of value through the price system however, the ultimate interest in resource allocation remains unchanged. The only difference between these two approaches is that the introduction of mathematics into the utility-based

[1] For the modern economy, the maximization of wealth can be viewed from the fact that producers or firms attempt to maximize the present value of all future profits for the shareholders, while consumers either shareholders or non-shareholders maximize the present value of their utility of lifetime consumption. Hence, the classical, the neoclassical and the modern day utility-based schools all have the issue of wealth under their consideration.

price/value analysis transformed the study of value from a moral philosophical subject into a natural/social science topic. Nevertheless, we are not discounting the fact that for both approaches the study of prices is essential to the understanding of value. Naturally one would ponder over questions such as what are prices, where do these prices come from, what was the very first price of exchange and why do we need money to reflect prices?

Most economists would agree that prices are just the *numéraire* of the value of goods and services produced and circulating in the economy. Historically, when people were living in a barter economy, there was no need for the study of value, money and price. In this economy, consumers simply exchanged with each other for whatever they desired but could not produce. However, over time the frequent problem of double coincidence of wants made barter an inefficient means of exchange.[2] Thus money was introduced. Once money is established as a form of legally accepted medium of exchange, it is inevitable that one identifies and expresses the prices or the value of any goods and services directly in terms of money. The relationship between value, price and money is obvious enough for most of us to comprehend, however we still need to find the answer to the question of how the value of individual goods and services is decided.

We are motivated to study the theories of value and money primarily because of the issue of wealth. In modern economies, the status or economic power of a nation or an individual is notably symbolized by its wealth. In turn, wealth is commonly expressed by the monetary value of all assets owned. Given this, fluctuations in asset value and the value of money holding play a key role in one's ability to trade or consume. But who or what decides the value of money in the first place? If the basis for the value of real goods and money is without foundation or so arbitrary, who wants to hold money as a form of wealth? This paper's main purpose is to provide a better understanding of the three concepts: value, money and wealth. Armed with this, we may be able to give answers to the questions raised thus far. The amount of literature written on the theory of value and money is vast and it is an impossible task to cover it all. As such, this paper reviews a

2 We are not completely dismissing the existence of barter in modern economies. In nearly all countries not all goods and services are monetized. For example, a farmer might give a dozen eggs in exchange for a bottle of wine made by his neighbour.

limited number of writers and approaches. These are subjectively chosen but we believe that they best serve the present purpose.

In order to perform a study of the theory of value and money, it is imperative that one goes back to the beginning of the story and introduces the initial development of the thought. The debate on the theory of value started in ancient Greece and became dormant during the Middle Ages. Following the formation of the classical school of economics, which followed the principle of *laissez faire* and the labour theory of value, that was initiated by Adam Smith, the study of value re-emerged in the eighteenth century to dominate economic thought for the next 200 years. However, due to the limited scope of this paper, we confine our attention to those writers who have produced influential work on the subject that are recognized by subsequent economists. We present reviews of the theory of value of the classical school, the neoclassical school and the modern utility-based, market analysis. These three approaches to the theory of value although different in focus and methodology, maintain equally important perspectives: supply and demand. On the supply side, classical economists believe that value is derived from the supply of goods and services in the economy. The neoclassicists on the other hand, put forward the idea that money or all goods and services has a value because of people's demand for it and since it creates utility for the owners. At a later date, Alfred Marshall accommodated the interactions of both supply and demand as equally crucial determinants of value in the market system. More recently, John Hicks uses the concept of ordinal utility and the decomposition of the income and substitution effect to further refine Marshall's analysis of supply and demand. To present a fuller picture, we also offer the discussion of the general equilibrium approach in which the multi-market equilibrium situation is studied.

To study the theory of money we contrast the classical approach with the Arrow-Debreu world in which the function of money does not exist. We also introduce the monetary thought of David Hume which we trust is of significance to the understanding of the development of modern monetary theory. Once the concepts of value and money are presented, we introduce the study of wealth. Similar to the theories of value and money, but to a greater extent, there does not exist a single conventionally accepted definition of wealth. And that is why the word 'concept' instead of the term 'theory' is used in the

section title. To achieve our study aim, we offer the classical school's viewpoint of wealth, as addressed by Adam Smith, together with the more contemporary view of the so-called 'spirit of capitalism'. As two exercises that are beneficial to the study of the paper, in the general equilibrium analysis of money we extend the model of Starr (1974) to include a wealth tax. For the study of credit and risk, social stigma and government bankruptcy exemption are added to the noncooperative model of Shubik (1972). These additions help to reflect the more realistic situation of the modern world in which personal bankruptcy is a matter of growing concern.

The organization of this paper is as follows: Section 1.2 introduces the theory of value according to the two main schools of thought: classical and neoclassical. Representing the classical school, detailed and critical reviews of the works of Adam Smith and David Ricardo are individually presented. For the neoclassicists, a discussion of the works of its forerunners in Trinity College Dublin is included and then followed by an introduction to the 'Jevonian (marginal) revolution'. We close this section with discussions of the more recent approaches of the theory of value of Alfred Marshall and John Hicks. In Section 1.3, the study of money begins with the classical approach in which commodity money is considered. It is then followed by a discussion of the Arrow-Debreu world in which money plays no part. This section ends with the presentation of David Hume's monetary thought. In Section 1.4 the concept of wealth is examined. By contrasting the old and the contemporary views on wealth, we hope to offer a good understanding of the subject. As an exercise in gaining further insight into the function of money, a general equilibrium model of money is studied in Section 1.5.1. To add realism to our discussions, issues of credit and bankruptcy under uncertainty enter into our consideration in Section 1.5.2. Section 1.6 concludes this paper.

1.2 Theory of Value – Why goods have value

Value is a subject that has drawn much attention and controversy among economic scholars from the time of Aristotle to the present. Discussions of the subject basically can be divided according to three main schools of thought: the classical, the neoclassical (sometimes also known as Jevonian/maginalists) and the more contemporary approach.

1.2.1 Classical school and labour theory

Prior to the emergence of the marginalists, the predominant school of economic and political thought was the classical school. The major classical economists include Adam Smith, Thomas Malthus, David Ricardo and John Stuart Mill. The underlying approach of the classical school on the topic of value is based on the supply side of commodities or more precisely, the labour theory. For the classicists, labour is the determining factor of value. In other words, value arises from labour. In spite of this generally consistent central theme, within the classical school itself a disparity of views on how labour derives value exists.

One of the better-known conflicts is that between Adam Smith and David Ricardo. For Smith it is the amount of labour-commanded (quantity of labour required to obtain the commodity) which determines the exchange value of a commodity. Ricardo on the other hand, maintains that it is the labour-embodied (amount of labour necessary for production) that decides a commodity's exchange value. It is not the intention of this paper to argue for or against any particular value theory. However, because of the rich insights that each of them offers to the theory, we choose to concentrate on Smith and Ricardo as major representative figures of the classical school to explore how the economic idea of value was developed and expressed.

1.2.1.1 Adam Smith (1732-1790)

Adam Smith, one of the greatest minds in the eighteenth century, wrote extensively both on human nature and on society. His two most famous books: *Theory of Moral Sentiments* (1759) and *Wealth of Nations* (1776)[3] explore these two subjects in great depth. Smith's value theory is fully developed in the *Wealth of Nations.* However, in order to have a thorough understanding of his theory, it is imperative that one first appreciates Smith's ideology presented in the *Theory of Moral Sentiments.*

[3] Both books are included in *The Essential Adam Smith*, which we shall cross reference under Smith (1986).

In the *Theory of Moral Sentiments*, Smith gives us a thorough account of how human beings form moral judgements. In his discussion on morality and social stability, he asserts that a socially stable society is crucial for a successful economy. Most importantly, in this book Smith clearly lays down the idea and the foundation of the 'invisible hand' whereby 'self-interest' becomes an essential part of the whole process.[4] This 'invisible hand' can be considered as a depiction of the concept of supply and demand and their interaction – an equilibrium situation. Hence, criticism of the classical school of being entirely a supply side theory appears to be unjustly made. Nonetheless, Smith's discussion of the 'invisible hand' takes such a verbal, deductive and intuitive attitude that some may think it lacks a formal analytical framework. Of significant relevance to the study of this paper is the notion of 'self-interest' that moves the 'invisible hand'. Without 'self-interest' individuals would not need to engage in exchange, and then money would have no function and the study of this paper would become superfluous. We believe that even for the utility-based approach of value that was developed by the neoclassical economists, the explicit assumption of the maximization of utility inevitably involved the implicit assumption that all individuals are driven by 'self-interest'. With the idea of 'self-interest', economic activities emerge; value, price and money become indispensable objects in the system. Undoubtedly, the *Theory of Moral Sentiments* gives an important footing for the *Wealth of Nations*.

The other famous work of Adam Smith is the *Wealth of Nations*, which focuses extensively on society and how its economic affairs should be arranged. The *Wealth of Nations* is divided into five 'books' which in general discuss production, distribution, capital, economic development, and the history of economics. The first two books are the

[4] Robert L. Heilbroner in this introduction to *The Essential Adam Smith* (1986) offers an excellent interpretation of Smith's idea of the 'invisible hand': "Thus the Invisible Hand refers to the means by which "the Author of nature" has assured that humankind will achieve His purposes despite the frailty of its reasoning powers. The means are a number of powerful instincts and promptings that the Deity has instilled within us, which we obey because we have to, quite unconscious of their long-term social purpose. In this way, "without intending it; without knowing it" the pursuit of our immediate desires brings us to follow courses of action that would otherwise require a Godlike intelligence to pursue." p. 60.

most relevant to our present discussion, containing issues such as division of labour and the theories of value, price, wages, profits and interest.

Assembling the ideas discussed in the *Theory of Moral Sentiments* with those in the *Wealth of the Nations,* Smith suggests that in general, all human beings possess three basic natures. First we are all sympathetic and benevolent to others. Secondly, we all endeavour to better our condition originated from our passion for 'self-interest'. Lastly and most connected to our discussions, man is the only creature of exchange.

> Nobody ever saw a dog make a fair and deliberate exchange of one bone for another with another dog.[5]

One of Smith's ideas that has great economic significance is the human nature of 'self-interest'. If one cares to start from the beginning of these two great works of Smith's, he consistently maintains that human beings are all governed by the passion of 'self-interest'. In fact, it is 'self-interest' that underlies work and the division of labour.

> It is not from the benevolence of the butcher, the brewer, or the baker that we expect our dinner, but from their regard to their own interest. We address ourselves, not to their humanity but to their self-love, and never talk to them of our own necessities but of their advantages.[6]

> As it is by treaty, by barter, and by purchase, that we obtain from one another the greater part of those mutual good offices which we stand in need of, so it is this same trucking disposition which originally gives occasion to the division of labour.[7]

The two passages cited above show that the division of labour arose from a propensity in human nature to exchange and this propensity is found in man alone. Thus,

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[5] Smith (1986) –*Wealth of Nations*, p.168.
[6] *Ibid.*, p.169.
[7] *Ibid.*, p.169.

once division of labour is established, every man lives by exchange. Of course, in the rude state without division of labour, 'stock'[8] is unnecessary, everyone just consumes whatever he can make and hunt. But as division of labour and exchange are developed, accumulation of stock becomes necessary and indeed it advances simultaneously with division of labour.

> A man does not think of obtaining revenue from a small stock, but when he has more than enough for immediate consumption, he endeavours to derive a revenue[9] from the rest.[10]

For Smith, the theory of value is very much related to the development of division of labour. When the division of labour has been established, due to the limited part of production one labourer can afford, exchanging goods among members of the society becomes inevitable:

> Every man thus lives by exchanging, or becomes in some measure a merchant, and the society itself grows to be what is properly a commercial society.[11]

And once division of labour, exchange and accumulation of stock were in place, labour value became essential to the whole system.

> Labour is the real measure of exchangeable value of all commodities.[12]

> Labour was the *first price*, the *original purchase money* that was paid for all things [italics mine].[13]

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[8] Stock is defined as goods that are stored up.
[9] The selling off of extra stock after satisfying the basic need for consumption.
[10] *Ibid.*, p.229.
[11] *Ibid.*, p.172.
[12] *Ibid.*, p.175.
[13] *Ibid.*, pp.175-176.

Since labour plays such a key role in Smith's value theory, naturally for him the first price of everything is labour. Smith then continues with a discussion of money. At the beginning, exchange in this society could possibly result in a barter economy with individuals swapping commodities that they produced with those they need. However, the difficulties[14] with this type of barter economy lead to the emergence of one commodity as money. This commodity has the confidence of members of the society since:

> "... few people would be likely to refuse [it] in exchange for the produce of their industry."[15]

Once the use of money as a medium of exchange has been established,[16] Smith goes into detail about what decides the exchange value of each commodity. Smith identifies the word 'value' with two different meanings: value in use and value in exchange. The water and diamond paradox is a good illustration of these two values. Water might have a high value in use but its exchange value is much lower than diamond. From this he concludes that commodities with great value in use might have no value in exchange and *vice versa*. As such, it is to the exchange value that individual agents attach greater importance and relevance in the economy. Due to the essential role it plays, it is the value in exchange that Smith proceeds to offer his famous labour theory of value:

> Every man is rich or poor according to the degree in which he can afford to enjoy the necessaries, conveniences, and amusements of human life. But after the division of labour has once thoroughly taken place, it is but a very small part of these with which a man's own labour can supply him. The far greater part of them he must derive from the labour of other people, and he must be rich or poor according to the quantity of that labour which he can command, or which he can afford to purchase. The value of any commodity, therefore, to the person who possesses it, and who means not to use or consume it himself, but to exchange it for other commodities, is equal to the quantity of labour which it enables him to

[14] The most apparent problem with barter is the "double coincidence of wants" and the organization and communication costs involved to overcome the problem.
[15] *Ibid.*, p.173.
[16] More detailed discussion of Smith's idea of money can be found in Section 1.3.1.

purchase or command. *Labour, therefore, is the real measure of the exchangeable value of all commodities* [italics mine].[17]

The above passage clearly illustrates Smith's labour-commanded theory of value. According to Smith, the value of all goods should reflect the amount of labour that they could command in the market. Why should labour commanded be a determining factor of value? Smith continues to explain by saying that by exchanging them the owner of these goods can escape the pain of labouring himself to produce what he receives in exchange. The following passage illustrates how escaping this labouring pain gives rise to the theory of value. At the same time, it also shows that the relationship between money, price and labour is merely:

> The real price of every thing, what every thing really costs to the man who wants to acquire it, is the toil and trouble of acquiring it. What every thing is really worth to the man who has acquired it, and who wants to dispose of it or exchange it for something else, is the toil and trouble which it can save to himself, and which it can impose upon other people. What is bought with money or with goods is purchased by labour as much as what we acquire by the toil of our own body. That money or those goods indeed save us this toil. They contain the value of a certain quantity of labour which we exchange for what is supposed at the time to contain the value of an equal quantity. Labour was the first price, the original purchase money that was paid for all things.[18]

Thus, labour-command is fundamental to determining the value of goods; it can also be interpreted in terms of purchasing power of labour units. However, Smith concedes the difficulties for people to express the value of goods in terms of the amount of labour commanded alone, hence:

> The greater part of people too understand better what is meant by a quantity of particular commodity, than by a quantity of labour. The one is a plain palpable

[17] *Ibid.*, p.175.
[18] *Ibid.* pp.175-176.

> object; the other an abstract notion, which, though it can be made sufficiently intelligible, is not altogether so natural and obvious.[19]
>
> ....
>
> It is more natural and obvious to him, therefore, to estimate their value by the quantity of money, the commodity for which he immediately exchanges them, than by that of bread and beer,.... the exchangeable value of every commodity is more frequently estimated by the quantity of money, than by the quantity either of labour or of any other commodity which can be had in exchange for it.[20]

In the *Wealth of Nations*, the relationship between value and money seems to be clearly established. However, why can't one observe this supposed direct link between labour and value in most economies? What causes this seemingly unbreakable chain of events to break? The answer lies in the middle: that is in the accumulation of stock. Smith recognizes that as society progresses the price of goods will be determined jointly by other factors of production such as land and capital. Taking the case of capital investment in the production of a good, its value should include both the labour cost and a return to capital. If these other factors of production were taken into account seriously and effectively, Smith's labour theory would become a cost-of-production theory. Unfortunately, Smith's discussion of how these other factors of production affect the value of a good is ambivalent. Although Smith's labour-commanded theory of value is frequently criticised for the over-simplification of the actual economic situation, it offers us an insight into a special case ('a very rude stage of economic activities') in which labour is the only factor of production.[21] Hence, we limit our presentation of Smith's theory of value to the labour-commanded theory.

> In that early and rude state of society which precedes both the accumulation of stock and the appropriation of land, the proportion between the quantities of labour

[19] *Ibid.*, pp.176-177.
[20] *Ibid.*, p.177.
[21] To offer support to Smith's labour-commanded theory of value, the non-substitution theorem is presented in Section 1.2.1.3.

> necessary for acquiring different objects seems to be the only circumstance which can afford any rule for exchanging them for one another. If among a nation of hunters, for example, it usually costs twice the labour to kill a beaver which it does to kill a deer, one beaver should naturally exchange for or be worth two deer. It is natural that what is usually the produce of two days or two hours labour, should be worth double of what is usually the produce of one day's or one hour's labour.
>
> ....
>
> In this state of things, the whole produce of labour belongs to the labourer; and the quantity of labour commonly employed in acquiring or producing any commodity, is the only circumstance which can regulate the quantity of labour which it ought commonly to purchase, command, or exchange for.

In summing up the above discussions of Smith, we notice a chain of events. Smith's thought on the theory of value builds on our human nature of bettering our condition – self interest. Division of labour arises simply because of individuals' desire to maximize their welfare. However, due to the limited amount of production one person can yield, it leads to the system of exchanging goods and services. In an exchange economy, money is needed to function as an exchange medium. Finally, if labour is the only input to production, then according to Smith, the quantity of labour that we can command should be the money price or the value of those goods that we can exchange but cannot produce ourselves.

1.2.1.2 David Ricardo (1772-1823)

David Ricardo was born in 1772 and died in 1823. Despite his brief formal education, under the influence and encouragement of James Mill, he became a leading thinker and writer of his time in economics. One of his most celebrated books, *The Principles of Political Economy and Taxation* (*The Principles*), has provided significant contributions to the subject of political economy up to modern days. In *The Principles*, he makes extensive contributions on issues which Adam Smith covers earlier in detail in the *Wealth of*

Nations. For this reason, certain differences inevitably arise. David Ricardo's writing was very deductive and he criticised Adam Smith's theory of value as inconsistent, therefore, Ricardo puts forward a different theory of value.[22]

Ricardo's labour theory of value,[23] and in particular his search for an 'invariable standard measure of value', is succinctly laid out in *The Principles*. Since the first appearance of *The Principles*, many different interpretations have been placed on Ricardo's 'invariable standard measure of value'.[24] In this section we present Ricardo's labour theory and examine some of the controversies that have spawned.

Ricardo regards the theory of value as the most difficult subject to discuss. When it comes to the discussion of value, both he and Smith focus on the exchange value of goods rather than their use value. While Smith uses labour-commanded as the major element for value measurement, for Ricardo, exchange value has three elements: utility, scarcity and labour-embodied.

> Utility then is not the measure of exchangeable value, although it is absolutely essential to it. If a commodity were in no way useful - in other words, if it could in no way contribute to our gratification – it would be destitute to exchangeable value, however scarce it might be, or whatever quantity of labour might be necessary to procure it.
>
> Possessing utility, commodities derive their exchangeable value from two sources: from their scarcity, and from the quantity of labour required to obtain them.[25]

These passages set up the basis for the fundamental difference in their labour value theory analysis. According to Ricardo, utility and scarcity have very little effect on the

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[22] Details about Ricardo's disagreements with Smith's value theory can be found in Stigler (1958) pp. 358-359.
[23] Stiglier (1958) clearly questions whether Ricardo did indeed have an actual labour theory of value. He prefers to consider it as an empirical labour theory of value.
[24] Ricardo's work has received very diverse reviews, ranging from adulation to extreme criticism.
[25] Ricardo (1987), p.5.

determination of a good's value. It is the amount of labour-embodied that is "of the utmost importance in political economy"[26] and by and large decides the exchange value of a good. Ricardo rejects Smith's concept of 'labour-commanded' because he believes that labour-commanded is a very unstable measure that varies according to changes in labour supply and demand and commodity prices. Given its nature, Ricardo believes that it should not be used as a measurement of the exchange value of a good.

Ricardo's labour-embodied theory of value postulates that labour determines the relative value of commodities through the following identity:

$$\frac{P_A}{P_B} = \frac{L_A}{L_B}$$

Given P_A and P_B are prices of two goods A and B and L_A and L_B are the amount of labour that are required to produce these two goods respectively, the above identity implies that whenever there is a change in the amount of labour required for the production of a good, its price will reflect this change. For example, if the ratio of L_A to L_B increases, say due to a rise in L_A, to maintain this identity we would expect the price ratio to increase. This proposed labour-price relationship of Ricardo's could be summed up as follows:

> The value of a commodity, or the quantity of any other commodity for which it will exchange, depends on the relative quantity of labour which is necessary for its production, and not on the greater or less compensation which is paid for that labour.[27]

It is clearly presented in *The Principles* that Ricardo takes an approach to the labour value theory and price quite different from that of Adam Smith. Smith considers labour as 'the first and the original purchase money price paid for all things', and returns on capital and land are assumed to be of little consequence to the final value of goods. In

[26] *Ibid.*, p.7.
[27] *Ibid.*, p.5.

Ricardo's analysis of price (P), other factors of production are also considered. These two additional determinants of a good's value are: 1) labour wages (W) (natural price of labour), and 2) profits (Π), and together they give the identity $P = W + \Pi$.[28] Ricardo defines the natural price of labour as the wages that enable labourers "to subsist and to perpetuate their race, without either increase or diminution"[29] and argues that it is not fixed but varies with time, place, customs and institutions. There is also the market price of labour which is determined by the supply and demand forces of the labour market. In the long run, there should not be any difference between these two, as the market price will tend to converge towards the natural price. The process simply follows that high wages will encourage population growth, causing an increase in labour supply, and consequently, wages will be brought down. When wages are low, population and supply will fall ultimately resulting in a rise in wages. As the natural price of labour is so defined, food prices will have a significant effect on this subsistent wage determination.

Ricardo asserts that while prices are determined by labour wages, which are proportional to prices, profits (Π) are more or less fixed. This is one of the key assumptions in his price determination mechanism. He maintains that whenever there is an increase in wages, profits have to fall, and states that: "There can be no rise in the value of labour without a fall in profits. If the corn is to be divided between the farmer and the labourer, the larger the proportion that is given to the latter, the less will remain for the former".[30] As mentioned above, Smith takes a different view on this issue. He certainly considers the possibility of both wages and profits rising or falling at the same time. However, he lacks an explicit demonstration of what determines high and low wages, and how this differential could be explained given his emphasis on the uniformity of human nature. At the end, Smith's discussions of profit and wages are ambivalent.

Central to Ricardo's study of the labour value theory is the labour-capital ratio. He believes that capital is an important input in virtually all production processes. It can be divided into two categories: fixed and circulating capital. The amount of capital used in

[28] W and Π are measured as 'per unit output'.
[29] *Ibid.*, p.52.
[30] *Ibid.*, p.21.

the production process, fixed or circulating, to some extent indirectly affects the exchange value of goods. However, it has to be emphasised that for Ricardo it is not the absolute value of either the amount of labour-embodied or capital which will alter the price (value) of a good. It is the ratio (*L/K*) used in the production process that is pertinent. For instance, an increase in labour wage in a good that is more labour intensive, that is, for example in a two goods situation where $\frac{L_1}{K_1} > \frac{L_2}{K_2}$, this implies that the relative price of the first good will rise. Nonetheless, in the long run equilibrium, there should be no change in commodity prices, as profits are assumed to be fixed. Following this analysis, goods would be exchanged in proportion to the amount of labour-embodied in them if labour-capital ratios were everywhere combined in the same proportion.

Rent was a topic covered extensively by Ricardo in *The Principles.* In fact, it has become one of his most famous discussions in economics. Nonetheless, for Ricardo rents are just residuals and should not have any effect on the determination of prices.

Throughout *The Principles*, it is apparent that Ricardo was preoccupied with an 'invariable standard measure of value'. There are two reasons to account for his interest in the subject. First, Ricardo believes that one would find it very difficult to address the theory of value if one could not have a standard of measure to start with. Second, and more importantly, Ricardo was concerned about the equity of income distribution in a society with the existence of classes. This is well illustrated in the following passage:

> It is not by the absolute quantity of produce obtained by either class that we can correctly judge of the rate of profit, rent, and wages, but by the quantity of labour required to obtain that produce... If we had an invariable standard by which to measure the value of this produce, we should find that a less value has fallen to the class of labourers, and landlords, and a greater to the class of capitalists, than had been given before. We might find, for example, that though the absolute quantity of commodities had been doubled, they were the produce of precisely the former quantity of labour. If then in the medium, which had not varied in value, the wages of the labourer should be found to have fallen, it will not the less be a real

> fall, because they might furnish him with a greater quantity of cheap commodities than his former wages.[31]

In this passage Ricardo indicates his intention to investigate the issue of income distribution and equity through the use of a medium or a measure that should be invariable. Ricardo claims that without the service of such a device, one would easily be misled by a change in the quantity and price of the commodities going to each class. The important message that is revealed from this passage is the link underpinning Ricardo's labour theory of value: changes in *income distribution* which are expressed in terms of changes in the quantity and prices of commodities going to each class. In other words, when the value of commodities is measured by this 'invariable standard measure of value', then any changes in a commodity's value should be related to changes in *the labour value of commodities.* Therefore, if this invariable measure could be found and be used to express prices of commodities, then the reward or the income distribution to each class would be just and fair. Now that we are armed with these basic but essential understandings of Ricardo's intention to seek this invariable measure of value, we can proceed with the analysis of his search.

Ricardo states at the beginning of his search in Chapter I, 'On Value', in *The Principles*:

> When commodities varied in relative value, it would be desirable to have the means to ascertaining which of them fell and which rose in real value, and this could be effected only by comparing them one after another with some 'invariable standard measure of value', which should itself be subject to none of the fluctuations to which other commodities are exposed.[32]

As Ricardo's arguments for the desirable functions of the measure develop, two distinct features emerge. 1) This 'invariable standard measure of value' should be such that the commodity to be chosen should at all times require for its production the same

[31] *Ibid.*, pp.31-32.
[32] *Ibid.*,p.27.

quantity of labour; it would have to be produced with exactly the same combination of fixed and circulating capital as all other goods. In other words, the labour-capital ratio for its production should be near-constant over time. 2) This 'invariable standard measure' of value should be as such that when it is used to measure prices of other commodities, they are invariant to 'changes in distribution'. Ricardo describes 'changes in distribution' in detail in *The Principles*. According to Ricardo, these changes include "the degree of durability of the fixed capital employed on it";[33] and the time necessary to bring a commodity to the market. This second feature caused Ricardo so much difficulty that eventually he acknowledged the impossibility of finding it and turned his focus to the first and accepted gold as an adequate measure. As he says:

> Although I fully allow that money made of gold is subject to most of the variations of other things, I shall suppose it to be invariable and therefore all alterations in price to be occasioned by some alteration in the value of the commodity of which I may be speaking.[34]

The need for this invariable measure of value is implicitly expressed in Ricardo's discussions of value. In *The Principles* he claims that two factors are responsible for causing a change in the relative prices of commodities. The first is a change the commodity's own distribution, that is, a change in the commodity's real value. The second is shifts in the permanent rate of profits, for "every alteration in the permanent rate of profits would have some effect on the relative value of all these goods, independently of any alteration in the quantity of labour employed on their production".[35] Therefore, the main task of this perfect measure of value is to differentiate this distribution effect from the profit effect; otherwise, the resulting observations made on price changes of the commodities could indeed be very misleading and a fair allocation of income or reward to labour would be unattainable.

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[33] *Ibid.*, p.27.
[34] *Ibid.*, p.29.
[35] *Ibid.*, p.28.

Ricardo never found his ideal invariable measure of value and gold was offered instead as the closest available solution. With regard to this issue, subsequent writers on the subject have expressed their discontent. Ong (1983) writes critically on Ricardo's invariable measure of value and Sraffa's 'standard commodity'. In the paper, in particular, he presents very direct and sometimes unmerited attacks on Ricardo's search for this invariable measure of value. In order to offer a better understanding of Ricardo's idea of this invariable measure of value and at the same time to assess the validity of these charges, we will examine some of Ong's accusations.

Ong attacks Ricardo's second feature of determining this 'invariable standard measure of value' on two fronts. First, he maintains that since Ricardo begins his search for an 'invariable standard measure of value' by conceding that it is an impossible task to achieve, all subsequent discussions on the topic thus become extraneous. Ong's charge is based on how Ricardo begins his section on an invariable measure of value in *The Principles*:

> Of such a measure it is impossible to be possessed, because there is no commodity which is not itself exposed to the same variations as the things the value of which is to be ascertained; that is, there is none which is not subject to require more or less labour for its production. But if this cause of variation in the value of a medium could be removed if it were possible that in the production of our money, for instance, the same quantity of labour should at all times be required, still it would be subject to relative variations from a rise or fall of wages, on account of the different proportions of fixed capital which might be necessary to produce it, and to produce those other commodities whose alteration of value we wished to ascertain.[36]

In addition to this issue, Ong also questions the dubiety of the money medium. According to Ong, if the first feature of this 'invariable standard measure of value' has already failed to satisfy the required qualification, therefore, and once again, any

[36] *Ibid.*, p.27.

deliberation on the second feature will be superfluous. In order words, without the existence of an invariable yardstick, how is one to carry out a search for an invariable measure?

Few, including this author, would disagree with Ong's logical development of his contentions. It is obvious that if one rejects the existence of the first feature, *i.e.* the existence of an invariable money medium, or accepts Ricardo's own confession of the impossibility on its face value, then the second feature seems unimportant. However, we believe that the use of gold as a money medium is a theoretical solution to a theoretical problem. Furthermore, Ricardo's own awareness of its impossibility does not disqualify him from carrying out such a search attempt. This argument of Ong's could be treated as semantic rather than economic, hence the strength of it is greatly diminished. Instead of plainly accepting the afore-cited passage on Ricardo's admission of the impossibility of ever finding this 'invariable standard measure of value', one would be more inclined to interpret it as a statement regarding the difficulties of finding a *perfect* measure of value and the necessity of using a *near-perfect* measure of value such as gold.

In all fairness to Ricardo, much of the defense presented in this paper is interpreted directly from his original work. We never claim that Ricardo has found the perfect measure of value. On the contrary, gold, an imperfect but workable measure had been used as a money measure medium by many countries over time. It is well known that Ricardo's search for an invariable measure of value was unsuccessful. It failed on the logical impossibility of defining a commodity that will satisfy the second feature.

There is little doubt regarding Ricardo's ingenuity as an economic thinker and writer. Analyses contained in *The Principles* prove this. However, one has to be a little sceptical on the accuracy of his analysis relating labour value theory to gold value. The long run assumptions of a fixed price of gold[37] and fixed profit rates are reasonably acceptable to most economists, but the use of gold as anchor point could be seen as a weakness in this inquiry. It may be valid for gold to be used as anchor when Ricardo is

[37] Since during Ricardo's time Britain was not on the gold standard, the term 'gold price' can be defined as the market price per unit of gold.

looking at the short run fluctuations of gold price, which by implication of his arguments, were small in his time. He further assumes that the value of gold will remain the same, if the labour-capital ratio in gold mining does not change. However, one can easily contend that as technology advances, and geographic factors differ, this ratio is unlikely to remain constant. Furthermore, as international trade expands (this was an important factor affecting gold price during his period), it would be very difficult for the price of gold to be fixed in the long run, unless the government were totally committed to such a policy. With gold price varying, wage increases will lose their neutral effect on price and his hypothesis will collapse. Unlike Ricardo, Smith in the *Wealth of Nations* did not seek a standard measure of value. However, under the discussion of the price of labour, he proposes to use corn price as a measuring rod for labour value. We are not saying that Smith's value yardstick, the corn price, betters gold. Corn, being an agricultural product, is subject to many unpredictable and uncontrollable factors that will eventually affect its yield, hence its price. Therefore, we believe that neither Smith nor Ricardo has a commodity that could be used as a standard of measure that is invariable in its own value.

To conclude, first, in modern days we can expect some inflationary pressure on the economy whenever there is a wage increase, hence the link between price and labour wage is a reasonable suggestion. Secondly, if gold could satisfy Ricardo's requirements of an 'invariable standard of measure' and correctly reflect the amount of labour embodied with minimal fluctuation, then his theory of value and labour could be a strong argument in supporting a return to the gold standard.

Overall, Ricardo did give us some instructional insights and masterly analytical techniques in economic analysis. These examples can easily be found in his examination of the relationships between wages, machinery, profits, taxation and last but not least, rents, which many subsequent economic writers such as John Stuart Mill benefited from. Regardless of the aforementioned weakness in his analysis of value, for students of economics, Ricardo's contributions and influence are serviceable and immense.

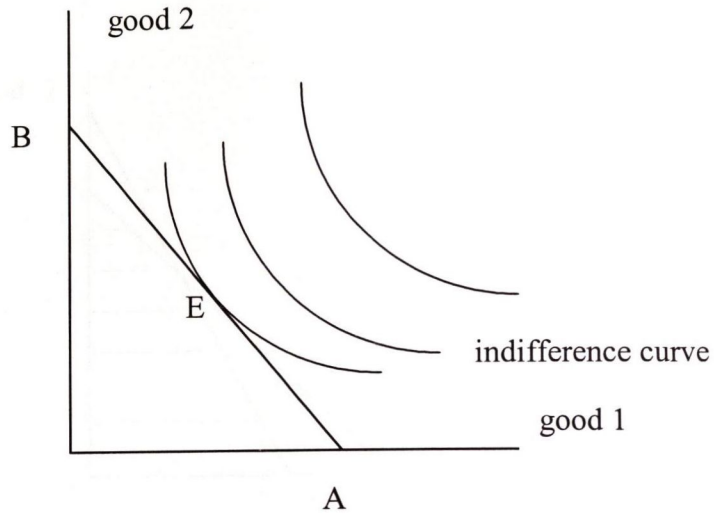
1.2.1.3 *A case for the Labour Theory of Value – Production with non-substitutability and constant returns to scale*

The labour theory of value of the classical school is frequently criticised on the grounds that other factors of production such as capital and rent are excluded from serious consideration.[38] The discussion of the nonsubstitution theorem, which started in the 1950s, shows us what the world would have to be like for the labour theory of value to be correct. This section presents the basic concept of this theorem and the situations in which it will fail to produce the required result.

The nonsubstitution theorem was first proved independently by Paul Samuelson (1951) and Nicolas Georgescu-Roegen (1951). The theorem states that if: 1) there is only one non-produced input (e.g. labour), which is essential as an input in all processes, and whose price is always positive. 2) there are constant returns to scale in all processes and 3) there is no joint production; then only one equilibrium vector of relative prices is possible for the economy. That is, when all three assumptions are fulfilled, equilibrium relative prices are independent of demand and depend only on supply side factors. Therefore, for a given technology, the price of any good depends only on the price of labour.

Consider the simplest case where labour is the only non-produced input (no inter-industry transactions). The typical firm under constant returns has production of $X_i = a_i L_i$, where the a_i are production coefficients. With two goods, X_1 and X_2, we have $X_1 = a_1 L_1$, and $X_2 = a_2(L-L_1)$, where L is total labour supply, so $X_2 = a_2(L-X_1/a_1)$, defining the (linear) transformation or production possibilities frontier (PPF).

[38] They are considered but they are also mostly assumed to remain constant over time.

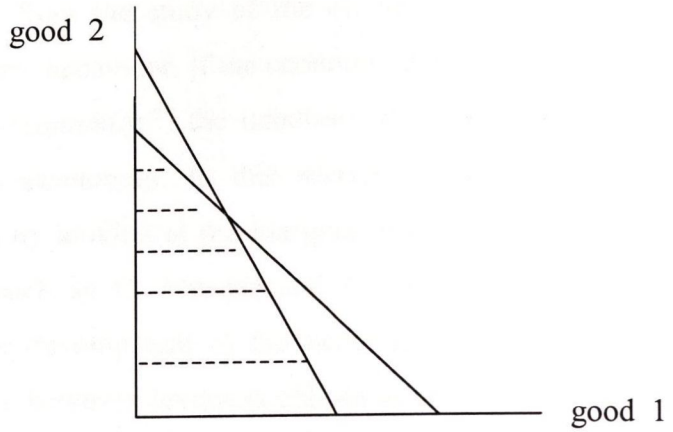


In the above diagram, *AB* is the PPF in an economy in which there are two produced goods, 1 and 2. Each requires an input of labour only (labour must be the only non-produced input),[39] and the fixed supply of labour locates *AB*. Constant returns everywhere means that *AB* is a straight line. In general equilibrium, all consumers' marginal rates of substitution between good 1 and good 2 (MRS_{21}) are equated. So when we look at the representative consumer's indifference curve, the general competitive equilibrium will be at a tangency point like *E*. The equilibrium P_1/P_2 is the slope of *AB*. A shift in demand equals a change in the indifference map and generally, *E* will be somewhere else on *AB* but P_1/P_2 doesn't change in equilibrium.

The result does not hold if we have decreasing returns at some points, since then *AB* will be concave to the origin at some points, and a shift in demand may shift relative prices. As increasing returns present difficulties for general equilibrium economics, we don't consider this case. But in the case of constant returns to scale, the theorem shows how the price of a good depends on the price of labour when it is an essential input in the production process.

However, if there were, say, two non-produced inputs in fixed supply, both essential to the production of goods 1 and 2, then the PPF would be as follows:

[39] But 1 can require input of 2 and *vice versa*.



Each of the backward sloping lines is the PPF for one non-produced input, ignoring the restrictions on supply of the other. The production set is the intersection of the sets below these lines *i.e.* the shaded area. The production frontier now has two linear segments and a kink. There is an infinity of possible equilibrium prices, bounded by the slopes of the two linear segments, and noting that equilibrium may occur at the kink. In this case, equilibrium prices also depend on demand. This contradiction demonstrates the importance of assuming labour as the only non-produced input in the nonsubstitution theorem. Although this theorem is built on very restricted assumptions, it provides us with an idea about the type of world that would be required for the labour theory of value of the classical school to be correct.

1.2.2 Neoclassical school and utility

Prior to the emergence of the neoclassical school, the classical school dominated the study of political economy. For the theory of value, the classical school produced a labour theory to account for the value of most commodities and services,[40] while the neoclassical school takes a complete different approach to the subject. According to the neoclassical school, the most important determinant of goods' value is utility, *viz.* the amount of satisfaction that the consumers can obtain from the consumption or possession of this

[40] We say 'most' because when Ricardo discusses about value, he excludes goods such as paintings, statues, rare books and coins. According to Ricardo, the value of these goods will be determined by demand (scarcity), but the number of such goods is assumed to be small.

bundle of goods. With the introduction of utility to the theory of value, the centre of attention is shifted from the study of the classes and society to the price system and individual consumers' behaviour. If the economic thoughts of the classical school could be classified as *macroeconomics*,[41] the neoclassical school's economic doctrines form the foundation of *microeconomics*. In this section we shall present the ideology of the neoclassical school by looking at the marginal revolution. We are aware that there were other economists such as C. Menger and L. Walras, writing and making significant contributions to the development of the neoclassical school at the same time as W.S. Jevons (1835-1882), however Jevons is chosen as the representative of the school simply due to his originality[42] in the subject.[43] The marginal revolution did not begin within a short period of time; indeed before 1871 discussions of a utility-based theory of value had already taken place in Ireland. The following section presents some of the forerunners of the neoclassical school at Trinity College, Dublin.

1.2.2.1 Trinity College, Dublin, 1832 - 1863

The economic doctrine of the neoclassical school is generally considered to have started in 1871 when the principle of diminishing marginal utility was formalized. However, if one looks back at the history of economic thought, in particular, at the work of economists at Trinity College, Dublin during the period 1832 – 1863, it is not difficult to detect the appearance of discussions of the theory of value based on the subjective utility approach.[44]

This era began in 1832 when the Professorship of Political Economy[45] was founded at Trinity College, Dublin by Richard Whately (1787-1863) after his appointment as Archbishop of Dublin. Whately himself was a well-known opponent of the labour theory of the classical school and strongly advocated the utility approach. In fact, in his

[41] In the sense of a concern with classes and income distribution within a nation.
[42] Jevons is so important to the marginal revolution that frequently it is called the Jevonian revolution.
[43] Of course, we admit that our choice of writer is a rather subjective one. Nevertheless, Jevons' contribution to the revolution is unquestionable by most standards.
[44] Material presented in this section is drawn heavily from Black (1945).
[45] This Professorship of Political Economy was renamed in Whately's honour in 1979, but it will be convenient to refer to it as the Whately Chair or the Whately Professor throughout our discussions.

lectures in Oxford University in 1831, Whately asserted, "It is not that pearls fetch a high price because men have dived for them; but on the contrary men dive for them because they fetch a high price".[46] He reiterated these views some years later in his *Easy Lessons on Money Matters; for the Use of Young People*. Due to his interest and personal influence over some of the subsequent occupants of the Whately Chair, his views on the theory of value were maintained and further developed.

The most prominent academic economist in Trinity College, Dublin during the mid nineteenth century was the first occupant of the Whately Chair – Mountifort Longfield (1802-1884). In his *Lectures on Political Economy*, delivered in 1833 and published in 1834, he dismisses the Ricardian theory of value and distribution. Instead of considering labour as the major factor in value determination, Longfield's idea of value attaches greater weight to the demand-supply determination of price, and to the importance of utility to value:

> that the value of every article depends upon the demand and supply, and that indirectly the cost of production of any commodity, as well as its utility, has an effect upon its price. The cost of production, by its influence upon the supply, since men will not produce commodities unless with the reasonable expectation of selling them for more than the cost of producing them. And the utility has some effect, although not so easily calculated, since it is to its utility, in the more extended sense of the word, that the demand is to be entirely attributed.[47]

> The measure of the intensity of any person's demand for any commodity is the amount which he would be willing and able to give for it, rather than remain without it, or forgo the gratification which it is calculated to afford him.[48]

Longfield acknowledges the different degree of intensity for individual consumers; sometimes the degree is so low that demand (purchase) cannot materialize. However:

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[46] Whately (1832).
[47] Longfield (1834).
[48] *Ibid.*, p.111.

> ... all will effect their purchases at the same rate, *viz.* at the market prices... Now if the price is attempted to be raised on degree beyond this sum, the demanders, who by the change will cease to be purchasers, must be those the intensity of whose demand was precisely measured by the former price... Thus the market price is measured by that demand, which being of the least intensity, yet leads to actual purchases.[49]

This passage shows Longfield's pioneering thought on marginal utility, and how this concept determines the maximum price that each individual would be willing to pay for a purchase. This analysis of the relationship between price and demand is similar in spirit to Marshall's analysis in later years. Longfield's idea of demand intensity is further supported and made most succinctly in the following statement:

> The intensity of demand varies not only in different places, and among different individuals, but in many cases the same person may be said to have in himself several demands of different degrees of intensity.[50]

Longfield's example of how a person would adjust his consumption as a result of a change in price, reflects the various degrees of desire intensity that he possesses. Looking at the above passage, we wonder whether if only Longfield had gone into more detail about how the different degrees of intensity varied as the quantity of the commodity increased, he might have discovered and formalise the idea of diminishing marginal utility before Jevons, Menger and Walras in 1871.

James Anthony Lawson (1817-1887) became the third Whately Professor in 1841. In his *Five Lectures on Political Economy*, the topic of 'nature and production of value' was discussed. In line with the thoughts on value of his predecessors, Lawson maintains that:

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[49] *Ibid.*, pp.111-113.
[50] *Ibid.*, p.113.

> It is a proposition always true, and of universal application, *that the exchangeable value of all articles depends upon their utility*, that is, upon their power to gratify the wants and wishes of man... Every other principle which has been assigned as the regulating cause of exchangeable value, is of partial and limited application, and subject to many restrictions and exception.[51]

To advance the principle of utility further, Lawson writes on the concept of diminishing utility, and states that:

> Demand and supply *generally* influence this utility; for instance, if *A*'s supply of *X* be increased, this will generally diminish its utility to him, or the degree in which he desires its possession, for as our particular desires are capable of being satisfied, it is obvious that we may have more of an article than we wish to use, and therefore the retaining the possession of that surplus is less desirable to us.[52]

Nevertheless, knowing that the case might not be universally applicable to all goods and services, Lawson also concedes that:

> The exception to this is, when the article is not one which will spoil by keeping, and when we have a prospect of being able, by keeping it longer in our possession, to obtain more of what we want in exchange for it.

This statement could be considered as an excellent contender to replace the tautology of John Stewart Mill of the classical school on the labour theory of value: "If the wine which is put in the cellar is increased in value one-tenth by being kept a year, one-tenth more of labour may be correctly considered as having been expended upon it".[53] Unfortunately, Lawson did not devote himself more thoroughly to economic theory and also regrettably little attention has been paid to his limited but great work in economics.

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[51] Lawson (1843), p. 144.
[52] *Ibid.*, p.144.
[53] Mill (1824), pp.97-98.

In 1846 William Neilson Hancock (1820-1888) succeeded Lawson in the Whately Chair. In his *Introductory Lecture on Political Economy*, delivered in 1848, Hancock points out the ambiguity of the word 'value' and sets out to discuss the theories of prices and of money. Extending beyond the tradition laid down by Longfield and moving more towards the mind of Alfred Marshall, in addition to utility Hancock discusses the importance of demand and supply in giving rise to price/value.

> To proceed then, with the theory of prices, it is found by observation, that no intrinsic variation takes place in the price of any commodity, except from one of two causes; either a change in the degree in which its possession is desired, or in its desirability; or a change in the force of the causes by which its supply is limited, or in other words, by which it is made scarce.[54]

> As very few commodities are capable of an instantaneous increase in supply, the intrinsic variations in prices for short periods depend almost entirely on the changes in the desirability of commodities. But as most commodities can be increased in supply, the permanent intrinsic variations in prices depend almost entirely on changes in the degree of their scarcity.[55]

Although Hancock has never been considered as a mainstream economic theorist, his sole essay in economics, *Introductory Lecture*, is praised by R. D. C. Black (1945) p. 145:

> This, however, provides one of the most interesting discussions of value theory given by any member of this group of Dublin economists, a discussion particularly noteworthy for its unusual anticipation of modern views.

Due to the limited capacity of this paper only three Whately Professors' thoughts in the theory of value are presented. However, during this period others such as John Elliott Cairnes (1823-1875) and Arthur Houston (1833-1914) also provided valuable

[54] Hancock (1848), p.14.
[55] *Ibid.*, p.14

discussions on the value theory that are closer to the idea of a cost-of-production theory of value. Taken together, the contributions to the theory of value of the nineteenth century Trinity economists though frequently overlooked are of great significance to the development of economic doctrine, in particular, by the subsequent more prominent neoclassical economists.

1.2.2.2 Jevonian (Marginal) revolution

The emergence of neoclassical economics is generally identified with the discovery of the principle of diminishing marginal utility in 1871 by W.S. Jevons (England); C. Menger (Austria) and L.Walras (France). In classical economics, there are classes but no individual, while for the neoclassical school the individual agent becomes everything. For the neoclassical school, economics now becomes a mental and a natural science. Economics is about the study of maximizing pleasure (wants) and minimizing pain (efforts). Neoclassicists believe that we can quantify pain and pleasure. Following Jeremy Bentham's approach, Jevons visualised economics as a 'calculus of pleasure or pain' or more generally 'hedonistic calculus'. He gives seven dimensions to the measurement of pleasure or pain including duration, intensity, certainty or uncertainty, propinquity or remoteness, fecundity, purity and extent. However, these measurements are both obscure and extremely subjective albeit influenced by the external factor of scarcity. For Jevons there is no natural price. The degree of utility for each individual varies and ultimately decreases whereas the final degree of utility determines the price. According to the Jevonian tradition, the true starting point of economics is consumption. In principle, every transaction affects price and because price is always in flux, time is an important factor.

The marginal school of thought was a product of the Jevonian (marginal) revolution around 1871. It established the principle of diminishing marginal utility, but most importantly, the utility theory of value contested the classical school's labour theory of value. With the development of the utility theory, the marginal revolution brought the treatment of economic analysis into a new era. Under the classical tradition, emphasis was placed on economic growth and income distribution. Aggregation of economic activities was assumed possible and labour played a central role in the value determination of all

commodities. However, upon the emergence of the neoclassical school, the economic thought of value was directed towards utility and scarcity. Under the utility-based value theory, aggregation was no longer germane, individual economic agents became the centre of attention. The previous more objective approach used by the classical school was now replaced by a more subjective point of view.

Jevons maintains that his utility-based value theory is better than Ricardo's because he covers every good, whereas the labour theory of value was only meant to apply to goods that could be produced with the help of labour. Furthermore, he asserts that the variation between the quantities of labour embodied and the market price of commodities is too great to be explained by the labour theory. Nevertheless, he concedes that the amount of labour devoted to the production of a good influences its supply which in turn affects the degree of utility of the good and hence, the price (or ratio of exchange). Labour can have utility and disutility. Each of us maximizing utility can decide the length of labour. Wage (W) can then be linked to the marginal product of labour (MP_L), which is balanced out by the disutility: $W = MP_L$.

Strictly speaking, the Jevonian (marginal) revolution did not begin with W.S. Jevons. There were other precursors such as Bentham and Cournot who had previously studied the utility concept. Also during the same period as Jevons were individuals such as Menger and Walras who deserve as much recognition as Jevons. However, Jevons's originality in being both a theorist and an empirical investigator[56] made him the most significant contributor to the revolution. With the inception of this Jevonian school of thought came a profound transformation in the structure of economics and also in the methods used in the analysis of the topic. In modern economic terms, the underpinning concepts of this school could be categorized under the field of *microeconomics*. The principal focus of this school is placed on issues such as consumers, firms, maximization of 'pleasure', minimization of 'pain', price, market and equilibrium positions of economic variables and so forth. Given this setting, the topic of classes that was previously so vital to the classicalists is removed from the discussion. But the most important development of

[56] In effect Jevons laid the foundation for the study of econometrics in the twentieth century.

all was that mathematics found a place in the methodology of economic analysis under the Jevonian school.

The application of mathematics in the Jevonian school was pivotal in the development of the marginal revolution. As mentioned above, central to this school is the theory of utility. All values, whether real or exchange – the distinction between them is no longer required - are derived from the subjective measure of utility.[57] Equations, graphs and formulas are extensively used. Variables are transformed into functional ones.

Many would consider that this evolution of mathematical application in economics should not be surprising since this is a world full of variables with numbers representing them. One can hardly escape the sight of numbers since the day of one's birth. The advantage of using mathematics is that one can more readily observe the movements of these variables, and thus better understanding can be obtained. With the application of mathematical methods in economic analysis, it is as if everything is being placed under the microscope. Attention on economic matters shifts from the aggregate to minute changes in the aggregate, and individuals become the centre of everything. Prior to the revolution, demand was not considered as a determining factor of prices, some, *e.g.* J-B Say, even asserted that 'supply creates it own demand'[58]. According to the classical school, prices were derived solely from the labour theory. After the Jevonian (marginal) revolution however, with the use of mathematics, a more detailed and intricate analysis of the price system was established. Changes in the quantity demanded are no longer taken as given but related to changes in price, which in turn is linked to changes in marginal utility. There is little doubt concerning the gains one can receive from the advancement of the utility theory through the applications of mathematical methods.

To summarize our discussion of the theory of value thus far, we come to two main conclusions. 1) After examining these two principal schools of economic thought, we

[57] However, Jevons never made the distinction between cardinal and ordinal utility. A further discussion on these two measures of utility will be provided in Appendix 1A.

[58] Say never actually wrote these five words. This popular expression of Say's Law was developed from the "law of markets" which he discussed in detail in his *Treatise on Political Economy*, first published in 1803.

question the degree of disparity between the value theories they each hold. In fact, we believe that both schools share some features of the value theory that are imperative for us to recognize. Instead of judging the labour theory of value of the classical school as entirely erroneous while claiming that the neoclassical school provides a precise definition of value, we prefer to say that they both have contributed significantly to the development of the theory. 2) However, the neoclassical school maintains an advantage over its counterpart because of its detailed study of one element, utility, to which the classical school has previously paid inadequate attention. Notwithstanding this comment, we are not saying that each school pays attention solely either to supply (labour) or demand (utility) condition of the market and entirely ignoring the significance of the other. In fact, the following passages show that the classical school is aware of the importance of utility to value, whereas neoclassicalist such as Jevons believes that labour is also a factor that affects supply and then in turn affects value.

Adam Smith:

The word VALUE, it is to be observed, has two different meanings, and sometimes expresses the *utility* of some particular object, and sometimes the power of purchasing other goods which the possession of that object conveys. The one may be called value in use; the other, value in exchange [italics mine].[59]

David Ricardo:

Utility then is not the measure of exchangeable value, although it is absolutely essential to it. If a commodity were in no way useful - in other words, if it could in no way contribute to our gratification – it would be destitute to exchangeable value, however scarce it might be, or whatever quantity of labour might be necessary to procure it [italics mine].[60]

W. S. Jevons:

But though labour is never the cause of value, it is in a large proportion of cases the determining circumstance, and in the following way: *Value depends solely on*

[59] Smith (1986) - *Wealth of Nations*, p.174.
[60] Ricardo (1987), p.5.

the final degree of utility. How can we vary this degree of utility? – By having more or less of the commodity to consume. And how shall we get more or less of it? – By spending more or less labour in obtaining a supply. [61]

These passages demonstrate that both utility and labour are considered as important factors of the determination of value. Neither the classical nor neoclassical school is discounting the existence of either element in the formulation of value. Nevertheless, the different amount of attention that each school pays to utility and labour causes a variance in their fundamental principle of value. Stigler (1958) defends Ricardo's value theory by asserting that his theory is an empirical but not an analytical labour theory of value - Ricardo came to the conclusion that labour was the dominant determinant of value only due to his observations during his time. Should Stigler's assertion be correct, then perhaps we should be more cautious in criticising the classical school and especially Ricardo for relying too much on labour as the key source of value.

The disparity between the two schools of thought is resolved to a great extent when the more modern concept of ordinal utility is introduced. Since the time of Alfred Marshall, modern economics proposes that both demand and supply play an equally important part in the determination of value. At a later date, John Hicks refined the analysis further.

1.2.3 The modern view

In the previous two sections we presented the views of the two leading schools and discussed their contributions to the development of the theory of value. In this section, a brief review of more recent work on the value theory will be undertaken. The modern view on the theory of value is dominated by the work of Alfred Marshall, John Hicks and the general equilibrium approach. Marshall's analysis of the demand for and supply of goods and services in particular has played an important role in the advancement of the utility-based study of value. At a later date, by using the concept of ordinal utility and

[61] Jevons (1970), p.187.

identifying the income and substitution effects, John Hicks refined Marshall's demand and supply analysis. Between the eighteenth and twentieth centuries the theory of value first evolved from a supply to a demand orientated perspective and then more recently to a synthesis in which both supply and demand have co-equal roles in price determination. However, up to and including Marshall,[62] these analyses of value had tended to focus on a single market equilibrium situation, hence the introduction of the general equilibrium approach in which the interactions among all markets are considered subsequently.

1.2.3.1 Alfred Marshall (1842-1924) – Supply and demand, a pair of scissors

In *The Principles of Economics* (1890), through the study of supply and demand Alfred Marshall offers a parsimonious but indispensable analysis of the theory of value and price. On the demand side, by applying the law of diminishing marginal utility, Marshall shows that the demand for a good is dependent on the consumer's utility.[63] As presented above, the law of diminishing marginal utility says that the more of a good a consumer has, the utility derived from its consumption diminishes from the additional purchase. This consumer will go on purchasing the good until the pleasure of its purchase becomes zero. In other words, the consumer will stop purchasing the good when he feels that the price he has to pay exceeds the gain from having an extra unit of good, hence an equilibrium situation arises. At this point of equilibrium, any fall in price will induce the consumer to start purchasing the good again. Thus, in theory a demand curve can be drawn up showing the quantity of goods the consumer would be willing to purchase at different price levels. On the supply side, Marshall believes that time is a key element in the production of goods. He classifies time as 1) the market period in which the supply of a good is fixed; 2) the short run in which supply can be increased, and 3) the long run in which production can be increased. Nonetheless, Marshall considers that the most important factor affecting supply is the fact that higher prices are necessary to increase the output of a good, resulting in an upward sloping supply curve. Bringing together the demand and supply curves, the price of a good is then determined at the point where the

[62] The majority of Hicks' economic analysis extends to the temporary and general equilibrium framework. However, for his work on value, especially his discussion on the income and substitution effects is based on a single market approach that is similar to Marshall.
[63] Marshall was talking about cardinal utility.

two curves intersect. This intersection of the two curves works like a pair of scissors for the determination of a good's value and price, neither blade of which cuts without the presence of the other.

In spite of the fact that Marshall was in the long tradition of the classical school, he maintains that demand and supply each plays an essential role in the price and the value of a good and as such both the classical and neoclassical schools are not entirely mistaken in their theory of value. Marshall's analysis of demand, supply and prices significantly helps to resolve the disparity between the classical school (supply side) and neoclassical school (demand side). For the theory of value, Marshall produced a system with a utility-based demand and cost-based supply functions. In short, Marshall's theory of value is wholly reduced to a theory of price that can be determined by the interaction between demand and supply.

There are other aspects of Marshall's economic analysis approach that make him into such a distinctive economist. Maybe because Marshall was a mathematician by training, he was a far more cautious practitioner of mathematical economics. In addition, Marshall had a profound attachment to earlier British economic thinkers such as Ricardo and James Mill and he wanted to salvage rather than destroy the classical school tradition. While the marginalists would fill their text with numerous symbols and formulas, Marshall, in *The Principles of Economics*, hides the diagrams in footnotes and the equations in appendices. Since Marshall integrates the works of the classical economists with the marginalists such as Jevons and the Lausanne and the Austrian schools, Marshallian economic analysis is also referred to as the Cambridge neoclassical school. Despite this title, Marshall and the Cambridge neoclassical economists relied on practical, intuitive arguments rather than mathematical formalism.

The other major difference between Marshall and other marginalists including Jevons, is that he kept utility theory in the background and went much further in developing a theory of supply. It is apparent that Marshall's economic analysis precedes general equilibrium analysis. Marshall claims that although in his studies he neglects the mutual interdependence between economic variables, this does not pose an obstacle so

long as adjustments within the framework are too small to cause significant repercussions to the whole system. Consequently, much of Marshall's work focuses on partial equilibrium rather than the more complicated multi-market general equilibrium system. To offer a fuller discussion on the modern view of the theory of value, we shall introduce John Hicks and his work, and it is then followed by a look at the general equilibrium approach to value.

1.2.3.2 John Hicks (1904-1989) - Ordinal utility

Prior to John Hicks the majority of the studies of the theory of value, including Marshall, were based on the concept of cardinal utility.[64] The cardinal utility approach relies heavily on the principle of diminishing marginal utility and hence, this subjective measure of satisfaction could pose a problem in the discussion of value. In the 1930s by using the concept of ordinal utility, Hicks began to break the strong Marshallian hold on British economics and consolidated the marginalist revolution that started over fifty years beforehand. In 1939, Hicks' classic book *Value and Capital* initiated much of modern *microeconomics*. In this book, the concept of 'composite commodity' and the conditions for the stability of a general equilibrium are clearly laid out, and more importantly, Hicks undertook a complete reworking of the theory of utility-based demand. In the derivation of a demand curve, Hicks extensively uses the concept of an individual maximizing utility subject to a budget constraint. Thus, in his analysis of the demand for a good he includes both the budget constraint and the indifference curves.

Hicks' analysis of the value theory is clearly shown in Chapter II (The Law of Consumer's Demand) of *Value and Capital*. Hicks noticed that when Marshall was deriving his downward sloping demand curve, the assumption of a constant marginal utility of money was made, hence, the ratio between the marginal utility of a good and its price is constant. Although Hicks concedes in this chapter that for many purposes this is a justifiable simplification, he believes that it would be beneficial to the study of the relationship between demand and price to include the income effect. By using indifference

[64] For a more detailed definition of ordinal and cardinal utility, see Appendix 1A.

curves analysis, Hicks decomposes a change in demand, primarily due to a change in price, into two parts: income and substitution effects. He sums up his finding as follows:

> A fall in the price of a commodity does actually affect the demand for that commodity in two different ways. On the one hand, it makes the consumer better off, it raises his 'real income', and its effect along this channel is similar to that of an increase in income. On the other hand, it changes relative prices; and therefore, apart from the change in real income, there will be a tendency to substitute the commodity whose price has fallen for other commodities. The total effect on demand is the sum of these two tendencies.[65]

Applying the concepts of income and substitution effects to the supply side, Hicks finds that the analysis produces an upward sloping supply curve exactly like that of Marshall. Overall, Hicks shows that for the buyer, the income effect and the substitution effect work in the same direction except for the case of an inferior good, so that in general, a downward sloping demand curve is observed. For the sellers, these two effects work in the opposite direction except for inferior goods. Although Hicks did not dismiss Marshall's demand, supply and price analysis, he added a substantial and rich insight into the modern theory of value in which demand, supply, price and income are influential factors. Furthermore, in the construction of a utility-based theory of value, Hicks replaced cardinal utility by ordinal utility.[66] In addition, his decomposition of the income and substitution effects of a price change has laid valuable foundation to modern *microeconomics* in the twentieth century, in particularly in the study of welfare economics where ordinal utility plays a key role.

1.2.3.3 General equilibrium analysis

So far in our discussions of the theory of value, a single market equilibrium situation has been examined. In the real world, there exist markets for all type of commodities and services at different locations; therefore, extending the study of the theory of value to a

[65] Hicks (1939), p.5.
[66] See Appendix 1A for further discussion of these two concepts.

multi-market condition will be beneficial to our understanding of the subject. According to the classical school value is determined by labour, whereas the neoclassical economists believe that it is utility that gives rise to the value of a good. At the later stage, both Marshall and Hicks developed a demand and supply framework to produce an equilibrium price. To these more recent economists, the study of the theory of value centres on the price system, in other words, the value of goods is represented by their prices. However, these different approaches lack the more complete analysis of the price system in which the interaction among all markets is taken into account when deriving an equilibrium market-clearing price.[67] The general equilibrium approach is the methodology that will provide us with such an examination. The following is one of the commonly used definitions of general equilibrium analysis.

General equilibrium analysis

> The study of simultaneous equilibria in a group of related markets. The prime focus is whether there is a set of prices that would ensure that equilibrium exists in each market. If so, is such an equilibrium stable - if disruptions occurred, would there be a tendency to return to equilibrium? And is such an equilibrium unique, or are there any sets of prices at which all markets clear? The analysis is attributable to Walras, who limited his consideration to a theoretical economic system in which all consumers were utility-maximizers and firms perfectly competitive. A unique, stable equilibrium can exist in such an economy. *The Penguin Dictionary of Economics.*

The most important aspect of general equilibrium analysis is the finding of a set of prices and quantities that would clear all the markets simultaneously. According to the above definition of the general equilibrium concept, there is no guarantee that such an equilibrium exists and is unique. However, if it exists and given the maximization

[67] Some may question the accuracy of our claim by saying that the general equilibrium concept has always existed in the neoclassical system in particular with reference to Walras's work on the subject. Our answer to this charge is that even though Walras was working on the subject under the framework of the neoclassical school, the full concept was introduced but never proven by him. The study of general equilibrium analysis and the proof of the existence of an equilibrium were only extensively performed at a later stage by economists such as John Hicks, K. J. Arrow and G. Debreu.

behaviours of both consumers and firms, this equilibrium will lead to a Pareto efficient situation in which all gains from trade are exhausted. The study of general equilibrium analysis is a natural product of the development of both supply and demand in the market situation. Once economists have accepted the use of supply and demand analysis or the price system to explain the value of goods and services, general equilibrium analysis simply offers us additional insight into a more comprehensive situation in which the set of equilibrium prices is a set of market clearing prices for each individual market. The introduction of the general equilibrium analysis perfectly concludes our chronological study of the theory of value from demand to supply to both interacting and then from a single market to each of the existing market. To summarize, for the study of value, we start with labour followed by utility and then they are assembled into a single-market price system, and finally it reaches a multi-market state.

1.3 Theory of Money – Modern money as the medium of exchange

The form of money that is being used in most modern economies is fiat money. It is a type of paper with no intrinsic value but with which any individual may buy most things by law. Its value is based on the fact that money is accepted because it is accepted.[68] Once fiat money is accepted the organization and communication costs involved in reverting to barter are so great that although individual players may feel that it is an unfair game, they will nevertheless find it impossible to get out of the game. The efficiency of fiat money comes from the fact that it can be produced at low cost. Thus, the essential advantage of fiat money over commodity money is that fiat money helps by freeing resources that would otherwise be used to produce commodity money. However, prior to the creation of fiat money, commodity money was the most readily recognized form of legal tender and it has been intensely studied by great economists such as David Hume, Adam Smith and David Ricardo. However, the existence of money is not essential for all economic modelling. In the Arrow-Debreu type of pure exchange economy, the function of money is entirely absent. In this section we shall present the views on the function of money corresponding to these two polar cases.

[68] Generally speaking we can think of money as accepted because 1) individual consumers need it for exchange and to pay taxes and 2) government needs it to pay its own employees.

1.3.1 The very classical world – commodity money

Commodity money can generally be defined as the commodities that are most saleable in an economy. Adam Smith mentions in the *Wealth of Nations*[69] that during different time periods and at various locations, commodities such as cattle, salt, shells, dried cod, tobacco, sugar, leather and even nails have all been used as a form of money. Eventually due to their durable and divisible quality, metals such as iron, copper, silver and gold were preferred. Then at the end, the inconvenience and difficulty of weighing those metals gave rise to the institution of coins. In the world of the classical economists, commodity money was the chosen type of money[70] and the need for money was brought forward:

> It is in this manner that *money* has become in all civilised nations the universal instrument of commerce, by the intervention of which all kinds are bought and sold, or exchanged for one another [italics mine].[71]

> It is more natural and obvious to him, therefore, to estimate their value by the quantity of money, the commodity for which he immediately exchanges them, than by that of bread and beer,.... the exchangeable value of every commodity is more frequently estimated by the quantity of money, than by the quantity either of labour or of any other commodity which can be had in exchange for it.[72]

These two passages show how once again Smith reiterates the necessity of using money as an approximation of the value of labour.[73] However, in its exchange function, what is the value of money reflecting? To this Smith submits the following:

> In this popular sense, therefore, labour, like commodities, may be said to have a real and a nominal price. Its real price may be said to consist in the quantity of the

[69] Smith (1986) – *Wealth of Nations*, Chapter IV, *Of the Origin and Use of Money*.
[70] Maybe because it was available for consideration during their time.
[71] *Ibid.*, p.174.
[72] *Ibid.*, p.177.
[73] Of course, we have come to the point at which we are familiar with the classical school's labour theory of value.

necessaries and conveniences of life which are given for it; its nominal price, in the quantity of money.[74]

So it is very clear in Smith's mind that money, when functioning as a medium of exchange, should also serve as a gauge of the nominal price of labour. In other words, according to the labour theory of value, it is desirable or expected that money should truly reflect the value of commodities or the price of labour.

Previously we examined how Ricardo's view on value (labour-embodied) is different from that of Smith (labour-commanded). And in addition, they also proposed different commodities to function as money. While Smith considers using corn price as a money medium, Ricardo uses gold as the anchor point for value measurement.

Ricardo's choice of gold is due to his belief, contrary to Smith's, that the price of gold is much more stable than an agricultural produce like corn and it also satisfies the requirements of a good value yardstick. The requirements are thus: 1) to be an invariable measure of value, the commodity has to embody at all times the same amount of labour; the same combination of fixed and circulating capital and 2) the turnover rate of circulating capital and the durability of fixed capital should be the same in the production. Although we have shown that Ricardo was unsuccessful in finding a commodity that would fulfil all these requirements to become his 'invariable standard measure of value', gold was chosen as the next best solution. In *The Principles of Political Economy and Taxation* when Ricardo talks about value, clearly gold is used as the anchor point for prices. In fact, during his time, he was a strong advocate for Britain to return to the gold standard. Furthermore, in his search for the invariable measure of value, Ricardo asserts that the first prerequisite for such a measure of value is that it must be an invariable money medium. This ideal medium should at all times require the same ratio of labour to capital in its production, even though at the same time the production conditions of all other commodities may be changing. Ricardo considers gold because: "it would be a perfect measure of value for all things produced under the same circumstances precisely as itself,

[74] *Ibid.*, p.178.

but for no others".[75] Furthermore, for Ricardo, when gold is used as the anchor point, a change in the value of a good could easily be measured by its money price. Another advantage of using gold is that if money can be treated as a commodity, then its value will always reflect the amount of labour embodied in it. Hence, through money a change in labour wages would have the same effect on the price of gold as on other commodities, and this relative exchange value will not be changed. This is how Ricardo interprets the value of money in terms of the labour theory of value in his celebrated work.

So if Ricardo believed that gold was a good approximation of an 'invariable standard measure of value', then why do we still observe variations in the market price of gold? We believe that one of the plausible reasons for Ricardo to choose gold as anchor probably because he was looking at the short run fluctuations in gold price in which the amount of fluctuations is small relative to the long run situation. In the *Wealth of Nations,* Smith also has a measure of value but instead of gold, Smith considers the real value of corn rent - corn price, should be used as the anchor point for the natural price of all commodities. Smith reasons that while the real value of corn rent varies more from year to year, it varies much less from century to century, given that the demand and supply of corn are very stable in the economy in the long run. He also believes that its fluctuation is much less than that of gold and silver and as such corn price is in general more stable than gold. On the contrary, Ricardo expects that the value of gold will remain the same if the ratio between capital and labour does not change. And he reasons that if the mean value of gold does not change, then we can use it as an anchor point. Although Ricardo chooses gold as the anchor point of value (or money), the following two passages from *The Principles* show his ambivalence:

> Gold and silver are no doubt subject to fluctuations from the discovery of new and more abundant mines; but such discoveries are rare, and their effects, though powerful, are limited to periods of comparatively short duration. They are subject also to fluctuation from improvements in the skill and machinery with which the mines may be worked; as in consequence of such improvements a greater quantity

[75] Ricardo (1987), p.28.

> may be obtained with the same labour. They are further subject to fluctuation from the decreasing produce of the mines, after they have yielded a supply to the world for succession of ages.[76]
>
> Neither gold, then, nor any other commodity, can ever be a perfect measure of value for all things; but I have already remarked that the effect on the relative prices of things, from a variation in profits, is comparatively slight; that by far the most important effects are produced by the varying quantities of labour required for production; and therefore, if we suppose this important cause of variation removed from the production of gold, we shall probably possess as near an approximation to a standard of value as can be theoretically conceived. May not gold be considered as a commodity produced with such proportions of the two kinds of capital as approach nearest to the average quantity employed in the production of most commodities? May not these proportions be so nearly equally distant from the two extremes, the one where little fixed capital is used, the other where little labour is employed, as to form a just mean between them?[77]

On perusal of the above passages, one can identify Ricardo's initial hesitation in using gold as the money medium. In the first passage he certainly acknowledges the presence of other factors (one of them is *technology*), which may cause fluctuations in the supply, and hence, in the price of gold. However, reasons are also given in both excerpts to substantiate his choice of gold as the invariable money medium. Ricardo is aware of the fact that the value of all commodities fluctuates and that gold is not exempted. Nonetheless, gold is chosen on the basis that first, discoveries of new mines are so rare that fluctuations in the price of gold will be minimal. Secondly, and more importantly, although the labour-capital ratio in the production of gold may not remain constant forever, it may on average, be fairly stable relative to all other commodities. In all fairness to Ricardo, he never claims that gold fully meets the criteria that he has established. Moreover, in a world where the values of all commodities fluctuate continually, he chooses gold as the best available choice, and by approximation, gold can then be used as

[76] *Ibid.*, p.8.
[77] *Ibid.*, p.29.

the theoretical invariable money medium. Maybe we can offer Ricardo some comfort on his choice of gold by considering that this invariable money medium is selected as a theoretical solution for a theoretical problem.

1.3.2 The very Arrow-Debreu world – no money

In modern economies, there exist at least two reasons for holding fiat money. These are: (1) as a medium of exchange; and (2) as a store of value. However, in an Arrow-Debreu (A-D)[78] or Walrasian general equilibrium model there is no function for money as a medium of exchange or a store of value. In such a model, all trades take place between individuals in an abstract market. A conceptual price formation is determined by the 'Walrasian auctioneer'. Each trader is given a certain amount of initial endowments and preferences that are represented by their individual utility functions. Once a set of prices that would ensure equilibrium exists, there would be no excess supply or excess demand in any market. In fact, in this type of pure general equilibrium economy, we can simply use one of the goods as a *numeraire*, fixing its price at 1, and all other prices become independent. Prices exist because they represent the exchange ratio among goods. Hence, the function of money as a medium of exchange becomes redundant. Furthermore, when this equilibrium is achieved at a single initial date, there is no reopening of markets at subsequent dates. If the markets were reopened, they would be dormant. Therefore, the need for an intertemporal store of value is absent and once again money performs no function.

In the past few decades, the A-D model has been widely used as a formal analytic exercise in the understanding of the Walrasian general equilibrium theory. A distinctive feature of the A-D model is the availability of a full set of futures markets for intertemporal allocation. In other words, an A-D economy is typically characterized as one in which there exist all markets, including all contingent futures markets. If the equilibrium allocation is attained, every household has arranged its desired consumption plan for the present through the future, subject to its lifetime budget constraint. The

[78] For a full account of the theory, see Debreu (1959) and Arrow and Hahn (1971).

resulting allocation is Pareto efficient in terms of household lifetime utility functions. All trade takes place at a single instant prior to the actual production and consumption of goods. Remaining economic activities merely consist of fulfilment of the contracted plans of household and firms.

One of the key assumptions behind the setting of this model is that there is no friction in trade. With the help of the 'Walrasian auctioneer', at the end of the trading day the markets always clear so that values of commodities are expressed only in terms of their exchange price. In such a framework our discussion of money and wealth is unwarranted in the sense that there is no role for money and wealth is always equivalent to one's initial endowments of individual traders.

The A-D model assumes an economy that exhibits a smoothly functioning market in which frictions in trade are absent and also there exists a complete set of futures markets as such the functions of money and finance becomes redundant. We can therefore interpret this non-monetary economy as a pure barter exchange economy. However, problems inevitably arise as bartering is expensive and an inefficient means of doing business in a decentralized modern economy with millions of individuals engaged in trade.[79] The fact is, whereas monetary exchange requires only a single coincidence: a demander of good *A* meeting a supplier of good *A* and paying the supplier in money, barter requires a 'double coincidence of wants'. The most precise statement describing this problem can be found in Jevons (1875).

> The earliest form of exchange must have consisted in giving what was not wanted directly for that which was wanted. This simple traffic we call barter ... and distinguish it form sale and purchase in which one of the articles exchanged is intended to be held only for a short time, until it is parted with in a second act of exchange. The object which thus temporarily intervenes in sale and purchase is money. At first sight it might seem that the use of money only doubles the trouble,

[79] On the other hand, we must also be aware that not all goods and services can be monetized. Even in well-developed economies such as the U.S.A. and the U.K., the value of the barter segment can be quite large and cannot be easily ignored.

> by making two exchanges necessary where one was sufficient; but a slight analysis of the difficulties inherent in simple barter shown that the balance of trouble lies quite in the opposite direction ... mutually suite each other's wants. There may be many people wanting, and many possessing those things wanted; but to allow of an act of barter there must be a double coincidence, which will rarely happen.[80]

In a typical Arrow-Debreu type of pure exchange economy, for the functions of money to materialize, certain conditions must be satisfied. First, there must be sufficient variety in terms of traders and goods to make trade desirable. Secondly, there must be intertemporal and interpersonal distortions in the pattern of trade that can result in possible misallocation, and then money can be used to restore the efficiency of resource allocation in equilibrium. When these two circumstances occur, a pure exchange monetary economy arises.

Each of the two reasons given for holding money creates a set of modelling considerations in the construction of a formal model. In Section 1.5.1 we set to explore a very small bandwidth of the functions of money in a general equilibrium framework. Specifically, the goal is to examine the role of money for transaction purposes in a pure exchange monetary economy, which does not function as perfectly as the kind of frictionless A-D barter economy that we described above.

1.3.3 David Hume (1711-1776) and monetary theory

In the previous two sections, we reviewed the two polar cases of the theory of money. In this section we shall present David Hume's monetary theory. Although Hume initiated his monetary thought in the eighteenth century, we strongly believe that an examination of Hume's monetary ideas can offer us a valuable insight into the development of modern monetary theory in the twentieth century, in particular the 'quantity theory of money'.

[80] Jevons (1875), Chapter 1, p.4.

David Hume is considered to be one of the greatest eighteenth-century writers in history, sociology, political theory, literary arts, economics and philosophy. David Hume's views on economics are expressed in his *Essays, Moral, Political and Literary*, Part II (1752). Out of his nine essays on economics, this paper mainly takes 'Of Money' as the basis for our discussion.

This section on David Hume's monetary thought consists of three main parts. First, we present an outline of Hume's original writing on money. This is followed by some critical views and comments on Hume. Lastly, we offer some concluding remarks in an attempt to arbitrate these debates and comments.

1.3.3.1 Hume's monetary thought

According to Hume, strictly speaking, there is only one function of money. Money is only an instrument to facilitate trade: it is the oil that makes the wheels of trade run smoothly and easily. Despite the very simple function of money as oil to the wheels of trade, Hume maintains that due to the exchange of goods in the economy, prices of commodities are always proportional to the stock of money.[81] In a very crude sense, money is nothing but a *numéraire* of goods which are to be exchanged. This simple observation and proposition about money turns out to be one of the most important and illustrious axioms in modern monetary economics – The Quantity Theory of Money.

In order to give supporting evidence to his theory that too great a stock of money can be disadvantageous or even harmful to a nation, Hume gives an example. He asserts that countries with less commerce and a lower abundance of money are inclined to be compensated with low wage labour. For these countries, this situation can bring about some beneficial outcomes to the economy because with low labour wages, both foreign and domestic manufacturers are attracted. However, eventually as demand for cheap labour increases, wages and prices begin to rise. They will continue to rise up to the point at which all cheap labour advantages have disappeared and then again this labour will be

[81] "A crown in Harry VII's time served the same purposes as a pound does at present." Hume (1955) p.33.

banished by the same causes, with manufacturers relocating their production to another country where cheap labour wages still exist. From this Hume concludes that an abundance of money "is a disadvantage, which attends an established commerce, and sets bounds to it in every country by enabling the poorer states to undersell the richer in all foreign markets".[82]

From this first example we see how a nation endowed with less abundance of money can derive an economic advantage. But what about when money (specie) begins to flow into a nation? In answering this question, one cannot resist quoting Hume:

> Accordingly we find, that, in every kingdom, into which money begins to flow in greater abundance than formerly, every thing takes a new face: labour and industry gain life, the merchant becomes more enterprising, the manufacturer more diligent and skilful, and even the farmer follows his plough with greater alacrity and attention.[83]

A brief review of this statement gives the impression that Hume is contradicting himself; especially with regard to the conclusion he has just drawn from the previous example. On the one hand, he says that too much money is harmful to the nation; on the other hand, he thinks that plentiful of money can give new life or greater incentive to the citizens. Being a great writer on numerous subjects, naturally Hume offers a convincing rationalization for this contradiction.

To account for this phenomenon, Hume warns us to consider that although the high price of commodities may be an indispensable consequence of an increased stock of money, this outcome does not come immediately. Rather, there is a time lag before this increased money stock circulates through all the channels of the economy and impacts on every citizen. In fact, the whole process follows such that: at the beginning, there is no change perceived. Then gradually there is an increase in the price of one commodity, then

[82] *Ibid.*, p.35.
[83] *Ibid.*, p.37.

of another until eventually the prices of all commodities in the economy reach a just proportion with the new quantity of money. Therefore, according to Hume, it is only during the time lag between the acquisition of money and the rise of commodity prices that the increasing quantity of specie will yield some beneficial effects to the nation. In this passage, Hume identifies the short run and long run effects of a change in the money stock for an economy. He was the first economic writer to contemplate such an effect and indeed, this effect is still the subject of much debate these days. Modern economists acknowledge its significance in economics by calling it the 'Hume Effect'.

For all the detrimental effects of too much money in a nation that Hume discusses, nevertheless, he also proposes that it is the proportion between commodities and money which is essential. In fact, Hume believes that it is the money growth rate consistent with gradual economic growth that is more important to a nation, rather than the nominal (absolute) quantity of monetary growth. This is indicated by the following statement of the essay:

> The absolute quantity of the precious metals is a matter of great indifference. There are only two circumstances of any importance, namely, their gradual increase, and their thorough concoction and circulation through the state....[84]

Although Hume was writing in the eighteenth century, the above outline of his monetary thought illustrates how his innovative discussion of prices, money stock and money growth rate lays important groundwork for the development of modern monetary theory, in which these three variables are key issues. In spite of this favourable remark of Hume, this essay presents some of the more recent critiques of Hume.

1.3.3.2 Critiques of Hume

Comments and views on Hume's monetary thought have been numerous and broad. Naturally many support and praise Hume's innovative economic ideas, while others resent

[84] *Ibid.*, p.46.

the ingenuity of his economic essays. We consider that by examining these critiques of Hume, we can gain a fair assessment of Hume's standing in the history of monetary thought. Two papers with diverse views on Hume's monetary thought are chosen for examination. Mayer (1980) offers favourable comments on Hume's work while Rashid (1984) criticises Hume for the lack of originality. In addition to these two papers, to further Rotwein's[85] query of Hume's inconsistent comments on the subject of inflation, a quote from McGee (1989) is included. We hope that by looking at these contrasting views we can provide a balanced presentation of Hume's monetary writings.

Thomas Mayer (1980) offers a favourable evaluation of Hume by relating Hume's economic ideas to modern monetarism. In particular, Mayer focuses on Hume's writing on the quantity theory of money - the core proposition of modern monetarism. Mayer goes as far as describing Hume's paper in these terms:

> As current economic theories change, so should our evaluation of previous economists. This paper, therefore, suggests that David Hume's reputation, which has declined since the nineteenth century, should now be rising again because in 1752, long before Ricardo, he anticipated modern monetarism on an amazing number of issues.[86]

Mayer (1980) evaluates Hume's monetary view based on the 'twelve characteristics of modern monetarism'. He shows that out of these twelve characteristics, five are explicit in Hume's writings: the quantity theory, the Chicago transmission process, private sector stability, the vertical Philips curve and the preference for free markets. In order to avoid incorporating any undue technicality into the present discussion, a focus on the quantity theory will be given priority.

In Mayer's paper, the quantity theory in its modern economic interpretation can be defined as changes in the money stock that lead to predictable changes in money income. If one cares to compare Hume's original writing on the issue and the aforementioned

[85] In his introduction to Hume (1955).
[86] Mayer, (1980).

interpretation, one cannot avoid questioning the discrepancies in the relationships of 1) money stock, 2) money income and 3) general prices. Mayer seems to assume that money income is solely determined by the money stock without giving reference to other factors that may also be at work, whereas for Hume, it is a very simple matter: the money stock and prices have an unquestionable positive. So what is the magnitude and relation of these two changes? Hume acknowledges that prices and the money stock need not always move proportionally. Indeed,

> It is the proportion between the circulating money, and the commodities in the market, which determines the prices.[87]

Mayer notices an important characteristic of Hume's quantity theory of money which was previously overlooked by many other writers. The strength of Hume's theory is that it applies to the whole world rather than just to a single country. Hume seldom disregards the interdependence of each country, derived from international trade. This is clearly illustrated and supported by his well-known specie-flow mechanism, in which a country's money stock is determined by the balance of trade with other countries.

For modern monetarists, Hume's theory of the interest rate is an indispensable component of the quantity theory. Hume believes that an increase in the money stock may sometimes lower the interest rate temporarily, depending on the sources of loans and he also states in his essay that a low rate of interest is not the effect of a high stock of money:

> Lowness of interest is generally ascribed to plenty of money. But money, however plentiful, has no effect, *if fixed*, than to raise the price of labour. Interest in BATAVIA and JAMAICA is at 10 per cent, in Portugal at 6; though these places, as we may learn from the price of everything, abound more in gold and silver than either LONDON or AMSTERDAM.[88]

[87] Hume (1955), p.43.
[88] *Ibid.*, p.47.

Mayer is aware of the source of the difference between Hume's interest theory and that of Friedman (1968) [p.67] statement:

> ....high and rising nominal interest rates have been associated with rapid growth in the quantity of money, as in Brazil or Chile or in the United States in recent years, and ....low and falling interest rates have been associated with slow growth in the quantity of money, as in Switzerland now, or in the United States from 1929 to 1933.

Without denouncing either writer as being inaccurate on the subject, Mayer is quick to recognise that the differences between them arise from the fact that Hume is talking about a high stock of money, while Friedman is talking about a high growth rate.

Hume agrees with modern monetarists that a change in the money stock can affect both consumption and investment. In fact, both Hume and Friedman believe that an increase in the money stock only has a temporary effect on employment and that afterwards only prices will be increased. Hume draws a sharp distinction between the short run and the long run.[89] Hence an increase in money stock will raise employment and output temporarily but only prices will increase in the end. Mayer praises Hume on this issue and even honours him by calling this the 'Hume Effect'.

In spite of Mayer's favourable evaluation of Hume's contribution to economics, in his paper he asserts that Hume is not the first to ascribe inflation to an increase in the quantity of money; Briscoe (1694) had already written out an equation of exchange.

Most frequently, many have claimed that Hume did not acknowledge his sources, in particular his predecessors such as Gervaise, Cantillon and Vanderlint. Furthermore, Hume's writing is somewhat inconsistent in certain areas. One of the most critical comments of Hume can be found in Rashid (1984). Apart from a few valid and useful examinations of Hume's essays which are somewhat unconnected to the discussion of this

[89] We have indicated this earlier under the discussion of the short and long run effect of an increased money supply.

paper, Rashid's criticism of Hume is mainly built on the charge of plagiarism. Nevertheless, to maintain a balanced view on both sides, here I quote from Rashid (1984):

> In apparent ignorance of the contribution of Hobbes, Barrow, Berkeley and others, Beattie wrote of Hume and induction in his *Essay on Truth*.
>
> > The sea has ebbed and flowed twice every day in time past; and therefore the sea will continue to ebb and flow twice every day in time to come – is by no means a logical deduction of a conclusion from premises – THIS REMARK WAS FIRST MADE BY MR. HUME.
>
> ....In reviewing closely Hume's contribution to eighteenth century monetary theory we have found Hume's theoretical stance to be ambiguous and his assumptions to be incompletely specified; furthermore, there is good reason to doubt the novelty of Hume's analysis.[90]

Even Rotwein who writes favourably of Hume in his introduction to the 1955 edition of Hume's writings, points out that on the one hand Hume argues that an inflow of specie would only cause inflation, whereas in a different essay, Hume asserts that a slow inflation is desirable and that governments should try to arrange for an unexpected increase in the money supply by helping to monetize the economy.

In order to answer Rotwein's query on Hume's inconsistency, perhaps one can cite Hume's essay on money: "An increase in the quantity of money can increase trade temporarily,[91].... And a decrease can harm trade".[92] In fact, it became obvious to many later writers on Hume's monetary thought that the answer to Rotwein's query can easily be found in the fact that the temporary effect of an increased money stock and prices (inflation) can be beneficial since some individuals are able to purchase more goods than before because they buy before prices rise. However, McGee (1989) argues against this:

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[90] Rashid (1984), p.163.
[91] *Op.cit,* p.38.
[92] *Ibid.,* p.39.

But as the money continues to circulate, the general price level will rise to take account of the increased quantity of money. The last individuals who receive this money will receive it after prices have risen, and thus will not be able to buy as many commodities as if they had received the money earlier, before the general price rise.

So what conclusions can one draw from these two apparently different statements of Hume and McGee? Previously, it has been stated that Hume did not regard inflation as a serious concern since there might still be scope for the economy to grow. However, we believe that given the situation of the time, if Hume were to rewrite his essay on today's economy, he might agree with McGee entirely.

1.3.3.3 Conclusions

In this paper, some different views and comments on Hume's writing on monetary economics have been presented. In reviewing Mayer (1980), one does gains some insights into the differences and similarities between modern monetarism and Hume's monetary thoughts in the eighteenth century. On the other hand, Rashid (1984) offers us some critical comments on Hume, in particular on the suspicion of plagiarism.

The intention of this paper is neither to cast doubt on David Hume's reputation as one of the greatest thinkers and writers in the eighteenth century nor to give unreserved support for regarding Hume as the father of modern monetarism. There is little doubt on Hume's ingenious understanding of numerous disciplines. However, in order to fully understand and acknowledge Hume's view on money or on other general economic theories, one has to bear in mind the kind of social and economic background during the time of his writings.

Finally, to add an interesting note to this paper, we quote from McGee (1989):

Had Hume devoted as much time to economics as had Adam Smith, we might now be referring to Hume as the father of modern economics rather than Smith.

1.4 Concept of Wealth[93]

This paper thus far has presented the theory of value from the classical school to the more recent view and also, the theory of money through a review of commodity money, the A-D world of no money and David Hume's monetary thought. The third issue that this paper addresses, which is very much linked to the other two theories, is the concept or the notion of wealth. Once again, by contrasting the old against the more contemporary view, we aim to provide a comprehensible account of how wealth is perceived and how the concept of wealth has evolved over time.

1.4.1 The old view

According to Adam Smith, this statement of his concisely illustrates the concept of wealth:

> Wealth, as Mr. Hobbes says, is power.... The power which that possession immediately and directly conveys to him, is the power of purchasing; a certain command over all the labour, or ever all the produce of labour which is then in the market.[94]

Given Smith's labour-commanded theory of value, this statement is an understandable remark. We can generalize Smith's definition of wealth to a citizen of a country and to an individual nation. The title of Smith's book *Wealth of Nations,* indicates clearly that the majority of his discussion of wealth is focused at a national level. Therefore, for the old idea of wealth, we can restrict our attention to the wealth of a nation.

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[93] Of course wealth could come in many forms. Some would argue that other aspects of life such as intelligence, health, knowledge and so on, are forms of wealth. We certainly are not discounting these factors, however, we intend to restrict our discussion to the form of wealth that can be represented by monetary units.

[94] Smith (1986) – *Wealth of Nations*, p.176.

However, in the subsequent section, our discussion will be extended to the individual level.

At the beginning of the *Wealth of Nations*, Smith defines the wealth of a nation in terms of the power of purchasing labour. Earlier, we highlighted Smith's emphasis on the uniformity of human nature, our nature of 'self-interest' and the working of the 'invisible hand'. Given these, how did he come to terms with the fact that some countries are rich while others are poor? The answer to this question, as Smith explains, comes from the labourers and their wages.

> The demand for those who live by wages, therefore, necessarily increases with the increase of the revenue and stock of every country, and cannot possibly increase without it. The demand for those who live by wages, therefore, naturally increases with the increase of national wealth, and cannot possibly increase without it ....[95]

According to Smith, as a nation becomes more opulent, demand for labour increases and wages must increase at the same time. However, there is always a limit on how high these wages can go. If wages are too high, there will be a constant scarcity of employment, and eventually wages will be bid down and reduced to the lowest subsistence level. In the *Wealth of Nations*, Smith classifies nations under three categories. First, are the rich and progressing nations, second are the stationary nations which could be rich or poor, and thirdly, are simply the poor nations. A discussion of these three types of nation is offered in the book, but most attention is paid to the so-called 'stationary rich nations'. One important conclusion is drawn from Smith's observation of these stationary countries: wages in these countries would not be high despite their richness. Smith uses the example of China to illustrate his point.

As Smith observed, China had been long recognized as one of the richest nations, in terms of being the 'most fertile, best cultivated, most industrious and populous in the world'. However, due to its long stationary status, there was nearly no progress in its

[95] *Ibid.*, p.198.

economy and wages were still very low. These low wages caused considerable difficulty for a labourer in bringing up a family. Poverty among the lower social classes in China was widespread and lingering. Despite this, one could not consider China as a backward country. Towns were still filled with inhabitants and labourers were in plentiful supply. The main cause of low wages was the fact that funds destined for the maintenance of labour were simply diminishing. In his book, Smith claims that the situation could possibly be true that China was a rich country that could advance no further, hence its low labour wages. But the kind of richness that China had acquired, given the nature of its laws and institutions, was simply much inferior to what other laws and institutions, the nature of its soil, climate, and situation might admit. In other words, the Chinese problem might result from the existence of deficient institutions and their defective systems. Nonetheless, Smith admits that despite the conceivable possibility that China could advance no further, he has yet to see any country truly reflecting such a phenomenon.

Adam Smith considers countries like Bengal and some English settlements in the East Indies as poor countries. In these countries there were too many workers fighting for jobs, thus reducing wages to the subsistence level. Naturally, famine and mortality immediately prevailed among the lower social classes. Unfortunately, this situation could subsequently extend to all the superior classes and it would only be halted when the number of inhabitants in the country was reduced to what could possibly maintained by the remaining revenue and stock which had eluded either 'the tyranny or calamity which had destroyed the rest'.

Smith regarded many contemporary European countries as rich because of the generally high level of wages. Hence, for Smith, a 'liberal reward for labour is a necessary effect and is also a natural symptom of increasing national wealth'.[96] In other words, a country's richness could be decreed by the generosity of the labour reward.

Further on in the *Wealth of Nations* Smith makes clear why such a criterion is used in evaluating a nation's wealth. He asserts that labourers made up the biggest majority of

[96] *Ibid.*, p.200.

every great political society. Therefore, surely no society could be flourishing and happy if these majority members were poor and miserable.

> The progressive state is in reality the cheerful and the hearty state to all the different orders of the society. The stationary is dull; the declining melancholy.[97]

Smith says that another important benefit relating to the liberal reward of labourers is that high wages tend to increase population. High wages enable labourers to better provide for their children, and consequently bring up a greater number of productive labourers in generations to come. Therefore, high wages also encourage industry. Nevertheless, Smith does emphasize that the quality of labour is more important than the quantity of labour. Also, high wages might induce labourers to overwork thus causing undesirable idleness for society. For example, increased sickness among workers due to overwork caused a greater loss of working days than was necessary.

In the *Wealth of Nations*, Smith gives us a very clear account of how labour wages are linked to the well-being of a nation's citizens and wealth. He shows us the extent of his awareness of the difference in wealth across nations. It is of particular interest that observations on some nations in the real world are used in order to support his theory, rather than presenting his claims as given. While Smith may not have been a great traveller of his time, he certainly was a great observer of the world economic situation. He also shows his concern for the benefits of workers in some poor or declining countries by strongly advocating a wage above the subsistence level, so that a stable and moral society could be realized.

Unfortunately, under the discussion of labour and wages, his analysis lacks an explicit demonstration of the factors determining high and low wages, and how this differential could be explained given his accent on the uniformity of human nature. His conclusions only emerge from a detailed reading of the whole book.

[97] *Ibid.*, p.205.

According to Smith, the amount of 'revenue'[98] and 'stock'[99] available in a society determines labour wages. For any opulent nation the accumulation of stock must be in such abundance that it will sustain the labour force with ease, hence liberal labour rewards are spontaneous. However, in the case of a decaying stock as in China in the eighteenth century, or in an even worse scenario where a deficient stock exists and continues, like that in Bengal and the East Indies, the whole labour force could literally be destroyed by it.

Smith says that instinctively one can imagine the occurrence of this vicious cycle with a low accumulation of stock giving rise to low wages and resulting in an even lower level of stock accumulation. This leads to further cuts in wages until all labour wages are reduced to the subsistence level, or some tragic events have to happen in order to reduce the labour force to a sustainable level. Consequently, whether a nation is rich or poor hinges on the accumulation of stock in relation to labour wages.

David Hume also provides a discussion on the concept of wealth. Although he lived in the period of mercantilism, in his essays Hume clearly distinguishes between money and wealth. In contrast to the mercantilistic point of view, Hume argues that an abundant quantity of money does not increase the wealth of a nation and domestic happiness, in fact in some circumstances it may be destructive. For Hume, a nation's wealth is determined by the goods and services it produces, but not by the amount of gold and silver it possesses, contrary to what the mercantilists believed.

> ..., that it is of no manner of consequence, with regard to the domestic happiness of a state, whether money be in a greater or less quantity. The good policy of the magistrate consists only in keeping it, if possible, still encreasing;[100] because, by that means, he keeps alive a spirit of industry in the nation, and encreases the stock of labour, in which consists all real power and riches.[101]

[98] The selling off of extra stock after satisfying the basic need for consumption.
[99] Stock is defined as goods that are stored up.
[100] Original spelling in Hume's book.
[101] Hume (1955), p.40.

1.4.2 The contemporary view

From the viewpoint of the classical school, wealth is the amount of goods and services that one owns or the amount of labour that one can command, while neoclassical economists believe that everything starts with consumption, in that wealth is the additional amount of resources or larger budget that leads to an additional amount of consumption satisfaction. However, we consider that wealth in the modern sense is beyond these two views. A very shallow but practical modern concept of wealth can be expressed by the amount of tangible assets such as bank accounts, possessions and property that an individual owns. Assuming this is an accurate definition of wealth in the modern sense, we are still puzzled by people's obsessive behaviour with wealth accumulation. The traditional assumption of the desire for consumption or the need for hard work for a higher wage seems no longer sufficient to describe an individual's craving for wealth accumulation. The following two passages perfectly sum up our belief:

> Man is dominated by the making of money, by acquisition as the ultimate purpose of his life. Economic acquisition is no longer subordinated to man as the means for the satisfaction of his material needs. This reversal of what we should call the natural relationship, so irrational from a naïve point of view, is evidently a leading principle of capitalism. (Max M. Weber, 1958 p.53)

> Once you reach a certain level in a material way, what more can you do? You can't eat more than three meals a day; you'll kill yourself. You can't wear two suits one over the other. You might now have three cars in your garage-but six! Or, you can indulge yourself, but only to a point. (Iacocca, (1988), p.67)[102]

There is little doubt about many people's preoccupation with making money – in many cases an unlimited amount of money. Under the 'spirit of capitalism', it has been suggested that social status is one of the driving forces behind our yearning for wealth. In

[102] Both quotes are extracted from Gurdip and Chen (1996).

other words, once we have satisfied our basic consumption needs and if we believe money is a symbol of wealth and success, and then the desire for making money could be solely due to the enhancement/preservation of one's social status in the society. In fact, considering its importance, Section 1.5.2.2 incorporates the idea of social status into our study of credit and bankruptcy. But before we end this section, we want to present a brief discussion of the problems that arise when defining wealth.

One technical note on Smith's notion of wealth is that he advocates high wages (rewards to labour) as a symbol of the wealth of a nation. On the surface it seems like a good definition to use since if all workers (who form a large proportion of the citizens) are receiving a higher reward, the country must be better off. But the problem remains that Smith seems to ignore the fact that higher wages could cause inflation[103] thus lowering the purchasing power of workers. Should this be the case, it could fail to produce the real benefit that Smith aspires. We have seen economists write passionately about the concept of wealth, but we still do not have a general consensus on the definition of wealth. The lack of a unified definition is quite possibly because wealth is a relative concept that is more subjective than the theories of value and price.

To facilitate our discussion of the notion of wealth, we examine the implications of using these two approaches: stock and flow. The first approach is a measure that entails the tangible amount of assets a person holds at a given point in time. However, under this approach the problem of how do we define wealthy people in a society remains. Maybe a simple and direct question to ask is how much does a person need to possess before he becomes a wealthy person? Surely the answer to the question varies from person to person and from country to country. In some developing countries, an individual might believe that to own any amount of food and resources above the subsistence level would make him wealthy, whereas, for individuals living in developed and more affluent countries, to become wealthy you may need one million dollars and two houses or ten million dollars and ten houses. The point we want to make is that the idea of a wealthy person is a very subjective and relative concept. Indeed, unlike the measurement of liquid and weight,

[103] We assume that high wages increase aggregate demand, hence results in an increase of demand-pull inflation.

there is no international standard of defining wealth, nor is there an absolute measurement of a wealthy person.

The second approach that we use in the consideration of wealth is a flow concept of income. This income approach can be further discussed through either per capita income or income growth rate. Unfortunately, the concept of wealth varies with the way we measure income. For example, in terms of per capita income, the U.S. is the one of the wealthiest countries in the world, yet poverty[104] still exists and the government is required to implement social programmes to assist those who are living with it. Alternatively, consider China - a case that was studied by Adam Smith in the *Wealth of Nations.* In Smith's time China was poor in terms of both assets and income, but nowadays though still has relatively low per capita income, China's impressive economic growth or growth rate of income has surpassed those of many developed countries. The situation of deficient institutions that was discussed by Smith is improving and China still possesses very fertile land and natural resources. Given all these advantages, in theory or at least in terms of income growth, China should be considered as a wealthy country. Nevertheless, if one pays a visit there it is not difficult to see that the gap between the rich (urban inhabitants) and the poor (rural peasants) remains big. These two examples evidently illustrate the ambiguity of the concept of wealth. If we measure wealth solely based on per capita income, China remains a poor country whereas the wealthy status of the U.S. continues. But if we use income growth to equate wealth, the result would be overturned. In fact, both the U.S. and the Chinese situations show us that may be the distribution of income among its citizens is a more fundamental issue than the aggregate amount of resources held or income received by a country.

If we believe that income distribution more accurately reflect the well-being of a nation than wealth (however defined), then a discussion of it seems serviceable. To measure the equality of income distribution within a country, the Gini coefficient and the Lorenz curve are commonly used. For an equalitarian, the amount of wealth as measured by either assets or income of a country is secondary to the issue of income distribution

[104] All those with an income below a certain threshold.

among its population, and as such the optimal objective for the country is to have evenly distributed income. Of course, this equalitarian approach towards wealth is an idealistic one. For the other approach, in the utilitarianism tradition, Jeremy Bentham's proposition of maximizing a social welfare function that focuses only on the less well off would also find it difficult to receive a wholehearted reception in the majority of capitalist countries. We agree with Adam Smith that we human beings are consistently driven by our nature/desire for bettering our conditions – 'self-interest'. The majority of the human race is so preoccupied with looking after themselves and their 'self-interests, that an equal distribution of income is not going to be a 'vote-winning' policy for most politicians.[105] Furthermore, some might argue that if we trust the working of Smith's 'invisible hand', then the amount of resources (assets or wealth) that one has should reflect a free market outcome. The final distribution will be an optimal one, regardless of whether it is equal or not.

It is not feasible to cover all the different ideas and discussions on the concept of wealth. To restrict our focus, we shall assume in the remainder of this paper that the 'spirit of capitalism' exists in developed economies and that the majority of citizens have resources well beyond what they need to subsist. Thus, the desire for excess money making and ultimately the desire to enhance social status, is outside the explanation given by the traditional theories of value and money. Regardless of its origin, the 'spirit of capitalism' is an appropriate reflection of the behaviour of many individuals in society.[106]

We cannot claim that this paper has provided a detailed study of the concept of wealth. Based on the discussion presented above, we admit our failure to find a generally accepted concept of wealth. Maybe our failure is due to the non-existence of a standard definition of wealth. Nevertheless, it is our belief that a thorough study and understanding of the theory of value and money facilitates a better appreciation of our preoccupation with wealth. In terms of money, to most laypersons, wealth is simply the amount of

[105] The problem of free riders tends to serve as a deterrent for most consumers.

[106] Actually, the significance of social status and the excessive accumulation of wealth cannot be considered as modern day events only. We strongly suspect that the idea of the 'spirit of capitalism' evolved not merely as an economic event but also due to human psychology. It must have already existed long before the development of modern economies.

monetary assets one holds or the amount of goods of services one can purchase given the amount of money one holds. However, just like someone who says that good health is wealth, this surely is also an acceptable definition of wealth. Nonetheless, this paper hopes to provide a better and broader understanding of the notion of wealth. With this understanding we might be able to gain a comprehension of our preoccupation with something (money or social status) that is beyond our basic consumption requirements.

1.5 Two Exercises on Money and Risk

The last section completes our theoretical review and examination of value, money and wealth. In this section we shall study two cases on the price of money and the subject of credit. The key difference between these two exercises comes from the treatment of risk. In the general equilibrium model of money, because of the absence of credit, risk is not discussed. However, in the second case in which a noncooperative model of money with credit is introduced, risk becomes an important issue for consideration. In fact, in this model, we include social stigma as a risk factor in the construction of an optimal bankruptcy law. We believe that these two exercises on money and risk help to extend the theoretical concepts of money and wealth into the more practical circumstances.

1.5.1 General equilibrium model of money

In Section 1.3.2 we presented a type of economy – an A-D pure exchange economy - in which the function of money does not exist. However, we also commented on the inefficiency - problem of double coincidence of wants, that is connected with this economic system, and considering the importance and advantage of a monetary exchange economy, a study of it would be beneficial to our understanding of the function of money. In this section a monetary exchange economy is analysed within a general equilibrium framework. By using this approach we aim to present an examination of the conditions under which the price of money will be positive.

The term 'price of money' has the same meaning as for other commodities. Assume an economy in which individuals are endowed with a certain amount of real

goods together with a lump sum of one commodity called money. However, amongst all commodities, money is a unique commodity in that its usefulness depends on its price. In a pure exchange monetary economy, given the price of money as P^m and the price of a commodity n as P^n, then $\frac{P^n}{P^m}$ (all real numbers) is just the number of units of money which is required in order to trade for one unit of commodity n.[107]

Money in the modern sense generally consists of useless pieces of paper whose only use is to be exchanged for some positive quantity of other goods. Like other commodities, one has to assume that the price of money is positive, that is, it possesses a positive purchasing power which reflects the exchange value of the other real commodities that we can purchase (exchange). However, if the price of money were zero, then for whatever vast amount of money one could buy absolutely nothing. When the price of money is zero there would be no unsatisfied demand for money and strangely, according to the definition of a general equilibrium, there also exists an equilibrium in which there would be no trade and no excess demand for transactions. We shall demonstrate this phenomenon subsequently in this section.

In this exercise, we shall study a pure exchange monetary economy with a finite horizon, fixed endowments amongst traders and no production. However, in such an economy it is disturbingly easy to find that only a zero price of money is consistent with equilibrium. A zero price of money effectively demonetarises the model and we may have a 'non-monetary equilibrium'. The logic behind this rather peculiar equilibrium in a finite horizon is fairly explicit. Near the terminal period of this economy, there is no point in having positive money holding at the end of the last period, if a positive price of money does exist, money holders will seek to trade money for goods to be consumed before the end of the world. Yet, at the same time, no traders will accept money in exchange for goods. Hence, money in the last period is useless and the price of money will be zero. With the expectation that the price of money would be zero in the last period, nobody will want to get stuck with any money even in the next to last period. We can regress this

[107] For discussion purposes, P^m is commonly set to one so that the price ratio is just the number of units of money that is required to exchange for one unit of goods.

argument indefinitely and the price of money will always be zero in all periods and an equilibrium with no excess demand exists and is consistent with the phenomenon.

Finite horizon models are convenient to work with; however as mentioned above we have to be extremely careful given the problem that the price of money maybe zero. In order to eliminate the possibility of the price of money being zero, previous studies have suggested three alternative models:

1. The Overlapping Generations Model of the Samuelson type: - In this framework newborn agents are assumed to arrive in each period, so excess demand for money always exists and thus the price of money is positive.

2. Expectations: - If agents always attach a positive probability to the positivity of the money price in the future, positivity of the present money price will then be ensured. Grandmont (1977) presented a temporary equilibrium model of a monetary economy that can be viewed as an extract of a single period from an overlapping generations model. In his model, inelastic expectations are used as sufficient conditions to avoid the zero price of money.

3. With taxation: - Starr (1974) suggests that the way to guarantee that the price of money is non-zero is through the taxation system. The government extracts taxes payable in money only, so that there will always be a positive excess demand for money independent of its usefulness as a medium of exchange.

We concur with the saying that in life two things are for certain: death and taxes, hence in this exercise we study a finite horizon model with taxes. We shall show that an equilibrium occurs with the payment of real taxes at a price level such that the volume of available money is just sufficient to pay for the volume of taxes. Central to our analysis is the significance of money endowment (or simply wealth) to the price of money. By further imposing a wealth tax in our model, a positive money price will then be guaranteed. Lerner (1947) offers a clear statement to support our belief in the importance of taxes on the demand for money:

> The modern state can make anything it chooses generally acceptable as money .... It is true that a simple declaration that such and such is money will not do, even if backed by the most convincing constitutional evidence of the state's absolute sovereignty. But if the state is willing to accept the proposed money in payment of taxes and other obligations to itself the trick is done. Everyone who has obligations to the state will be willing to accept the pieces of paper with which he can settle the obligations, and all other people will be willing to accept these pieces of paper because they know that the taxpayers, etc., will accept them in turn.[108]

1.5.1.1 A model with taxes and no risk

This model can be considered as a simplified version of Starr (1974). However, we endeavour to summarize the important features of Starr's model through a more deductive and intuitive approach. Furthermore, we supplement Starr's tax on the prices of real goods with a tax on wealth.

Model Assumptions:

1. N perishable[109] real goods denoted by n; for $n = 1, \ldots, N$.
2. Good $N+1$ is money denoted by m.
3. A set of T traders, whereby asymmetry is assumed in transaction activities. Hence, we can focus our attention on one trader (trader t) as the representative trader.
4. Each trader (in this case, our representative trader t) has an endowment $\overline{w}_t >> 0$. This endowment consists of both real goods $\overline{w}_t^n$ $(n = 1, \ldots, N)$ and money $\overline{w}_t^m$. Hence, the total endowment is $\overline{w}_t = (\overline{w}_t^n, \overline{w}_t^m)$, $n = 1, \ldots, N$.
5. Each trader has a continuous, semi-strictly quasi-concave utility function that fulfils strong monotonicity.[110]

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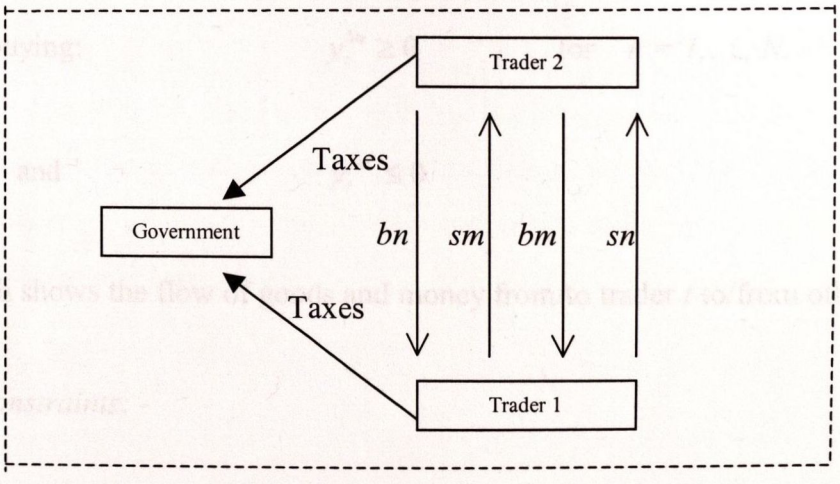
[108] Lerner (1947), p. 313.

[109] This is to ensure that the use of commodity money is forbidden.

[110] That is $x^1 > x^2 \Rightarrow u_t(x^1) > u_t(x^2)$ and $\{y | u_t(y) \geq u_t(x)\}$ is convex for all x.

6. Transactions in the economy are indicated by the 2 possibilities: *b* is buying and *s* is selling.
7. Tax payment is represented by ψ, a scalar θ which varies with prices, thus $y_t^{\psi} = \theta_t(p)$. Price vectors will be elements of ***P***, the unit simplex in E^{N+1}. Let ***P*** $= \left\{ p \mid p \in E^{N+1}, p > 0, \sum_{n=1}^{N+1} p^n = 1 \right\}$. Prices are the same for buying and selling.
8. Trader *t*'s trading activities (buy, sell, tax) are represented by $y_t \in E^{2(N+1)+1}$, or alternatively, the vector of trader *t*'s buying and selling transactions and tax payment is $(y_t^{b1}, y_t^{b2}, ..., y_t^{bN}, y_t^{bm}, y_t^{s1}, y_t^{s2}, ..., y_t^{sN}, y_t^{sm}, y_t^{\psi})$.

A general equilibrium system that trades in money must maintain both goods and money. The diagram below shows the trading flows between two representative traders. All traders in our model will follow the same transaction pattern asymmetrically[111] and identically. Henceforth, our discussion of the model and its equilibrium will focus on one of the representative agents – trader *t*, thus the summation of all individual transaction activities becomes unnecessary.



[111] Clower (1967) points out that in a monetary exchange economy, "money buys goods, goods buy money, but goods do not buy goods". In other words, exchange is a relation among goods, and the existence of a monetary exchange is evidence that this relation is asymmetric (Ostroy and Starr (1990)).

Where,

sn = sell real goods; *bn* = buy real goods; *sm* = sell money (pay money); *bm* = buy money (receive money).

We assume that all consumers in this model will try to maximize the utility that they derive from the consumption of real goods subject to the constraints they face in this monetary exchange system. Unlike the usual utility maximization problem in which consumers are only faced with a single budget constraint, in our model there are in total five different types of constraint.

(I) Transaction constraints: -

For selling: $y_t^{sn} \geq 0$ for $n = 1, \ldots, N.$ (1.1)

and $y_t^{sm} \leq 0$ (1.1a)

which shows the flow of goods and money to/from trader *t* from/to other traders.

For buying: $y_t^{bn} \geq 0$ for $n = 1, \ldots, N.$ (1.2)

and $y_t^{bm} \leq 0$ (1.2a)

which shows the flow of goods and money from/to trader *t* to/from other traders.

(II) Value constraints: -

For selling: $p \cdot y_t^s = 0$ (1.3)

For buying: $p \cdot y_t^b = 0$ (1.3a)

Since trade is made through money, the value of real goods sold and the amount of money received and *vice versa*, must equal.

(III) Tax payment constraint: -

$$y_t^{\psi} = \theta_t(p) \tag{1.4}$$

Each trader in this economy is subject to a tax payment that varies with prices. To ensure that this tax payment is not so great as to make the other constraints impossible to satisfy, we impose a restriction on equation (1.4). This restriction specifies that if the market value of the trader's endowment is smaller than the tax payment, the trader is not required to pay the tax, so we have:

$$p^m \theta_t(p) \leq p \cdot \overline{w}_t \tag{1.4a}$$

(IV) Ownership constraint: -

$$\overline{w}_t^n + y_t^{bn} - y_t^{sn} \geq 0 \qquad \text{for} \quad n = 1, \ldots, N. \tag{1.5}$$

At the end of trade, each trader will face a nonnegative constraint which requires that the amount of real goods they sell to each other must be less than their initial endowments. In other words, one cannot sell what one does not own – no commodity debts are allowed.

(V) Cash flow constraint: -

$$\overline{w}_t^m + y_t^{bm} - y_t^{sm} - y_t^{\psi} \geq 0 \tag{1.6}$$

Since taxes are paid in money and no credit is allowed, each faces a cash flow constraint. We shall see later that this constraint and its feature of no credit (no risk) is the key factor in producing a positive price of money.

Given all of the above listed constraints, trader t can maximize his[112] utility from the consumption of real goods only if constraints 1.1 to 1.6 are fulfilled.

Based on this framework, we know that since the consumption of real goods offers utility to the traders, these goods must carry a positive value and a positive price. However, although money has no intrinsic utility value, when it functions as a medium of exchange, a store of value and also as a payment for taxes, there exists a demand-driven value for it. For this reason, the next task of this paper is to identify the price of money at which all markets clear in this trading system.

1.5.1.2 The equilibrium

According to the traditional definition of equilibrium, an equilibrium arises when the results of an individual's utility maximization problem subject to constraints imply non-positive excess demand. Inasmuch as general equilibrium theory is the study of how the economy adjusts so as to ensure that demand equals supply in all markets simultaneously, the standard procedure in identifying a general equilibrium position in an exchange economy is as follows:

Beginning with an arbitrary initial set of prices, we need to check if this set of relative prices between goods fulfils the following conditions:

1) Given this set of prices and the traders' initial endowments, each individual trader is maximizing his utility.

2) Supply equals demand in all markets.

If this set of prices exists and fulfils these two conditions, it is called the general equilibrium set of prices.

[112] Throughout this thesis let us assume that his is an abbreviation of his/her.

In our model, excess demand is defined as the difference between total demand and initial endowments. In other words, we depict an equilibrium situation by requiring the following condition to hold:

$$\overline{w} + y^b - y^s \leq 0 \qquad (1.7)$$

This condition specifies that after the completion of all buy and sell transactions, there is non-positive excess demand.

Previously we indicated the importance of using taxes to achieve a 'meaningful' equilibrium. We shall demonstrate the derivation of this equilibrium through the study of two scenarios. To facilitate our study, we extract from Starr (1974) those of his results that are relevant to this paper.

1.5.1.3 Price of money is zero, and there is no trade

Let us take the case of $p^m = 0$ and $p^n > 0, n = 1, \ldots, N$.

According to the value constraints of (1.3) and (1.3a), the value of real goods bought/sold must equal the amount of money paid/received. But in this case, when the values of all real goods are positive and the money price is zero, no trader will be willing to trade their goods in return for a piece of worthless paper and no trade will take place. However, strangely enough when $p^m = 0$ and there is no trade, there is also no excess demand for real goods in any market so that this set of prices and quantities is a set of general equilibrium prices and quantities. Unfortunately, this also implies that a zero money price is a market clearing equilibrium price. Nonetheless, we are not claiming that there exists absolutely no trade in this economy. We imagine that some trades will take place through barter. Hence, in the end, the economy would probably revert to a barter system as a means of avoiding using money as a medium of exchange. At the same time, traders could still expand their consumption bundle.

As for taxes, with no trade and a zero money price, whether the government receives tax payment from the traders or not depends on the amount of money endowments each trader initially possesses. Before we proceed with this examination, we first consider the most fundamental problem relating to tax payment when money price is zero. When taxes, which vary with the price vector, have to be paid in money, a problem arises with a zero money price. Despite the price of money being zero, other components in the price vector such as the prices of real goods are not necessarily zero, hence tax payment will not be zero at all times. However, even if traders are faced with a positive tax payment, with a zero money price, no specific amount of money can be defined or paid by the traders. For example, if according to the prices of real goods, when $p^m = 1$ and $p^n = 5$, then 5 units of money would be required as tax payment. However, when $p^m = 0$, the trader would need an infinite amount of money to pay for taxes. This clearly shows the problem of defining a tax payment with the price of money is zero. But let us assume solely for tax payment purposes that the government is able to overcome this problem by arbitrarily declaring that p^m equals to 1, thus taxes are expressed in terms of price of real goods in real numbers only. Under this situation, the amount of government tax revenue will depend on traders' initial money endowments.

For a trader with a given amount of money endowment, with no trade and a zero money price, the only money he possesses to pay for the taxes[113] is from his initial money endowment. However, the tax payment restriction of (1.4a) specifies that no trader is required to pay taxes if the market value of the trader's endowments is less than the money value of the taxes, that is, equation (1.4a) excludes the case that $p^m \theta_t(p) > p \cdot \overline{w}_t$. In other words, as long as the value of the initial money endowments of this trader is smaller than the tax payment, he is not subject to a tax payment and the government receives no tax revenue. In the opposite scenario in which the amount of money that trader t possesses - $\overline{w}_t^m$ is sufficient to pay taxes, trader t will not demand any money through participation in trading activities in exchange for something that cannot buy any real goods and improve his utility. In neither scenario will the traders engage in trade and the price of money remains at zero. The only difference in the outcome is that in the first case, tax revenue to

[113] Once again due to the positive value of all other real goods.

the government is zero. The second case clearly demonstrates that when taxes are smaller than the initial money endowment, the price of money remains at zero, there is no trade and no excess demand. Under this situation however, the government receives tax revenue that is paid entirely out of the traders' original money endowments.[114] Nevertheless, this outcome would still not alter the zero price of money that is observed in the market/trading place.

1.5.1.4 Price of money is positive, prices of real goods are positive

In this part let us examine the case where $p^m > 0,\ \ p^n > 0, n = 1, \ldots, N$.

When the price of money is zero, no trade takes place as long as initial money endowments can pay for taxes, because the traders would not want to get stuck with a piece of worthless paper (money). However, when the money price is positive, the function of money as a medium of exchange facilitates trade and exchange takes place, and the cash flow constraint of (1.6) together with the value constraints of (1.3) and (1.3a) enter into our consideration.

The cash flow constraint of (1.6) requires that $\overline{w}_t^m + y_t^{bm} - y_t^{sm} - y_t^{\psi} \geq 0$. We can further decompose it into two cases: 1) $\overline{w}_t^m + y_t^{bm} - y_t^{sm} = y_t^{\psi}$ (1.6a) and 2) $\overline{w}_t^m + y_t^{bm} - y_t^{sm} > y_t^{\psi}$ (1.6b). These two equations give rise to different outcomes and we shall examine each case individually.

Case (1.6a) says that all the money left over after the completion of all transactions must be exactly equal the amount of taxes that the government collects. In this case, equations (1.3) and (1.3a) require that the amount of money bought (received) equals the amount of money sold (paid) and the value of all the real goods sold equals the value of

[114] Of course the government would not want to collect worthless taxes when the price of money is zero. However, one has to remember that the original intention of imposing taxes on traders is to help to produce a positive price of money.

real goods bought,[115] *i.e.*, $y_t^{sm} = y_t^{bm}$, and this means that the initial money endowment must be exactly sufficient enough to pay for taxes. Since this situation produces no excess money balances that lead to excess demand for real goods, all markets clear and a general equilibrium that is consistent with $p^m > 0$, $p^n > 0$, $n = 1, \ldots, N$ exists. This case shows that the key factor in producing such an outcome depends on the precise magnitude of taxes such that it will take away any excess money holding at the end of the trading day.

However, for second case of $\overline{w}_t^m + y_t^{bm} - y_t^{sm} > y_t^{\psi}$, a different story emerges. If we assume that the value constraints of (1.3) and (1.3a) must hold and also the value of goods bought and sold must equal, then (1.6b) implies that $\overline{w}_t^m > \theta_t(p) = y_t^{\psi}$. Alternatively, we can say that our trader has extra money left over after paying taxes. What this situation tells us is that when the price of money is positive and taxes are too low, traders end up with excess money balances and hence, excess demand for real goods. In this case, since the markets do not clear,[116] it fails to fulfil our general equilibrium requirement. Therefore, the supposition of both $p^m > 0$ and $p^n > 0$, $n = 1, \ldots, N$, cannot be an equilibrium. This contradiction shows that we can only obtain an equilibrium situation when $p^m = 0$ or $\overline{w}_t^m = y_t^{\psi}$.

From the above two scenarios: $p^m = 0$ and $p^m > 0$, one observes that in order to achieve an equilibrium the cash flow constraint of (1.6) plays a key role and ensuring that it is exactly binding at all times in order to produce a positive price of money becomes a key issue. Taxes of course play an equally important part in our whole discussion. When the tax payment is too little, traders will face situations of either being able to pay taxes with the initial money endowments therefore no need to engage in trade, or having too much money, that is an excess supply of money in the system. With this excess money

[115] This is a valid and an important assumption in this finite horizon model as our traders would not want to exchange their real goods for a piece of paper called money that gives them no utility and is useless when trade completes at the end of the day.

[116] Although we are looking at the case of a single representative trader, the assumption of symmetry in trading activities gives us the situation of $\sum_n p^n y_t^{sn} < \sum_n p^n y_t^{bn}$ in the economy; therefore we fail to have a general equilibrium.

holding, excess demand for real goods follows. One way to solve this problem and produce an equilibrium is to have the tax payment exact and large enough to make (1.6) binding at the end of the trading day, thus lifting the price of money above zero.

Considering the significance of both taxes and the initial monetary endowments (money wealth) in our model, we propose the following two methods to ensure a positive money price that is consistent with a general equilibrium. To achieve this let us assume that in addition to the tax payment that varies with price ($\theta_t(p)$), which we previously introduced, there is a lump sum tax on excess wealth $\overline{w}_t^e$.[117] With these two tax schemes, the government has two tools at its disposal. First, before trading begins consumers must know the exact magnitude of $\theta_t(p)$ so that at the end of trading, the government can collect the amount of taxes $\theta_t(p)$ precisely enough to make sure that there are no excess money balances to generate excess demand for real goods. The second method is to deplete the excess money balances *i.e.* a tax that varies with left over wealth after the completion of all transactions. In this case, even if the government sets a low rate of $\theta_t(p)$, $\overline{w}_t^e$ will take away any excess money holding. In order to pay taxes, traders have to engage in trading to obtain the necessary money for tax payments, demand for money will then be positive and so is the money price. However, there are two conditions necessary for these two methods to work. Firstly, these two types of taxes (price or wealth) have to be sufficiently high and exact enough for the initial amount of the money endowments to be below the tax payment: that is, $\theta_t(p) \geq \overline{w}_t^m$ and $\overline{w}_t^e > \overline{w}_t^m$. Secondly, these taxes must be not so great as to make it impossible for traders to pay, that is $\theta_t(p) + \overline{w}_t^e \geq \overline{w}_t^m$ has to hold.

In our second case of a wealth tax, there are strong distributional effects for this economy. Assume that our traders are not homogenous in wealth, in the sense that initial money endowments are different across individual traders. The wealth tax will then have a stronger effect in producing a positive money price than the price tax. To explain our

[117] $\overline{w}_t^e = \overline{w}_t^m + y_t^{bm} - y_t^{sm}$. When $\overline{w}_t^e = 0$, trader t is not required to pay the tax.

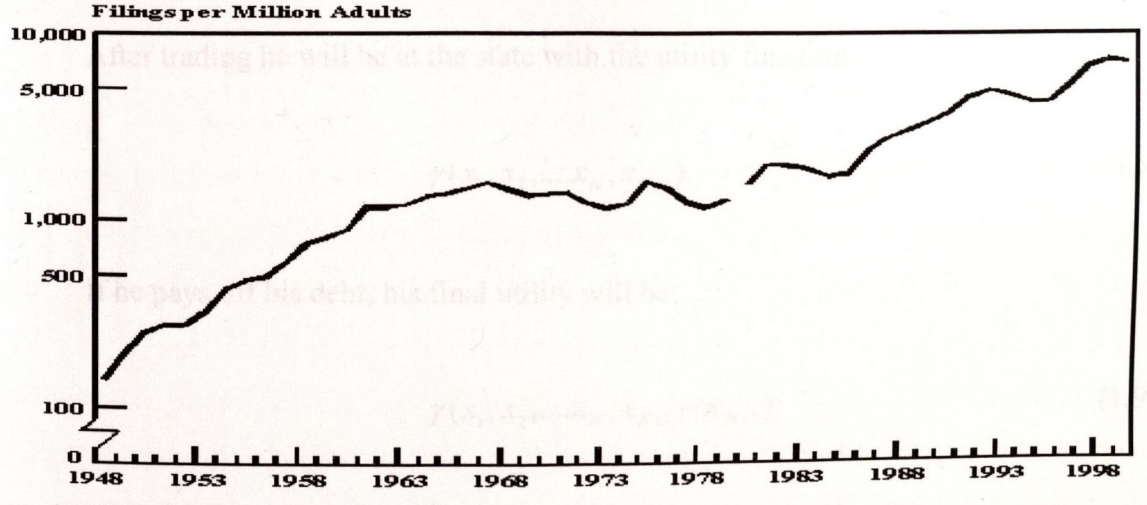
assertion, consider the example of two different groups of traders, the rich and the poor. The rich are those traders who are endowed with a larger amount of money. Given a tax that varies only with prices, the poor group will exhaust their money balances to the point at which taxes are just covered much quicker than the rich group. In other words, we might observe the cash flow constraint to be binding and give rise to an equilibrium with a positive money price among the poor group of traders. However, the rich group still possesses excess money holdings and can create excess demand for real goods, hence a general equilibrium is lacking in this case. With the wealth tax however, we can ensure that this extra money held by the rich group will be taken away and an equilibrium point is reached, once taxes are paid. We are not saying that all traders will be facing an identical consumption bundle if money endowments are equalized. Preferences of individual traders will still have an effect on final consumption patterns. Unfortunately, enforcing a wealth tax might not be a Pareto improvement for this economy as money taken out of the system is not guaranteed to be redistributed back to all traders in the economy. The only beneficiary in this scenario is the government with the final effect depending on how tax revenues are used. Although the case of a wealth tax is an extreme measure in a real life situation, nonetheless, these two taxation methods ensure a positive money price with trading flowing freely and costlessly between traders.

Previous studies of general equilibrium models which attempt to maintain a positive money price utilize approaches such as including money in the trader's utility function: Sidrauski (1967) and the search theory of Kiyotaki and Wright (1993), and the original approach of Clower (1967) which imposes a cash-in-advance constraint that is similar to constraint (1.6) of our model. In these approaches, the aim is to establish an environment for the demand for money to emerge so that the price of money is always positive. The taxation method that we discussed above shares the same spirit and it can certainly be considered as another tactic to avoid the problematic equilibrium situation with a zero money price and no trade.

1.5.2 Noncooperative model of money with credit risk and bankruptcy law

In the general equilibrium model of money that we presented above we ruled out the existence of credit and the presence of uncertainty or risk. However, it is well known that the need for credit or borrowing can come about in a world without uncertainty as long as there is a difference in time preferences among traders and/or if there is a difference in the sequencing of the availability of resources. In fact, in modern economies, the demand for credit is enormous. With the development of diverse credit products such as credit cards, car loans, mortgages, line of credits either for consumers or corporations and so forth, credit has become an integral part of our daily lives. However, with the growing availability of the credit facilities also comes the unfortunate event of bankruptcy. According to Gross and Souleles (2001), between 1994 and 1997 the number of personal bankruptcy filings in the U.S. rose by 75 per cent. In 1997 these 1.35 million filings represented well over 1 per cent of U.S. households. The following chart from the Congressional Budget Office of the U.S. further illustrates the problem of bankruptcy in modern economies.

THE PERSONAL FILING RATE FOR BANKRUPTCY, 1948-1999



SOURCES: Congressional Budget Office; Administrative Office of the U.S. Courts; Department of Commerce, Bureau of the Census.

NOTES: The personal filing rate is the number of nonbusiness bankruptcy cases filed per million adults age 20 and older. The data are plotted on a logarithmic scale.

A break occurs in the personal filing rate between 1979 and 1980 because the data are not strictly comparable. The break represents the introduction of joint husband-and-wife filings allowed by the Bankruptcy Reform Act of 1978.

Whenever a credit or a money market is introduced, the specification of bankruptcy laws is required. A basic requirement for an optimal bankruptcy law is that it should reflect a fair balance between risk and return. The selection of an adequate set of rules for borrowing and for bankruptcy, which will be consistent with the equilibrium, is by no means an obvious procedure. It is generally agreed that in order to preserve an orderly market and to prevent strategically profitable bankruptcies, a bankruptcy law must be enforced which is strong enough to make strategically planned bankruptcy not worthwhile, but is lenient enough not to discourage borrowing.

1.5.2.1 A general bankruptcy law

According to Shubik (1972), in a noncooperative model of a market economy, an optimal bankruptcy law should precisely relax cash flow constraints and at the same time enable the system to generate prices that will give rise to a Pareto optimal distribution. He proposes the following optimal bankruptcy rule: [118]

In a market with N real goods where the $N+1^{st}$ good is money, suppose an individual borrows an amount of money κ_{N+1}.

After trading he will be at the state with the utility function:

$$\gamma(x_1, x_2, \ldots . x_N, x_{N+1}). \tag{1.8}$$

If he pays off his debt, his final utility will be:

$$\gamma(x_1, x_2, \ldots . x_N, x_{N+1} - \kappa_{N+1}). \tag{1.9}$$

But if the size of his debt is larger than his final money holdings *i.e.* $\kappa_{N+1} > x_{N+1}$, the bank will try to reclaim from him by selling other real goods at market prices until the

[118] The notation used in the original model is changed so as to be consistent with the models previously discussed in this paper.

debt is fully paid or he has no further assets left. In selecting the real goods to garnish, the bank will try to minimize the borrower's payoff or utility. Therefore, the borrower's payoff under this bankruptcy law will be:

Minimize

$$\gamma(x_1 - \varepsilon_1, x_2 - \varepsilon_2, ..., x_N - \varepsilon_N, 0) \tag{1.10}$$

subject to

$$\sum_{i=1}^{N} p_i \varepsilon_i \leq \kappa_{N+1} - x_{N+1} \tag{1.11}$$

and

$$0 \leq \varepsilon_i \leq x_i \tag{1.12}$$

In this model, if the borrower is maximizing his welfare, he will wilfully go bankrupt if the creditor is not able to reclaim the value of the item, which is equal to or greater than his gains from bankruptcy. However, conditions (1.11) and (1.12) above will prevent this and ensure that bankruptcy is unprofitable. Shubik believes that this optimal bankruptcy rule is not sufficiently harsh to discourage borrowing by those who have no intention of trying to make gains from bankruptcy.

1.5.2.2 A bankruptcy law with social stigma and government exemptions

In Section 1.4.2 we discussed how social status plays an important role in explaining why people are preoccupied with wealth accumulation. Building on this premise, we propose a bankruptcy rule that will take into account the adverse effects or the social stigma of bankruptcy. Bakshi and Chen (1996) look into the relationship between social status and stock market prices and find both analytically and empirically that social standards seem to be a driving force behind stock market movements. More directly related to our study, the stigma of bankruptcy is explicitly studied by White (1997), Fay, Hurst and White

(1998) and Gross and Souleles (1998). In all of these studies the authors find in general that a reduction in social stigma[119] contributed to a rise in filing for personal bankruptcy.

Another factor that has been found to have a contributing effect on the amount of credit borrowed and the filing of personal bankruptcy is the amount of government exemptions available to households. In the U.S., each individual state has its own preset bankruptcy exemption level. Take two extreme examples, in 1983 Iowa's exemption was $500 for homestead equity and $5,000 for non-homestead property while in Texas, the exemption was unlimited for homestead equity and $30,000 for non-homestead property. Gropp, Scholz and White (1996) find empirical evidence to show that state bankruptcy exemptions have a substantial positive effect on households' debt levels and the amount of filings for personal bankruptcy. Based on these studies, we extend Shubik's model to include consumption, relative social standing and bankruptcy exemption in the consumer's lifetime utility function,[120] and we thereby develop it into an optimal bankruptcy law.

Once again we have a market with N real goods, the $N+1^{st}$ good is money, the $N+2^{nd}$ good is social status, and E is the amount of allowed personal bankruptcy exemption. Consumers in this economy derive utility from both the consumption of real goods, the amount of money holding and their relative social standing.

With credit of κ_{N+1}, after trading the consumer will be at the state:

$$\gamma(x_1, x_2, \ldots x_N, x_{N+1}, x_{N+2}). \tag{1.13}$$

[119] White does not have a measure or proxy for social stigma, but he finds that many eligible households did not file for bankruptcy possibly because of social stigma. Fay, Hurst and White on the other hand computed their proxy for the stigma of bankruptcy by using state and national personal filing rates. Gross and Souleles use simple binary variables (dummy variables) to capture the stigma effect.

[120] Their lifetime utility function is in the form of $\int_0^\infty e^{-\rho t} E_t\{u(C_t, S_t)\}dt$, where C_t and S_t are consumption and relative wealth status respectively.

If he pays off his debt, his final utility will be:

$$\gamma(x_1, x_2, \ldots x_N, x_{N+1} - \kappa_{N+1}, x_{N+2}). \tag{1.14}$$

If this consumer pays off his debt after trading, his social status remains unchanged. But if the size of his debt is larger than his final money holdings *i.e.* $\kappa_{N+1} > x_{N+1}$, he will face two consequences. First, similar to the previous case, the bank will try to reclaim from him by selling other goods at market prices until the debt is fully paid or he has no further assets left. The bank now has both consumable real goods and social status to choose from. However, with the bankruptcy exemption E, the bank might find it difficult to reclaim the full amount from selling real goods. Secondly, and this could be more serious for this consumer, is the possibility that his social status will be lowered in the eyes of his fellow citizens.[121] Again, in selecting the goods to garnish, the bank will try to minimize the borrower's payoff. The bank can achieve its goal by either 1) selling off some (or all) of this consumer's real goods to recover the loan or 2) lowering his social status by the amount of (δ_{N+2}) by black-listing him or even taking him to a public court. Of course, the $N+2^{nd}$ good might not have a financial value to the bank but it could help to improve future screening processes thus reducing the chances of bad debt. Since both options are at the dispense of the bank, we present both methods in the borrower's payoff under this bankruptcy law:

Minimize

$$\gamma[(x_1 - E_1) - \varepsilon_1, (x_2 - E_2) - \varepsilon_2, \ldots, (x_N - E_N) - \varepsilon_N, 0, x_{N+2} - \delta_{N+2}] \tag{1.15}$$

subject to

$$\sum_{i=1}^{N} p_i \varepsilon_i \leq \kappa_{N+1} - x_{N+1} \tag{1.16}$$

[121] A lower social status in this individual consumer's own mind could be strong enough to be a deterrent to wilful bankruptcy.

and

$$0 \leq \varepsilon_i \leq x_i \text{ and } 0 \leq \delta_{N+2} \leq x_{N+2} \tag{1.17}$$

Some might claim that this bankruptcy law is harsher than in the previous case because of the adverse social effects on the consumer due to bankruptcy. However, we would disagree with this claim. As mentioned earlier, although one cannot place a market value on δ_{N+2} and it can be an extremely subjective measurement, the lowering of one's social status can function as a very strong deterrent to wilful bankruptcy. One might question the negative aspect of this law and its potentially discouraging effect on those who were not intentionally trying to go bankrupt from borrowing. However, the bankruptcy exemption works in the opposite direction so as to reduce the costs of bankruptcy. In fact, if E_i is large, then there are very few real goods left for the creditor to claim thus greater incentive for the borrower to go bankrupt, and *vice versa*. The effect of a very generous bankruptcy exemption will surely increase the level of risk faced by the bank, thereby increasing future borrowing costs. The original intention of government bankruptcy exemption is to benefit the less-well-off households. However, its effect on encouraging risk-taking attitude cannot be ignored. We believe that the inclusion of the bankruptcy exemption and social status variables in our proposed bankruptcy law help to make the law more reflective of the real world situation by taking into account the real financial and social costs of bankruptcy. Inevitably for some, the potentially damaging effect of social stigma is an additional risk that consumers have to face when they contemplate a loan, whereas government bankruptcy exemption offers them a kind of insurance. In any case, with the availability of credit, consumers can possibly facilitate a higher consumption utility. The typical situation facing a consumer is the beneficial return verses the risk of having to reduce final real consumption and experience lower social status if he fails to repay the loan.

1.6 Concluding Remarks

The content of this paper has been various and substantial in length. In each individual section we endeavour to provide a serviceable study on at least one of the three main

themes. While value, money and wealth are three seemingly independent subjects, this paper hopes to establish some form of association among them. In fact, we notice that there exists some degree of independence that is built on the validity of the others. We shall summarize our observations as follows:

1) Goods must have value, regardless of whether this value takes the form of the labour theory of value, is utility-based or both. Without value, there will be no trade and no need for money.

2) When goods have a value and trade (exchange) takes place (bettering our conditions), we must have money to function either as a medium of exchange or a store of value. Under this situation, if the money price is a true reflection of goods' value, it cannot have a zero price, otherwise we will revert back to a barter economy. One way to ensure that the money price is positive is through the use of taxes. We have shown that either, or both, a price tax and a wealth tax is/are sufficient to guarantee the outcome of a non-zero price of money.

3) When goods have value and the use of money is accepted, then the accumulation of wealth becomes meaningful. Wealth signifies the amount of purchase or consumption that one can enjoy. However, the modern notion of wealth has gone beyond consumption: it is also an indication of one's social standing. Social status may be a psychological idea or a subjective perception; nonetheless, it has become an integral part of many consumers' daily lives.

The development from a pure exchange barter economy with no function for money into the modern monetary economy is a historical fact. Once money is accepted, frictions in trade and differences in time preferences give rise to the need for credit. Credit facilitates trade and smoothes the consumption path, but uncertainty and risk is an organic part of it. For borrowers, this risk may come from potential bankruptcy and social stigma. For lenders, the risk of default has an adverse consequence on their future consumption

path.[122] Given the rapid growth in the supply of and demand for credit facilities, risk becomes an issue of great significance.

It is not just with respect to a simple loan or a credit agreement that we encounter risk. Investments in various forms also carry risk of different natures and degrees. In the following two chapters of this thesis we shall examine the issue of risk in more detail. Both chapters study investments in stocks and the risk factors that affect their returns. In Chapter Two the relationship between stock market returns volatility and returns to the property market, which is used as a proxy for wealth, is empirically tested. This study of risk takes a more domestic or internal approach as all data used are from a single country - Hong Kong. Chapter Three on the other hand investigates the international risk situation. The effect of a potential change in the U.S. economic conditions on three foreign countries is examined. These two chapters provide us with a good understanding of the risk to returns, however this current chapter lays an important foundation for the purpose of these studies.

[122] Of course, inflation risk, interest risk and so forth, can also play an important role in the total amount of risk that an investor faces, however for simplicity, we shall restrict our attention to the current discussion to default risk only.

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Appendix 1A

Cardinal and Ordinal Utility

In economics, two measures of consumers' satisfaction or utility are used: cardinal and ordinal utility. Until the turn of the nineteenth century, economists assumed that consumers were able to assign an absolute value to a bundle of goods that would reflect the amount of satisfaction derived from its consumption. This type of subjective measure of utility is called cardinal utility. Under this utility measure, different consumers will value different goods according to their own level of satisfaction or *utils* obtained from the consumption of goods, hence, the price for a particular good will be set according to individual consumers' *utils*. For example, if eating an apple will give me 40 *utils* while another person can only obtain 30 *utils* from the same consumption, given the cardinal measure, I would pay 40 cents for the apple while the other person would be willing to pay 30 cents for it. This method claims that if consumers are rational, they will equalize the utility derived from the marginal unit of a dollar spent on each good. Therefore, a rise in the price of apples requires that consumers raise the marginal utility they receive from apples, otherwise no apples will be purchased. Alternatively, the assumption of diminishing marginal utility requires that an increase in the price of apples leads to a rise in their marginal utility. But since marginal utility is diminishing with additional consumption, eventually consumers will reduce their consumption to a point at which their consumption of apples gives them more satisfaction than they received before the price rise

Under the ordinal utility approach however, no such absolute value of utility measure is required. Individual consumers only need to rank the bundle of goods in order of their rational preference. Ordinal utility is only concerned with the relative benefits (satisfaction) that each good provides; as such, the ratio of marginal utilities is the key determinant of the price of goods and the need for some absolute value as a subjective measure of consumption satisfaction becomes redundant. This ordinal utility approach

ensures that the ratio of prices of goods equals the ratio at which the consumer is indifferent in substituting between goods.

Debreu (1954) has shown that if a consumer has a preference ordering that satisfies the axioms of transitivity, reflexivity, completeness and continuity, then there exists a continuous utility function representing this ordering, which means that if the consumer ranks x at least as high as y, then $u(x) \geq u(y)$. This utility function is unique up to a monotonic increasing transformation so that no particular significance attaches to the behaviour of marginal utility in any particular representation of preferences, *i.e.* to whether or not marginal utility is decreasing.

CHAPTER 2

WEALTH, VOLUME AND STOCK MARKET VOLATILITY: CASE OF HONG KONG (1993-2001)

2.1 Introduction

Since the stock market crash of 1987 and prior to the outbreak of the Asian financial crisis (*AFC*) of October 1997, an important and unprecedented phenomenon was observed in Hong Kong: increasing investment (speculative) activities in both the stock and property markets. These activities were steadily rising to the point that they dominated the economy and the daily lives of many Hong Kong citizens. Often daily conversations involved the subject of who bought what stocks or what was the price of property being quoted in the market on that day, how much the person had gained (possibly due to human nature, in particular in the Chinese culture, loss was very seldom mentioned) and what would be tomorrow's pick of the stocks and housing areas. In terms of stock investments, according to the *Hong Kong Stock Exchange Fact Book 1999*, during the period October 1998 to September 1999, even after the *AFC*, local individuals and institutions were the major participants in the stock market, contributing 63 per cent of total market trading in value terms, while 31 per cent of market turnover came from overseas investors that almost exclusively were institutional clients with the remaining 6 per cent from stock exchange members' trading. Figures 2-1.1 to 2-1.3 present graphically the composition of trading contributions of the Hong Kong, Japan and U.K. stock exchanges.[1] In comparison with the other two stock exchanges, these figures clearly demonstrate the high degree of stock market participation by local investors in Hong Kong by the end of 1999.

The majority of studies of market volatility focus on two areas: the information side showing how the rate of news dispersion affects movements of stock prices, and alternatively how human behaviour plays an influencing role in investment decision making. This paper attempts to incorporate both areas into our investigation. Firstly, we examine how human behaviour such as a change in wealth endowment affects people's investment decision in the stock market and secondly through the study of trading volume, we analyse how the rate of news dispersion causes movements of stock prices.

[1] Unfortunately, data of the composition of trading of the New York Stock Exchange is not available, therefore, for comparison purpose, we present another major international stock market - the London Stock Exchange. All data used in the three figures are from the websites of the stock exchanges of Hong Kong, Tokyo and London.

To the best of our knowledge, the most distinctive feature of this paper lies in the fact that we are the first to test the hypothesis that the property market bubble, that started after the 1987 crash in Hong Kong, generated a wealth effect which changed the degree of loss aversion of investors in such a way that stock market volatility increased. We aim to answer the question, whether the gain and loss in property speculations and rate of information dispersion possess the power to explain market volatility in Hong Kong. To achieve that, we seek to examine the relationship between wealth, trading volume and stock market volatility. We are interested in this topic partly because there has been limited work done directly on linking these two topics to market volatility. More importantly, the observed trend in abnormal trading and wealth, which we assume mostly originated from property speculations, raises interesting questions in terms of investor behaviour. In a perfect setting, the best solution is to let the free market run its own wheel and find its own equilibrium by allowing supply and demand to clear the market. However, faced with the likely problem of extra stock market speculation fuelled by excess property market returns, studying details of its effect will provide an additional tool for the authorities to reduce market abnormalities, if deemed necessary.

As one of the most densely populated cities in the world where land has always been the most valuable asset, Hong Kong provides a unique setting to associate property prices to household wealth. According to Hong Kong Government Statistics for 1999, the total land area of Hong Kong is approximately 1075 km^2; about 80 per cent is too hilly to be considered suitable for building purposes. Therefore, after fulfilling the demand for commercial uses, only about 50 km^2 is available to house a total population of 6.8 million people. Given this geographic backdrop, without doubt property ownership is an important form of wealth accumulation. In addition to the genuine desire of some Hong Kong residents to possess their own dwelling, it is also a well-documented fact that during the late 1980s and throughout the 1990s activities of a purely speculative nature in the property market made many millionaires within a very short period of time[2] and furthermore these market participants came from diverse economic backgrounds. By the end of 1997, over 45 per cent of all bank loans were directly tied to properties. Half of

[2] Unfortunately for some they also become heavily in financial debts later on following the onset of the *AFC*.

those loans were mortgage loans totalling in excess of HK$500 billion[3] (US$64.1 billion).[4] At the same time, the Hong Kong stock market was also prospering with a total market capitalisation of HK$3,202 billion[5] (US$410.51 billion). These figures certainly show the significance of both property market and stock market investments to the overall Hong Kong economy. Although many of these property transactions were heavily leveraged, the ownership of a few pieces of property automatically granted the owners enormous amounts of financial credit for additional property purchase or alternative investment uses. This kind of easy credit policy of banks generated some unexpected adverse consequences that we will cover in more detail later on in this paper.

It is a general sentiment in Hong Kong[6] that for some of these property owners or investors, wealth is created when profits are realised upon selling their properties at a higher price, while others just happily accept the perceived wealth creation simply through property ownership. Given these two customary approaches to wealth creation or accumulation, it is reasonable to hypothesize a close relationship between wealth and property market speculation. And building on this premise, it is not difficult to envisage a wealth effect, for which in this paper we use excess returns from property investments as proxy, on stock market movements for the period of 1993 to 2001 in Hong Kong. Accordingly, we seek to investigate whether this wealth effect changes stock market investors' loss aversion and subsequently leads to extra stock market volatility.

Besides the wealth effect, we also want to investigate the effect of abnormal trading volume on stock market volatility. Finance theory and previous empirical research have shown that the key determinant of stock price movements and trading volume is information. Hence, we want to find evidence to support the hypothesis that abnormal trading volume is a consequence of the arrival of new information with a positive resulting effect on stock prices. Should our supposition be proved correct then capturing this information effect will further help to explain Hong Kong stock market volatility in recent times. Thus by applying both the absolute volatility and conditional (EGARCH)

[3] Finance Bureau, Government Secretariat, Hong Kong Government.
[4] All conversions into U.S. dollars are based on the official exchange rate of US$1.0 to HK$7.8.
[5] *Hong Kong Stock Exchange Fact Book 1999.*
[6] Could be applicable to property owners all over the world.

approaches to develop our core models, we simultaneously explore both the behavioural and the information effects on stock market volatility. By using the Hong Kong stock market daily trading price data for the period 1993 to 2001, plus trading volume data and the different classes of property price index, we set the stage for testing.

The organization of this paper is as follows: In Section 2.2, we present some background information on the Hong Kong situation, which forms the basis of our inquiry. Section 2.3 reviews previous work on the wealth effect and trading volume. Since we employ extensively the prospect theory, the house money effect and conditional confidence in our models estimation, Section 2.4 gives a theoretical overview of these three theories. Section 2.5 specifies the development of the models under investigation. Section 2.6 describes the data used and estimation results are presented in Section 2.7. To test for forecast power of our models, Section 2.8 provides details of the test results. We are also interested in detecting structural change of the parameter of our absolute volatility model, and results of the examination are discussed in Section 2.9. In Section 2.10, some concluding remarks with policy implications from our findings are offered. Finally, Section 2.11 proposes some potential areas for future research.

2.2 The Hong Kong Case

Before we proceed with our study of stock market volatility, we present evidence to support our choice of country by showing that amongst the three major stock markets of recent times, Hong Kong, Japan and the United States, relatively speaking the Hong Kong market has been the most volatile since the 1987 crash. Daily trading figures from the Hong Kong Hang Seng Index (HSI), Japan Nikkei 225 Index (Nikkei) and the U.S. Standard and Poors' 500 Composite Index (SPC) are examined and some interesting results are revealed in the tables and figures below.[7]

In Tables 2-1 and 2-2, numbers of days with more than 5 per cent change (increase and decrease) in these three indices are shown. Considering both the number of days and the magnitude of these changes, Hong Kong leads in both categories, followed by Japan

[7] All indices are from DataStream checked against Reuters daily trading data.

and then the U.S. On 28th October 1997 immediately after the onset of the *AFC*, Hong Kong experienced the largest one-day drop of 13.71 per cent in stock prices; this was followed by an 18.82 per cent increase on the following day. From Tables 2-1 and 2-2 it maybe seen that the Hang Seng Index moved by more than five per cent on nearly twice as many days as the other two indices combined. Therefore, we are confident in asserting that volatility in the Hong Kong stock market is substantially higher than in Japan and the U.S. Another interesting pattern that emerges from these figures is that of reversals: large drops in stock prices followed immediately by large increases. Between 4th January 1988 and 29th December 2000, in Hong Kong there existed eight occasions of reversal. In addition to the 29th October 1997 reversal, consider the example of 22nd May 1989 when there was a one-day drop of 10.78 per cent but the following day there was a reversal of a 9.3 per cent gain. Looking at the numbers in both Table 2-1 and Table 2-2, we can only identify two reversals for the Nikkei and one for the SPC. These reversal patterns certainly show that an increase in stock market volatility brings an increased chance of large stock price changes of either sign (Schwert (1990c, p.79)). In line with this reversal-volatility relationship, the Hong Kong case of greater volatility also comes with more occasions of price reversals and this validates our choice of country for stock market volatility study.

The next piece of evidence of a volatile Hong Kong stock market comes from the visual examination of Figures 2-2 and 2-3. Figure 2-2 shows the daily movements of the three market indices for the period 4th January 1988 to 29th December 2000, while the three graphs in Figure 2-3 depict the monthly volatility of daily returns based on the HSI, Nikkei and SPC indices for the same period.[8] To make volatility more easily comparable across these three countries, the *y*-axis that represents monthly volatility in percentage is shown in the same scale. Once again, although the movements of these three indices as shown in Figure 2-2 follow different patterns over time, the three graphs in Figure 2-3 confirm that the HSI exhibits a much greater volatility than the other two indices. In Japan, there are ten occasions when the volatility level is higher than the 10 per cent level with the highest achieved at 15.19 per cent in October 1990. The U.S. market has only one occasion in which it came close to the 10 per cent level: in October 1987, with a volatility level of 9.67 per cent. The Hong Kong market tells a completely different story: there are

[8] These three markets' stock volatility is measured by equation (2.1) of this paper.

seventeen cases when volatility rose above the 10 percentage point with the highest of 26.47 per cent occurring also in June 1989 and subsequently a similar peak of 28.24 per cent following the outbreak of the *AFC* in October 1997. Once again, based on these observations, one can see that the Hong Kong stock market during the past fourteen years has definitely been more volatile than the other two major international stock markets. For that reason, Hong Kong provides an interesting location to study the relationship between volatility, wealth and trading volume.

2.3 Previous Research

Apart from the unique geographical reason - an affluent city with extremely limited land supply, which Hong Kong possesses, another reason for studying the wealth effect on the Hong Kong stock market comes from the limited recent academic work that has been done in this subject area. In this paper we intend to find a relationship between stock market volatility and the wealth effect associated with investors' success in property market speculations. Trading volume is another aspect under investigation and given the existing voluminous work on the subject, we basically extend the research to the Hong Kong case. Empirical studies have shown the significance of information to trading volume and consequently on stock prices, but we are more interested to test whether a small city such as Hong Kong would produce the same information effect on trading volume and the movements of stock prices.[9]

Attempts to study the wealth effect have been made by Carroll (2000) using survey data in a modified Life Cycle/Permanent Income Hypothesis model. In his research, for example, given a certain endowment of wealth, households are asked how they would construct a portfolio containing different assets with different risk levels. Carroll finds that relative risk aversion is a decreasing function of wealth. By looking at the rich (defined as the top one per cent of households by net worth), he examines households' choice between saving and investments in high and low risk assets. Under his hypothesis of heterogeneity in risk tolerance, that is, assuming that not all households in the population have the same

[9] In this paper stock market volatility and stock price movements are used interchangeably.

risk-tolerance, he states that those people with high-risk tolerance will tend to choose highly risky assets with high-expected-return portfolios and vice versa. As a result, on average these high-risk tolerant households would be rewarded with higher returns and would therefore become richer than the rest of the population. Studying the survey responses, Carroll accepts the possible ambiguity in the causality between high-risk tolerance and wealth. Looking at the figures of risk aversion by income and net worth does not answer the question of the direction of causality between risk preference and wealth. In other words, the causality of high-risk tolerance to wealth is equally possible the other way around, that is wealth to risk tolerance, and it is the aim of this paper to delve deeper into finding the answer to this question. To support Carroll's hypothesis of a risk and wealth relationship, he cites one piece of existing evidence by Holtz-Eakin, Rosen, and Joulfaian (1994), which suggests that the causality runs from wealth to risk. Since both Carroll (2000) and Holtz-Eakin *et al.* (1994) focus their examination of wealth in terms of inheritance, however, it leaves the question of whether other forms of wealth creation and accumulation such as gambling, business success or even property speculations will have the same effects on the household's risk tolerance level and investment decisions.

Studies of risk aversion have predominantly concentrated on the expected utility theory approach, which says risk aversion arises solely because the utility function over wealth is concave, *i.e.* the assumptions of diminishing marginal utility of wealth and that a risk averse consumer will always prefer to have the expected value of his/her wealth rather than face the gamble itself. With much discontent about this approach, Rabin (2000) provides a calibration theorem of risk aversion and wealth. Rabin's calibration theorem involves the conventional assumption of an expected utility maximizer over wealth with Von Neumann-Morgenstern preferences, that is strictly increasing and weakly concave. The most interesting feature of this model is that Rabin places an upper bound on the rate at which utility increases above a given wealth level, and a lower bound on the rate at which utility decreases below that wealth level. Through this calibration theorem, he shows the inability of the expected utility theory to explain consistently people's risk attitudes over, in particular, modest stakes.

Considering the insufficient power of the expected utility theory in explaining consumers' risk attitudes, a variety of theories that depart from the expected utility approach have been advanced. Barberis, Huang and Santos (1999) employ two ideas in psychology, prospect theory and the house money effect, to explain investors' risk taking behaviour and stock return volatility. The prospect theory of Kahneman and Tversky (1979) introduces the concept of loss aversion, which states that people are more sensitive to losses relative to the *status quo* than they are attracted by gains. Thaler and Johnson (1990) use evidence obtained from an experiment and find that prior outcomes do exert influence on people's willingness to take risk just like those casino gamblers who feel like gambling on the house money after accumulating a considerable gain. More succinctly, Thaler and Johnson's theory of the house money effect says that a loss is less painful or somehow cushioned following a substantial earlier gain in wealth. By incorporating these two theories into a standard consumption-based asset pricing model, Barberis *et al.* (1999) seek to explain stock return volatility and find that compared with the empirical mean value of log excess stock return of 6.03 per cent, their model produces a value of 4.1 per cent, which is considered to be a reasonably good result. But more importantly, they also find that an investor's risk aversion changes over time as a function of his/her investment performance.

Robert Shiller (1998, 2000) offers a broad review of different theories that could help to explain people's risk attitudes. Shiller takes a human behavioural approach in examining the effects of these attitudes on finance and investments. In Shiller (1998), he discusses and criticises the power of the expected utility theory to explain investors' risk stance using examples similar to those in Rabin (2000). Also presented in detail are theories in psychology, sociology and anthropology such as prospect theory, overconfidence, gambling behaviour, global culture, the availability heuristic and others. Overall, Shiller provides an excellent summary of recent developments in the studying of risks. At the same time he supplies us with additional means for the understanding of the possible causes of stock market volatility. Odean (1998 and 1999) furthers the theory of overconfidence by using actual trading data to demonstrate how overconfidence contributes significantly to investor's decisions in stock trading.

There exists an extensive literature on the relationship between trading volume V and stock price movements. According to Karpoff (1987), attention to the price-volume relationship can be traced back to Osborne (1959), in which a model of stock price changes follows a diffusion process with the variance dependent on the number of transactions. Karpoff (1987) offers a comprehensive survey of this topic by reviewing empirical work on the relationship between price changes and the volume of trading in both equity and futures markets. He examines this price-volume relationship according to the absolute price-change $|\Delta P|$ and the simple price change ΔP individually. In terms of the correlation of $|\Delta P|$ with V, out of nineteen of the empirical papers reviewed, only one fails to find evidence to support a positive relationship. For empirical testing of a ΔP and V relationship, the inference is comparatively weaker, with thirteen out of sixteen positive findings. Nevertheless, the majority of the observations do support a positive price-volume relationship. As frequently stated and shown, the price-volume relationship can be traced to their common ties in information flow while transaction costs are assumed to be insignificant. In many of the theoretical models that Karpoff surveyed, disagreement or divergent interpretation of information content is fundamental in explaining how excess trading volume arises.

However, in his earlier study, Karpoff (1986) develops a model to show that trading does not necessarily imply disagreement among investors. In fact, he shows that excess trading can occur even if investors interpret information identically, as long as they have different prior expectations on the price level. Synthesizing one of the key findings obtained from model simulations together with other theoretical models he has reviewed, he concludes that information has a persistent effect on volume, in particular in markets with high transaction costs, and instantaneous contract clearing is not possible. This important finding has led many trading volume researchers such as Schwert (1989) and Naidu and Rozeff (1992) to incorporate this persistence effect into their models.

Two recent articles attempt to test for a direct relationship between trading volume and volatility.[10] Jones *et al.* (1994) produce results that are contrary to the conventional findings of numerous researchers. Using daily trading data of 853 NYSE listed securities between 1986 and 1991, they fail to find evidence to support a positive relationship between volatility and trade size. They conclude by suggesting that 1) both the frequency and size of trades are endogenously determined, and 2) on average the size of trades has no information content beyond that contained in the number of transactions. This implies that it is transactions themselves or simply the frequency that investors trade their stocks, but not the size of their trades, that generates volatility. Their finding certainly contradicts the old Wall Street saying, "it takes volume to move stock prices." However, their deduction is consistent with the postulate that if traders are only willing to trade upon the arrival of new information, then logically one should observe a positive relationship between the frequency of trade and stock price movements. Based on the belief that trading volume contains information about price changes, for a long time many investment firms have been employing these analysts to predict price movements by closely watching trading volume of stocks. If proven correct, the findings of Jones *et al.* (1994) makes technical studies of stock market movements redundant, and it is very bad news for many of those highly paid technical analysts currently working in Wall Street.

In response to Jones *et al.*'s finding, Xu and Wu (1999) re-test the price volume relationship by utilizing average trade size and intraday transaction data of NASDAQ stocks. The main differences between these two papers lie in the log transformation of data and the method of estimation. By applying the generalized method of moments (GMM) method, which requires weaker distributional assumptions than the method of ordinary least squares (OLS) to produce more efficient estimation results, they are able to show that both trade size and trade frequency have explanatory power for return volatility. In addition, this positive relationship is more significant for stocks that are actively traded. In general, these results do not entirely reject the conclusions of Jones *et al.* (1994); on the contrary, we interpret them as added supports of the significance of trading frequency for stock market volatility. Interestingly enough these two papers, though based on near

[10] Different from those reviewed by Karpoff, price volume-relationship is not measured in terms of the absolute value of price changes or simple price changes, instead, amount of excess price change or return volatility and trading volume is being tested.

identical estimation models, yield different results on the relationship of trade size and stock returns.

2.4 Wealth and Risk

In this section, we look into the theoretical background and our basis for postulating a volatility and wealth relationship. To illustrate our hypothesis of a wealth effect on stock market volatility, a model built on the prospect theory, house money effect and overconfidence which we call the *conditional confidence theory* will be developed and used. By applying this theory, we are able to demonstrate our hypothesis in a more succinct and convincing manner.

Conventional treatment of wealth and risk aversion has been set in the expected utility framework. Though frequently criticized for its lack of explanatory power in some cases, one cannot reject the importance of this theory in offering a parsimonious account of an agent's rational behaviour under uncertainty. According to this theory, risk aversion arises since the utility function is strictly concave in wealth *viz.* strictly diminishing marginal utility of wealth. In other words, economic agents dislike changes in their wealth so much that they consider avoiding poverty as more valuable than taking risks to become very rich. As cited by Rabin (2000), Arrow[11] points out that expected utility theory implies that consumers who maximize their expected utility function are risk neutral when stakes are small but little has been mentioned about modest and large stakes. Samuelson (1963) gives a very good example to illustrate how, in real life, people systematically violate the theory. In a lunch meeting, Samuelson offers his colleague a bet of 50 per cent lose $100 and 50 per cent gain $200, which the colleague refuses. However, this colleague of Samuelson's accepts 100 of those bets taken together. Samuelson's colleague's acceptance is rational in the sense that the expected total gain from this bet is $5,000 with nearly no chance of losing. This is clearly a violation of the expected utility theory as it implies that when a person turns down a particular bet, then he/she should also turn down an offer to play $n > 1$ of those bets.

[11] Arrow, K. (1971), *Essays in the Theory of Risk-Bearing*, Markham Publishing Company, p.100.

2.4.1 Prospect theory: $PC_t = a(WLT_t)$ [Portfolio choice in current period is a function of current wealth]

Kahneman and Tversky (1979) offers a succinct example to illustrate the above problem of using the expected utility theory to explain people's risk attitude. Following an experiment, it is found that when asked to choose between two sets of lottery, one with 25 per cent winning $3,000 and the other with 20 per cent winning $4,000, 65 per cent of the participants chose the second one. While later when asked to choose between the chance of for certain to win $3,000 and a 80 per cent chance winning $4,000, 80 per cent of the participants chose the first lottery. Once again, this demonstrates the inconsistency in the outcome that is predicted by the expected utility theory. According to Kahneman and Tversky (1979), the explanation for this difference in outcome is called the 'certainty effect', that is people have a preference for certainty over uncertainty; this forms the basis of their prospect theory.

The prospect theory of Kahneman and Tversky is a psychology-based behavioural theory emphasizing 'loss aversion'. The loss aversion feature states that people are much more sensitive to reductions in wealth than to increases. In general, prospect theory maximizes a weighted sum of utilities that are determined by a value function. These weights reflect the degree of certainty of events. The value function has a kink at a point – 'reference point', which is the individual's point of 'status quo'. Kahneman and Tversky find evidence to show that that section of the value function above the reference point is concave downward, which is the same as the expected utility function, but below the reference point it is concave upward which means people become risk lovers for losses. The two main features of this theory– weighted sum of utilities and the value function of prospect theory - fit in well with our hypothesis of wealth and stock market volatility. Firstly, underpinning this theory is the maximization of a weighted sum of utilities, which are based on the probabilities of events. It is reasonable to assume that those stock market investors in Hong Kong who have been previously successful in activities in the property market would tend to assign a heavy weight to the event of speculative success in the stock market. Consequently they would be willing to take on additional risks. Secondly, the value function, which is based on the reference point – 'status quo' - plays a crucial

part in investment decision making. Given the importance of the idea of 'status quo' in the prospect theory, we can express the dynamics of the theory as a positive function of portfolio choice in current period and wealth in the current period. In other words, as current period wealth increases, portfolio choice for stocks in the current period increases by the amount of the coefficient *a*. As we shall see later on, this statement plays an essential part in the subsequent development of our *conditional confidence theory*.

Applying the prospect theory to the Hong Kong case, we believe that given an existing higher wealth level ($\uparrow WLT_t$), once again assuming it resulted from property market success, this would move the point of status quo to a higher level. As a result, people's loss aversion would be reduced.[12] In other words, people are more inclined to take on additional risk as long as it does not affect their status quo. In either case, the end result would be extra risk taking in the stock market thus causing additional movements in stock price. Prospect theory has been successful in explaining situations in which the expected utility theory fails. However, Barberis *et al.* (1999) find that prospect theory alone is not strong enough to explain volatilities in stock returns.

2.4.2 House money effect: $PC_t = b(WLT_{t-1})$ [Portfolio choice in current period is a function of previous period wealth]

Thaler and Johnson (1990) propose the 'house money effect' to account for why some individuals are less risk averse than others. According to this theory, a loss is less painful after a substantial prior increase in wealth. As a result, these people are less risk averse and take on bets with higher risk. The house money effect reflects the situation in which gamblers are more willing to take on bets when ahead. In conjunction with the above presentation, we can sum up the dynamics of this theory by a positive relationship between current period portfolio choice and pervious period wealth ($PC_t = b(WLT_{t-1})$). This function tells us that a person's portfolio choice for stocks will be increased by the amount of the coefficient *b* whenever there is an increase in the wealth of previous period. This succinctly demonstrates the cushion effect as suggested by the house money effect.

[12] Naturally, when a person's loss aversion reduces, his willingness to take on additional risk increases.

Once again, applying the house money effect to the investment state of affairs, the rationale follows that the degree of pain or loss is not constant over time and it depends on prior investment performance. In effect, people are more sensitive to a loss following another loss whereas a loss after a substantial gain is a lot less painful. This effect is acutely appropriate in supporting our proposition of how a once successful property market investor becomes a risk lover and a noise trader in the stock market. With additional wealth (WLT_{t-1}), losing part of the money in the stock market becomes a trivial outcome since the pain of a loss is comfortably cushioned by prior gains thus risk aversion decreases. Barberis *et al.* (1999) incorporate this house money effect in their model and find more satisfying results in explaining the U.S. stock return volatilities. We believe that by incorporating these two theories together we may obtain a viable alternative to the conventional expected utility theory in explaining risk aversion.

2.4.3 Overconfidence: $PC_t = c(OC_t)$ [Portfolio choice in current period is a function of overconfidence of current period]

Overconfidence is another pertinent idea behind our proposition of a relationship between wealth and stock market volatility. Overconfidence can be seen as an individual's excess confidence about his/her own judgement. This shapes the centre and the driving force of the network interlinking the other two theories discussed above. Without this extra confidence, our hypothesis of the wealth effect would be greatly weakened. Odean (1998 and 1999), using trading data from a large nationwide brokerage firm, looks into the possible trading patterns and investors' ability in estimating the reality (the true investment returns). In each case, Odean finds that investors tend either to sell their winners too soon while holding onto their losers for too long, or to trade too much without valid reasons. These two studies are fine examples in showing the effect of overconfidence on investors. In Odean (1998, 1999) and Shiller (1998), overconfidence is considered as a general human trait with little reference to the source of such behaviour. In this paper, we attach an important source to the origin of investor's overconfidence and we shall call it the *conditional confidence theory*. The development of this theory will be presented in the next section, nevertheless, the working of the overconfidence theory can be showed as

portfolio choice in current period is a function of overconfidence of current period. Once again, a person's willingness to take additional risk during the current period has a positive relationship with the current period overconfidence and will be increased by amount of *c* when overconfidence increases.

2.4.4 Conditional confidence theory: $PC_t = f(WLT_t, WLT_{t-1}, OC_t)$ [Portfolio choice in current period is a function of current period wealth, previous period wealth and overconfidence of current period]

One of the main purposes of this paper is to establish a relationship between wealth accumulation through property market speculation and stock market volatility. To offer support for our hypothesis, we make use of the three theories discussed above. Prospect theory gives us a plausible reason to explain why and how people become less loss averse. By applying the house money effect we hold that when people gain wealth from one market (property), it provides a cushion against losses in the other (stock) market. The theory of overconfidence adds an important dimension to the explanation of when given a particular level of wealth how this human instinct drives our investment decision of taking on additional risk. Putting these three together, we expect a positive contribution of wealth to stock market volatility. Unfortunately as mentioned above, Barberis *et al.* (1999) find that upon incorporating both prospect theory and the house money effect into their model, volatility generated for the NYSE 1926-1995 data only produces an annual volatility of 4.1 per cent, which is below the empirical value of 6.03 per cent. This points to the inference that these two theories alone cannot explain historical volatility, and further hypotheses seem warranted. It is our belief that the *conditional confidence theory* which is built on incorporating the three theories together, it further reinforces the explanation of why people can be economically and financially irrational when it comes to risk taking. In general, but specifically in application to the case of Hong Kong, we believe that investors' overconfidence is conditioned on both their human instinct and also their prior experience or prior wealth and current wealth situation. With these two wealth aspects working concurrently, it produces excess assessment of investors' abilities to beat the stock market thus driving them to become less rational and fall into the category of noise traders. Table 2-3 presents the working of this hypothesis and shows how the chain of events starts from

a simple change in property price and eventually, through the essential feature of changing confidence, leads to extra volatility in the stock market.

According to finance literature, noise traders are defined as irrational and uninformed traders. Experiments on mass psychology have also shown that noise traders have a tendency to overreact to news (Tversky and Kahneman (1982)) and become overconfident and take on excessive risk (Shleifer and Summers (1990)). Financial markets consist of both informed and uninformed (noise) investors. The informed investors act on information but also have an aversion to risk. Though the uninformed investors cannot affect the fundamental prices of stocks,[13] they can increase the risk present in stocks. The larger the proportion of noise traders in the market, the greater the noise content of stock prices – larger potential pricing movements. Let us consider the example of an informed trader who just recently received a piece of good news about a stock, and who buys the stock, causing a jump in stock price. A noise trader observes this increase in price and increases his demand for this stock thus causing a further rise in price that is now above its fundamental values. The informed trader therefore begins to unload his shares onto the market. These actions cause stock price to peak and fall. Observing this, the noise trader panics and also begins to sell his stocks further depressing the price, which may now undershoot the fundamental value. All these price movements around the stock's fundamental value are the volatility that we plan to explore.

Combining prospect theory, the house money effect and the overconfidence theory we have the *conditional confidence theory.* In this paper as the title indicates our interest of empirical testing is in wealth effect. There exists very minor difference between the *conditional confidence theory* and the wealth effect. Since our model specification only includes the current and past wealth variables with the functioning of overconfidence implicitly assumed in the model, to avoid confusion we call it the wealth effect.[14] Though contains very minor technical difference, the wealth effect approach that is tested in this paper gives us a more precise and practical investigation into our hypothesis.

[13] The fundamental or the intrinsic price of stocks is the part of the price that reflects the true value of the stock which in turn is determined by the overall performance of the company and economy.
[14] Or simply put, we can consider the wealth effect function only contains the current and past wealth variables whereas the conditional confidence theory includes the additional overconfidence variable.

Nevertheless, the *conditional confidence theory* that is developed in this paper offers us a very useful tool to theoretically account for the behaviour of some the Hong Kong investors during the time period being studied. This paper plans to show how the wealth effect plays a crucial part in explaining why people in Hong Kong became less risk averse prior to the onset of the *AFC*. We also aim to show how this change in risk tolerance affects stock market volatility. Throughout our wealth effect analysis, the assumption of decreasing absolute risk aversion is used. Under this assumption as a person becomes wealthier, he would be willing to accept more gambles expressed in absolute dollars. We believe that this is a reasonable assumption to describe investors' risk attitude.[15] Moreover, it avoids producing ambiguous results such as those generated under the assumption of relative risk aversion.[16]

2.5 Model Specification

We begin our testing of the relationship between stock market volatility, wealth effect, abnormal trading volume and volatility persistence by describing the theoretical expected contribution of individual variables in our formal model and the way each is measured.

2.5.1 Stock market volatility

Stock market volatility can be measured in various manners. Granger and Sin (1999) utilize the simple *observed* absolute return (calculated as the absolute value of log price difference) as a measure of risk/volatility[17] and find that it provides good forecastability, especially after the start of the *AFC*. Ma (1992) uses the spread, which is the difference between the logarithmic values of the highest and lowest prices on day *t*, and claims that it may reflect the extreme movement of the price. Freris (1990), for the sample period before the 1987 stock market crash, employs interday price changes, which are calculated by using the appropriate daily closing price. For the *post*-crash period, Freris calculates

[15] "Since we must assume that absolute risk aversion decreases with wealth to obtain results that accord with both intuition and observations of rational behaviour… we can infer that agents must satisfy this assumption in general." Laffont (1989), p.24.

[16] Under the assumption of relative risk aversion as wealth increases it is not certain whether he is more or less willing to risk losing a specific amount of it.

[17] Throughout their paper, the terms risk and volatility are used interchangeably.

intraday spreads as the difference between high and low daily values expressed as percentage of the closing price.

In our paper, monthly stock market volatility is computed by using two different volatility models: absolute volatility and conditional volatility. First we will introduce notation that we use extensively in these two models. Let P_t be the stock price index at time t and $r_t = \ln(\frac{P_t}{P_{t-1}})$ be the continuously compounded return on the index over the period *t-1* to *t*.

2.5.1.1 Absolute volatility

In the absolute volatility model, we shall make use of the following equation:[18]

$$\hat{\sigma}_m = \left[\sum_{i=1}^{N_T} \left(r_{i,m} - \mu_m \right)^2 \right]^{\frac{1}{2}}, \qquad (2.1)$$

where $r_{i,m}$ is the log daily returns on the stock market index in month m, there are N_T number of trading days within the month m, and μ_m is the monthly log daily mean return. Unlike the conventional standard deviation measure, although we use the sum of daily deviations from mean to calculate $\hat{\sigma}_m$ it has the monthly dimension because we do not divide it by the square root of the number of trading days. Finally, $|\hat{\sigma}_m|$ the absolute value of $\hat{\sigma}_m$ in percentage terms is the required estimate for monthly absolute stock market volatility, henceforth in this paper called VOL_t. This stock market volatility forms the basis of our studies and serves as the endogenous variable in our first estimation model.

[18] The general formulation of volatility measure is developed in Schwert (1990c), however we take the absolute value of this measure as a modification.

2.5.1.2 *Conditional volatility (EGARCH)*

There is overwhelming evidence of the time-varying conditional variance (volatility) of asset returns (Bollerslev, Chou and Kroner (1992)). The Autoregressive Conditional Heteroscedastic (ARCH) model introduced by Engle (1982) is a frequently used volatility measure that takes into account the possibility of such a phenomenon in financial time series. The differences in the various types of ARCH models stem from how the conditional variance evolves over time. In the basic ARCH (1) model, conditional variance at time t is a function of the squares of past shocks ($h_t = \varpi + \alpha\varepsilon_{t-1}^2$). A generalized ARCH (GARCH (1,1)) model ($h_t = \varpi + \alpha\varepsilon_{t-1}^2 + \beta h_{t-1}$) specifies that the conditional variance h is a function of an intercept (ϖ), a shock[19] from the prior period (ε_{t-1}) and the variance from last period (h_{t-1}).

In these two types of ARCH models there is the assumption that conditional volatility of the asset is affected symmetrically by positive and negative shocks - the square of the lagged shock term. For stock returns it is particularly unlikely that positive and negative shocks have the same impact on the volatility. In fact, according to So, Li and Lam (2002), by using a threshold stochastic volatility model which lets the parameters switch between the two regimes corresponding to the rise and the drop of asset prices, they find strong evidence of asymmetries in the mean and variance of the SPC and HSI data plus better forecast power for future conditional variance. We are not entirely surprised to see asymmetries present in return data. According to the leverage effect theory, as the price of a stock falls, its debt-to-equity ratio rises, thus increasing the volatility of stock returns to the stockowners. Furthermore, we do observe in the real world the situation of panic selling upon arrival of a piece of bad news to a company, while in comparison panic or rush buying of stocks due to good news is less frequent and pronounced. In other words, the variance will be higher under bad news or a price fall than under good news or price rise.

[19] Frequently, this shock is also referred as 'news', or 'error', or 'unpredictable component' of a time series.

Considering the potential existence of asymmetry in stock returns and the desire to investigate the leverage effect in the HSI data and test for forecast power of our models, we chose the EGARCH (Exponential GARCH) (1,1) model to generate the conditional stock market volatility that we require in the second model. The specification of the EGARCH conditional variance is as follows:

$$\log(h_t) = \varpi + \alpha\left|\frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}}\right| + \beta\log(h_{t-1}) + \gamma\frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}}, \tag{2.2}$$

The left hand side is the log of the conditional variance. This implies that the leverage effect is exponential rather than quadratic, and that forecasts of the conditional variance are guaranteed to be nonnegative. The presence of the leverage effect can be tested by the significance of γ and the hypothesis that it is smaller than zero. The impact is asymmetric if $\gamma \neq 0$. Furthermore, when the shock coefficient and the coefficient of last period conditional variance sum up to 1 ($\alpha + \beta = 1$), it means that there is a unit root in the conditional variance; *viz.* past shocks do not dissipate but persist for a very long period of time.

2.5.2 Wealth effect

To estimate the wealth effect, we use different classes of the private domestic monthly property price index *PRT*. We take the absolute value of the monthly property price return as our required change in wealth measurement. In its simplest form, property market returns $RET(k)_t$ at time t for each individual class are calculated as:

$$RET(k)_t = \left|\log\left(\frac{PRT_t}{PRT_{t-1}}\right)\times 100\right|, \tag{2.3}$$

where k signifies various property classes. There are eight different classes of private domestic property according to saleable area, and details of classification are reported in Appendix 2A.

2.5.3 Abnormal trading volume

To illustrate the theoretical relationship between trading volume and price changes, a simple model[20] is developed. The basic assumptions of the model are as follows:

A1. There are N potential sellers and M potential buyers in an exchange with a fixed supply of assets.

A2. All potential sellers must be asset (stock) owners at the time of exchange[21] and all potential buyers are non-owners[22] such that $M \geq N$.

A3. In general, all buyers (sellers) have identical reservation price, however, the reservation price of the sellers (P_S) does not equal the reservation price of the buyers (P_B).

A4. At any time t, stock trading will be at equilibrium[23] when $P_S > P_B$. In other words, exchange will only occur whenever the seller's reservation price is below the buyer's reservation price.

A5. Both P_S and P_B are revised from time to time based on the expected return from the asset.

A6. Price revision for both potential sellers and buyers in each time period is based on: $P_{S1} = P_{S0} + \Omega_{S1}$ and $P_{B1} = P_{B0} + \Omega_{B1}$, where Ω reflects the change in the valuation of expected return from the asset for each group of participants.

A7. Transaction costs are small enough not to affect investment decisions.

The above assumptions describe how investors in our simple exchange make decisions. As mentioned previously many studies of trading volume have shown both theoretically and empirically that the rate of information flow and interpretation of

[20] This can be considered as a simplified version of the model used in Karpoff (1986).
[21] Short selling is not allowed in this case. However, even with short selling, the only effect will be on the volume of trade when the general sentiment of the market is pessimistic.
[22] This assumption though not an accurate reflection of financial markets, avoids the problem of grouping investors according to various characteristics.
[23] In this model, equilibrium is defined as a situation in which no trade takes place.

information content play a central role in explaining excess volume[24] as information tends to alter investors' reservation prices for an asset through the change in Ω. Based on the assumptions listed above and using the following three scenarios, we shall show how information, trading and market volatility are related.

S1) *Asymmetric information - Information of this news does not disperse equally among all investors*: This is the case in which heterogeneous belief among investors is not fundamental to initiate trade. When some investors have private information over the others, regardless of the nature of this information (good or bad news) and the position of the investor (buyer or seller), trade will take place. As soon as new information arrives, the investor will revise his reservation price for the asset that is affected by this news. If the news is favourable, the price will be revised upward and *vice versa*. In any case, if the price revision causes $P_B > P_S$, an exchange will take place. In other words, in any given period, whenever the news affects the value of Ω on the reservation price formula such that $P_B > P_S$, stock disequilibrium arises and settles down again when potential buyers' reservation price is smaller than that of sellers'. This scenario certainly demonstrates that volume and price change exhibit a positive relationship and disagreement among investors is not essential for trade to take place.

S2) *Symmetric information, heterogeneous reactions -Investors interpret identical information differently*: Very often the same piece of information can cause heterogeneous reactions from investors. This reflects the conventional notion that disagreement leads to trade. Although they all receive the same piece of information, some investors may take a very optimistic view about the outlook of the asset return, while others may become very pessimistic about possessing this asset. In our model, any information that changes the investor's expectation on the return of the underlying asset will certainly lead to reservation price adjustments. If one group revises its reservation price upward while the other group does the opposite, assuming $P_B > P_S$ continues to hold, normal trading will be increased to

[24] Normal trading volume is defined as the situation when a lack of unanticipated information enters the market.

an abnormal level. Once again, a positive relationship between price and volume is observed.

S3) *Symmetric information, homogenous reactions -Investors interpret identical information identically*: All investors in this exchange receive the same piece of information at the same time and interpret this news with the same view. Take the example that a company announces to the public a huge profit jump.[25] The general consensus will take it as good news. In reaction, both P_S and P_B reach a higher value that leads to an overall upward revision. However, by being current owners of the stock, Ω_S must be greater than Ω_B prior to the arrival of the news at time t. In order to keep both Ω_S and Ω_B equal at $t+1$ to reflect the good news, the increase in Ω_B and thus P_B must be greater than Ω_S and P_S. As a result trade occurs. The same logic goes with the case of a bad news. When facing a piece of bad news, all investors become pessimistic about the return of this asset thus revising the price downward. But once again, the magnitude of this downward adjustment will be greater for current owners than non-owners. This implies that even as prices are adjusted down, as long as there are differences in the size of these adjustments, trade occurs and volume increases.

The three scenarios discussed above present a summary of investors' reaction to information and of how stock prices and volume are affected accordingly. One cannot claim that these scenarios accurately represent the operations in financial markets. On the contrary, the real financial markets contain a mixture of all three cases. It is the contention of this paper that by empirically testing the price-volume relationship for Hong Kong, we would gain some insights into the functioning of Hong Kong investors in terms of information flow.

For trading volume, we use the measure of abnormal volume. According to Karpoff (1986), there exists persistence[26] in the amount of trading volume.[27] After running

[25] Assuming insider information and insider trading are absent in this case, so that disequilibrium will not occur before the news reaches the public. This is a rather restrictive assumption, but useful in allowing the model to generate results.

[26] Persistence result from frictions in the clearing process such as computer clearing delays.

regressions on 12 lags of monthly volume growth rates (*TVOLM*) in percentage, we found that persistence only exists in the first lag.[28] Thus the absolute value of the residuals $|\hat{e}_t|$ obtained from the following equation give us the amount of abnormal trading volume (*ATV*):[29]

$$TVOLM_t = \lambda_0 + \lambda_1 TVOLM_{t-1} + e_t \tag{2.4}$$

2.5.4 Volatility persistence

Recent literature on stock market volatility (Xu and Wu (1999), Jones *et al.* (1994) and Schwert (1989, 1990b)) has paid notable attention to the persistence of volatility. Continuing with the convention and also attempting to test for presence of volatility persistence in our model, three lags of stock market volatility are included.

2.5.5 The core models

To gauge the characteristics of the volatility-wealth-volume relationship, two core models are set up according to the way stock market volatility is measured.

2.5.5.1 Absolute volatility model

$$VOL_t = \theta_1 + \theta_2 RET(k)_t + \theta_3 RET(k)_{t-1} + \theta_4 ATV_t + \theta_5 VOL_{t-1} + \theta_6 VOL_{t-2} + \theta_7 VOL_{t-3} + u_t \tag{2.5}$$

Again, VOL_t measures the absolute volatility of the HSI in month t by using equation (2.1). Following (2.3), $RET(k)_t$ and $RET(k)_{t-1}$ stand for the property price index return in months t and $t-1$, which is used as a proxy for testing the wealth effect. k signifies different property classes from *A* to *All*.[30] ATV_t are absolute values of residuals obtained through a one period autoregressive equation of (2.4), which seek to measure abnormal

[27] In millions of Hong Kong dollars.
[28] Regression results can be found in Table 2-4.1.
[29] Regression results of equation (2.4) are presented in Table 2-4.2.
[30] See Appendix 2A for definition of classes.

trading volume activity in the Hong Kong Stock Exchange. The lagged *VOL* terms are included to capture any possible persistence in return volatility.

2.5.5.2 *Conditional volatility (EGARCH) model*

Since we expect that other variables may contain relevant information for stock market volatility, in our conditional volatility model we introduce exogenous variables such as wealth and excess trading volume into our EGARCH conditional variance equation:

$$\log(h_t) = \varpi + \alpha\left|\frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}}\right| + \beta\log(h_{t-1}) + \gamma\frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} + \phi_1 RET(k)_t + \phi_2 RET(k)_{t-1} + \phi_3 ATV_t \qquad (2.6)$$

Equation (2.6) infers that in addition to information contained in the stock price index series' history, there exist other factors of the market around them that also contribute to the volatility of the returns.

Although both absolute volatility and conditional volatility models are used to test the volatility-wealth-volume relationship, there is one key difference between them. In the first model, we run OLS on equation (2.5) to try to establish a statistical relationship between individual exogenous variables. However, in (2.6) we include two exogenous variables (wealth and volume) and attempt to test for their contribution in the process of generating the conditional variance by following an EGARCH method. Although the results that we present in Tables 2-9.1 2-9.2 and are listed as conditional volatility results, strictly speaking we are presenting the relationship between conditional variance and the two exogenous variables. We believe that at this stage this slight ambiguity in volatility measure will not pose a significant impediment to our empirical result analysis, since we are still observing how these two exogenous variables affect the dispersion (variance) of stock returns. Nonetheless, when we perform the test of the forecast power of this conditional volatility model in Section 2.8, following the conventional measure of volatility, by taking the square root, all conditional variances are converted into conditional standard deviations.

2.6 Data Description

All data used in this paper are monthly data covering the sample period of February 1993 to July 2001. Hong Kong stock price index - HSI data together with stock trading volume measured as turnover in Hong Kong dollars - are collected from Datastream. To maintain accuracy, each observation is checked against those posted by the Hong Kong Stock Exchange and Reuters. Hong Kong statistics are from the Finance Bureau, Government Secretariat, Hong Kong Government. Additional price index data of SPC and Nikkei used in Figures 2-2 and 2-3 are also collected from Datastream and carefully checked against Reuters'[31] sample data. In order to derive monthly estimates from daily data, great effort has been made in the reconciliation of trading days according to calendar dates. To ensure there is minimum or preferably no correlation between the HSI and other stock indices, detailed information on the HSI constituent stocks is presented in Appendix 2B. Information in Appendix 2B informs us that indeed all constituent stocks in the HSI are local companies such that the possibility of cross listing in other stock exchanges is small.

Monthly property price data are collected from the Private Domestic – Price Indices by Class (Territory-Wide),[32] which is published by the Rating & Valuation Department, Hong Kong Government. To facilitate subsequent discussions in this paper, property classes are categorised as follows:

[31] Both sample data sets can be obtained from the Internet through the website of Yahoo's financial services (URL: http://finance.yahoo.com/?u).
[32] Appendix 2A presents technical notes on these indices.

Categorization of property classes[33]

Class *A*	Small Residential
Class *B*	Medium Residential
Class *C*	Large Residential
Class *D*	Lower Luxury[34]
Class *E*	Upper Luxury
Class *ABC*	Residential
Class *DE*	Luxury
Class *ALL*	Overall

Prior to subjecting the data to statistical testing, Table 2-5 reports some descriptive statistics for all the variables used in our model. The top half of Table 2-5 shows statistics of those time series that we use in the absolute volatility model, while the bottom half of it displays statistics of the *r* series together with the standard deviation or volatility[35] generated by (2.6). The positive skewness estimates show a long right tail for eighteen out of nineteen of our sample series, except for the return (*r*) series. Furthermore, the rather high kurtosis estimates, which range from 11.134 to 3.685, suggest that stock market volatility is the most leptokurtic in the *VOL* series. These estimates showing fat-tailed distributions are consistent with the stock market return data that are presented by Campbell, Lo and MacKinlay (1997). As for the dispersion of the series data, abnormal trading volume has the highest standard deviation of 27.391 and amongst the property market return series, returns of Class *E* property are the most dispersed, while the other seven property market return series share similar dispersion estimates. In the second half of the table we can see that *r* has the highest standard deviation of 9.247, whereas in the EGARCH data series once again the Class *E* property series produces the highest volatility dispersion of 2.955. In order to have a more meaningful comparison amongst all nineteen time series, we also calculated the coefficient of variation (*CV*) for individual series. Looking at these *CVs*, one can easily identify that the *r* series is the most spread out, while

[33] This paper focuses on properties that are solely for residential purposes.
[34] Luxury is of course arbitrarily set according to Hong Kong standard.
[35] We just take the square root of the conditional variance that we produced from the EGARCH model of (2.6).

all property class series share a similar level of dispersion and so do the EGARCH standard deviation series.

We are aware of the possible correlation between property market returns and abnormal trading volume since investors with more wealth might also trade more heavily in the market. Therefore, sample correlations between these two exogenous variables together with correlations amongst different property market returns and stock market volatility are reported in Table 2-6.[36] The correlation matrix shows that our concern about a close relationship between wealth *i.e.* returns from different classes of property returns and excess trading volume is unfounded since the correlation values are all below 0.25. This also serves as an indication of the unlikelihood that wealthy investors are creating abnormal trading volume in the market. For the different categories of property market returns, their values are in line with our broader two classifications of residential and luxury, *i.e.* Classes *A, B* and *C* are closely related to each other as they are all in the same (residential) category, whereas Class *D* and Class *E* (luxury) are related to each other for a similar reason. Given the notably low correlation between our two exogenous variables: *RET(k)* and *ATV*, we believe that the problem of multicollinearity would not pose a serious nuisance to our model estimation.

Empirical research based on time series assumes the underlying series are stationary. To test whether our series fulfil this requirement, a test for unit root is performed on individual series. Tables 2-7.1 and 2-7.2 report the test results. The Phillips-Perron test on all sample series rejects the hypothesis of a unit root at all critical levels thus a stationary process of I(0) is established. We also applied the Augmented Dickey-Fuller test to our time series, and the results remain unchanged. Furthermore, a visual inspection of all the graphs in Figures 2-4 and 2-5 supports our account.

[36] Discussion on the correlation amongst EGARCH produced standard deviations will be presented later on in this paper when it is deemed more appropriate.

2.7 Empirical Results

2.7.1 Absolute stock market volatility model

To identify clearly the volatility-wealth-volume relationship in our first model, we run regressions on equation (2.5) according to each individual property return class. Results of these estimations are presented in Table 2-8.1. It is a well-established fact that most financial time series suffer from the problems of heteroscedasticity and serial correlation. As such the classical assumptions for OLS are violated and both *t*-statistics and standard errors are no longer valid. To test for the presence of heteroscedasticity, we use the White test. The computed statistics for all eight regression models fail to reject the null hypothesis of homoscedasticity. For detecting serial correlation we perform the Breusch-Godfrey serial correlation LM test. A quick glance at the *p-values* reveals that once again the residuals are not serially correlated. Hence, we gain confidence in our OLS estimates as they fulfil the classical assumptions and are shown to be unbiased and efficient. Nevertheless, in order to ensure the robustness of our estimation results, the Newey-West Heteroscadasticity and Autocorrelation Consistent Covariances estimation technique is used. Using this technique does not change the point estimates of parameters, only the estimated standard errors; thus we reported robust standard errors.

Looking at these results, a very distinctive picture appears. In all the eight models that we have tested, only when $k = C$ and E, *i.e.* for the large residential and upper luxury classes of property return do we obtain a significant wealth coefficient of 0.703 and 0.604 respectively at 5 per cent critical level, whereas for all other property class return coefficients we fail to reject the null hypothesis that they are equal to zero. This implies that a 1 per cent increase in wealth from speculating in luxury property leads on average to about 0.7 to 0.6 per cent increase in the stock market volatility. A coefficient of this size certainly suggests an influential relationship and provides valuable information to both policy makers and investors. Let us assume that, for some reasons that are pertinent to the operation of the economy, the government aims to reduce stock market volatility by a certain percentage, together with adjustment on other market factors such as interest rate

and corporate bond return.[37] This objective can be partly achieved through the stabilization of upper luxury property price. For these Class *C* and Class *E* models, the explanatory powers are the strongest among all property classes with an adjusted R^2 ranging from 0.374 to 0.385 together with *F*-statistics of 10.758 and 11.217 which reject the null hypothesis that all slope coefficients are simultaneously equal to zero.

A glance at the estimation results of Table 2-8.1 show that although most of the change in wealth coefficients are statistically not different from zero, due to the rather similar size, we also want to confirm that they are not equal to each other. To achieve our aim we perform the Wald test after obtaining results of including Classes *A* to *E* property return variables in one single equation. We purposely exclude Classes *ABC, DE* and *ALL* for the reason of potential high correlation between these three aggregate classes and the other individual property classes. Wald test result presented in Table 2-8.S for equal coefficient shows that we reject the null hypothesis of equal coefficients and it adds robustness to our original results.

The other important estimation result is the highly significant volatility persistence in the first lag. This volatility persistence consistently appears in all eight regression models with the size of the coefficient at around the 0.4 level but it decays to half of its original value by the third lag. Nonetheless, the persistence of stock market volatility with its relatively large size of around 0.4 in the first lag reveals its key role in causing present volatility. Earlier figures in Table 2-7.1 tell us that all our time series are stationary. It implies that the size of this persistence coefficient should be less than 1, and our result of 0.4 is in line with the supposition. If it is not the case, then our observations on stock volatility would not be considered as generated by a stochastic process and accordingly the condition of time invariant mean, variance and covariance could not be fulfilled.

From the outset we seek to test for the existence of a positive relationship between market volatility and *ATV*. The estimated *ATV* coefficients, apart from being highly insignificant at all critical levels, also carry a very small size of equal or less than 0.005.

[37] For a discussion of these potential factors see Schwert (1989).

There exist numerous previous studies[38] that also fail to establish such a relationship so we are not entirely disappointed or surprised by our results. We shall offer some probable explanations to account for our failure to establish a price-volume relationship later on in this paper.

2.7.2 Conditional stock market volatility (EGARCH) model

The second approach in testing our hypothesis of a volatility-wealth-volume relationship is the use of an EGARCH model to conditional stock volatility. By incorporating wealth and volume as exogenous variables in the conditional variance equation of an EGARCH model, we hope to identify how these variables affect the conditional volatility generation process. Estimation results of this EGARCH model are presented in Table 2-9.1.

Our estimation results show that amongst all eight property classes, the wealth effect variable for Classes *D, E* and *DE* are significant in generating stock market volatility. In particular the Class *E* property return is highly significant at 1 per cent critical level. This result is in line with those we obtained from the absolute volatility model, nevertheless, these significant wealth coefficients are only half the size of those in the previous model. We are not entirely surprised by this observation because the coefficient ϕ_1 in equation (2.6) means that a 1 per cent change in property returns changes volatility by a factor of $\exp(\frac{\phi}{2})$. By contrast, the absolute volatility regression suggests the level of volatility changes by θ_2. So we would expect $\theta_2 = \left(e^{\frac{\phi}{2}} - 1 \right) VOL \approx \frac{\phi VOL}{2}$. The estimates seem to be pretty well consistent with this. Once again we fail to detect any significant contribution of our abnormal trading variable (*ATV*) to the conditional volatility. This is consistent with our previous finding even in terms of the size of the estimated coefficients.

As mentioned earlier when $\alpha + \beta = 1$, it implies that volatility persistence exists. Looking at our results, we notice that both α and β are nearly all insignificant except in

[38] See Karpoff (1987) for a list of previous studies that fail to find a trade volume and stock price relationship.

one occasion of Class *C* property. In other words, volatility persistence seems to be absent in our conditional volatility model. However, in order to ensure that this model has adequately captured all of the persistence in the variance equation, we complete the Ljung-Box Q-statistic. If the model is adequate, then the standardized squared residuals should be serially uncorrelated. Ljung-Box Q-statistics at six lags of the standardized squared residuals presented in Table 2-9.1 indicate that they are indeed serially uncorrelated.

The presence of the leverage effect can be detected through the hypothesis that $\gamma \neq 0$. Estimated results of γ in Table 2-9.1 show that we fail to reject the hypothesis that $\gamma = 0$ for all property classes. Hence, we have to conclude that maybe a fall in stock return has the same impact as a rise in returns, *viz.* the impact is symmetric. Although previously we mentioned that So, Li and Lam (2002) have found significant results illustrating the asymmetric impact of HSI daily data, we suspect that because we utilize a monthly measurement of volatility, much of the leverage effect has disappeared within a month's time.

2.7.3 Estimation result summary

The most interesting finding of this paper comes from our estimation results of property Class *E,* that is wealth gained from upper luxury property. Although we aim to establish a positive wealth relationship with stock market volatility for all classes of property, we only find a consistent wealth effect in this class. Are we surprised in finding that only wealth created from speculating in the luxury class property has a positive relationship with stock market volatility? We can examine and answer this question in various ways and they all lead to the same conclusion that the result is consistent with the observation and theory. Descriptive statistics in Table 2-5 show that this class of property return, though carrying the highest standard deviation amongst all eight property market returns, also produces the highest mean return of 1.890 per cent per month. This observation tells us that if one were to speculate in the Hong Kong property market during 1993 to 2001,

investing in this upper luxury property would on average deliver the best return together with the biggest monetary gain.[39]

The residential class has the lowest return, quite conceivably because most buyers are purchasing properties for their own housing purpose or for long-term investment. Therefore frequency of transaction and price change (return) would be lower than the luxury class, where the high return attracts frequent transaction activities to realize the capital gains. In this case, any gain or loss from these residential property purchases will not be quickly realized and the gains would not be channelled into the stock market, hence the wealth effect on the stock market failed to materialize. High return also comes with high risk. The gain and loss from luxury property speculation, especially when one is engaged with a high level of leverage financing, can simply be regarded as an irrational risking behaviour.

In order to participate in speculation in upper luxury property, an investor needs a substantial amount of capital to support the initial down payment and the subsequent monthly mortgage payments.[40] Although at the beginning we assert that, during this time period in Hong Kong, many people were preoccupied with the property and stock markets, our empirical result accords with the fact that the biggest players would be from the middle class and wealthy investors who traditionally were also more inclined to be regular participants, particularly in the stock market. At the same time, in addition to individual investors, many local companies were also engaged in property speculations as part of their daily business activity. Since their revenue was so much tied to property market performance, when the market began to fall in late 1997, added movements surfaced in these companies' own company stock price and this further increased stock market volatility.

[39] Since the amount of original investment in upper luxury property could easily be many times over that of residential class, therefore, a 2 per cent return for a upper luxury property could give a substantial gain in money terms over other classes of property.

[40] We assume the event of paying up the full amount at one time being an unlikely and unreasonable event, as this will only substantially reduce the amount of capital available for additional property purchases.

Besides the initial wealth that these groups of investors possessed, the easy credit situation during that time also created a vicious cycle. When applying for personal or mortgage financing, in general, the banks would take into account the borrower's professional status, income level and amount of present asset holding. Therefore, when a person has already maintained title for a few pieces of upper luxury property with rising prices, it is not difficult to envisage that the bank would take a very lenient approach in granting additional credit even if the fund was likely to be used for additional property speculation. Supplemented with more credit, more speculation activities would be supported. Following the *AFC*, when the property market began to collapse, the amount of overdue bank leverage payments was so large that many people were heavily in debt and forced to sell the property at an unreasonably low price while dumping their stock holdings in the stock market. When these two actions were taken simultaneously, this caused extra volatility in both markets and for some of the more unfortunate ones[41] the ultimate result was the inevitable bankruptcy. In any case, we suspect[42] that the most significant flaw in the whole 'game' came from the fact that when this speculation extravaganza started, the increase in the number of irrational speculators changed the proportion of informed (rational) traders to noise (irrational) traders thus allowing this wealth effect to arise and to persist. It is exactly this composition change, which exacerbated the extra volatility that we observe in the Hong Kong stock market data during our sample period.

Putting all the results together, we establish some essential interpretations and observations. Firstly, for wealth accumulation from investments in upper luxury property, statistically we fail to reject the hypothesis that success in property market speculations contribute significantly to stock market volatility. So how do we make use of our *conditional confidence theory* to account for this wealth effect of the Hong Kong case? As mentioned above, during this period, many people in Hong Kong were preoccupied with their involvements in these two markets and our estimation results support our claim that those upper luxury property investors who achieved success in the property market

[41] Unfortunate in terms of the huge amount of loss sustained from both property and stock markets.
[42] Our suspicion is partly based on empirical results of this paper which finds a wealth effect in the upper luxury class property investors and also the news coverage at that time regarding the intensity of people's preoccupation with the markets.

advanced their belief of having the ability to beat the stock market. By assigning a higher weight to a positive outcome and by changing their reference point, loss aversion of this group of investors was reduced. This phenomenon certainly fits in well with the prospect theory of Kahneman and Tversky (1979). Furthermore, and might be to a much lesser extent, the fact that these investors were successful in the upper luxury property speculation also brought substantial monetary rewards. Naturally with more money in hand, they felt less pain if ever they had to lose part of it and this is exactly what the house money effect hypothesis predicts. Carrying these two factors with them, overconfidence amongst investors developed and it was precisely this confidence *per se* (or extreme overconfidence)[43] that somehow drove them into taking irrational actions, which also turned them into risk lovers and exacerbated further volatility in the stock market.

One might question that when the property market began to weaken at the end of 1997, investors' confidence should also have begun to deteriorate so that its influence on stock market volatility should have disappeared. The *conditional confidence theory* we have devised in this paper indeed can help to explain this occurrence. Table 2-3 lists out the path that the relationship between confidence and stock volatility follows. This hypothesis is called *conditional confidence theory* because it is conditional on two factors: human psyche *i.e.* beliefs in one's own ability to win, and the cushion effect of having prior gains (house money).

The second scenario presented in Table 2-3 adequately describes the situation following the outbreak of the *AFC*. It is an empirical fact that, starting at the end of 1997, property prices began to fall but stock volatility remained high. Tracing the reasoning path of scenario two, it is not difficult to see that, although we saw a large decrease in property price, our measure of wealth, which is the absolute value of property market return, remained high. This large decline in property price caused a negative effect on the confidence of these upper luxury property previously successful speculators and they began to sell (dump)[44] their stocks in the market resulting in extra movements in stock prices. Also shown in Table 2-3 in the first scenario is the opposite case of when there was

[43] Confidence supported by excess wealth accumulation.
[44] Either for reasons of panic or liquidity.

a large increase in property price, which depicts accurately the Hong Kong case prior to the *AFC*. By using the same logic as predicted by our *conditional confidence theory*, this led to the same outcome of a high volatility. These analyses certainly demonstrate that our newly developed and more refined *conditional confidence theory* works well in both up and down market situations. Nevertheless, we have to point out that our empirical results of no statistically significant lagged wealth proxy variables suggest that at least for Hong Kong our *conditional confidence theory* is mainly driven by the prospect theory type of reaction among investors. This means that Hong Kong investors' overconfidence was mostly fuelled by current change in wealth and past wealth level was ignored in their current investment decisions.

As for our failure to find a positive relationship between trade volume and stock market volatility, we can interpret this result as an indication that information[45] plays an inconsequential role in the Hong Kong investment community. Previously, we presented a simple model to illustrate how information flow can lead to trading action and price adjustment. According to this simple price-volume model, disagreement amongst investors is not necessary to move stock price as long as news contains new information that changes people's valuation of the stock. Once again, given the high degree of stock market participation during our sample period, and also because of the stake involved, investors watched news about the market intensely and reacted to this news almost immediately, hence the surprise element of this news is substantially reduced. Consequently, price adjustment to information is very quick or nearly instantaneous and excess trading could be negligible. Indeed, the Hong Kong case proves that although there is abnormal trading volume as a result of new information, as long as these news reaction movements are very short lived, movements in stock prices will be so rapid that the effect will be difficult to observe.[46]

Hong Kong being one of the most densely inhabited cities in the world, with numerous newspapers, magazines, radio and television stations reporting news each day, the rate of information flow within the community could be extremely swift. Therefore, if

[45] Information must contain news – surprises that majority of investors did not possess previously.
[46] This could be particularly applicable for monthly data such as those used in this paper.

one takes the conventional information approach to link trading volume and price movements, Hong Kong would be one of those places where the theory is inapplicable. Empirically in this paper, we have shown that information or abnormal trading volume has little effect on the Hong Kong stock returns and based on this observation we propose two probable explanations: size and participation. First, geographically speaking, for a place that is small in size such as Hong Kong and secondly for a community with high stock market participation intensity such as the time period of this studied, the information effect on the price-volume relationship is reduced. Despite the result, one cannot completely reject the theoretical hypothesis of a price-volume relationship. This hypothesis is based on valid economic and financial foundations supported by many favourable empirical results.

Given the fact that the lagged values of *RET(k)* are not statistically significant in all our regression results and to reduce the loss of valuable data point in our future regressions, statistical testing performed in subsequent sections will only be based on a model that is identical to equations (2.5) and (2.6) except without the $RET(k)_t$ term, which we call equations (2.5a) and (2.6a). Furthermore, when we run regressions on these two modified models, estimation results as presented in Tables 2-8.2 and 2-9.2 show that they are of little difference from those of Tables 2-8.1 and 2-9.1, hence analysis of empirical results offered above remain valid. Henceforth, our focus of statistical testing will be based on the following two equations:

$$VOL_t = \theta_1 + \theta_2 RET(k)_t + \theta_3 ATV_t + \theta_4 VOL_{t-1} + \theta_5 VOL_{t-2} + \theta_6 VOL_{t-3} + u_t \tag{2.5a}$$

$$\log(h_t) = \varpi + \alpha\left|\frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}}\right| + \beta\log(h_{t-1}) + \gamma\frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} + \phi_1 RET(k)_t + \phi_2 ATV_t \tag{2.6a}$$

2.8 Test of Forecast Power

A very important reason for our study of stock market volatility is that one hopes to find ways to reduce the adverse effects that extra market volatility brings to the economy. In

previous sections by using the full sample period data, we establish a relationship between stock market volatility and wealth gained from investment in the upper luxury property in Hong Kong. Most economists are aware that the essence of formulating an econometric model is to generate forecasts of one or more variables. In our case, the aim is to see whether we can use past observations to forecast future stock market volatility. At the same time we hope to use this forecasting power to support our choice of model for the entire sample period. To achieve our aim, we employ the in-sample, out-of-sample, one-step-ahead forecasting technique.

2.8.1 Out-of-sample, one-step-ahead forecasting

When we first estimate equations (2.5a) and (2.6a) with results shown in Tables 2-8.2 and 2-9.2, we have already tested the in-sample relationship by running a regression for the entire sample period of February 1993 to July 2001. And for this type of in-sample testing, the adjusted R^2 statistic provides a goodness-of-fit of the average relationship between stock market volatility, wealth, trading volume and also lagged volatility terms, over the full period. As discussed above, we find that the only model with statistically significant wealth effect comes from the upper luxury property class, which explains about 40 per cent of the variations in stock volatility. Theoretically speaking, once we have established this estimated relationship we can use it to forecast future values of stock volatility. However, this type of forecast has the shortcoming of making use of information that is not available at the time market participants formed their forecast. For example, the forecast of December 1997 is made based on information up to July 2001, which was definitely not available when investors formed their forecast. In order to check for the usefulness of the wealth, volume and past volatility as predictors of stock volatility, or simply to offer more supporting evidence to our previous empirical finding, we also estimate the out-of-sample forecast.

For out-of-sample, one-step-ahead forecast,[47] we first divide our whole sample into two parts – first part, we call n (n = 78): February 1993 to July 1999, second part, m (m =

[47] The one-step-ahead forecast produces a forecast one period after the sample ends.

24):[48] August 1999 to July 2001. This out-of-sample period constitutes about 30 per cent of the in-sample data which would seem a reasonable period over which the forecast performance may be assessed. This out-of-sample, one-step-ahead forecasting method is relatively straightforward. Let us take a simple one exogenous and one endogenous variable case, the following equation sums up the whole idea behind this methodology:

$$y_t = \alpha_0 + \alpha_1 y_{t-1} + \alpha_2 x_{t-1} + \varepsilon_t \tag{2.7}$$

From (2.7) we can infer that the forecast of y_{t+1} at time t is just $\alpha_0 + \alpha_1 y_t + \alpha_2 x_t$. If we know the parameters, we can just plug in the values of y_t and x_t. In short, equation (2.7) tells us that forecasts for each period are based on an estimate using data up to the previous period. For instance, the forecast of December 1999 is estimated by using coefficients from the regression estimated over February 1993 to November 1999 while the forecast of January 2001 is generated from information up to December 2000. In general, but more specifically applying to our absolute volatility model, the out-of-sample forecasting procedure can be summarized in four steps:

1) Obtain estimates for period n by running OLS on the original regression model of $VOL_t = \theta_1 + \theta_2 RET(k)_t + \theta_3 ATV_t + \theta_4 VOL_{t-1} + \theta_5 VOL_{t-2} + \theta_6 VOL_{t-3} + u_t$ for all property classes.

2) Use the fitted values of *VOL* which are generated from period n to forecast *VOL* of period m.

3) Quality of this out-of-sample forecast is then evaluated by using root mean square error (RMSE)[49] statistic criteria.

4) Pick the model that produces the lowest RMSE as the one with the best-forecast performance.

[48] Our full sample period is just $n + m$ observations.
[49] This is essentially the sample standard deviation of the forecast errors. If we compute RMSE for two or more forecasting models, we prefer the one with the smallest out-of-sample RMSE.

2.8.2 Absolute volatility model – Forecast power

Table 2-10 presents the OLS results for the first in-sample (February 1993 to July 1999) estimation. In explaining stock market volatility the wealth effect comes out as only significant in the Class *C,* Class *E* and Class *DE* property return models. After performing the complete forecasting procedure as prescribed above, we obtain the required RMSE for the regression model of each individual property class. Interestingly enough in Table 2-11, it is shown evidently that these three classes of property return models have the highest RMSE (all above 2.000). In fact, Class *A* – small residential property model gives the lowest RMSE of 1.888. In other words, the Class *A* model performs best when used to forecast future movements of stock market volatility. Although in all the regression estimations we have performed thus far the only class of property return which consistently produces a significant wealth effect is in Class *E*, it turns out that it is not the best model for forecast. This is not an entirely surprising result. If we look at the correlation matrix of Table 2-12, clearly our absolute stock market volatility (*VOL*) has the highest correlation with the forecast volatility produced by the Class *A* property return model which is labelled as (*VOLFA*)[50] at 0.31. Figures 2-6.1 and 2-6.2 depict graphically both the actual and forecast absolute volatility for the out-of-sample period for the eight property classes.

2.8.3 Conditional volatility (EGARCH) model – Forecast power

Conditional volatility – ARCH family of models are renowned for generating superior forecasting performance.[51] We generate the forecast of the conditional volatility by following the first two steps of the out-of-sample technique described above. Previously we have already mentioned the key difference of the estimation methods of our two volatility models. In our first model the method of OLS is used while the second model utilizes wealth and volume as two exogenous variables in the conditional variance

[50] Forecast volatilities (absolute volatility) are labelled according to the class of property used in each model, i.e. *VOLFB* implies forecast volatility produced by using Class *B* property in the model and so forth.

[51] See for example Frennberg and Hansson (1995).

equation. Because of the disparity in estimation approach, and also the limitation of EVIEWS[52] the procedure in generating forecast conditional variance is modified. We first obtain conditional variance by using equation (2.6a) for all property classes for period *n*. Then we use the generated conditional variance of period *n* to forecast one point at a time the series of conditional variance of period *m*. By taking the square root of the conditional variances series of period *m*, we obtain the required forecast conditional standard deviations – conditional stock market volatility.

Table 2-13 presents the first set of in sample results. In this EGARCH model we obtain significant wealth effect from the *D, E*, and *DE* classes of property. However, the size of these significant coefficients is greatly reduced. Instead of calculating the RMSE, we plot the forecast together with their actual values in Figures 2-7.1 and 2-7.2. It is very clear in these eight graphs that our conditional volatility forecast track their actual values extremely closely. This is certainly in strong contrast to the graphs in Figures 2-6.1 and 2-6.2. We can quantify these results through the use of the three correlation matrices in Tables 2-14.1 to 2-14.3. In particular Table 2-14.1 shows that the correlation between the in-sample condition volatilities (*SDA,...,SDALL*) have a very high correlation with the forecast volatilities (*FSDA,...,FSDALL*) with values above 0.9 levels.[53] Given these relationships the superior forecast power of the EGARCH model is evident. For further reference, correlation between individual actual and forecast volatilities is also presented in Tables 2-14.2 and 2-14.3. Overall, these two matrices provide us with a picture of how each category of property class is related.

2.9 Structural Change

In our model specification of (2.5a), we begin our investigation by assuming that this volatility-wealth-volume relationship remains stable for all the observations in our sample. However, due to the impacts of the 1997 *AFC* on the Hong Kong economy,[54] we are interested to test whether this event has changed our hypothesised relationship and if

[52] Computer package that we use in our model estimation.
[53] See the values in bold.
[54] Of course, we are not discounting the *AFC*'s impacts on other Asian economies such as Malaysia, Singapore, Indonesia, Korea and so on.

found positive, in what ways it has been changed, *i.e.* we attempt to test whether the intercept and/or the slope coefficients are different before and after the *AFC*. To capture this potential structural change, we apply a dummy variable approach. Most testing of structural change uses the Chow Test. However, this test cannot distinguish the structural change in each individual coefficient. We strongly believe that the dummy variable approach is more robust and befitting for our purpose. By employing the entire sample period of February 1993 to July 2001, we assign the period February 1993 to October 1997 as *pre-AFC*, whereas November 1997 to July 2001 is considered as *post-AFC*. We then split our sample period with dummy variables carrying different values according to *pre-AFC* and *post-AFC*. In total, we utilize six dummy variables to test for structural change and the specification of this test is as follows:

$$\text{Let} \quad D_1 = \begin{cases} 1 & post\ AFC \\ 0 & pre\ AFC \end{cases}$$

For D_i, $i = 2, 3, 4, 5, 6$ we let

$$D_i = \begin{cases} RET(k), ATV & values\ of\ RET(k), ATV\ in\ post\ AFC \\ 0 & for\ all\ observations\ in\ pre\ AFC \end{cases}$$

Then the regression model for each property class is written as:

$$\begin{aligned} VOL_t = {} & a_1 + (a_2 - a_1)D_1 + b_1 RET(k)_t + (b_2 - b_1)D_2 \\ & + c_1 ATV_t + (c_2 - c_1)D_3 + d_1 VOL_{t-1} + (d_2 - d_1)D_4 \\ & + e_1 VOL_{t-2} + (e_2 - e_1)D_5 + f_1 VOL_{t-3} + (f_2 - f_1)D_6 + e_t \end{aligned} \tag{2.8}$$

Hence,

(1) when $D_1 = 0$, *all* $D_i = 0$, it implies that $a_1 = a_2$, $b_1 = b_2$, ..., $f_1 = f_2$, *i.e.* all coefficients (intercept and slope) remain unchanged.

(2) when $D_1 = 0$, *all* $D_i \neq 0$, it implies that $a_1 = a_2$, $b_1 \neq b_2$, ..., $f_1 \neq f_2$, *i.e.* all slope coefficients are changed.

(3) when $D_1 \neq 0$, *all* $D_i = 0$, it implies that $a_1 \neq a_2$, $b_1 = b_2$, ..., $f_1 = f_2$, *i.e.* only intercept is changed.

(4) in general, we can detect the change in the coefficient whenever we find that the attached dummy variable coefficient is significantly different from zero.

The results of estimating (2.8) for all of our eight property market class returns are reported in Table 2-15. The coefficient of D_1, that is $(a_2 - a_1)$, measures the difference in the intercept terms whereas the rest of the coefficients D_2 to D_6 measure the difference in the slope terms between *pre* and *post-AFC*. Estimation results for all eight models show that there is structural change in all the intercepts during these two periods except for Classes *A* and *D* property return. In other words, the majority of the two regressions are concurrent regressions. For our wealth proxy coefficients, except for the small residential class and the upper luxury class property returns, all return coefficients show structural change before and after the *AFC*. In fact, all these statistically significant coefficients display a positive increase in their size ranging from 1.2 to 1.5 for the *post-AFC* period. Placing this in a volatility-wealth relationship context, it implies that, compared with the *pre-AFC* situation, a 1 per cent increase in wealth created from these property classes adds about 1.2 to 1.5 per cent extra volatility during *post-AFC*. It is interesting to observe that comparing with the full sample estimation results of Table 2-8.1 in which only Classes C and *E* property classes produce a wealth effect,[55] we now see all but Class *A* and Class E have a significant wealth effect on stock volatility. This change in magnitude is possibly due to the adverse effects of a weakening economy on investors of these classes of property. Alternatively, these supposed long-term, rational investors might be following in the footsteps of investors in the luxury (upper and lower) property and were forced to sell off some of their stocks at a falling price either for panic or liquidity reasons.

The other dummy slope coefficients that also exhibit structural change are the second and third stock market volatility lags. In particular the second volatility lag is significant at the 5 and 1 per cent levels at five occasions. Once again, the *F*-statistic confirms our finding by statistically failing to accept the joint null hypothesis that all coefficients are zero. In all cases, both the *ATV* and first volatility lag and also the Class *A* property model show no sign of structural change. These results provide evidence for the

[55] In the EGARCH model both upper and lower luxury classes are significant, hence we include both in our discussions on wealth effect.

impact of the *AFC* on our hypothesis of a stable volatility-wealth-volume relationship. Nonetheless, it seems that impacts of this financial crisis are somehow substantial on the majority of our wealth effect variables and also the second volatility lag. Upon the *AFC* the previously found significant wealth coefficients now become insignificant whereas the second volatility has the opposite outcome. That means, after the *AFC*, despite the structural changes in some of the wealth variables, they are not great enough to cause them to have any effects on stock volatility for the whole sample period. Apparently the adverse effect on the luxury (upper and lower) property class is so severe that investors in this class of property reduced their participation in the stock market substantially after the *AFC*. The fact that both the lower and upper luxury property coefficients show instability does not reject our volatility-wealth-volume hypothesis altogether. This simply further supports our assertion of the high degree of preoccupation that Hong Kong investors had prior to the onset of the *AFC*. More importantly, for the whole sample period under our study, the previous results confirm that the luxury (upper and lower) class models are the appropriate models to support the underlying wealth effect hypothesis.

One way to offer additional support to our findings of Table 2-8.1 is through our *conditional confidence theory*. Subsequent to the outbreak of the *AFC* and the ensuing collapse of the property market, the confidence of many investors was somewhat shaken, thus making them more cautious in their risk-taking attitude. However, working simultaneously was the opposite effect that as property prices began to fall, a liquidity crisis commenced. In order to raise capital to support their property market investments (mortgage payments), investors were dumping their stocks at prices far below their fundamentals. This action of forced selling caused a contagious effect amongst investors. To avoid being the last in the queue, this collective action initiated further stock price declines. The luxury (upper and lower) property case serves as the best candidate to support the above scenario. When the amount of capital held in this class of property is so vast, a falling market will make the act of forced selling more intensified while at the same time strengthening the volatility-wealth relationship when the *AFC* began. This serves as an excellent example of how these two markets are closely linked to each other in such a way that profit and loss in one market can have direct effects on the ups and downs of the other market and our volatility-wealth-volume hypothesis is hereby validated.

2.10 Conclusions

In this paper, we find supporting evidence for our hypothesis of a positive relationship between wealth and market volatility. But why should one care for such a relationship and what are the implications? The answer to the question lies in the possible detrimental effects that a volatile stock market can produce. A stable market environment possesses many advantages for the economy. In an ideal world, the stock market should be one of the main sources for companies to obtain capital (raising money by issuing shares) and for investors (general public) to invest. According to the general asset-pricing model, stock prices should reflect adequately the future returns (or stream of future dividend payments) from this investment. From a broader point of view, movements of the market should reveal all the fundamentals of the economy (both current and expected). In other words, the driving force behind the movements of the market should be the economy, not the sentiments of speculators[56] for quick profits. However, there seems to be evidence showing that the market is quite often dictated by purely speculative activities. Nevertheless, as the economy grows slowly, investors should expect long-term growth on their investments instead of short-term gains. In fact, many mutual funds and unit trust companies are using this concept in promoting their investment products.

For most long-term investors, both domestic and overseas, a stable market provides assurance in their investments while a volatile market weakens investors' confidence. With short-term speculations, capital investment that is needed to support a country's infrastructure cannot be sustained. The stock market is an important place where local companies secure their capital to finance their development and operations on a long-term basis. A stable market environment with less speculative activities gives both short and long-term investments a better place to grow. Furthermore, in a market economy, price is one of the important pieces of information for policy formulation. If prices do not reflect the underlying fundamentals, misguided policies may be made in consequence. It is true that one cannot control the amount of trading in an open market. However, this paper has shown that in Hong Kong property market fluctuations have adverse effects on stock

[56] Especially those irrational noise traders.

market volatility; reducing these fluctuations may be a more powerful and warranted policy for the Hong Kong government to consider.

Hong Kong for a long time has enjoyed the reputation as being one of the most *laissez faire* market economies in the world. Nonetheless, two events in recent years have tarnished its reputation in the international financial community. In August 1989, the Hong Kong government took the unprecedented step of supporting the stock market by purchasing total HK$118 billion (US$15.13 billion) worth of stocks, which was about 2.5 per cent of the total market capitalization of all stocks at that time. This act shook many international observers and the question of whether Hong Kong could ever remain a completely free market economy was raised as a result.

The second dilemma is still an ongoing issue under the current Hong Kong government agenda. Arising from the collapse of the property market in late 1997, the government has been under constant pressure to intervene and to try to support property prices, both from the property developers and those who incur huge losses in property investments.[57] One can certainly understand the government's dilemma in this stance. On one hand the government wants to reduce the harmful effects of this property price collapse to the economy,[58] on the other hand, the government is apprehensive about being criticised for market interference. The latter concern is an especially sensitive political issue following the return of Hong Kong to China in 1997.

Although officially and publicly denying that it has intervened in the property market, government policies during the past couple of years have shown signs of such an action. Since 1998, under revised government policies, provision of public housing, auction of government land, amount of government loans to purchase public housing units, percentage of initial mortgage deposit and so on have all been reduced. These policies should have the effects of reducing residential land supply whilst encouraging more public participation in the private property market. For those who lost greatly in the

[57] A new class of people emerged as a result of the property market collapse and in Hong Kong they are now called the "negative asset class".

[58] Since 1998 the Hong Kong economy has suffered a recession and many blame the collapse of the property market as the main cause of the event.

property market, these policies may offer a chance of escape from their predicament, but for the economy as a whole we question whether a long-term gain exists.

This paper finds evidence to support the relationship between wealth and stock market volatility; therefore, if the Hong Kong government did attempt to bail out the speculators through government intervention, we should predict a stronger wealth effect on the stock market. Our basis for such a claim is not difficult to perceive because one's risk attitude is deeply rooted into how one conceives the consequences of one's actions. Therefore, the logic goes that if an investor believes that the rule of the game is 'win I keep, lose someone else pays', then naturally this investor would become extremely risk loving.

According to our newly developed *conditional confidence theory* together with our empirical findings, any wealth creation through speculation would add substantial amounts of conditional confidence to the investor and advance speculation in the stock market with an extremely risk loving approach. It is not a bad government policy to support a market that is going through tough times, but granting the '*negative asset class*' assistance such as the recently suggested special interest concession on their mortgage loans will have an effect similar to redistributing income from the more cautious risk averse group of investors to the risk loving ones. Put aside the question of whether such an act is a Pareto improvement,[59] and also the issue of social equality. Bailing out of this group of risk loving investors would only create a signal similar to promoting excessive risk taking behaviour among investors. The consequence is likely to be long-lasting and devastating to the economy and eventually everyone will suffer. It is imperative that the Hong Kong government must consider carefully any policies that could convey such a message. The stability of the Hong Kong financial system has been haunted by the property cycle over the past couple of decades. Despite the government's intention to stabilize it, the property cycle is likely to repeat itself again in Hong Kong. As discussed in detail, these cycles, though providing abundant profit opportunities for some, also threaten Hong Kong's financial and economic stability and, in turn, its conditions as a financial centre.

[59] Making at least one person better off without making others worse off.

2.11 Issues for Future Work

This paper focuses extensively on the relationship between wealth as measured by property market returns and stock market volatility and finds positive results for the luxury property class (upper and lower). However, one cannot discount the fact that wealth creation can come from diverse sources. In reality, people can become wealthy from higher labour income, inheritance, winning a lottery, business success and so on. Hence, in order to validate fully the theory of wealth effect on stock market volatility, more direct investigations into the different categories of wealth creation would need to be undertaken.

Our discussions on the topic thus far have been centred on the domestic property market of Hong Kong. But Hong Kong being an international financial centre, external factors play an important role in her stock market movements. The ideal way to identify all the possible contributors to stock market volatility will be through the examination of these external factors such as balance of payment accounts, foreign direct investments, degree of openness, foreign exchange policy etc. Adding an international dimension to our wealth effect model should provide policy makers with the appropriate tools to lessen significantly the levels of unwanted fluctuation in the stock market.

Another aspect of investors' risk attitude on stock market volatility that deserves attention is the cultural difference effect. It may be interesting to examine whether Asian investors in general tend to be more risk loving than people in the West. Gambling has always been a very popular hobby for people in Asia for many centuries. For some people, investments in the stock market could be considered as just another form of gambling. Hence, by comparing the degree of gambling loving attitudes, it may offer us more insights into why the Hong Kong stock market is more volatile than other stock markets in the rest of the world.

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Table 2-1
Numbers of Days with more than 5% daily percentage INCREASE
4 January 1988 – 29 December 2000

Rank	Date	HSI	Date	Nikkei	Date	SPC
1	29 Oct 1997	18.82%	2 Oct 1990	13.24%	28 Oct 1997	5.11%
2	2 Feb 1998	14.33%	17 Nov 1997	7.96%	8 Sep 1998	5.09%
3	23 May 1989	9.30%	31 Jan 1994	7.84%		
4	16 Oct 1998	8.99%	10 Apr 1992	7.55%		
5	14 Aug 1998	8.47%	7 Jul 1995	6.27%		
6	7 Sep 1998	7.86%	21 Aug 1992	6.22%		
7	12 Jun 1989	7.56%	7 Oct 1998	6.17%		
8	13 Jan 1998	7.38%	27 Aug 1992	6.13%		
9	9 Oct 1998	7.14%	16 Jan 1998	6.11%		
10	3 Sep 1997	7.13%	6 Jan 1988	5.63%		
11	24 Oct 1997	6.89%	15 Aug 1990	5.40%		
12	18 Jun 1998	6.39%	7 Sep 1998	5.32%		
13	17 Jun 1998	6.35%	12 Oct 1998	5.24%		
14	3 Nov 1997	5.94%	8 Mar 1993	5.17%		
15	14 Jan 1994	5.87%	5 Mar 1999	5.01%		
16	4 Dec 1992	5.82%				
17	14 Jan 1998	5.81%				
18	14 Apr 1993	5.79%				
19	19 Aug 1998	5.71%				
20	12 Oct 1998	5.68%				
21	19 Jan 1998	5.62%				
22	6 Feb 1995	5.60%				
23	25 Sep 2000	5.58%				
24	28 Aug 1990	5.51%				
25	31 May 2000	5.17%				
26	5 Jan 1988	5.11%				
27	23 Mar 1994	5.03%				

Note. Daily price indices from Datastream. Calculations mine.

Table 2-2
Numbers of Days with more than 5% daily percentage DECREASE
4 January 1988 – 29 December 2000

Rank	Date	HSI	Date	Nikkei	Date	SPC
1	5 Jun 1989	-21.75%	18 Apr 2000	-6.98%	27 Oct 1997	-6.87%
2	28 Oct 1997	-13.71%	2 Apr 1990	-6.60%	31 Aug 1998	-6.80%
3	22 May 1989	-10.78%	19 Aug 1991	-5.91%	8 Jan 1988	-6.77%
4	23 Oct 1997	-10.41%	23 Aug 1990	-5.84%	13 Oct 1989	-6.12%
5	12 Jan 1998	-8.70%	8 Oct 1998	-5.78%	14 Apr 2000	-5.83%
6	17 Apr 2000	-8.55%	23 Jan 1995	-5.60%		
7	25 May 1989	-8.51%	19 Nov 1997	-5.29%		
8	19 Aug 1991	-8.38%	19 Dec 1997	-5.24%		
9	3 Dec 1992	-8.01%	25 Nov 1997	-5.11%		
10	6 Aug 1990	-7.42%	11 Sep 1998	-5.11%		
11	11 Mar 1996	-7.31%				
12	5 Jan 2000	-7.18%				
13	31 Aug 1998	-7.08%				
14	15 Jan 1998	-7.02%				
15	6 Jan 1994	-6.52%				
16	16 Oct 1989	-6.49%				
17	22 Oct 1997	-6.17%				
18	7 Feb 1994	-6.11%				
19	7 Jan 1998	-5.89%				
20	27 Oct 1997	-5.80%				
21	15 Jun 1998	-5.72%				
22	11 Dec 1997	-5.46%				
23	1 Dec 1992	-5.32%				
24	27 May 1998	-5.26%				
25	15 Mar 1993	-5.12%				
26	21 Mar 1994	-5.10%				
27	1 Sep 1997	-5.02%				
28	13 Jan 1994	-5.01%				

Note. Daily price indices from Datastream. Calculations mine.

Table 2-3

Conditional confidence theory

Property price Δ	|property market return| (|wealth Δ|)	Confidence Δ	Stocks	Stock price Δ - volatility
Large ↑	High	+ve	Buy	↑
Large ↓	High	-ve	Sell	↑
Small	Low	No	-	-
No	No	No	-	-

Table 2-4.1 Test for trading volume persistence
Dependent Variable: $TVOLM_t$
Sample: 1993:02 to 2001:07

Intercept	13.632* (6.868)
TVOLM(-1)	-0.289** (0.114)
TVOLM(-2)	-0.109 (0.117)
TVOLM(-3)	-0.092 (0.119)
TVOLM(-4)	-0.003 (0.118)
TVOLM(-5)	-0.102 (0.116)
TVOLM(-6)	0.135 (0.117)
TVOLM(-7)	0.008 (0.117)
TVOLM(-8)	0.113 (0.117)
TVOLM(-9)	0.129 (0.116)
TVOLM(-10)	0.073 (0.117)
TVOLM(-11)	-0.161 (0.115)
TVOLM(-12)	-0.132 (0.112)
Adjusted R^2	0.068
F-statistic	1.544

Note. Values enclosed in parentheses represent Newey-West HAC standard errors. ***$p < 0.01$; **$p < 0.05$ and *$p < 0.1$.

Estimation of the regression model:

$$TVOLM_t = \varphi_1 + \varphi_2 TVOLM_{t-1} + \varphi_3 TVOLM_{t-2} + \varphi_4 TVOLM_{t-3} + \varphi_5 TVOLM_{t-4}$$
$$+ \varphi_6 TVOLM_{t-5} + \varphi_7 TVOLM_{t-6} + \varphi_8 TVOLM_{t-7} + \varphi_9 TVOLM_{t-8}$$
$$+ \varphi_{10} TVOLM_{t-9} + \varphi_{11} TVOLM_{t-10} + \varphi_{12} TVOLM_{t-11} + \varphi_{13} TVOLM_{t-12} + \vartheta_t$$

$TVOLM_t$ = monthly volume growth rates in percentage.

Table 2-4.2 Regression results for equation (2.4)
Dependent Variable: $TVOLM_t$
Sample: 1993:02 to 2001:07

Intercept	12.717* (4.497)
TVOLM(-1)	-0.254** (0.098)
Adjusted R^2	0.053
F-statistic	6.648

Note. Values enclosed in parentheses represent Newey-West HAC standard errors.
***$p < 0.01$; **$p < 0.05$ and *$p < 0.1$.
Estimation of the regression model:

$$TVOLM_t = \lambda_1 + \lambda_2 TVOLM_{t-1} + +e_t$$

$TVOLM_t$ = monthly volume growth rates in percentage.

Table 2-5

Descriptive Statistics

	VOL	*RETA*	*RETB*	*RETC*	*RETD*	*RETE*	*RETABC*	*RETDE*	*RETALL*	*ATV*
Mean	7.453	1.049	1.236	1.223	1.380	1.890	1.103	1.347	1.100	32.902
Median	6.785	0.788	0.923	0.934	0.992	1.397	0.829	0.969	0.814	30.428
Maximum	28.24	5.503	5.301	6.650	5.228	7.595	5.538	5.243	5.470	138.93
Minimum	2.840	0.000	0.043	0.045	0.000	0.043	0.037	0.000	0.000	0.283
Std. Dev.	3.775	0.938	1.019	1.126	1.181	1.624	0.966	1.169	0.963	27.391
Skewness	2.195	1.802	1.497	1.829	1.101	1.206	1.674	1.166	1.642	1.534
Kurtosis	11.134	7.855	5.331	7.492	3.685	4.154	6.851	3.832	6.651	6.222
Sum	760.21	107.00	126.0	124.73	140.77	192.73	112.55	137.37	112.19	3257.4
Sum Sq. Dev.	1439.2	88.816	104.90	128.02	140.92	266.32	94.299	137.91	93.585	73525
Coefficient of Variation	0.504	0.894	0.824	0.921	0.856	0.859	0.876	0.868	0.875	0.833
Observations	102	102	102	102	102	102	102	102	102	99

	r	*SDA*	*SDB*	*SDC*	*SDD*	*SDE*	*SDABC*	*SDDE*	*SDALL*
Mean	0.747	9.235	9.236	9.169	9.180	8.982	9.232	9.055	9.228
Median	0.578	8.928	8.916	9.006	8.652	7.957	8.905	8.374	8.872
Maximum	26.452	16.341	16.273	16.988	19.323	19.793	16.848	20.783	17.309
Minimum	-34.823	5.974	5.527	5.304	5.105	5.144	5.891	4.426	5.769
Std. Dev.	9.247	2.035	1.914	2.169	2.595	2.955	2.068	2.637	2.097
Skewness	-0.106	1.083	1.015	0.824	1.562	1.707	1.160	1.665	1.193
Kurtosis	4.772	4.560	4.643	3.828	6.347	5.853	4.881	7.186	5.059
Sum	76.149	914.28	914.31	907.70	908.81	889.25	913.93	896.40	913.59
Sum Sq. Dev.	8636.1	405.75	359.16	461.16	660.13	855.60	418.95	681.69	430.82
Coefficient of Variation	12.379	0.220	0.207	0.237	0.283	0.329	0.224	0.291	0.227
Observations	102	99	99	99	99	99	99	99	

*All figures are expressed as per cent per month (except for observations).

Table 2-6

Correlation Matrix

	VOL	*RETURN*	*RETA*	*RETB*	*RETC*	*RETD*	*RETE*	*RETABC*	*RETDE*	*RETALL*	*ATV*
VOL	--	--	--	--	--	--	--	--	--	--	--
RETURN	-0.30	--	--	--	--	--	--	--	--	--	--
RETA	0.26	0.02	--	--	--	--	--	--	--	--	--
RETB	0.26	-0.13	0.81	--	--	--	--	--	--	--	--
RETC	0.30	-0.05	0.69	0.74	--	--	--	--	--	--	--
RETD	0.20	0.11	0.55	0.54	0.61	--	--	--	--	--	--
RETE	0.38	-0.03	0.31	0.42	0.39	0.36	--	--	--	--	--
RETABC	0.28	-0.07	0.93	0.95	0.79	0.60	0.41	--	--	--	--
RETDE	0.28	0.04	0.54	0.60	0.65	0.90	0.63	0.63	--	--	--
RETALL	0.29	-0.07	0.92	0.95	0.81	0.63	0.43	0.99	0.66	--	--
ATV	0.09	0.05	0.02	0.03	-0.01	-0.06	0.24	0.01	0.06	0.02	--

Table 2-7.1

Phillips-Perron Unit Root Test

Variables	PP Test Statistics
VOL	-5.173
RETA	-7.526
RETB	-7.746
RETC	-8.262
RETD	-7.705
RETE	-7.553
RETABC	-7.408
RETDE	-6.951
RETALL	-7.250
ATV	-9.683

MacKinnon critical values for rejection of hypothesis of a unit root:

-3.4959 (1%); -2.8900 (5%); -2.5818 (10%)

Lag truncation for Barlett kernel: 4 (Newey-West suggests: 4)

Table 2-7.2

Phillips-Perron Unit Root Test (Continued)

Variables	PP Test Statistics
RETURN	-10.276
SDA	-14.197
SDB	-13.769
SDC	-13.993
SDD	-13.710
SDE	-10.397
SDABC	-14.034
SDDE	-12.754
SDALL	-13.947

MacKinnon critical values for rejection of hypothesis of a unit root:

-3.4959 (1%); -2.8900 (5%); -2.5818 (10%)

Lag truncation for Barlett kernel: 3 (Newey-West suggests: 3)

Table 2-8.1 Absolute Volatility
Regression results for various property market returns -- Whole Sample

Dependent Variable: VOL_t 1993:02 to 2001:07

	$(k) = A$	$(k) = B$	$(k) = C$	$(k) = D$	$(k) = E$	$(k) = ABC$	$(k) = DE$	$(k) = ALL$
Intercept	1.881***	1.932***	1.619**	1.957***	1.713***	1.901***	1.874***	1.887***
	(0.661)	(0.695)	(0.618)	(0.686)	(0.610)	(0.682)	(0.631)	(0.675)
RET(k)	0.467	0.339	0.703**	0.267	0.604**	0.495	0.534*	0.555
	(0.537)	(0.431)	(0.325)	(0.317)	(0.270)	(0.491)	(0.320)	(0.483)
RET(k)(-1)	-0.011	-0.016	-0.152	-0.079	-0.082	-0.086	-0.208	-0.114
	(0.222)	(0.256)	(0.221)	(0.268)	(0.161)	(0.267)	(0.267)	(0.275)
ATV	0.004	0.004	0.005	0.005	-0.004	0.004	0.002	0.004
	(0.011)	(0.011)	(0.011)	(0.011)	(0.009)	(0.011)	(0.011)	(0.011)
Volatility (-1)	0.458***	0.449***	0.462***	0.480***	0.375***	0.450***	0.460***	0.448***
	(0.097)	(0.099)	(0.110)	(0.087)	(0.115)	(0.100)	(0.091)	(0.100)
Volatility (-2)	0.078	0.099	0.077	0.055	0.099	0.095	0.050	0.095
	(0.115)	(0.124)	(0.091)	(0.124)	(0.122)	(0.116)	(0.119)	(0.114)
Volatility (-3)	0.126	0.119	0.130	0.143	0.181	0.119	0.167	0.119
	(0.136)	(0.143)	(0.127)	(0.140)	(0.117)	(0.137)	(0.135)	(0.135)
Adjusted R^2	0.343	0.337	0.374	0.336	0.385	0.344	0.354	0.348
F-statistic	9.529	9.320	10.758	9.283	11.217	9.581	9.960	9.713
Breusch-Godfrey LM Test (*p value*)	0.651	0.562	0.734	0.564	0.598	0.796	0.802	0.811
White Heteroscedasticity Test (*p value*)	0.326	0.470	0.441	0.459	0.077	0.417	0.446	0.447

Note. Values enclosed in parentheses represent Newey-West HAC standard errors. ***$p < 0.01$; **$p < 0.05$ and *$p < 0.1$.

Estimation of the regression model:

$$VOL_t = \theta_1 + \theta_2 RET(k)_t + \theta_3 RET(k)_{t-1} + \theta_4 ATV_t + \theta_5 VOL_{t-1} + \theta_6 VOL_{t-2} + \theta_7 VOL_{t-3} + u_t$$

$VOL_t = \left|\hat{\sigma}_m\right|$.

$RET(k)_t$ = proxy for testing the wealth effect, is the property price index return measured as an absolute value in percentage change, $k = A, B, C, D, E, ABC, DE, ALL$.

ATV_t = absolute value of the 1st order autoregressive residuals.

Breusch-Godfrey LM Test at six lags of VOL_t.

Table 2-8.S Absolute Volatility

Regression results for property market returns (Class *A* to *E*) -- Whole Sample

Dependent Variable: VOL_t	1993:02 to 2001:07
Intercept	1.584**
	(0.692)
RET(A)	0.373
	(0.544)
RET(A)(-1)	0.113
	(0.375)
RET(B)	-0.863
	(0.692)
RET(B)(-1)	-0.075
	(0.624)
RET(C)	1.018*
	(0.545)
RET(C)(-1)	0.072
	(0.714)
RET(D)	-0.337
	(0.249)
RET(D)(-1)	-0.293
	(0.403)
RET(E)	0.586*
	(0.320)
RET(E)(-1)	-0.017
	(0.177)
ATV	-0.004
	(0.008)
Volatility (-1)	0.396***
	(0.139)
Volatility (-2)	0.066
	(0.130)
Volatility (-3)	0.227
	(0.119)
Adjusted R^2	0.465
F-statistic	5.216
Wald Test (p value) H_0: All RET(k) coefficients are equal	0.062

Note. Values enclosed in parentheses represent Newey-West HAC standard errors. ***$p < 0.01$; **$p < 0.05$ and *$p < 0.1$.

Estimation of the regression model:

$$VOL_t = \theta_1 + \theta_2 RET(k)_t + \theta_3 RET(k)_{t-1} + \theta_4 ATV_t + \theta_5 VOL_{t-1} + \theta_6 VOL_{t-2} + \theta_7 VOL_{t-3} + u_t$$

$VOL_t = \left|\hat{\sigma}_m\right|$.

$RET(k)_t$ = proxy for testing the wealth effect, is the property price index return measured as an absolute value in percentage change, $k = A, B, C, D, E$.

ATV_t = absolute value of the 1st order autoregressive residuals.

Breusch-Godfrey LM Test at six lags of VOL_t.

Table 2-8.2 Absolute Volatility
Regression results for various property market returns -- Whole Sample

Dependent Variable: VOL_t 1993:02 to 2001:07

	$(k) = A$	$(k) = B$	$(k) = C$	$(k) = D$	$(k) = E$	$(k) = ABC$	$(k) = DE$	$(k) = ALL$
Intercept	1.876***	1.922***	1.538**	1.916***	1.671***	1.859***	1.799***	1.836***
	(0.660)	(0.661)	(0.636)	(0.641)	(0.595)	(0.662)	(0.609)	(0.658)
RET(k)	0.465	0.335	0.680**	0.251	0.590**	0.472	0.473	0.523
	(0.527)	(0.433)	(0.333)	(0.324)	(0.262)	(0.487)	(0.300)	(0.477)
ATV	0.004	0.004	0.005	0.005	-0.004	0.004	0.003	0.004
	(0.011)	(0.011)	(0.011)	(0.011)	(0.009)	(0.011)	(0.011)	(0.011)
Volatility (-1)	0.458***	0.449***	0.449***	0.479***	0.367***	0.447***	0.453***	0.445***
	(0.094)	(0.098)	(0.095)	(0.084)	(0.117)	(0.097)	(0.088)	(0.097)
Volatility (-2)	0.078	0.097	0.076	0.056	0.089	0.090	0.047	0.089
	(0.112)	(0.115)	(0.095)	(0.124)	(0.116)	(0.112)	(0.118)	(0.111)
Volatility (-3)	0.126	0.120	0.132	0.138	0.187	0.122	0.158	0.122
	(0.135)	(0.137)	(0.127)	(0.143)	(0.114)	(0.134)	(0.134)	(0.133)
Adjusted R^2	0.350	0.345	0.379	0.343	0.390	0.351	0.358	0.354
F-statistic	11.560	11.31	12.954	11.236	13.553	11.603	11.912	11.748
Breusch-Godfrey LM Test (*p value*)	0.174	0.249	0.467	0.338	0.315	0.201	0.307	0.208
White Heteroscedasticity Test (*p value*)	0.241	0.419	0.478	0.458	0.036	0.392	0.386	0.426

Note. Values enclosed in parentheses represent Newey-West HAC standard errors. ***$p < 0.01$; **$p < 0.05$ and *$p < 0.1$.

Estimation of the regression model:

$$VOL_t = \theta_1 + \theta_2 RET(k)_t + \theta_3 ATV_t + \theta_4 VOL_{t-1} + \theta_5 VOL_{t-2} + \theta_6 VOL_{t-3} + u_t$$

$VOL_t = \left|\hat{\sigma}_m\right|$.

$RET(k)_t$ = proxy for testing the wealth effect, is the property price index return measured as an absolute value in percentage change, $k = A, B, C, D, E, ABC, DE, ALL$.

ATV_t = absolute value of the 1st order autoregressive residuals.

Breusch-Godfrey LM Test at six lags of VOL_t.

Table 2-9.1 Conditional Volatility – EGARCH Model
Regression results for various property market returns -- Whole Sample

Dependent Variable: $\log(h_t)$ 1993:02 to 2001:07

	$(k) = A$	$(k) = B$	$(k) = C$	$(k) = D$	$(k) = E$	$(k) = ABC$	$(k) = DE$	$(k) = ALL$
ϖ	5.889***	5.956***	6.342***	4.648***	4.511**	5.995***	4.910***	5.976***
	(1.252)	(1.306)	(1.080)	(1.772)	(2.343)	(1.245)	(1.638)	(1.270)
α	-0.363	-0.350	-0.432*	-0.234	-0.084	-0.388	-0.100	-0.387
	(0.305)	(0.293)	(0.255)	(0.256)	(0.278)	(0.301)	(0.239)	(0.296)
β	-0.380	-0.390	-0.486*	-0.142	-0.170	-0.407	-0.195	-0.406
	(0.309)	(0.323)	(0.272)	(0.413)	(0.653)	(0.312)	(0.387)	(0.316)
γ	0.024	-0.002	0.017	-0.028	-0.116	0.030	-0.093	0.029
	(0.143)	(0.146)	(0.134)	(0.161)	(0.133)	(0.142)	(0.152)	(0.139)
ϕ_1	0.142	0.041	0.218	0.309*	0.325***	0.159	0.353**	0.178
	(0.235)	(0.208)	(0.161)	(0.171)	(0.099)	(0.247)	(0.144)	(0.249)
ϕ_2	-0.002	0.056	-0.054	-0.224	-0.085	0.007	-0.320	0.001
	(0.176)	(0.116)	(0.193)	(0.210)	(0.245)	(0.129)	(0.199)	(0.139)
ϕ_3	0.009	0.010	0.009	0.012*	0.004	0.009	0.008	0.009
	(0.006)	(0.006)	(0.007)	(0.006)	(0.008)	(0.006)	(0.007)	(0.006)
Ljung-Box Q-statistics (*p value*):								
Lag 1	0.506	0.528	0.520	0.512	0.747	0.487	0.755	0.482
Lag 2	0.720	0.725	0.701	0.708	0.893	0.713	0.953	0.710
Lag 3	0.393	0.450	0.376	0.581	0.481	0.399	0.811	0.397
Lag 4	0.434	0.502	0.445	0.594	0.610	0.460	0.810	0.460
Lag 5	0.568	0.633	0.579	0.730	0.742	0.598	0.894	0.599
Lag 6	0.621	0.685	0.674	0.725	0.616	0.652	0.853	0.652

Note. Values enclosed in parentheses represent Bollerslev-Wooldrige robust standard errors. ***$p < 0.01$; **$p < 0.05$ and *$p < 0.1$.

Estimation of the EGARCH model:

$$\log(h_t) = \varpi + \alpha\left|\frac{\varepsilon_{t-1}}{\sqrt{h}_{t-1}}\right| + \beta\log(h_{t-1}) + \gamma\frac{\varepsilon_{t-1}}{\sqrt{h}_{t-1}} + \phi_1 RET(k)_t + \phi_2 RET(k)_{t-1} + \phi_3 ATV_t$$

h_t = conditional variance in month t.

$RET(k)_t$ = proxy for testing the wealth effect, is the property price index return measured as an absolute value in percentage change, $k = A, B, C, D, E, ABC, DE, ALL$.

ATV_t = absolute value of the 1st order autoregressive residuals.

Table 2-9.2 Conditional Volatility – EGARCH Model
Regression results for various property market returns -- Whole Sample

Dependent Variable: $\log(h_t)$ 1993:02 to 2001:07

	$(k) = A$	$(k) = B$	$(k) = C$	$(k) = D$	$(k) = E$	$(k) = ABC$	$(k) = DE$	$(k) = ALL$
ϖ	5.893***	5.875***	6.402***	5.503***	4.950***	5.978***	5.727***	5.973***
	(1.202)	(1.318)	(1.103)	(1.294)	(1.320)	(1.213)	(1.346)	(1.227)
α	-0.364	-0.350	-0.437*	-0.297	-0.131	-0.389	-0.212	-0.387
	(0.300)	(0.277)	(0.250)	(0.245)	(0.267)	(0.302)	(0.225)	(0.296)
β	-0.382	-0.352	-0.513*	-0.381	-0.298	-0.401	-0.454	-0.405
	(0.297)	(0.338)	(0.267)	(0.266)	(0.304)	(0.298)	(0.290)	(0.299)
γ	0.024	-0.027	0.024	0.040	-0.099	0.028	0.035	0.029
	(0.142)	(0.144)	(0.129)	(0.134)	(0.127)	(0.142)	(0.123)	(0.139)
ϕ_1	0.142	0.023	0.231	0.277*	0.315***	0.158	0.362**	0.178
	(0.235)	(0.213)	(0.156)	(0.146)	(0.102)	(0.242)	(0.144)	(0.241)
ϕ_2	0.009	0.010	0.008	0.011	0.004	0.009	0.008	0.009
	(0.006)	(0.006)	(0.007)	(0.007)	(0.008)	(0.006)	(0.007)	(0.006)
Ljung-Box Q-statistics (*p value*):								
Lag 1	0.660	0.665	0.731	0.798	0.709	0.669	0.821	0.671
Lag 2	0.741	0.758	0.688	0.520	0.737	0.712	0.599	0.697
Lag 3	0.703	0.664	0.761	0.661	0.893	0.746	0.786	0.756
Lag 4	0.808	0.775	0.881	0.799	0.952	0.852	0.898	0.864
Lag 5	0.900	0.875	0.943	0.887	0.850	0.929	0.951	0.936
Lag 6	0.878	0.842	0.931	0.920	0.297	0.857	0.902	0.864
Lag 7	0.863	0.825	0.905	0.802	0.252	0.851	0.687	0.855
Lag 8	0.826	0.759	0.921	0.861	0.053	0.782	0.680	0.787
Lag 9	0.881	0.833	0.956	0.910	0.082	0.846	0.766	0.850
Lag 10	0.889	0.839	0.928	0.920	0.079	0.859	0.772	0.861
Lag 11	0.917	0.882	0.921	0.909	0.112	0.896	0.734	0.897
Lag 12	0.974	0.678	0.877	0.931	0.091	0.745	0.788	0.755

Note. Values enclosed in parentheses represent Bollerslev-Wooldrige robust standard errors. ***$p < 0.01$; **$p < 0.05$ and *$p < 0.1$.

Estimation of the EGARCH model:

$$\log(h_t) = \varpi + \alpha\left|\frac{\varepsilon_{t-1}}{\sqrt{h}_{t-1}}\right| + \beta\log(h_{t-1}) + \gamma\frac{\varepsilon_{t-1}}{\sqrt{h}_{t-1}} + \phi_1 RET(k)_t + \phi_2 ATV_t$$

h_t = conditional variance in month t.

$RET(k)_t$ = proxy for testing the wealth effect, is the property price index return measured as an absolute value in percentage change, $k = A, B, C, D, E, ABC, DE, ALL$.

ATV_t = absolute value of the 1st order autoregressive residuals.

Table 2-10 Absolute Volatility – Forecast Power
Regression results for various property market returns – In Sample

Dependent Variable: VOL_t Sample: 1993:02 to 1999:07

	$(k) = A$	$(k) = B$	$(k) = C$	$(k) = D$	$(k) = E$	$(k) = ABC$	$(k) = DE$	$(k) = ALL$
Intercept	1.791**	1.791**	1.251*	1.735**	1.513**	1.723**	1.549**	1.689**
	(0.716)	(0.754)	(0.691)	(0.720)	(0.608)	(0.737)	(0.651)	(0.729)
RET(k)	0.503	0.381	0.799**	0.364	0.701**	0.529	0.619*	0.584
	(0.616)	(0.525)	(0.353)	(0.398)	(0.292)	(0.569)	(0.341)	(0.554)
ATV	0.002	0.002	0.003	0.003	-0.010	0.003	-0.000	0.002
	(0.014)	(0.014)	(0.013)	(0.013)	(0.011)	(0.014)	(0.014)	(0.014)
Volatility (-1)	0.451***	0.439***	0.436***	0.473***	0.330**	0.436***	0.437***	0.434***
	(0.105)	(0.113)	(0.103)	(0.091)	(0.126)	(0.109)	(0.094)	(0.108)
Volatility (-2)	0.108	0.125	0.101	0.066	0.103	0.121	0.057	0.120
	(0.128)	(0.132)	(0.102)	(0.140)	(0.127)	(0.128)	(0.132)	(0.126)
Volatility (-3)	0.117	0.115	0.129	0.138	0.210	0.115	0.168	0.115
	(0.153)	(0.153)	(0.142)	(0.160)	(0.119)	(0.151)	(0.148)	(0.149)
Adjusted R^2	0.362	0.356	0.401	0.358	0.412	0.364	0.378	0.367
F-statistic	9.387	9.187	10.901	9.263	11.354	9.462	9.983	9.593

Note. Values enclosed in parentheses represent Newey-West HAC standard errors. ***$p < 0.01$; **$p < 0.05$ and *$p < 0.1$.

Estimation of the regression model:

$$VOL_t = \theta_1 + \theta_2 RET(k)_t + \theta_3 ATV_t + \theta_4 VOL_{t-1} + \theta_5 VOL_{t-2} + \theta_6 VOL_{t-3} + v_t$$

$VOL_t = \left|\hat{\sigma}_m\right|$.

$RET(k)_t$ = proxy for testing the wealth effect, is the property price index return measured as an absolute value in percentage change, $k = A, B, C, D, E, ABC, DE, ALL$.

ATV_t = absolute value of the 1st order autoregressive residuals.

Table 2-11 Absolute Volatility

Test of Forecasting Power – Root Mean Squared Error (RMSE)

Property Class	RMSE
A	1.888
B	1.893
C	2.028
D	1.961
E	2.026
ABC	1.904
DE	2.033
ALL	1.908

Table 2-12 Test of Forecast Power – Absolute Volatility

Correlation Matrix

	VOL	*VOLFA*	*VOLFB*	*VOLFC*	*VOLFD*	*VOLFE*	*VOLFABC*	*VOLFDE*	*VOLFALL*
VOL	--	--	--	--	--	--	--	--	--
VOLFA	0.31	--	--	--	--	--	--	--	--
VOLFB	0.30	0.97	--	--	--	--	--	--	--
VOLFC	0.26	0.94	0.96	--	--	--	--	--	--
VOLFD	0.23	0.94	0.95	0.89	--	--	--	--	--
VOLFE	0.23	0.61	0.66	0.65	0.67	--	--	--	--
VOLFABC	0.30	0.99	0.99	0.96	0.94	0.65	--	--	--
VOLFDE	0.23	0.90	0.93	0.87	0.97	0.70	0.91	--	--
VOLFALL	0.30	0.99	0.99	0.95	0.94	0.64	0.99	0.92	--

Table 2-13 Conditional Volatility – Forecast Power
Regression results for various property market returns – In Sample

Dependent Variable: $\log(h_t)$ Sample: 1993:02 to 1999:07

	$(k) = A$	$(k) = B$	$(k) = C$	$(k) = D$	$(k) = E$	$(k) = ABC$	$(k) = DE$	$(k) = ALL$
ϖ	5.614***	5.474***	6.189***	5.335***	5.104***	5.706***	5.497***	5.732***
	(1.111)	(1.243)	(1.016)	(1.256)	(1.571)	(1.135)	(1.504)	(1.134)
α	-0.447	-0.391	-0.531*	-0.374	-0.195	-0.459	-0.244	-0.463
	(0.359)	(0.320)	(0.322)	(0.289)	(0.307)	(0.363)	(0.240)	(0.357)
β	-0.303)	-0.236	-0.454*	-0.342	-0.306	-0.319	-0.446	-0.333
	(0.280)	(0.328)	(0.249)	(0.249)	(0.369)	(0.287)	(0.292)	(0.282)
γ	0.024	-0.078	0.007	0.008	-0.067	0.020	0.083	0.034
	(0.172)	(0.190)	(0.163)	(0.163)	(0.137)	(0.179)	(0.141)	(0.176)
ϕ_1	0.114	-0.053	0.233	0.272*	0.260**	0.102	0.451**	0.137
	(0.239)	(0.255)	(0.181)	(0.164)	(0.105)	(0.265)	(0.191)	(0.262)
ϕ_2	0.013	0.013	0.011	0.014**	0.007	0.013	0.010	0.013
	(0.006)	(0.006)	(0.007)	(0.007)	(0.009)	(0.006)	(0.008)	(0.006)

Note. Values enclosed in parentheses represent Bollerslev-Wooldrige robust standard errors. ***$p < 0.01$; **$p < 0.05$ and *$p < 0.1$.

Estimation of the EGARCH model:

$$\log(h_t) = \varpi + \alpha\left|\frac{\varepsilon_{t-1}}{\sqrt{h}_{t-1}}\right| + \beta\log(h_{t-1}) + \gamma\frac{\varepsilon_{t-1}}{\sqrt{h}_{t-1}} + \phi_1 RET(k)_t + \phi_2 ATV_t$$

h_t = conditional variance in month t.

$RET(k)_t$ = proxy for testing the wealth effect, is the property price index return measured as an absolute value in percentage change, $k = A, B, C, D, E, ABC, DE, ALL$.

ATV_t = absolute value of the 1st order autoregressive residuals.

Table 2-14.1 Test of Forecast Power – Conditional Volatility Correlation Matrix

	SDA	*SDB*	*SDC*	*SDD*	*SDE*	*SDABC*	*SDDE*	*SDALL*
FSDA	**0.98**	0.97	0.97	0.84	0.61	0.99	0.78	0.98
FSDB	0.92	**0.98**	0.92	0.77	0.61	0.93	0.69	0.92
FSDC	0.97	0.97	**0.99**	0.82	0.60	0.98	0.76	0.98
FSDD	0.95	0.92	0.91	**0.97**	0.57	0.94	0.92	0.95
FSDE	0.76	0.80	0.77	0.65	**0.96**	0.78	0.64	0.78
FSDABC	0.97	0.99	0.97	0.83	0.62	**0.98**	0.77	0.98
FSDE	0.84	0.78	0.79	0.94	0.50	0.84	**0.99**	0.85
FSALL	0.98	0.97	0.97	0.86	0.58	0.99	0.82	**0.99**

Table 2-14.2 Test of Forecast Power – Conditional Volatility Correlation Matrix (Continued)

	SDA	*SDB*	*SDC*	*SDD*	*SDE*	*SDABC*	*SDDE*	*SDALL*
SDA	--	--	--	--	--	--	--	--
SDB	0.96	--	--	--	--	--	--	--
SDC	0.98	0.96	--	--	--	--	--	--
SDD	0.88	0.84	0.83	--	--	--	--	--
SDE	0.57	0.60	0.58	0.48	--	--	--	--
SDABC	0.99	0.97	0.98	0.87	0.59	--	--	--
SDE	0.82	0.77	0.78	0.95	0.49	0.82	--	--
SDALL	0.99	0.97	0.98	0.88	0.58	0.99	0.83	--

Table 2-14.3 Test of Forecast Power – Conditional Volatility Correlation Matrix (Continued)

	FSDA	*FSDB*	*FSDC*	*FSDD*	*FSDE*	*FSDABC*	*FSDDE*	*FSDALL*
FSDA	--	--	--	--	--	--	--	--
FSDB	0.97	--	--	--	--	--	--	--
FSDC	0.98	0.94	--	--	--	--	--	--
FSDD	0.93	0.87	0.92	--	--	--	--	--
FSDE	0.81	0.80	0.79	0.75	--	--	--	--
FSDABC	0.99	0.97	0.98	0.92	0.82	--	--	--
FSDE	0.80	0.70	0.78	0.93	0.66	0.78	--	--
FSALL	0.98	0.92	0.99	0.94	0.78	0.98	0.84	--

Table 2-15 Absolute Volatility
Dummy variable approach for testing structural change

Dependent Variable: VOL_t Sample: 1993:02 to 2001:07

	$(k) = A$	$(k) = B$	$(k) = C$	$(k) = D$	$(k) = E$	$(k) = ABC$	$(k) = DE$	$(k) = ALL$
a_1	1.373	1.105	0.881	1.175	0.429	1.183	0.912	1.098
	(0.896)	(0.866)	(1.014)	(0.903)	(1.194)	(0.877)	(1.016)	(0.896)
$a_2 - a_1$	2.022	2.917*	3.025**	2.361	3.360*	2.727*	3.304**	2.902**
	(1.404)	(1.587)	(1.362)	(1.452)	(1.964)	(1.425)	(1.548)	(1.417)
b_1	-0.496	-0.261	-0.037	-0.427	0.413	-0.303	-0.113	-0.232
	(0.656)	(0.639)	(0.365)	(0.469)	(0.307)	(0.647)	(0.384)	(0.634)
$b_2 - b_1$	1.846	1.242*	1.327***	1.379**	0.098	1.551**	1.232**	1.544**
	(0.714)	(0.742)	(0.415)	(0.646)	(0.431)	(0.704)	(0.589)	(0.690)
c_1	0.017	0.015	0.015	0.015	0.006	0.016	0.015	0.016
	(0.017)	(0.016)	(0.016)	(0.015)	(0.015)	(0.016)	(0.017)	(0.017)
$c_2 - c_1$	-0.013	-0.017	-0.018	-0.011	-0.012	-0.015	-0.018	-0.015
	(0.024)	(0.025)	(0.022)	(0.021)	(0.024)	(0.025)	(0.024)	(0.024)
d_1	1.011**	1.015**	0.995**	1.045**	0.881**	1.010**	1.013**	1.006**
	(0.456)	(0.483)	(0.455)	(0.483)	(0.416)	(0.467)	(0.497)	(0.469)
$d_2 - d_1$	-0.779	-0.817	-0.766	-0.731	-0.658	-0.811	-0.766	-0.810
	(0.515)	(0.548)	(0.518)	(0.523)	(0.486)	(0.531)	(0.554)	(0.531)
e_1	0.420**	0.417**	0.414**	0.431**	0.340**	0.419**	0.423**	0.418**
	(0.163)	(0.163)	(0.164)	(0.166)	(0.158)	(0.163)	(0.164)	(0.162)
$e_2 - e_1$	-0.440	-0.378*	-0.436**	-0.560***	-0.345*	-0.406**	-0.539***	-0.411**
	(0.194)	(0.205)	(0.176)	(0.193)	(0.203)	(0.198)	(0.192)	(0.195)
f_1	-0.613	-0.584	-0.568	-0.583	-0.402	-0.597	-0.583	-0.590
	(0.400)	(0.387)	(0.378)	(0.367)	(0.324)	(0.405)	(0.398)	(0.404)
$f_2 - f_1$	0.796	0.739	0.741*	0.818*	0.649*	0.752	0.816*	0.742
	(0.444)	(0.445)	(0.422)	(0.418)	(0.372)	(0.453)	(0.440)	(0.452)
Adjusted R^2	0.483	0.450	0.500	0.469	0.449	0.468	0.461	0.471
F-Statistic	9.314	8.286	9.903	8.854	8.272	8.843	8.627	8.920
Breusch-Godfrey LM Test (*p value*)	0.745	0.285	0.766	0.240	0.369	0.487	0.288	0.503
White Heteroscedasticity Test (*p value*)	0.039	0.080	0.073	0.061	0.024	0.075	0.063	0.075

Note. Values enclosed in parentheses represent Newey-West HAC standard errors. ***$p < 0.01$; **$p < 0.05$ and *$p < 0.1$.

Estimation of the regression model:

$$VOL_t = a_1 + (a_2 - a_1)D_1 + b_1 RET(k)_t + (b_2 - b_1)D_2 + c_1 ATV_t + (c_2 - c_1)D_3 + d_1 VOL_{t-1} + (d_2 - d_1)D_4 + e_1 VOL_{t-2} + (e_2 - e_1)D_5 + f_1 VOL_{t-3} + (f_2 - f_1)D_6 + e_t$$

$VOL_t = |\hat{\sigma}_m|$.

$RET(k)_t$ = proxy for testing the wealth effect, is the property price index return measured as an absolute value in percentage change, $k = A, B, C, D, E, ABC, DE, ALL$.

ATV_t = absolute value of the 1st order autoregressive residuals.

D_i = structural dummies with 1 for period of *post AFC* (1997:11 to 2001:07) and 0 for *pre AFC* period (1993:02 to 1997:10).

Breusch-Godfrey LM Test at six lags of VOL_t

Figure 2-1.1 Contribution of market trading by investor type

Hong Kong Stock Exchange (Year 1999)

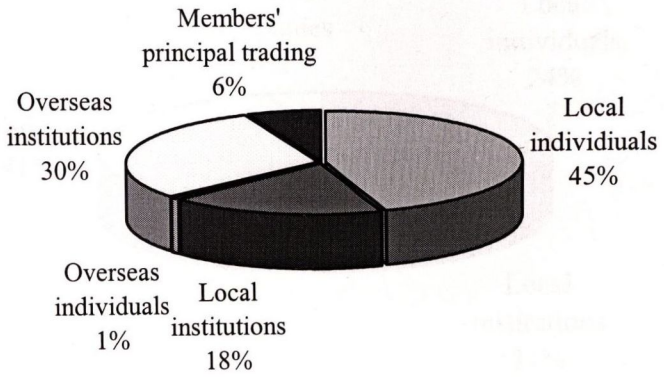
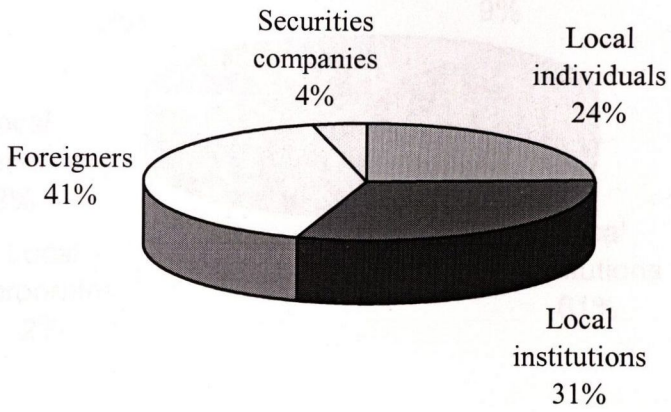


Figure 2-1.2 Contribution of market trading by investor type[60]

Tokyo Stock Exchange (Year 2001)



[60] For the Tokyo Stock Exchange, the following chart shows the trading volume by investor type in the 1st section market. Definition of this market can be found in Appendix 2C.

Figure 2-1.3 Contribution of market trading by investor type

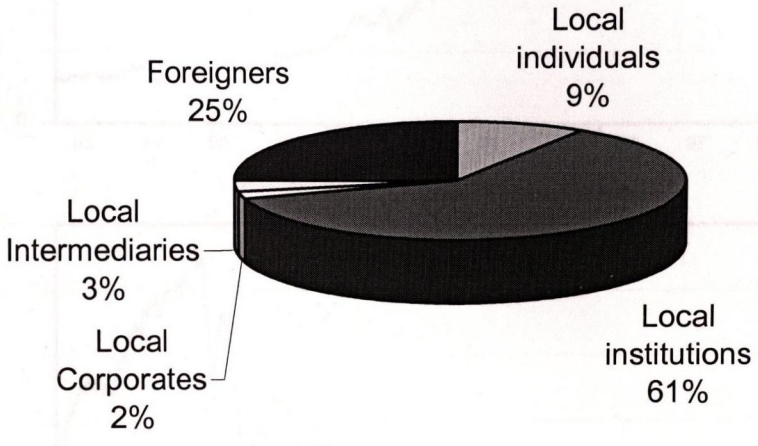


Figure 2-2 Daily stock market price index

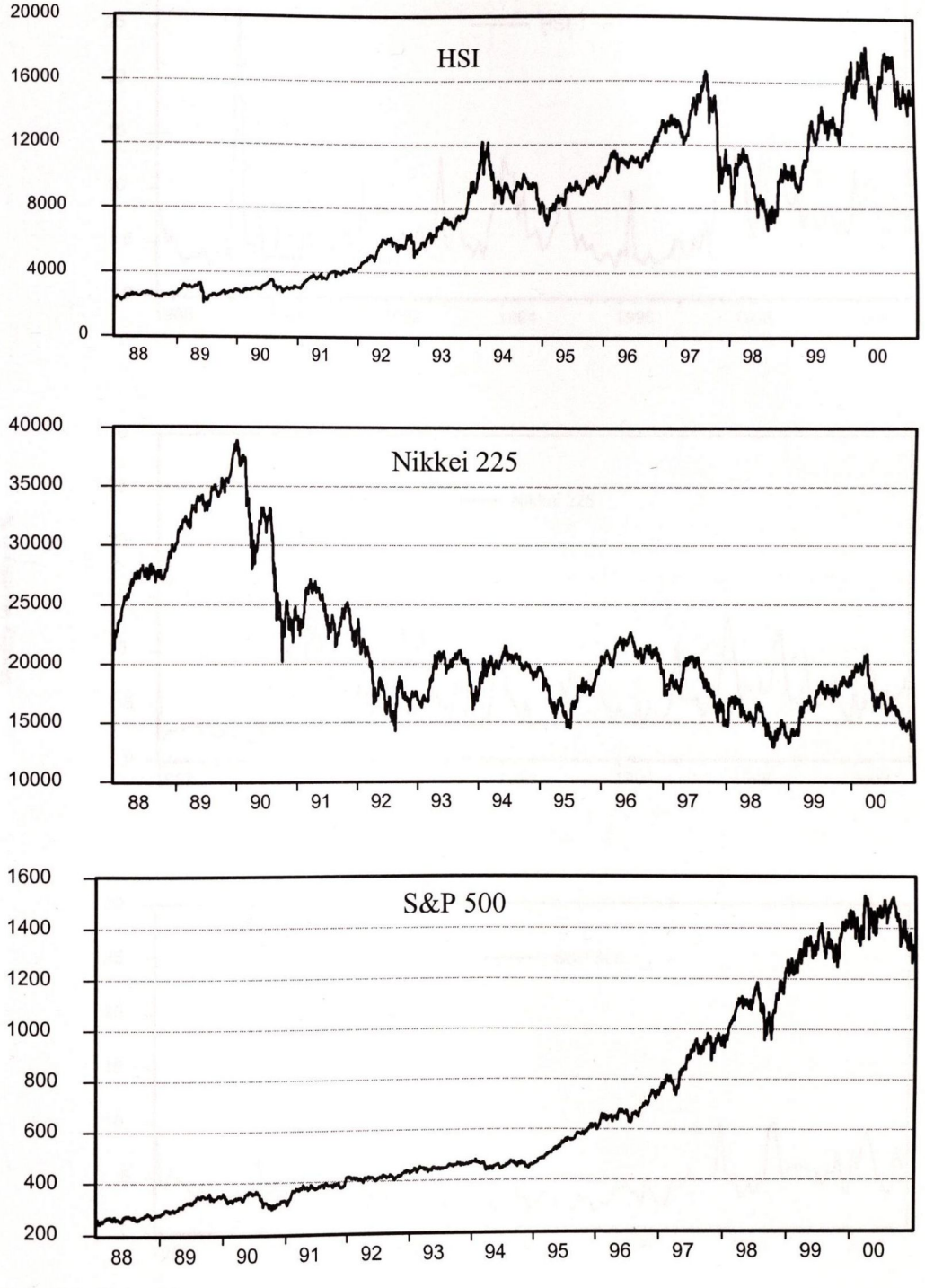


Figure 2-3 Monthly stock market volatility

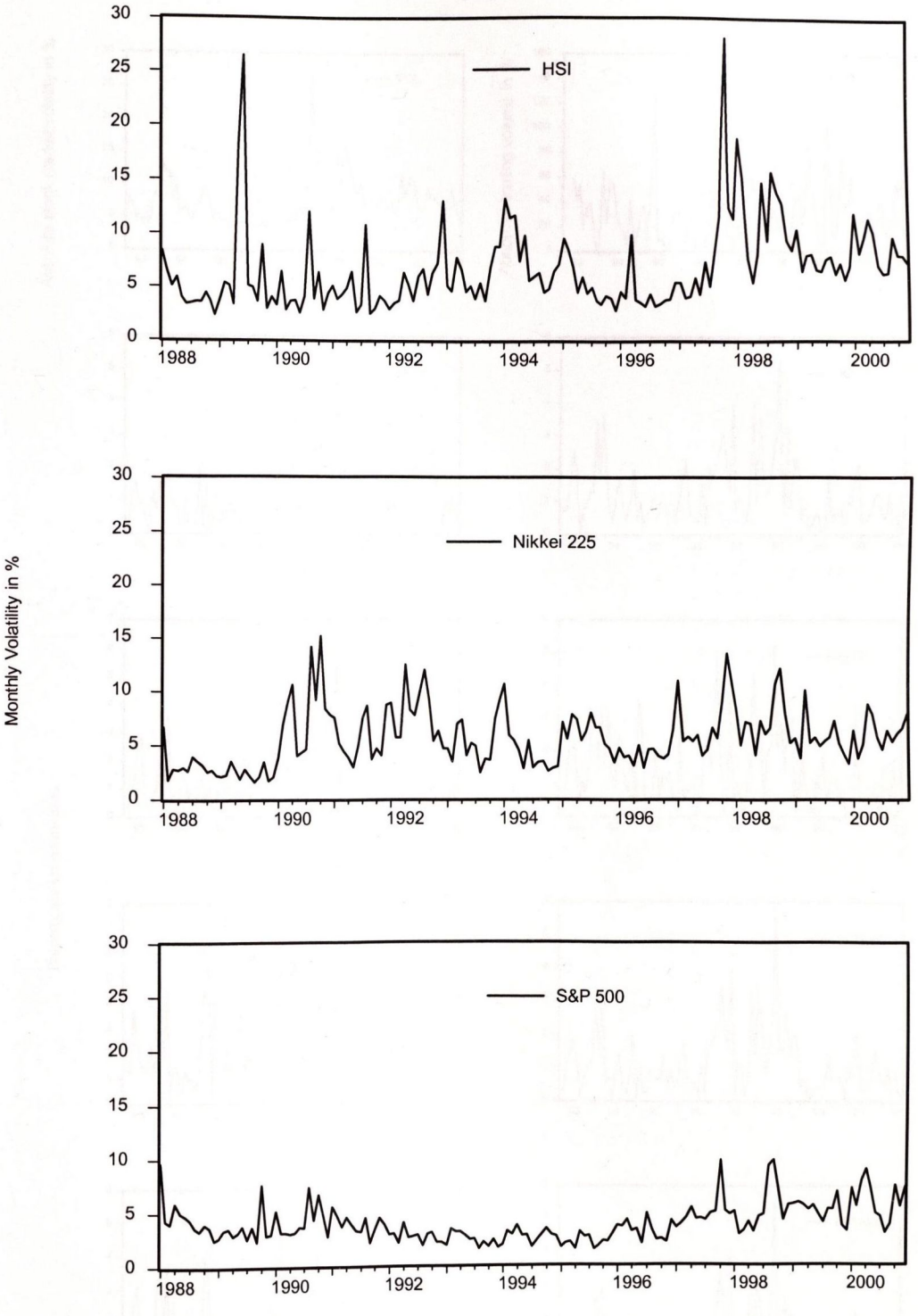


Figure 2-4 Absolute volatility, abnormal trading volume and property market return data series

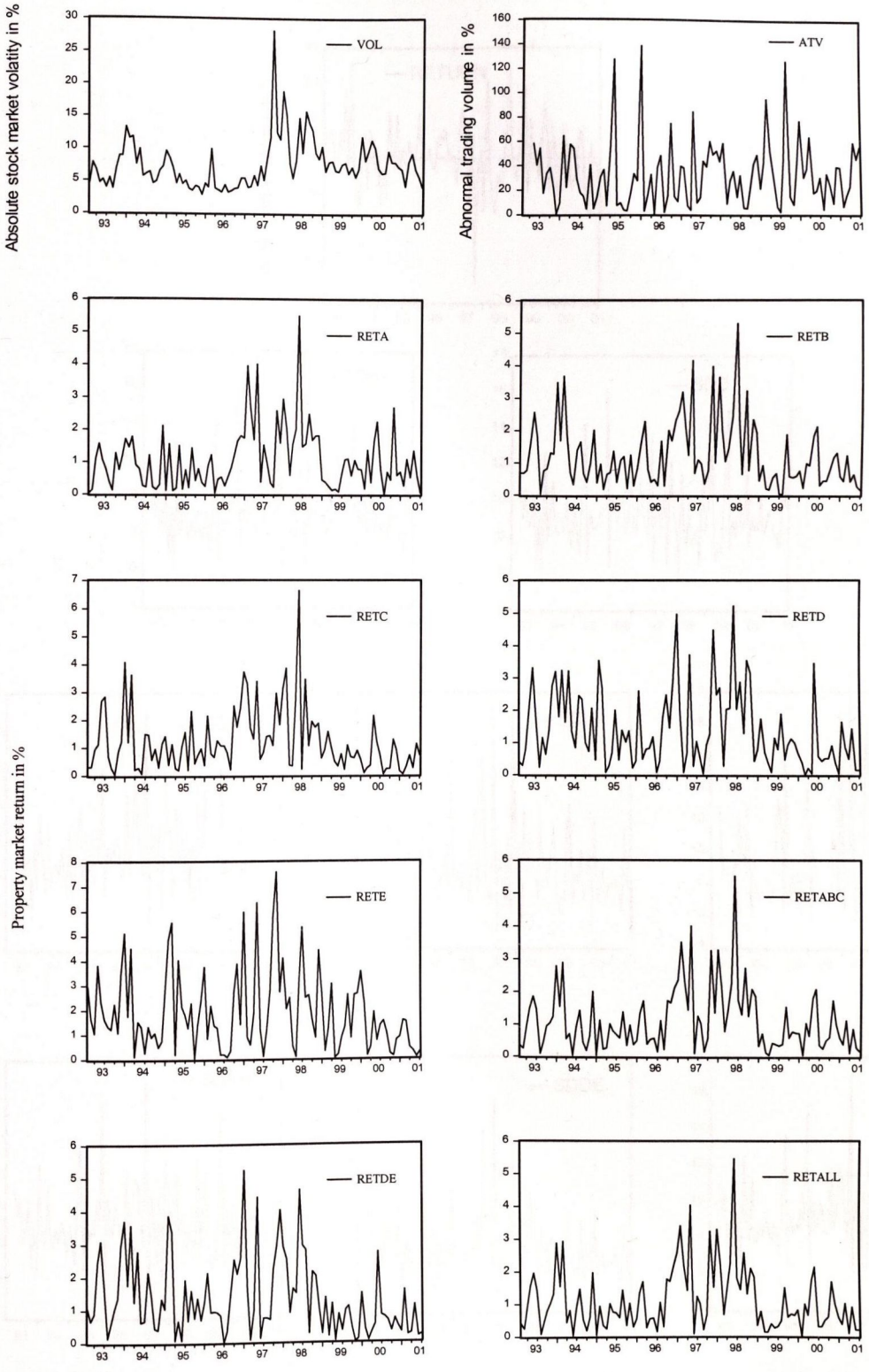


Figure 2-5 Stock market return and conditional volatility data series

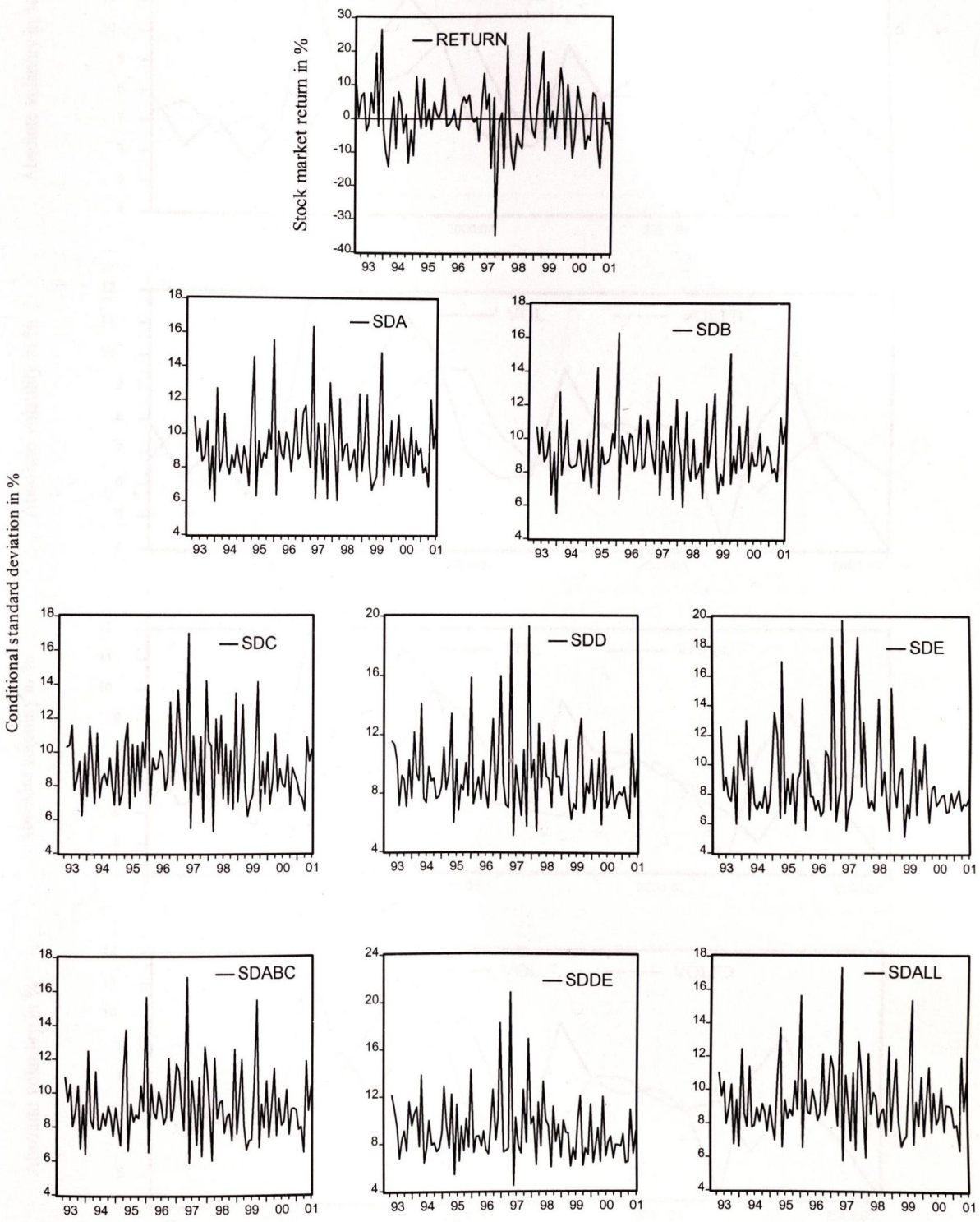


Figure 2-6.1 Actual vs. forecast absolute volatility

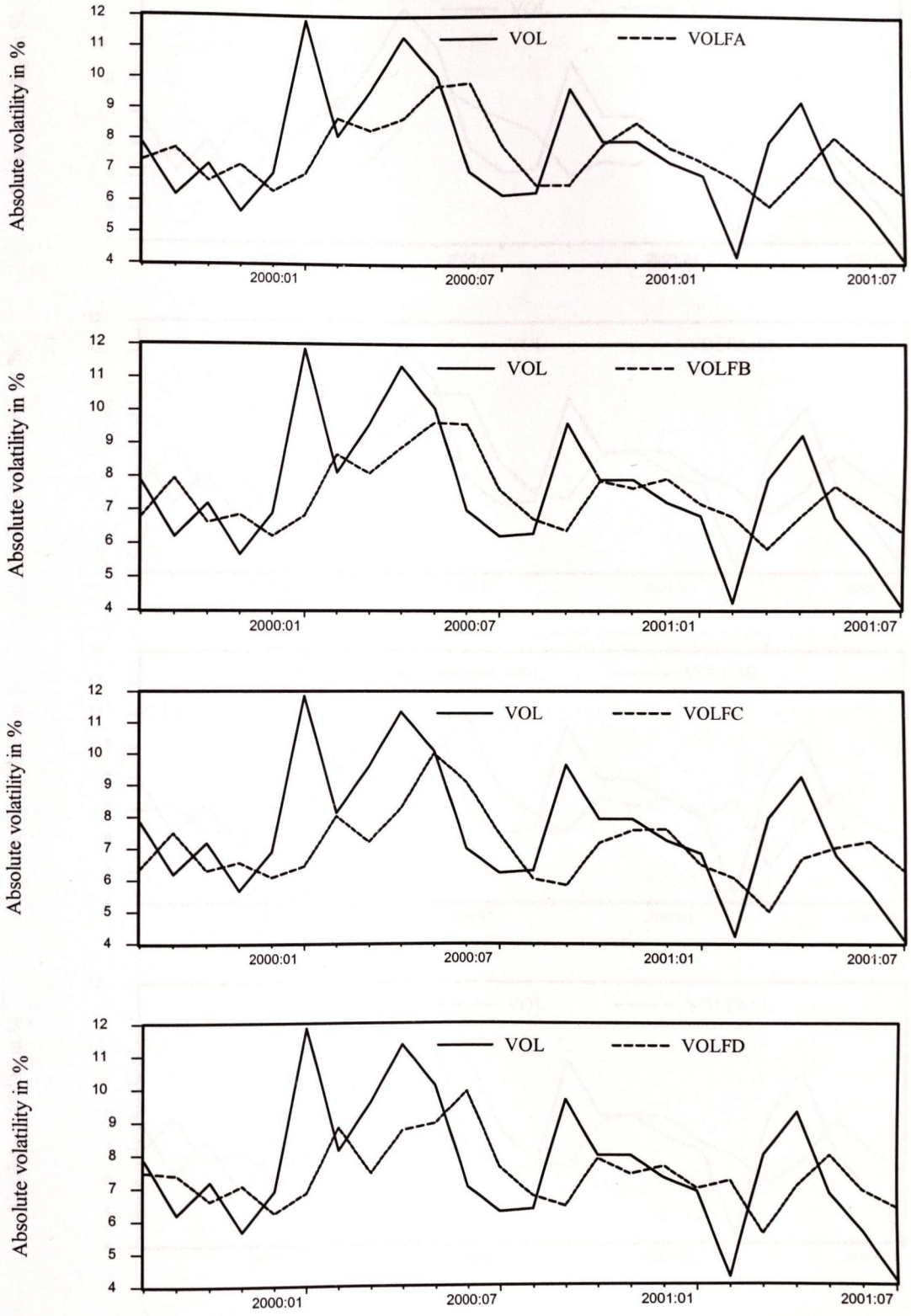


Figure 2-6.2 Actual vs. forecast absolute volatility (Continued)

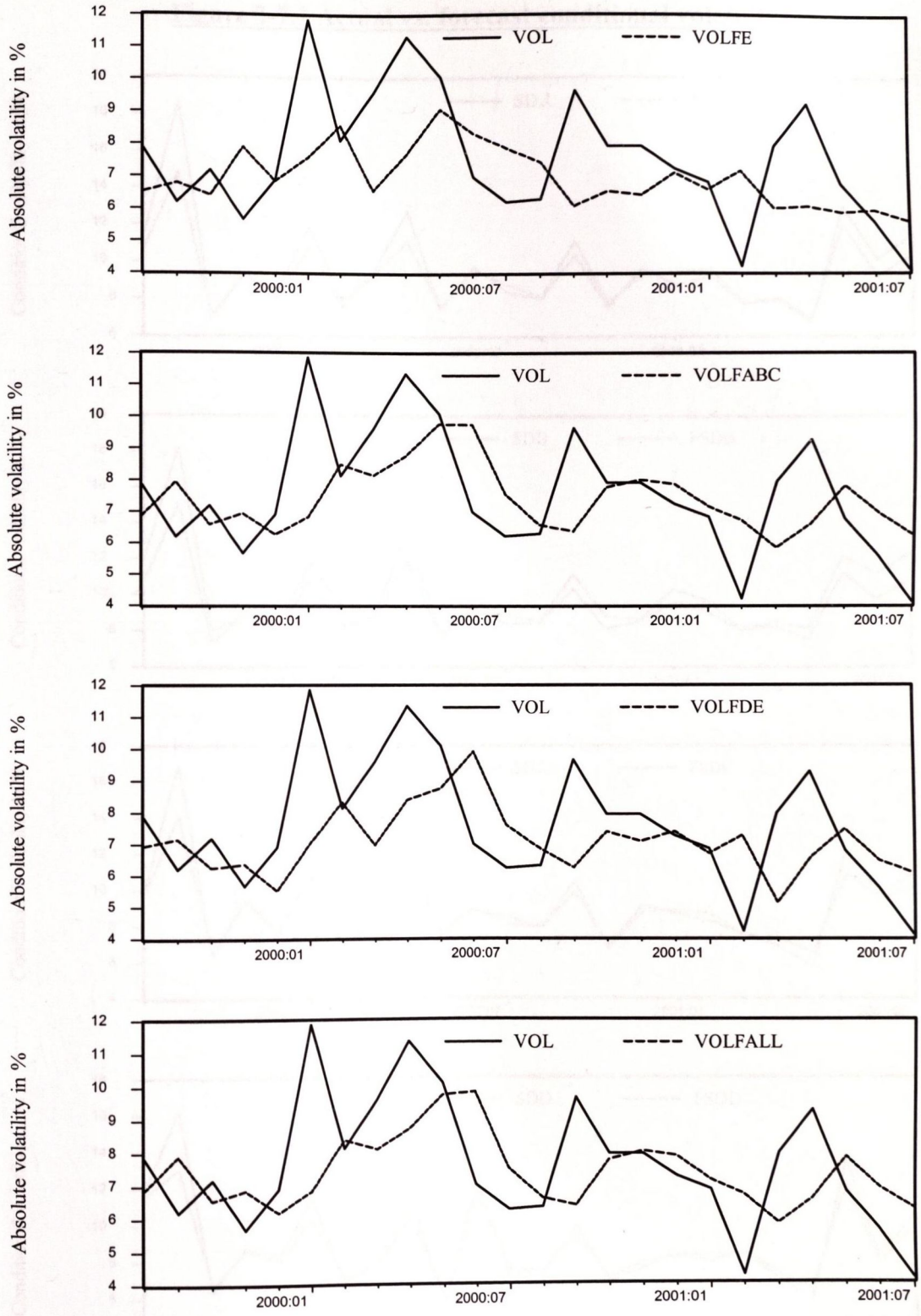


Figure 2-7.1 Actual vs. forecast conditional volatility

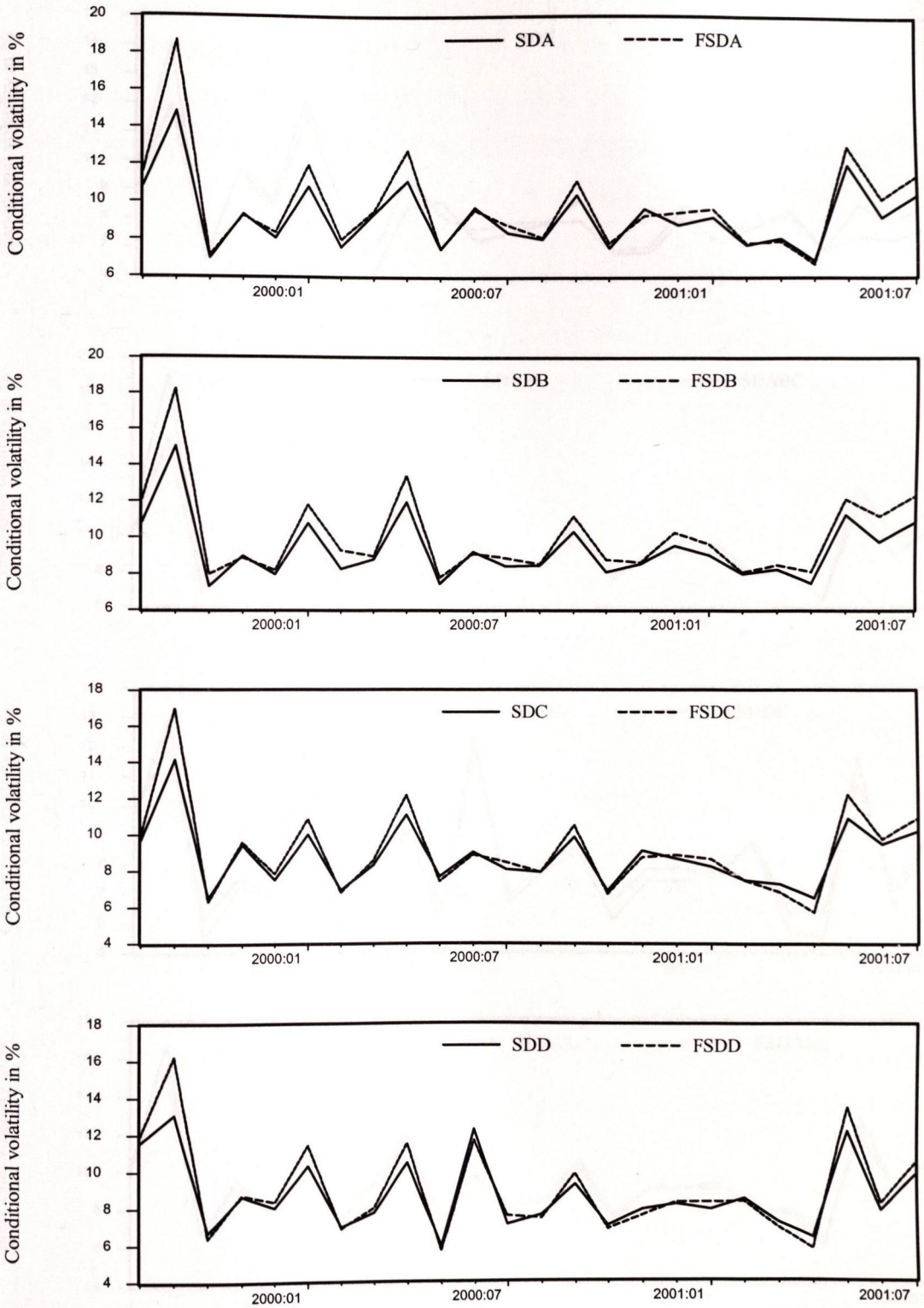
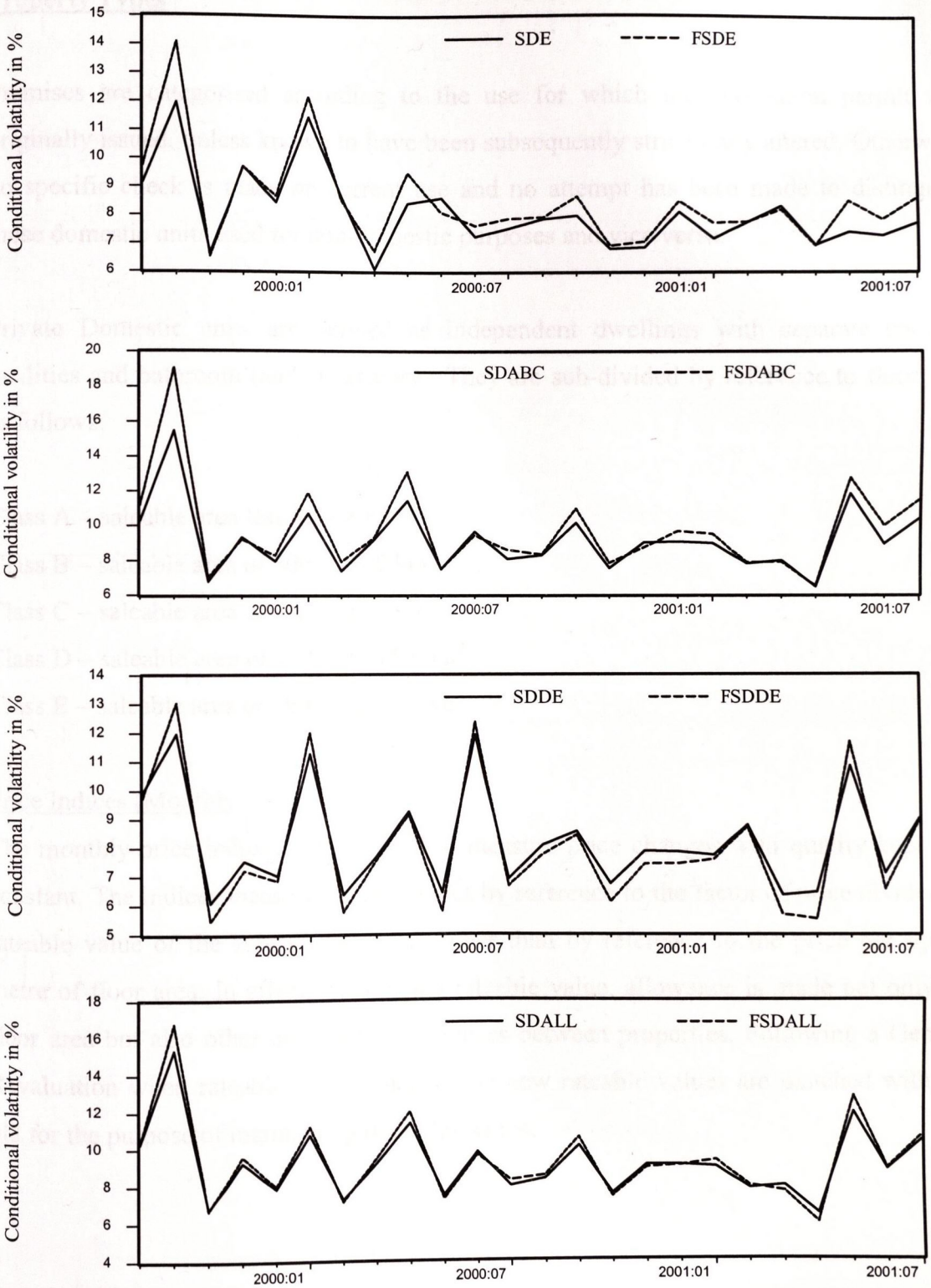


Figure 2-7.2 Actual vs. forecast conditional volatility (Continued)



Appendix 2A

Property Types

Premises are categorised according to the use for which the occupation permit was originally issued, unless known to have been subsequently structurally altered. Otherwise, no specific check is made on current use and no attempt has been made to distinguish those domestic units used for non-domestic purposes and vice versa.

Private Domestic units are defined as independent dwellings with separate cooking facilities and bathroom (and/or lavatory). They are sub-divided by reference to floor area as follows:

Class A – saleable area less than $40m^2$

Class B – saleable area of $40m^2$ to $69.9m^2$

Class C – saleable area of $70m^2$ to $99.9m^2$

Class D – saleable area of $100m^2$ to $159.9m^2$

Class E – saleable area of $160m^2$ and above

Price Indices (Monthly)

The monthly price indices are designed to measure price changes with quality kept at a constant. The indices measure value changes by reference to the factor of price divided by rateable value of the subject properties rather than by reference to the price per square metre of floor area. In effect, by utilizing rateable value, allowance is made not only for floor area but also other qualitative differences between properties. Following a General Revaluation when rateable values change, the new rateable values are matched with the old for the purpose of maintaining the index series.

Appendix 2B

The following information about the Hang Seng Index is obtained from the HSI Services Ltd. Hong Kong website.

Hang Seng Index

A barometer of the Hong Kong stock market. The constituent stocks are grouped under Finance, Utilities, Properties and Commerce and Industry sub-indexes.

Constituent Stocks

The Hang Seng Index (HSI) currently comprises 33 constituent stocks which are representative of the market. The aggregate market capitalisation of these stocks accounts for about 70% of the total market capitalisation on The Stock Exchange of Hong Kong Limited (SEHK).

Selection Criteria

Constituent stocks of the HSI are selected by a rigorous process of detailed analysis, supported by extensive external consultation. To be eligible for selection, a company:

1. must be among those that constitute the top 90% of the total market capitalisation of all ordinary shares listed on the SEHK (market capitalisation is expressed as an average of the past 12 months);
2. must be among those that constitute the top 90% of the total turnover on the SEHK (turnover is aggregated and individually assessed for eight quarterly sub-periods for the past 24 months);
3. should normally have a listing history of 24 months; and
4. should not be a foreign company as defined by the SEHK.

From the many eligible candidates, final selections are based on the following:

1. the market capitalisation and turnover rankings of the companies;

2. the representation of the sub-sectors within the HSI directly reflecting that of the market; and
3. the financial performance of the companies.

Appendix 2C

Definition of different sections of the Tokyo Stock Exchange

There are four separate sections within the TSE market. The first, second and foreign sections, and Mothers (venture capital market).

1. The first section is for the largest, most successful companies - often referred to as 'blue chips'.

2. The second section is for smaller companies with lower trading volume levels.

3. The foreign section is for companies from countries other than Japan.

4. Mothers (market for the growth and emerging stocks), established in November 1999, is for newer, innovative venture enterprises, both in Japan and overseas.

CHAPTER 3

THREE-DIMENSIONAL STUDY OF THE U.S. SPOT YIELD SPREAD AND STOCK MARKET VOLATILITY (1979-1998): A COMFAC APPROACH

3.1 Introduction

A multitude of studies have been published on the theory of the term structure of interest rates *vis-à-vis* the yield spread of the bond market. A majority of this research is directed towards examining the validity of the expectations hypothesis (EH) of the term structure of interest rates. According to this hypothesis, the yield spread contains information about future movements of interest rates, and one should be able to apply this predictive power to the study of future economic activities such as growth, output, consumption, investment and business cycles. Although for a long time economists have noticed the important influence of interest rates on stock market movements, most studies centre their attention on either 1) spectrum of maturities, or 2) country differences, or 3) forecasting horizons. This paper attempts to cover all three dimensions between the U.S. spot yield spread of the bond market and volatility of the stock markets. Four major international stock markets are chosen for examination, namely: Hong Kong, Japan, U.K. and the U.S.

The movements of the U.S. interest rates have long played a significant role in the global economy and financial markets. The use of interest rate by the U.S. government either to reverse an economic slowdown or to stabilize rising inflation is frequently observed. Subsequent to the tragedies of 11th September 2001, the U.S. government, in view of a sluggish economy, once again used interest rates as a tool to encourage economic activities.

As a result of the tragedies, many economists have put forward their concern of a further slowdown or even a recession of the U.S. economy and its potential effects on the global economy. The inspiration for writing this paper came after reading the following passage in the *Irish Times* on the day following the tragic events:

> 'The economic consequences of yesterday's events are equally ominous. Many analysts have concluded that US consumer confidence is a critical factor in holding out the promise of avoiding a world economic downturn, given the collapse of confidence in Japan and sluggish growth in the Euro zone. It could take a long time for it to be restored after this body blow to the heart of the US

commercial world. The knock-on effects on stock, currency and oil markets show how suddenly volatile international economic behaviour has become.....'

Irish Times, 12th September, 2001

From the above passage, one can easily envisage the significant economic influence of the U.S. on the global stage. If these analysts' concerns about the adverse effects of a U.S. slowdown are correct, then studying and quantifying these effects on each individual country should offer the respective governments valuable tools to make the necessary adjustments.

The frequent use of U.S. interest rate policy together with the international impact of the U.S. economic condition give us the motivation for this study. The aim of this paper is to capture and quantify the U.S. economic influence on Japan, Hong Kong, the U.K. and the U.S. itself. Our results are of interest to investment practitioners, because they could use the information contained in the yield spread in pricing and making investment decisions. Academic financial economists are also keen to identify some of the sources that cause stock market volatility and suggest ways and means to minimize these fluctuations if possible.

The novelty of this paper is that to the best of our knowledge this is the first attempt to expand the study of the co-movements between stock and bond markets through three-dimensions in terms of multi-maturity spectrum, multi-forecasting periods, and multi-country. Although numerous empirical studies have been advanced on the topic of yield spread, we believe that the yield spread study of this paper is the first to use the COMFAC method for model selection so as to ensure that our model adequately captures all the required dynamics. We begin our investigation with the application of the term structure of interest rates under a rational expectations model with a time invariant risk premium. A time-varying risk premium model then follows, and finally the yield spread is decomposed into two components, the difference between expected future and current short rates, and the time-varying risk premium. In addition to quantifying the effects of the U.S. spot yield spread on these four national stock markets, in this paper we hope to provide economic explanations for our empirical findings.

Another major difference between this paper and other previous studies (Duffee (2001) and Zhou (1996)) on the subject of the yield spread comes from the fact that instead of using simple stock returns or excess stock returns,[1] we use daily deviation from monthly mean returns as our measure of stock market volatility. Further discussions on our choice and detail of this measurement of stock market volatility will be presented later in this paper. As mentioned above, we attempt to examine the whole spectrum of the maturity of the yield curve covering maturity periods which are considered as short term: 3 months, 6 months and 1 year (12 months); medium term which includes 2 years (24 months) and 5 years (60 months), and finally long term of 10 years (120 months). This paper endeavours to investigate theoretically three hypotheses: 1) stock market movements are closely related to the shifts of the U.S. spot yield curve, 2) the magnitudes of the U.S. spot yield curve effect on different stock markets are equal and 3) the predictive power of the U.S. spot yield spread persists up to twelve months ahead.

The organization of this paper is as follows: we first introduce the concept of the spot yield spread through examination of the development of the term structure of interest rates from adaptive expectations to rational expectations followed by the discussion of various models under the rational expectations hypothesis. Armed with a better understanding of the term structure of interest rates, derivation of the spot yield spread is presented in Section 3.2. Section 3.3 reviews some previous studies on the subject. Section 3.4 offers a brief discussion of stock market volatility and its importance to our investigations. Section 3.5 describes the data used in this paper. The development of our hypothesis testing is discussed in Section 3.6. The concept of business leverage effect that is introduced in Section 3.7 though founded on economic theories, we consider it of significant relevance to the empirical analysis of this paper and we will employ it to offer explanation on our estimation results. In Section 3.8 we provide details of our model specifications and estimation methodology. To assist the understanding of our model selection process we present the COMFAC approach in Section 3.9. Empirical results of our estimation organized according to their appropriate categories are available in Section

[1] Which is usually defined as the difference between return to holding the stock for n periods and the return to holding a risk-free n-period bond to the maturity.

3.10. Section 3.11 presents a decomposition of the yield spread for the purpose of testing for the significance of the expected short rates and risk premium term in our models. Finally, we end this paper with some concluding remarks in particular with discussions on policy implications in the last section.

3.2 Spot Yield Spread

In this section we derive the spot yield spread through discussions of both the theory of the term structure of interest rates, and the developments of different expectations models that form the foundation of this theory. However, prior to these discussions, basic understanding of fixed income securities pricing is indispensable.

Traditionally, fixed income securities or bonds are defined by the fact that they make advanced fully specified payments to investors. This feature of predetermined payments makes it easy to calculate either the price of a bond or its simple yield.[2] Take the example of a zero-coupon bond[3] that makes a single payment of \$1 (face value) with m periods to maturity. The price (P_{mt}) and yield (Y_{mt}) at time t satisfy

$$P_{mt} = \frac{1}{(1+Y_{mt})^m} \tag{3.1}$$

or

$$(1+Y_{mt}) = P_{mt}^{-(\frac{1}{m})} \tag{3.2}$$

Looking at it the other way, Y_{mt} is the discount rate that equates the bond's price to the present value of its final payment. For continuously compounded yield, which is

[2] Since we are working with zero coupon bonds, this simple yield is equivalent to the redemption yield or the yield to maturity.

[3] Studies of yield spread or the term structure tend to use zero-coupon bond rates instead of coupon-bearing bond rates. The simple reason for that is because, with coupons, each cash flow should be discounted at a unique interest rate that is appropriate for the time period in which that cash flow will be received.

commonly used in financial literature, we take the natural log of the above equation and it becomes

$$\ln P_{mt} = -m \ln(1 + Y_{mt}) \tag{3.3}$$

Alternatively we can express it as $p_{mt} = -my_{mt}$, where $p_{mt} \equiv \ln P_{mt}$ and $y_{mt} \equiv \ln(1 + Y_{mt})$.[4] This expression of the relationship between log bond price and its log yield has the advantage of transforming a nonlinear equation such as (3.2) into a linear one. In (3.3), we can see that bond price is negatively related to its yield multiplied by m, the length of maturity.

3.2.1 Expectations models of the term structure

According to the theory, the term structure of interest rates is defined as the set of yields to maturity at a given time on bonds of different maturities. In other words, the term structure of interest rates characterizes the relationship that exists among "interest rates" on bonds[5] with different maturities but with the same risk of default. Since future interest rates associated with different bond maturities are unknown at the time of pricing, the determination of the term structure is deeply rooted in expectations of future interest rates that investors form today, and hence the development of the expectations theory.

The central idea behind the expectations theory of term structure of interest rates is that individuals form their expectations of the future structure of interest rates and then decide whether to invest in the short or long end of the market. One of the main advantages of studying the term structure of interest rates is that one learns a great deal about the mechanism of how market participants form their expectations about the future that, in turn, affects interest rate movements. Furthermore, it is not just the investors who are interested in the structure of future interest rates that affects their investment returns; in terms of policy formulation, the monetary authorities are also concerned about the future path that interest rates take. The monetary authorities can control or influence the market

[4] Henceforth, we use the lower case to represent log bond price and log yields.
[5] In this paper, the term 'bonds' is used instead of 'fixed income securities'.

short-term rates, however, economic activities are related to long-term rates, which the authorities have to take into account when determining the term structure. Thus if the term structure theory holds, the authorities will be able to exert influences on real economic activities through their imperfect and indirect control over future short rates.

Before we proceed with the formal discussion of the expectations models of term structure, the understanding of two key concepts is important: holding period (length of time an asset is held by its owner) and risk. In today's presumably well-organized financial markets, in theory there is little relationship between holding period and maturity. One can easily buy a 30-year bond and hold for 1 year or alternatively buy a 1-year bond every year for 30 years. Risk, however plays a very important role in the formation of all expectations term structure models. In general, when it comes to facing risk, investors can be categorized into three types: risk averse, risk neutral and risk loving. A risk averse investor is someone who when given the choice between two investments with the same expected return, will always choose the less risky investment. A risk neutral investor on the other hand will be indifferent to risk, whereas a risk loving investor is someone who enjoys taking on risks and will always pick the investment with greater risk. In recent financial economics literature, six rational expectations models are frequently used in the discussion and testing of the term structure of interest rates. These models are classified according to the different considerations given to the maturity and risk premium term and they are namely: 1) Pure Expectations Hypothesis (PEH); 2) Expectations Hypothesis (EH); 3) Time-varying Risk (TVR); 4) Liquidity Preference Hypothesis (LPH); 5) Market Segmentation Hypothesis (MSH) and 6) Preferred Habitat Theory (PHT). Let θ be the risk premium term, that is the excess return on the n-period bond over the m-period bond. These rational expectations models can be summarized as:

1) Pure Expectations Hypothesis (PEH): term premium is zero for all maturities.

$$\theta = 0$$

2) Expectations Hypothesis (EH): term premium is a constant and same for all maturities.

$$\theta = k$$

3) Time-varying Risk (TVR): term premium depends on the time to maturity n and varies over time. $\theta = \theta(n,t)$

i.e. k is some function of n and t.

4) Liquidity Preference Hypothesis (LPH): term premium increases with n (the time period to maturity). $\theta = \theta^{(n)}$ where $\theta^{(n)} > \theta^{(n-1)}$...*etc.*

5) Market Segmentation Hypothesis (MSH): term premium depends in part on the outstanding stock of assets of different maturities.

$$\theta = \theta(x_t^{(n)})$$

where $x_t^{(n)}$ is some measure of the relative holdings of assets of maturity n as a proportion of total assets held.

6) Preferred Habitat Theory (PHT): bonds which mature at dates close to each other should be considered as close substitutes and hence have similar premia.

$$\theta^{(m)} \approx \theta^{(n)} \text{ if } m \approx n$$

In all these expectations models of term structure, the degree of risk aversion is crucial. In the first 'pure' expectations model, risk neutrality is assumed and, therefore, the risk premium term is absent. However, in the other five rational expectations models, the existence of a risk premium term is included: thus risk averse investors are presumed. In fact, with reference to the PEH model if all investors are risk neutral, it can easily be shown that their expectations concerning future interest rates are embedded in the term structure. Hence, yields on bonds of different maturity differ only because market participants expect the short rate to change in the future. This explanation of the relationship among yields on bonds of different maturities is often referred to as the expectations approach because it uses expectations of future short-term interest rates to explain the term structure of interest rates. However, in the economy where reality dictates, while risk neutral investors attempt to equate the rate of return on bonds of different maturity, the actual rates prevailing in the market reflect the presence of forecast errors. These forecast errors introduce risk and this certainly can influence the decisions of

risk averse investors concerning the choice among bonds. Moreover, the existence of these forecast errors gives rise to the growth in the search for alternative accounts for the term structure theory. The length of the holding period together with the risk element is significant in the discussion of this paper on the yield spread. These two factors affect the expected return via the current and future interest rates and the amount of risk an investor will be facing in making an investment decision.[6]

In general, the definition of the term structure of interest rates offers us a set of spot yields for bonds with different maturities at any given point in time. We can present these spot yields derived from (3.3) by distinguishing them as the short rates (r_t) and long rates (R_t) for each individual yield curves at time t.[7] Assuming PEH, at equilibrium the relationship of these two interest rates can be written as follows:

For a 1-period bond: $$1 + R_t^1 = 1 + r_t^1 \tag{3.4}$$

2-period bond: $$(1 + R_t^2) = \sqrt[2]{(1 + r_t^1)(1 + E_t r_{t+1}^1)} \tag{3.5}$$

3-period bond: $$(1 + R_t^3) = \sqrt[3]{(1 + r_t^1)(1 + E_t r_{t+1}^1)(1 + E_t r_{t+2}^1)} \tag{3.6}$$

. .
. .
. .

n-period bond: $$(1 + R_t^n) = \sqrt[n]{(1 + r_t^1)(1 + E_t r_{t+1}^1).....(1 + E_t r_{t+n-1}^1)} \tag{3.7}$$

[6] For simplicity, it is assumed that there is no transaction cost for buying or selling bonds.

[7] Equation (3.3) shows the relationship between yield (return) and price of a m-period bond. According to the term structure theory, we can simply extrapolate this relationship to an n-period bond by assuming that there is no difference between the return from investing on an n-period bond or buying a *one*-period bond and reinvesting at the end of each period continuously for n periods.

or $$(1+R_t^n)=[(1+r_t^1)(1+E_t r_{t+1}^1)(1+E_t r_{t+2}^1)...(1+E_t r_{t+n-1}^1)]^{\frac{1}{n}}, \quad (3.8)$$

where

R_t^n = Actual observed rate for an n period bond. (long rate).

r_t^1 = Actual observed rate for a one period bond. (short rate).

$E_t r_{t+n-1}^1$ = Expectation of future short rate made at time t.

n = term to maturity.

When we define the expectations theory according to (3.8),[8] how individuals form their expectations becomes crucial to the outcome of any test of the validity of the term structure theory. This part of the paper undertakes to review the two primary approaches underpinning the term structure theory: namely adaptive and rational expectations.

3.2.1.1 Error-learning, adaptive expectations model

The first approach we are going to survey is the so called "traditional, pure expectations model" – (PEH). Before the development of the rational expectations theory, most empirical studies on the term structure of interest rates were based on the "error learning" model, which was innovatively applied by David Meiselman in 1961.[9] In essence, the Meiselman Hypothesis is an adaptive expectations type model. The major contribution of Meiselman's model to term structure theory is that he was the first to provide an operational test of the expectations hypothesis that did not depend for its validity on accurate forecasting. Based on the expectations of future short rates implicit in the term structure, Meiselman tried to observe how these implied short rates change over time with the receipt of new information.

From (3.8), we can see that, in general, the long rates are just a geometric mean of a series of current and expected short rates. Based on a rearrangement of this relationship,

[8] Equation (3.8) is presented based on the forward-looking approach; nevertheless, it details the key concept behind the term structure theory.

[9] It is later known as the Meiselman Hypothesis.

Meiselman postulates that under error-learning adaptive expectations, individuals use previous levels of interest rates as a source of expected future rates. The term structure theory implies that at time t, whenever the previously expected rate is not equal to the actual rate *i.e.* $E_{t-1}r_t^1 \neq r_t^1$, then future expected short rates would be revised to incorporate this new information. This gives rise to a general form of relationship as follows with $(r_t^1 - E_{t-1}r_t^1)$ representing the forecast error:

$$E_t r_{t+n}^1 - E_{t-1} r_{t+n}^1 = f(r_t^1 - E_{t-1} r_t^1) \tag{3.9}$$

By using a linear functional form, the basic equation for Meiselman's estimation becomes:

$$\Delta r_{t+n}^1 = a_n + b_n \omega_t + \mu_t \qquad \text{for } n = 1, \ldots, 8. \tag{3.10}$$

where Δr_{t+n}^1 is the change in expected short rates, a_n is the premium term which is assumed to be zero, ϖ_t is the forecast error, b_n is the coefficient of the forecast error and μ_t is the disturbance term.

An error-learning approach would suggest that market participants revise their expectations of future rates in response to differences between the observed rate and the rate that they had predicted in the previous period. A high correlation between changes in future rates and past prediction errors would indicate that these rates are varied systematically. Since, under the original expectations theory, longer rates are averages of present and expected future short rates, forecast errors cause the whole structure of interest rates to rise or fall. In summary, the Meiselman Hypothesis says that future short rates change on the basis of errors made in forecasting the current short rates.

In his study, as shown in Table 3-1, Meiselman did find that changes in future one-year rates were highly correlated with forecast error ω_t. In other words, a significant part of the movements of long rates can be explained by errors in the prediction of the current one-year rate. This contrasts with the results obtained by Startz (1982), which will be

presented later. Another important finding is the existence of a zero constant term (risk premium term) that is supported by the estimate of the coefficient a which is not significantly different from zero, thus the assumption of risk neutrality is validated. Alternatively, if it were not the case, then future short rates would be revised even when expectations proved correct. Based on these results, Meiselman concludes that founded on this error-learning mechanism, his tests provide impressive support for the pure expectations hypothesis (PEH). Despite his contribution to the topic, criticisms have been put forward on Meiselman's empirical finding of a zero constant term. We shall examine alternative modelling of the risk premium term in more detail in the literature review section of this paper.

3.2.1.2 Rational expectations model

After the revolutionary development of the rational expectations theory in the early 1970s, empirical works on the expectations theory have turned their focus to the forecast errors based on expectations that are made by using all available information (rationally). Under this perfect foresight behaviour, the term structure of interest rates theory states that expected future long rates would always be equal to the average of all future short rates. In general, this type of rational expectations model can be postulated by the following:

$$R_t^n = \theta + \frac{1}{n}\sum_{j=0}^{n-1}(E_t r_{t+j}^1) \tag{3.11}$$

Equation (3.11) shows that long rates are equal to θ, which is the risk premium term, plus the average of the current short rate (r_t^1 when $j = 0$) and expected future short rates.

Basically the derivation of (3.11) begins with the linearized version of a rational expectations term structure model that relates the n-period long rate R_t^n to the one period short rate r_t^1 as:

$$R_t^n = \theta + \alpha(r_t^1 + E_t r_{t+1}^1 + E_t r_{t+2}^1 + E_t r_{t+3}^1 + ...E_t r_{t+n-1}^1) \tag{3.12}$$

where $E_t r_{t+n-1}^1$ is the expected value of r_{t+n-1}^1 given information available at period *t*. Under rational expectations, $E_t r_{t+n-1}^1$ is given by $E(r_{t+n-1}^1 \mid I_t)$, where I_t symbolizes the information available at period *t*.

Taking an example of a *two*-period bond for demonstration purposes, (3.11) can be written as:

$$R_t^2 = \theta + \frac{1}{2}(r_t^1 + E_t r_{t+1}^1) \tag{3.13}$$

given
$$E_t r_{t+1}^1 = r_{t+1}^1 + V_{t+1}, \tag{3.14}$$

where V_{t+1} is the forecast error term.

Substituting (3.14) in (3.13) and rearranging, we have:

$$(r_{t+1}^1 - r_t^1) = -2\theta + 2(R_t^2 - r_t^1) - V_{t+1} \tag{3.15}$$

For regression purposes, (3.15) can be represented by:

$$(r_{t+1}^1 - r_t^1) = \alpha + \beta(R_t^2 - r_t^1) - V_{t+1}, \tag{3.16}$$

$(R_t^2 - r_t^1)$ is the spread between the long and short rates,[10] and β is known as the slope of the yield curve.[11] Clearly, according to (3.16), as implied in the term structure, this spread should reflect the path that expected future short rates follow.

[10] The hypothesis can also be expressed in terms of the relationship between an *n*-period and *m*-period spot rate by $R_t^n = \frac{n}{m}\sum E_t r_{t+mi}^m + C$. In other words, R_t^n is a sum of simple average of current and expected future *m*-period rates up to $n - m = (K\text{-}1)\ m$ periods in the future plus a constant *C* (term premium), where $K = \frac{n}{m}$ is an integer.

Under rational expectations, one important implicit assumption of (3.16) is that the disturbance term is uncorrelated with information dated at t. By fulfilling this condition, it implies that ordinary least square (OLS) produces consistent estimates.

The core objective of this paper is not testing the validity of the term structure models. Instead, we focus on the relationship between the spot yield spreads and stock market volatility. In this section of the paper we introduce different term structure models solely for a better understanding of the relationship between long and short interest rates.[12] For example, under PEH,[13] interest rates are expected to move to equalize expected returns on short and long term investment strategies. Assuming equation (3.11) holds and the absence of a risk premium, this implies that whenever a long bond yield is greater than a short yield, the short yields tend to rise to equalise returns over the life of the long bond. Once the term structure model validates this long-short interest rate relationship, our application of the spot yield spread as a sign of interest rate movement is not inconsequential.

3.2.2 The spot yield curves and yield spread

This paper works predominantly with continuously compounded zero-coupon yields, which we simply refer to as 'yields' or 'spot yields'. Equation (3.3) gives us the price-yield relationship, and following the spirit of (3.16), the difference between the long-term yield and the short yield is known as the yield spread.[14] The main advantage of utilizing spot yields in our investigation is that they are excellent proxies for the discount rates[15] that investors use when analyzing their portfolio holding and returns. For this paper, this characteristic of the spot yield spread is particularly useful when we attempt to establish a correlation between the spot spread and stock market volatility. Furthermore, spot yield

[11] Later on in our formal testing we define the spot yield spread of different maturities as $R_t^n - r_t^1$, where n indicates the term of maturity.

[12] To be more applicable to our case, we are interested in the relationship between short and long bond yields, which is equivalent to short and long interest rates.

[13] Henceforth in this paper, rational expectations behaviour is assumed.

[14] The difference between the *one*-year return and the short yield is known as the excess return.

[15] Spot yield comes from zero-coupon bonds with redemption price fixed and known at time of issue.

data are readily available especially for short term yields with maturity less than one year.[16]

Yields can be summarized in a plot of yields to maturity against maturity for different bonds but with the same default risk, on a given date. This plot is called the yield curve and very often also known as the term structure of interest rates. Normally, the yield curve is upward sloping but it can also be downward sloping (inverted), or even with a hump or inverted hump shape. The yield spreads, which serve as a measure of the slope of the yield curve, are normally positive, but they become negative when the yield curve is inverted. Whenever the yield curve has a hump or inverted hump shape the yield spreads contain mixed signs. Yields that are depicted in the yield curves are spot yields on a zero coupon[17] treasury with different maturity: therefore they are commonly known as spot yield curves. Figure 3-1 shows five U.S. spot yield curves constructed from our dataset.

The observation of a spot yield curve gives us an accurate picture of the yield spread. In most finance literatures, for pure discount bonds, the spread of the spot yields can be formulated in two fashions:

(1) Spread between the *n*-period spot rate and a sequence of *one*-period short rates:-

$$Spd_t^{(n,1)} = R_t^n - r_t^1 \tag{3.17}$$

(2) Spread between the *n*-period spot rate and any *m*-period rate:-

$$Spd_t^{(n,m)} = R_t^n - R_t^m \tag{3.18}$$

Both (3.17) and (3.18) illustrate a clear relationship between the long and short rates. Putting together this long short rate relationship with the definition of the spread,

[16] For maturities beyond one year, spot yields can be calculated from coupon paying Treasury securities, see McCulloch (1990).
[17] Fixed income securities that make a single known payment at date of maturity.

which says the shape of the yield curve depends on the spread, it is apparent that whenever the short rate is higher than the long rate we have an inverted spot yield curve. In Figure 3-1, the yield curve of December 1979 shows the characteristic shape of such an inverted curve. For December 1984 and 1994 we observe a positive yield curve, which means that the short rate is lower than the long rate. The two curves for 1989 and 1998 are two flat yield curves that show negligible difference between short and long rates.

The U.S. yield curves are chosen for our studies for two reasons. In addition to the strong influence of the U.S. economic condition on the global economy, the U.S. Treasury securities also have negligible default risk, plus in recent years, they have had no call provisions and therefore they are most closely related to the theoretical definition of the yield spread. Another advantage of observing the yield curves comes from the Fisher effect,[18] which says that since expected future short rates are influenced by inflation expectations,[19] the shape of these curves can offer us valuable information about the future inflation path. In summary, when the slope of the yield curve is positive then inflation is expected to rise in the future and *vice versa*. On the other hand, if we have a flat yield curve, overall consensus is towards an inflation rate that remains constant over time.

Nonetheless, according to prevailing finance theory, the slope of the yield curve should be positive since investors who are willing to tie up their money for a longer period should be compensated for the extra risk by receiving a higher yield.[20] Another frequently observed phenomenon regarding this long-short yield relationship is that long yields are less volatile than short yields since long rates are just weighted averages of future expected short rates. Hence an increase in subsequent short rates will produce a smaller increase in the current long rate. Figures in Table 3-2 confirm this supposition by showing

[18] One important assumption of the Fisher effect is the efficient market hypothesis in which people are assumed to use correctly all relevant information in setting prices. Alternatively, there will be a relationship between the one-period nominal interest rate observed at time t and subsequently observed one-period inflation rate. Otherwise, if the inflation rate is to some extent predictable and no such relationship exists, the market is inefficient, which implies that in setting the nominal interest rate, people overlook relevant information about future inflation.

[19] Assuming the real rate of interest is constant over time, which is a frequently quoted assumption in many studies of the term structure or interest rate movements. For result comparison purpose, we shall maintain this assumption throughout our empirical testing, however, we will produce evidence to challenge its validity later on in this paper.

[20] This clearly illustrates the Liquidity Preference Hypothesis.

that short term yields move more than the long term yields. Looking at the standard deviations for individual yields across the whole maturity spectrum, we see that the value decreases from 3.084 for the 6-month yield to 2.398 for the 120-month yield. However, long yields do vary and, according to equations (3.1) and (3.12), small movements in long yields can produce big changes in long bond prices and volatile returns on long bond.

3.3 Review of Previous Studies

The majority of the research on the term structure of interest rates or spread of the yield curves focuses on the predictive power of the spread on macroeconomic variables such as growth, consumption, business cycles and so on. Frequently these studies attempt to show how one can use observations made on the yield spread *vis-à-vis* movements of the current and expected future short-term interest rates to draw implications for future real economic activities. One key factor linking all these issues is whether the yield spread offers us any significant and functional insight into the path future inflation will take as implied by both the term structure theory and the Fisher effect. In this section, we undertake to review some of the previous studies on the predictive power of the spread and also the relationship between the yield curve and stock market returns.

3.3.1 Predictive power of the yield curve

Ever since the emergence of the rational expectations model of the theory of term structure, numerous empirical works have been advanced. The focal point of these studies tends to rest on either testing the implication and validity of the rational expectations theory, that is how accurately future short rates follow the path as forecasted by the long rate, or simply seeking the existence and property of a time-varying risk premium. Reviews of the following influential studies certainly give us some insights into the above issues.

Fama (1984) states that the traditional pure expectation theory model as used by Meiselman (1966), in which the assumption of a zero risk premium is used,[21] if a risk premium does exist and is time-varying, it can easily obscure the predictive power of long-short spread. In his paper, Fama tries to resurrect the view that the term structure of interest rates has forecast power about movements of future short rates. Conscious of the possible existence of a time-varying risk premium term, he sets up his testing according to the following equations:[22]

$$(r^1_{t+n} - r^1_{t+1}) = \alpha_1 + \beta_1 (R^n_t - r^1_{t+1}) + \varepsilon_{t+n-1} \tag{3.19}$$

$$(r^1_{t+n} - r^1_{t+n-1}) = \alpha_2 + \beta_2 (R^n_t - R^{n-1}_t) + \eta_{t+n-1}, \tag{3.20}$$

where $(r^1_{t+n} - r^1_{t+1})$ measures the change in short rate, $(R^n_t - r^1_{t+1})$ is long-short differential. While $(r^1_{t+n} - r^1_{t+n-1})$ expresses the one-month change in short rates, $(R^n_t - R^{n-1}_t)$ represents the difference in adjacent maturity long rates. Regressions are carried out on (3.19) and (3.20). Fama hypothesises that if $\beta_1 > 0$, then the long-short differential contains information about movements in short rates, and if $\beta_2 > 0$, then $(R^n_t - R^{n-1}_t)$ has predictive power for future one-month changes in the short rate. He expects both β_1 and β_2 to be positive but less than one in the results. Nevertheless, he acknowledges that under PEH when $\beta_1 = 0$ and $\beta_2 = 1$, it indicates that all variations in future short rates are due to expected risk premium.

Fama's data consists of monthly averages of end-of-month bid and asked prices of one to six month Treasury bills. Regressions are run on the sample period from 1959 to1982.[23] The slope coefficients are generally positive and statistically significant for all maturities except the shortest time period. In both the long-short spread and difference between adjacent maturity long rate regressions, it is shown that they help to predict changes in short rates. More importantly, in contrast to negative findings of Shiller,

[21] It was first assumed in his paper and then empirically proven.
[22] For consistency, most notations used in the original articles are modified, but efforts are made to have the authors' ideas preserved.
[23] Results are summarized in Table 4 of the original paper (p.517).

Campbell and Schoenholtz (1982), for the early part of the sample period, future long rates show predictive power of one-month short rates up to five months ahead. In Mishkin (1988), by examining an extended data set and using more advanced econometric techniques in producing more reliable standard errors, Fama's hypothesis was re-tested. The paper provides more refined results, which are in broad agreement with those of Fama.

Similar to Fama (1984), the main purpose of Mankiw and Miron (1986) is to test for the predictive power of the spread between the long and short rates. At the same time, the authors attempt to identify the conditions under which the expectations theory works or does not work. Furthermore, the paper tries to link the performances of the expectations theory to the existence of the Federal Reserve System and the different monetary regimes that existed in the United States. The term structure model used by Mankiw and Miron is identical to equation (3.16) of this paper. In their paper, several sets of data are tested with the sample period ending in 1979 because there appears to have been substantial differences in the behaviour of interest rates after the Fed's announcement of the changes in operating procedure in October 1979.

Table 3-3 contains estimates obtained for all periods and except for one, they all fail to find supporting evidence for the expectations theory. In other words, the slope of the yield curve appears to contain no information about the path of future short rates. The one exception is the period from 1890 to 1914. Although the improved statistics for this period do not fully confirm the expectations theory, the slope of the yield curve does seem to contain substantial information on the path of future short rate. Nonetheless, the authors caution us that the absence of predictability alone cannot account for any statistically significant rejection of the theory. They maintain that if a time-varying risk premium does exist, then changes in the short rate would be unpredictable and the long-short spread would always be equal to this risk premium term θ_t. Hence, in principle, the lack of predictive power together with even slight change in the term premium can then be used to explain an empirical rejection. Based on these results they conclude that during the period 1890 to 1914, there were considerable predictable changes in the short rate. Thus, expectations played a more prominent role in the yield curve fluctuations. However, since

1914, the short rate has been following a random walk. Fluctuations in this risk premium term therefore have governed fluctuations in the slope of the yield curve.

Both Fama (1984) and Mankiw and Miron (1986) have shown the extent of the predictive power of the term structure under different situations and monetary regimes. Their results indicate that both the risk premium and forecast error terms play a non-trivial role in these rational expectations term structure models. Startz (1982) endeavours to examine the significance of these two terms in the expectations theory of term structure. He first asserts that the estimate of the term structure contains two sources of error: 1) forecasting error in the future short rate and 2) error caused by the variation in the risk premium term embedded in the long rate. The model for such examinations is as follows:

$$s \equiv s^e + \varepsilon \tag{3.21}$$

$$f \equiv s^e + P \tag{3.22}$$

$$s^e = E(s \mid \Phi) \tag{3.23}$$

where s is the short rate realized in the next period. s^e is next period's expected short rate based on the market's expectation formed on market's information set Φ today that obviously includes s^e and P. The term ε represents the forecast error with f standing for the implied future short rate and P is the risk premium term. Thus, equation (3.21) states that the short rate realized next period is the market's expectation formed today plus a forecast error. Rational expectations imply that ε is uncorrelated with elements of the information set Φ. Then the second moment can be shown as $\text{var}(s) = \text{var}(s^e) + \text{var}(\varepsilon)$. Taking the difference between (3.21) and (3.22), we obtain $\text{var}(s - f) = \text{var}(P) + \text{var}(\varepsilon)$.

Under the Pure Expectations Hypothesis (PEH), in which P is assumed to be zero, $\text{var}(s) > \text{var}(f)$ must be true. As pointed out in his paper, rational expectations cannot identify any of the basic time-series *per se*. Therefore, statistically Startz sets down the upper and lower bounds on these second moment statistics. Startz claims, "If s is regressed on any subset of Φ, all the explained variation is due to s^e, and none to ε, since ε is

uncorrelated with Φ. The standard error of the regression is an *upper bound* on the standard deviation of ε." By the same logic, the lower bound should be equal to either $\hat{\text{var}}(s^e) = \text{var}(s) - \hat{\text{var}}(\varepsilon)$ or $\hat{\text{var}}(P) = \text{var}(s - f) - \hat{\text{var}}(\varepsilon)$.

In his conclusions, Startz finds that one-third to two-thirds of the error in using the long rate to forecast the one-month short rate is due to variations in the term premium - *lower bound*. Thus he further concludes that the use of term structure for predicting short rates into the relatively near future is adequate, while attention to changes in the market risk premium is vital for longer-term predictions.

Hamilton and Kim (2000) extend the vast literature on testing the predictive power of the yield spread on the business cycle. Spread is measured as the difference between a 10-year Treasury bond rate and a 3-month T-bill rate. In addition to the usual testing of the predictive power of the yield spread on future real GDP growth, other economic factors such as lagged real GDP growth, change in Federal funds rate, growth of monetary aggregates and oil price changes are also incorporated.

Hamilton and Kim confirm statistically that the yield spread does contain useful information about future GDP growth. Finally a separation of the yield spread into two components: change in short rates and risk term premium, is applied to the testing of the hypothesis. By decomposing the spread, they find that the contribution of the future expected change of short rates to predicting future GDP growth is significantly bigger than that of the risk term premium. Hence, they conclude that the most important reason that a negative yield spread predicts recession is that a low spread implies falling future short rates. The methodology of spread decomposing is also employed in the present paper.

3.3.2 The yield curve and stock markets

Financial economic theory says that stock prices equal the discounted values of expected future dividends. As such, any information about stock discount rates including the information contained in the slope of the yield curve should be reflected in stock prices. Theoretically, stock prices are determined by expectations made on certain variables –

expected future cash flow and expected future discount rates. The above statements imply the existence of a relationship between stock price movements and the slope of the yield curve via the expectations on future inflation changes. It is believed that the spot yield curve or the spot yield spread offers us two important sets of information – discount rate and future inflation path. For our investigation, we are going to utilize these two assumed features to draw an association between stock market volatility and the long-short spread.

In a seminal paper, which also is the paper most closely related to our investigation of stock market volatility and yield spread, Schwert (1989) investigates possible factors such as producer price index (PPI), inflation rates, monetary base growth rates and industrial production growth rates that could contribute to stock market volatility. He postulates that if these macroeconomic data provide information about the volatility of either future expected cash flows or future discount rates, they can help to explain why stock return volatility changes over time. By using a measure of stock market volatility which is identical to ours, he finds weak evidence to support the hypothesis that macroeconomic volatility helps to predict stock volatility. Nevertheless, he produces supporting evidence showing that financial leverage affects stock price volatility. This theory of financial leverage effect will be exploited heavily in the explanation of our empirical findings.

Zhou (1996) presents a study of the relationship between stock market fluctuations and the term structure. Previous studies on the predictive power of the yield spread to forecast stock returns and/or short-term risk premiums have shown that it is only useful in predicting short horizon variations. By using both short and long U.S. bond maturities, Zhou finds evidence to support the hypothesis that the term structure contains information on real and nominal stock returns particularly for the long horizon. In other words, high volatility of the stock market is related to high volatility of long term bond yields. Apart from the three-dimensional approach utilized,[24] the methodology applied in Zhou (1996) is very similar to that used in this paper. However, one fundamental difference between the present paper and Zhou's lies in the way stock market volatility is measured. While our focus in stock market volatility is measured by the monthly sum of daily deviations from

[24] Zhou (1996) uses only the U.S. yield data on seven maturity horizons.

the monthly mean returns, Zhou concentrates on excess stock return which is defined as the difference between return to holding the stock for *n* periods and the return to holding a risk-free *n*-period bond to maturity. Also tested in Zhou (1996) are the dividend-price (D/P) ratios. He finds evidence suggesting that long-term real interest rates explain a great deal of the variations in D/P ratios. Many financial economists have proposed that D/P ratios are frequently relevant to the pricing of a stock. Thus we should gain additional insight into stock return movements by testing the relationship between interest rate and D/P. However, to keep this paper within reasonable bound, extensions suggested by Zhou's work will be left for future research. Notwithstanding this, Zhou (1996) provides us with a good base for comparing results especially for the U.S. stock market testing.

Aburachis and Kish (1999) is another study that provides a succinct analysis of the subject. Although they do not test for the expectations hypothesis, they offer some important insights into the relationship between the bond and stock markets situation. By applying an error correction model and the standard Granger causality test in an eight-country (Canada, France, Germany, Japan, Netherlands, Switzerland, U.K. and the U.S.) setting, they show that stock and bond returns do not follow pure random walks (*i.e.* they are to some extent predictable) in all eight countries. The most important piece of evidence in the Aburachis and Kish paper that is favourable to our current investigation is that it establishes support for our testing of the predictability of stock returns volatility through the observations made on yield spread.

3.4 Stock Market Volatility

A stable market environment possesses many advantages for the economy. For most long-term investors, a stable stock market provides assurance in their investments while a volatile market weakens investors' confidence. According to the general asset-pricing model, stock price should reflect adequately the future returns (or stream of future dividend payments) from an investment. From a more macro point of view, movements of the market should reveal all the fundamentals of the economy (both current and expected). In a market economy, price is one of the important pieces of information for policy formulation. When the market is having extra movements that are not reflecting the

underlying fundamentals, misguided policies may consequently be made. Due to the potential harm that this price volatility could present to the economy, many financial economists have put forward theories and hypotheses to reduce these anomalies. This is also the key reason for our investigation into the relationship between stock market volatility and bond spot yield spreads. We believe that if somehow we can identify and quantify this relationship, we might be able to offer additional policy prescriptions to lessen stock market volatility through the observations made on the U.S. yield spreads.

Stock market volatility can be measured in various ways. Granger and Sin (1999) find that the simple absolute return, which is measured as the absolute value of log price difference, provides good forecast power especially after the start of the Asian financial crisis. Ma (1992) uses the spread, which is the difference between the logarithmic values of the highest and lowest prices on day t, and he claims that it may reflect the extreme movement of the price. Whereas Freris (1990), for the sample period before the 1987 stock market crash, employs interday price changes, which are calculated by using the appropriate daily closing price. For the *post*-crash period, Freris calculates intraday spreads as the difference between high and low daily values expressed as percentage of the closing price.

In this paper, although daily trading data are used for the four individual stock markets, we measure volatility by using a simple statistical approach of calculating daily deviations from the monthly mean within the month. As this volatility measure shows the dispersion of returns, it can be considered as a good measure of stock volatility. Moreover, the method of deviation from the mean summarizes the probability of seeing extreme values of return: a large deviation usually means that the chance of a large positive or negative return is huge. Before we proceed with this volatility measure, we shall first introduce notations that we use extensively in these two models.

Let P_t be the stock price index at time t in the relevant domestic currency and $r_i = \ln(\frac{P_t}{P_{t-1}})$ be the continuously compounded return on the index over the period *t-1* to *t*.

Based on this formulation of stock return, for our testing, stock market volatility within each month is calculated by the following equation:

$$\hat{\sigma}_m = \left[\sum_{i=1}^{N_T} \left(r_{i,m} - \mu_m \right)^2 \right]^{\frac{1}{2}}, \tag{3.24}$$

given that there are N_T number of trading days within the month m, $r_{i,m}$ are the log daily returns on the stock market index in month m, and μ_m is the monthly mean return. And finally, $|\hat{\sigma}_m|$, the absolute value of $\hat{\sigma}_m$ in percentage points per month is the required estimate for monthly stock market volatility, henceforth in this paper called VOL_t.[25] This stock market volatility forms the basis of our studies and serves as the endogenous variable in our first estimation model. Stock market volatilities (VOL_t) for the four stock markets are depicted in Figure 3-2. As one can easily observe from these four graphs, with this volatility measure, the Hong Kong Hang Seng Index (HSI) emerges as the most volatile amongst the four markets, followed by Japan Nikkei 225 (Nikkei), then the U.S. S&P 500 (S&P) and the U.K. FTSE 100 (FTSE) which share a similar degree of volatility during our sample period.

3.5 Data and Descriptive Statistics

This paper employs extensively the use of nominal data in our testing instead of measuring our variables in real terms. There are two reasons to justify our approach. Firstly, bond yields although risk-free are always quoted in nominal terms.[26] Therefore we can observe only the nominal yields *ex ante*. Secondly, previous study (Fama and Schwert (1977)) of a similar subject surprisingly finds a negative correlation between nominal stock returns and

[25] Unlike the conventional standard deviation measure that takes into account the number of observations, in (3.24) we use the sum of daily deviations from mean to calculate $\hat{\sigma}_m$ it has the monthly dimension because we do not divide it by the square root of the number of trading days.

[26] Of course, we exclude the possibility of using the indexed bonds that are issued by the U.K. government in recent years to raise the demand for government bonds.

nominal interest rates over short horizons. Hence it would be of benefit if we could extend this test on rates over longer horizons.

We use high frequency daily pricing data in calculating monthly stock market volatility. We believe that this type of observation contains a great deal of information about stock market movements, thus providing us with a better (more detailed and more accurate) picture of the relationship between stock market volatility and the U.S. yield curve. The entire sample covers the period February 1979 to December 1998. Daily pricing data for the HSI, Nikkei, S&P and also part of the FTSE are transformed into measures of stock volatility through the use of equation (3.24). The magnitude of these stock volatilities is comparable to those used in the majority of William Schwert's (1989, 1990b, 1998) papers on stock market volatility.

Daily stock pricing data of the FTSE became available in January 1978. Prior to December 1983, only monthly data were posted by the FTSE. Therefore, for the period between January 1978 and December 1983, stock volatility of the FTSE is measured by using the following equation:[27]

$$R_m = \sum_{j=1}^{12} \alpha_j D_{jm} + \sum_{i=1}^{12} \beta_i R_{m-i} + \zeta_m \ , \tag{3.25}$$

where R_m is the log monthly returns on the market index in month m and D_{jm} are the twelve monthly dummies used to capture differences in mean returns. The 12 lagged returns $\sum_{i=1}^{12} R_{m-i}$ are used as regressors to estimate short-term movements in conditional expected returns. Finally, the absolute value of the residuals ($|\zeta_m|$) is the required estimate for market volatility of month m, in conjunction with the above volatility measure, we also called VOL_t for the FTSE.

As this paper aims at quantifying the relationship between the U.S. yield spread and stock market volatility up to twelve months ahead, we use the same measurement of

[27] Jones, Kaul and Lipson (1994) and Schwert (1989) also used this method of calculating stock market volatility in their papers.

cumulative change that has been used extensively by numerous previous researches (Hamilton and Kim (2000), Estrella and Hardouvelis (1991), Estrella and Mishkin (1995), Bonser-Neal and Morley (1997) and Kozicki (1997)) of term structure and economic activities. In this paper, we apply this measure to the stock market volatility case. After obtaining stock market volatility of the four stock markets, to measure the annualised cumulative percentage change in these four stock market volatilities, we apply the following:

$$CCV_t^k \equiv \left(\frac{1200}{k}\right)[\log(VOL_{t+k}) - \log(VOL_t)], \tag{3.26}$$

where k denotes the prediction horizon in months running from 1 to 12, VOL_{t+k} denotes the level of volatility during month $t + k$, and CCV_t^k denotes the annualised cumulative percentage change in volatility over the next k months. Hence, each CCV_t^k provides us with the required quantified accumulated amount of change in stock market volatility in the twelve months horizon; by using the U.S. spot yield at time t. Figures 3-3.1 to 3-3.4 show the resulting CCV after applying equation (3.26) to our stock market volatility data.

Standard time series analysis assumes that the underlying series are stationary in that both the mean and variance are constant over time and the autocovariances are independent of time. The Augmented Dickey-Fuller (ADF) test on unit root performed on CCV_t^k of the four stock markets confirms that indeed they are all stationary. Results of these unit root tests are presented in Tables 3-4.1 to 3-4.4.

Difficulty in finding a pure risk-free interest rate is another issue we have to address in this paper. The closest candidate that we can find, and also the most frequently used yield spread, comes originally from McCulloch and Kwon (1993) data set on monthly zero-coupon yields as implied by the yield curve for U.S. Treasury securities. For our estimation and empirical testing, we use the yield data covering the period of February 1979 to December 1998.[28] This data set has also been used extensively in empirical studies

[28] Our choice of time period under investigation is of course constrained by the availability of the spot yield data.

by other authors such as Campbell and Ammer (1993), Campbell and Shiller (1991), and Backus and Zin (1994) and Campbell, Lo and MacKinlay (1997). Duffee (2001) later spliced and extended the original data from February 1991 to December 1998. We adopt the extended dataset of Duffee (2001) and apply it as our full yield spread data set for this paper. Figures 3-4.1 and 3-4.2 present these series in pairs of maturity. In total, we have five spot spread series covering maturity horizons of three, six, twelve, twenty-four, sixty and one hundred and twenty months. To calculate the corresponding spot yield spreads, we use the equation:[29]

$$Spd_t^{(n,3)} = R_t^n - r_t^3 \tag{3.27}$$

In all, we obtain five spread series of the 6-3, 12-3, 24-3, 60-3 and 120-3 long-short differentials. In general, we classify the 6-3 as the short, 12-3 and 24-3 as the medium and lastly the 60-3 and 120-3 as the long maturity series, respectively. Figure 3-5 depicts all the five calculated series. Once again, to ensure the validity of our statistical inference, we perform an Augmented Dickey-Fuller test unit root on all five sets of spot spread data. The results of the test, which can be found in Table 3-5, tell us that all the spread series are stationary.

3.6 Hypothesis Development

1) *One-for-one* movements for all maturity spectrums between the yield spread and change in stock market volatility.[30] We shall present these two issues as follows:

   For Model 1A – static model:[31]

$$H_0^{S1} : \hat{a}_1^{6-3} = \hat{a}_1^{12-3} = \hat{a}_1^{24-3} = \hat{a}_1^{60-3} = \hat{a}_1^{120-3} = 1 \qquad \text{vs.}$$

[29] Similar to equation (3.17) discussed previously, but replacing the one-period short rates with the three-month spot yield.

[30] This hypothesis is based on the Fisher effect, which we have covered extensively in the last section.

[31] The full model is presented in Section 3.8.1.

$$H_1^{S1} : \hat{a}_1^{6-3} = \hat{a}_1^{12-3} = \hat{a}_1^{24-3} = \hat{a}_1^{60-3} = \hat{a}_1^{120-3} \neq 1.$$

For Model 1B – dynamic model:[32]

$$H_0^{D1} : \hat{b}_2^{6-3} = \hat{b}_2^{12-3} = \hat{b}_2^{24-3} = \hat{b}_2^{60-3} = \hat{b}_2^{120-3} = 1 \qquad \text{vs.}$$

$$H_1^{D1} : \hat{b}_2^{6-3} = \hat{b}_2^{12-3} = \hat{b}_2^{24-3} = \hat{b}_2^{60-3} = \hat{b}_2^{120-3} \neq 1$$

The first hypothesis we want to test in this paper is very simple. We intend to establish a *one-for-one* relationship between the slope of the yield curve and the cumulative change of stock market volatility within the horizon of twelve months by using the full spectrum of our U.S. yield maturities for the four countries. Theoretically our claim involves the supposition of three interconnected issues. Firstly, there is the relationship between interest rate and inflation, which Fama (1975) finds supportive evidence. Secondly, the relationship between inflation and stock return that both Fama and Schwert (1977) and Boudoukh and Richardson (1993) find strong support for a positive relationship. And finally, the correlation between interest rate and stock return which both Campbell (1985) and Zhou (1996) undertake to examine. Although Campbell (1985) finds predictive power of the spread for the short maturity, Zhou (1996) finds it exists in the long maturity. In this paper we proceed one step further to look at the cumulative effect of stock volatility. To establish our first hypothesis clearly, we shall apply the following analysis to interest rate, inflation and stock volatility.

As mentioned earlier, the Fisher equation states that the nominal interest rate is simply the sum of the real interest rate and the expected inflation rate. Therefore, assuming that over time the real interest rate remains constant,[33] one should observe a positive *one-for-one* relationship between the movements in nominal interest rate and expected inflation. Let nr_{t+1} be the expected rate of nominal returns on asset at time $t+1$. π_{t+1} is the expected inflation rate of period $t+1$ with expectation made using the available

[32] The full model is presented in Section 3.8.2.
[33] More discussions on this assumption will be offered subsequently.

information set Θ_t at time t, and rr is the real rate of return which is assumed to be constant over time. Thus, the simplest form of the Fisher equation can be represented by the following equation:

$$nr_{t+1} = rr + E_t(\pi_{t+1} \mid \Theta_t) \tag{3.28}$$

This Fisher effect is often formulated by setting the *ex ante* real rates[34] as being constant. Likewise, the *ex ante* inflation rate is frequently used because at time t when we set the nominal interest rate only expected inflation rate could be formed. As Fisher (1965) points out, the two possible outcomes of this formulation depend on the degree of uncertainty in the real world. With perfect foresight and a well-functioning capital market, equation (3.28) should hold fully. Given a constant equilibrium real rate of return, one should observe a positive *one-for-one* relationship between the one-period nominal interest rate and the fully anticipated inflation rate. However, in a world of uncertainty where imperfect foresight prevails, the nominal interest rate can be considered as the equilibrium expected real rate of return plus the market's assessment of the expected rate of inflation. From these statements, it is very clear that the validity of the assumption of a constant real rate of return is subject to the degree of uncertainty that exists in the real world. Based on this important feature, Fama (1975) examines Fisher's hypothesis and finds that in general the relationship presented in (3.28) holds, at least during the 1953-1971 period. Fama concludes that this can be served as an indication of an efficient market. In this paper, we begin the investigation of our first hypothesis by assuming that equation (3.28) is valid. Later on in the analysis of our empirical results, we shall offer further comments on this assumption of a constant real rate of interest.

To observe the relationship between interest rate and changes in stock volatility, let us assume that investors are sensitive to the change of future inflation. So when inflation is expected to rise, as stocks are simply just claims against real assets, to maintain a constant real rate of return in the long run, investors would expect to be compensated for movements in inflation. The same also holds true for an expected fall in the future inflation rate. In other words, when inflation of goods' prices is uncertain, this creates

[34] Since we do not observe real interest rates until inflation is realised.

additional movements in stock price. Thus given our measure of stock volatility (deviation from mean return), the volatility of nominal asset returns will be increased which reflects these movements in inflation. Hence, we should expect a theoretical correlation between the spot spread as indicator of future inflation rate change and movements in stock price. However, this paper differs from the others in that we do not impose the requirement of a positive relationship between interest rate and stock movements as part of our first hypothesis because as we shall explain shortly, the direction of this relationship depends on the degree of business leverage of firms.

Alternatively, the above analysis can also be viewed through the economic condition approach such as the one used by Hamilton and Kim (2000). Their study of the relationship between economic activity and the yield spread finds that the spread contains useful information for forecasting GDP growth. Taking the case of an inverted yield curve,[35] which means that future nominal interest rates are expected to fall as a result of an expected falling inflation, this downward movement of expected future interest rates can serve as a signal for a forthcoming recession[36] in the economy. Thus reduction in future real GDP growth can be expected. We can extend this analysis to our first hypothesis by asserting that since common stock reflects claims on future profits of firms, it is highly plausible that volatility of real economic activity plays a major role in the change of stock return volatility. Or to be more pertinent to our hypothesis analysis, a change in nominal interest rates *vis-à-vis* the yield spread which functions as a signal of future inflation movement and also future real economic activity, profitability of firms will be affected and so will the volatility of stock return and stock price.

All in all, the economic condition approach supports an association between the yield spread and stock volatility, whereas the Fisher hypothesis stipulates a *one-for-one* magnitude for this relationship.

2) All countries under investigation are equally affected by changes in the U.S. yield spread.

[35] When the yield spread is negative, *i.e.* short rate is greater than long rate.
[36] Recession is defined as the slowing in GDP growth.

For Model 1A – static model:[37]

$$H_0^{S2}: \hat{a}_1^{HSI} = \hat{a}_1^{Nikkei} = \hat{a}_1^{FTSE} = \hat{a}_1^{S\&P} \quad \text{vs.} \quad H_1^{S2}: \hat{a}_1^{HSI} \neq \hat{a}_1^{Nikkei} \neq \hat{a}_1^{FTSE} \neq \hat{a}_1^{S\&P}.$$

For Model 1B – dynamic model:[38]

$$H_0^{D2}: \hat{b}_2^{HSI} = \hat{b}_2^{Nikkei} = \hat{b}_2^{FTSE} = \hat{b}_2^{S\&P} \quad \text{vs.} \quad H_1^{D2}: \hat{b}_2^{HSI} \neq \hat{b}_2^{Nikkei} \neq \hat{b}_2^{FTSE} \neq \hat{b}_2^{S\&P}$$

The second issue that we want to examine is the degree of influence of the U.S. economic condition on both the domestic and international stock markets. As discussed in detail above, we plan to identify the degree of this U.S. influence through observations made on the U.S. yield spread and the reactions of the four stock markets to changes in the yield curve slope. Assuming perfect capital mobility,[39] we begin our enquiry by hypothesizing that Hong Kong, Japan, the U.K. and the U.S. should receive an equal degree of U.S. influence. In other words, we expect that movements of capital across countries should efficiently reflect investment returns that take into account the economic condition of individual countries. Hence, an anticipated U.S. economic downturn will cause an outflow of capital from the U.S. into other capital markets such as the U.K., Hong Kong or Japan and *vice versa*. It is interesting to test this homogeneous response hypothesis as, to a certain extent, it implies the testing the notion of perfect capital mobility at the same time.

3) The U.S. yield spread and cumulative change in stock market volatility relationship exists in all 12 months horizons.

[37] The full model is presented in Section 3.8.1.
[38] The full model is presented in Section 3.8.2.
[39] Although a rather restrictive assumption but certainly helps to test our hypothesis.

For Model 1A – static model:[40]

$$H_0^{S3} : \hat{a}_1^{1m} = \hat{a}_1^{2m} = \hat{a}_1^{3m} =,...,= \hat{a}_1^{12m} \quad \text{vs.} \quad H_1^{S3} : \hat{a}_2^{1m} \neq \hat{a}_1^{2m} \neq \hat{a}_1^{3m} \neq,...,\neq \hat{a}_1^{12m}$$

For Model 1B – dynamic model:[41]

$$H_0^{D3} : \hat{b}_2^{1m} = \hat{b}_2^{2m} = \hat{b}_2^{3m} =,...,= \hat{b}_2^{12m} \quad \text{vs.} \quad H_1^{D3} : \hat{b}_2^{1m} \neq \hat{b}_2^{2m} \neq \hat{b}_2^{3m} \neq,...,\neq \hat{b}_2^{12m}$$

The third area that we want to investigate is the persistence of the U.S. spot yield spread and the change in the stock market volatility relationship. It means, should we be able to successfully accept our first hypothesis, this then raises the question how far ahead this spread-volatility relationship persists in our models. Since we are using monthly data, we thus impose a testing of 12 months ahead. We place no prior expectation on the level of persistence in our model, however, for the testing of the yield spread and GDP growth in Hamilton and Kim (2000) it is found that when using quarterly data, information content of the spread persists up to 12 quarters ahead in their model. Based on this result, and given that we are using monthly data, we apply a 12 month ahead horizon in our testing.

Overall, it is not difficult to see that these three proposed examinations are interrelated and once we are able to successfully accept the first hypothesis, then the rest seems comprehensible. The three hypotheses can be summarized by the following simple questions: 1) Does a *one-for-one* spread-volatility relationship exist? 2) If it does, is the magnitude of this relationship the same for all four countries? 3) If yes to 1), how long does this relationship last? Obviously, the second and third questions are independent to each other. However, prior to finding an answer to either question two or three, the answer to the question one must first be validated.

[40] The full model is presented in Section 3.8.1.
[41] The full model is presented in Section 3.8.2.

3.7 Business Leverage Effect – *Financial Leverage (FL) + Operating Leverage (OL)*

Before we proceed with the discussion of our model specification and empirical results, it is imperative that we introduce the business leverage[42] effect in this section. As previously mentioned in our introduction section, the business leverage effect hypothesis with the issue of export concentration embedded is not being empirically tested in this paper and is presented as an economic theory only. However, due to its considerable relevance to our present research interest, in addition to the conventional assumptions of the Fisher effect and perfect capital mobility that we utilize in our hypothesis development, we believe that this theory will assist us significantly in the interpretation of the empirical results presented in subsequent sections.

According to Modigliani and Miller (1958) under the assumptions of perfect capital markets and fixed investment policy, the value of any firm must be independent of its financial structure. However, given the fact that these are rather restrictive assumptions for the real world, subsequently researches on the topic continue with the study of the effects of business leverage on stock values or the risk factor of common stock. Mandelker and Rhee (1984) find that indeed the degree of operating and financial leverage account for a large portion of the variation in the systematic risk of common stock. The relationship between business leverage and the systematic risk of common stock is succinctly summed up by Van Horne (1977, p.784): "Operating and financial leverage can be combined in a number of different ways to obtain a desirable amount of risk of common stock. High operating leverage can be offset with low financial leverage and *vice versa*. Another piece of research that is more directly related to the current paper is Schwert (1989). By using both daily and monthly U.S. stock return data for the period 1920 to 1987, Schwert finds empirically that the degree of financial leverage explains significantly the movements of stock return. In fact his result shows that an increase in the debt to equity ratio leads to an increase in stock return volatility. The contribution of Modigliani and Miller to the understanding of the relationship between leverage and the

[42] In this paper we prefer to use the term 'business leverage' to link specifically to the business structure of the corporation, which includes both the financial and operating aspects of a firm.

value of a firm is indisputable, however the cited researches have also provided us with a more practical look at the importance of leverage to common stock and its movements.

Based on the generally accepted leverage and firm value relationship, it is commonly known in the investment community that one can use the degree of business leverage to value a firm. Therefore, if a firm is entirely financed by ordinary shares, *i.e.* all investors are also owners of the firm, then this firm is unlevered and the value of it is simply the product of the market stock price and the number of shares outstanding. On the other hand, when a firm is financed by both equity and long-term debt,[43] it becomes a levered firm and its value is simply the sum of the market values of the individual liabilities.[44] Faced with these two types of firms in the economy, the next question many investors are interested in finding an answer to is the effect of leverage on the value of the stocks. A straightforward answer to this question is that in general a levered firm has a higher value than an unlevered one. The key reason behind this answer has two parts. First, in many countries, if a firm is incorporated, the interest it pays on debt is tax-deductible, whereas dividend payments on stocks are not. Secondly, if a levered firm can borrow money that produces a return which exceeds interest costs, then a positive gain arises. Putting these two benefits together, it is obvious that the gains from leverage bring about a higher value of the firm – higher value also means higher stock price. Exactly because of this reason, in most countries, levered firms represent a large portion of corporate formation in the economy. Nevertheless, one has to note that beyond a certain level of leverage the added risk accrued from leverage outweighs the benefits and greater stock volatility results.

In general, leverage or business leverage consists of two components. The first is financial leverage (*FL*), which represents the debt-to-equity ratio of a business firm. A firm with a high debt-to-equity ratio signifies a high *FL*. The second business leverage component is operating leverage (*OL*), which shows the extent to which a firm's costs of operating are fixed as opposed to variable.

[43] Usually in the form of bonds.
[44] It is rather common to use the market value of liabilities to value a firm because they are more easily determined than the market value of assets.

Basically, a high *OL* implies that a large portion of the firm's operating costs is fixed in nature. A totally automated firm in which costs are virtually all fixed is an excellent example of a high *OL* firm, whereas a labour intensive firm demonstrates a case of low *OL*. On the surface, both *FL* and *OL* appear to be independent of each other. By definition, *FL* relates to the financing side of the firm, while *OL* is associated with the operating structure of the firm. This remark is very misleading indeed. Although one might fail to find a common definition between *OL* and *FL*, a direct relationship between the level of *FL* and *OL* does exist in the economy and finding a trade-off between *FL* and *OL* is a frequent occupation of the management.

As mentioned earlier, the degree of *OL* is both an operational and structural concern. Given the characteristic of *OL*, it is often considered that it is significantly influenced by economy-wide events and the uncertainty associated with the firm's operating efficiency. However, when a firm changes the level of *FL*, the degree of *OL* is also affected. Take the case of a firm increasing its *FL* due to either tax incentive and/or return seeking purposes: this action leads to a greater amount of interest expenses. From both economic and financial viewpoints, the debt-servicing charge is a fixed cost to the firm. Clearly, this increase in fixed cost raises both *FL* and *OL* even though there is no actual change in the cost of operation[45] *per se*. By the same token, when a firm reduces its debt position, this will surely lead to a fall in *OL*. In this paper, we will draw heavily on the business leverage hypothesis as a tool to explain the relationship between the U.S. yield spread and change in stock market volatility. Figure 3-6 depicts a tree diagram of our business leverage effect hypothesis. We start with the analysis by examining a case of falling yield spread.

The scenario presented in Figure 3-6 shows the situation of an inverted yield curve *vis-à-vis* when future interest rates are expected to fall. This negative yield spread signals that future inflation is falling with an ensuing recession. For most firms, a forthcoming recession suggests negative impacts on sales. These negative impacts indubitably will lower the share price of many firms thus causing extra price movements and changed volatility in the stock market. In this paper, we want to assert that not all firms will receive

[45] Here we consider operation cost as the cost involved in the production process.

the same degree of stock price movements as a result of an expected recession. In fact, we believe that the degree of these negative impacts will vary across firms according to the initial degree of *OL* of each individual firm.

Firms with high *OL* usually bear two characteristics: 1) the breakeven point[46] is at a relatively high sales level; 2) beyond breakeven point, as costs remain constant at every level of production, every dollar increase in sales is a dollar increase in operating income. Given these two features, it is not difficult to perceive that a firm with high *OL* is more sensitive to changes in sales volume. In other words, for firms that have large fixed costs, when demand falls, net profits fall faster than revenue when compared with firms with low *OL*,[47] and a bigger drop in the share price of this firm also takes place. This analysis shows that the degree of *OL* of a firm plays a key role in the change in its stock value when future economic conditions are expected to alter.

Of course most economies are made up of firms of different degrees of *OL*. However, let us assume for simplicity that there only exists two types of firms in the economy, high *OL* and low *OL*. Confronted with falling future interest rates, both high and low *OL* firms have two options. They can either take advantage of a future falling interest rate by increasing *FL*, which also translates into higher *OL*. Alternatively, they can keep the existing level of *FL*, thus leaving *OL* unchanged. As discussed above, assuming that marginal costs are negatively related to *OL*, then the degree of *OL* within a firm measures the sensitivity of its profits to changes in sales volume. Hence we can safely assume that regardless of which option this firm takes, the high *OL* firm will suffer from a larger adverse effect of a recession than a low *OL* one. In other words, if a high *OL* firm has relatively lower marginal costs, then regardless of how it reacts to changes in interest

[46] The point at which sales cover fixed and variable costs. All sales over the breakeven point produce profits.

[47] This statement is subject to the following condition:
Given Π is profit, $TR(q)$ is total revenue and $TVC(q)$ is total variable costs at q level of output, F stands for fixed costs, $\Pi = TR(q) - TVC(q) - F$ and when MR is the marginal revenue and MC is marginal cost, $\frac{d\Pi}{dq} = MR - MC$. For given MR, this will be true if high F (or OL) implies lower MC. This condition is assumed to hold all through the discussions on the topic of business leverage in this paper.

rates, the result of an adverse impact on its profit will be greater than that faced by a low *OL* firm.

The only exception we can perceive is when a low *OL* firm increases its *FL* by such a large amount that it substantially raises the level of *OL* to the point that surpasses the other high *OL* firms. However, we believe that this is an unlikely event because when firms are expecting a forthcoming recession, which results in a reduction in sales, it is financially imprudent to intensify further its *OL* position. The scenario depicted in Figure 3-6 describes exactly the possible outcome with high *OL* firms suffering from a larger negative effect than low *OL* firms when a fall in sales is expected. Either way, as profit fluctuates, additional movements in share price arise – greater change in stock volatility. To further summarize our business leverage effect, we have the following:

1. Large spread-volatility effect – High OL firms:

↓ spread ➔ falling interest rates → Recession →

Firms react by either – 1) increase *FL* → increase *OL* or/

2) no change in *FL*, but if already high *OL*

→ fall in sales ➔large stock price movements → large ↑stock volatility

2. Small spread-volatility effect – Low OL firms:

↓ spread ➔ falling interest rates →Recession →

Firms react by either – 1) increase *FL* → increase *OL* or/

2) no change in *FL*, but if very low *OL*

→ fall in sales ➔small stock price movements →small ↑stock volatility

3. No spread-volatility effect:

1) Firms have extremely small *OL*; or
2) U.S. inflation (economic conditions) has little or no impact on both domestic and foreign economies.

The above three scenarios demonstrate the equally possible reaction magnitude of either a domestic U.S. firm or an overseas firm when faced with a falling U.S. yield spread. However, due to the importance of the *OL* in our analysis, these firms' reactions will be greatly magnified if there exists a high ratio of export-oriented firms in the economy. This is a reasonable postulate in particular for countries such as the U.S., the U.K. and Japan. In any event, the inclusion of an extra assumption should not lessen the performance of our business leverage effect analysis.

The three probable relationships between yield spread and stock market volatility listed above are facilitated via our business leverage effect. Through the understanding of this theory, we hope to offer further support in explaining our empirical results presented in the subsequent sections.

To summarize the materials presented in the above two sections and to further assist the understanding of our three hypotheses, we produce the following chart:

H_0:	Fisher effect	Economic condition approach	Business leverage effect	
			High *OL*	Low *OL*
One-for-one relationship	√	√		
Homogeneous reaction			Large	Small
Effect persistence				

In general, we expect that with the economic condition approach providing confirmation of the existence of the information content of the yield spread, the Fisher hypothesis will give rise to a *one-for-one* relationship between the U.S. spread and cumulative change in stock volatility. The existence of 'hot money' seeking high return in the short run and the interdependence of international markets lead us to believe that the four countries should receive an identical degree of effect from a change in the U.S. yield

spread. However, the exact direction of this reaction is difficult to assess and we shall discuss this problem in more details later on in this paper. However, generally one can assume that a change in the U.S. interest rate would give rise to uncertainty about the U.S. economic condition and this should have a positive effect on the international stock market volatility. Although the sign of the spread coefficient might be ambiguous, the business leverage effect hypothesis helps to identify the magnitude of the spread coefficient. Should the economic condition approach be proved valid (that is the yield spread contains useful information about future U.S. economic growth) the ratio of high *OL* to low *OL* firms existing in individual countries plays an important role in the extent of the reaction to a change in the U.S. yield spread. As for the final hypothesis testing, we shall let the empirical finding speak for itself.

3.8 Model Specification and Estimation

3.8.1 Model 1A – Static model

Recent empirical studies of the predictive power of the yield spread on stock returns have covered mostly European and U.S. markets (Duffee (2001), Aburachis and Kish (1999), Zhou (1996) and Campbell and Shiller (1991)). This paper extends the study to one other major international market namely, Hong Kong.

In the central testing of a linear relationship between yield spread and stock volatility, two models are constructed. In our first model of equation (3.29) below, we try to confine our focus to a very basic yield spread-volatility relationship. In order to examine simultaneously the three hypotheses that we listed in Section 6, this basic model is applied to the five different maturity spectrum spreads *i.e.* 6-3, 12-3, 24-3, 60-3 and 120-3, four different international stock markets – Hong Kong, Japan, the U.K. and the U.S. and twelve months cumulative change in stock market volatility. In total, each individual model entails 240 (5 x 4 x 12) regressions.

Model 1A:

$$CCV_t^k = a_0 + a_1 Spd_t + \varepsilon_t \ , \tag{3.29}$$

where CCV_t^k is the cumulative change in stock market volatility over the next k months, with k running from 1 to 12. Spd_t equals $(R_t^n - r_t^1)$ which measures the difference between long and short yields, while a_0 is the intercept, a_1 is the slope coefficient and ε_t represents the disturbance term.

The methodology used in Model 1A follows closely the one used by Hamilton and Kim (2000), Bonser-Neal and Morley (1997), Kozicki (1997), Estrella and Hardouvelis (1991) and Estrella and Mishkin (1995). Although these studies centre on empirically testing the predictive power of yield spread on economic activity, we chose this methodology due to the benefit of having the capability of measuring the cumulative effect of the yield spread on stock volatility over the next 12 months. The set up of Model 1A is considered as a typical static model that only includes both the current and future values of cumulative volatility change and the yield spread at each point in time. Given that we are working with financial time series, this type of model is well known for suffering from the potential problem of serial correlation, and to add dynamic elements into this model, we derive Model 1B.

3.8.2 Model 1B – Dynamic model

Model 1B:

$$CCV_t^k = b_0 + b_1 CCV_{t-1}^k + b_2 Spd_t + b_3 Spd_{t-1} + u_t \tag{3.30}$$

Model 1B is an autoregressive distributed lag (ADL(1)) model with a dependent variable that is expressed as a function of its own lagged values, and the current and lagged values of all explanatory variables. In this particular case, we only include the one period lag of both the dependent and independent variable. The reason for such a decision will clearly emerge upon the discussion of the COMFAC approach for our model selection in the following section.

3.9 COMFAC Approach

Prior to the construction of our Model 1B, OLS was run on equation (3.29) for each of the individual stock markets. However, the Breusch-Godfrey serial correlation LM test reveals a problem of serial correlation, in particular in the first order, in each of our regression models. The existence of serial correlation can reflect simply the problem of the correlated residual due to inertia of time series or more serious specification errors resulting from excluding important variables from the model. From our testing, we find that not all models suffer from serial correlation and heteroscedasticity. There is one occasion (see Table 3-6.2) in which we fail to detect the presence of these two problems. For this case which we call the basic static model, we simply use OLS regression without going through the COMFAC analysis.

A seminal paper by Hendry and Mizon (1978) shows that serial correlation might not be a nuisance to model specification: rather it can be used as a convenient simplification. Based on a set of simple derivations as presented in Appendix 3A, it is established that by testing restrictions placed on the dynamic model such as the one in (3.30) one can reduce the model to a static one as shown in equation (3.29). In other words, if these restrictions, which are implied by the *common factor*, are proved to be valid, then instead of estimating the dynamic model, one can assume that the simple static model allowing for first order serial correlated errors has incorporated all the required dynamics. This approach in model selection is known as the COMFAC approach and details of this methodology can be found in Appendix 3A.

To utilize this COMFAC approach in our estimation, we pursue a search for the correct estimation model amongst our 240 possible regression models by way of the following procedures:

1) Run OLS on equation (3.29). Use the Breusch-Godfrey serial correlation LM test to detect the existence of serial correlation.

2) If serial correlation is found, run OLS on (3.30).[48]

3) Using the Wald-test, test restriction of $b_3 = -b_1 b_2$.

4) If restriction is proved valid, use Model 1A for regression with an AR(1) process to take into account the presence of first order serial correlation.

5) If the is restriction is proved not valid, then the appropriate model to use should be Model 1B.

Although this model searching process[49] is extremely time consuming, we are confident that we obtain more reliable results than directly proceeding with the Newey-West HAC method in correcting the standard errors for serial correlation and heteroscedasticity. In particular, during our estimation process, the presence of heteroscedasticity is tested and is consistently rejected by the White test.[50] By using the COMFAC approach in model selection we identify the correct dynamic specification of our regression models, whereas by allowing an AR(1) process for estimation in Model 1A, we alleviate the problem of serial correlation in our models and at the same time reduce the parameters to be estimated.

Tables 3-6.1 and 3-6.2 list the results of the COMFAC approach in model selection between equations (3.29) and (3.30). Evidently, Model 1A – static AR(1) fits well with the majority of our regression models, except for the case of the FTSE where both static and dynamic regression modelling share equal importance. We tabulate these model selection results as follows:

[48] Equation (3.30) is just a simple first order dynamic model, theoretically it should incorporate the exact degree of serial correlation existed in the static model.

[49] Strictly speaking we are performing a simplified version of the COMFAC approach, which is similar to Godfrey (1973). Nonetheless, given the volume of estimation involved in the current paper, we believe that our exercise of model selection based on the idea of the COMFAC approach has certainly added robustness to our empirical results.

[50] Unfortunately due to the vast amount of estimation this paper undertakes, results of the White test will not be presented in this paper. However, they are available upon request.

Stock Index	No. of basic static model (%)	No. of static AR(1) model (%)	No. of dynamic ADL(1) model (%)
HSI (Hong Kong)	0 (0%)	49 (82%)	11 (18%)
Nikkei (Japan)	0 (0%)	58 (97%)	2 (3%)
FTSE (U.K.)	1 (2%)	35 (58%)	24 (40%)
S&P (U.S.)	0 (0%)	55 (92%)	5 (8%)

3.10 Empirical Results

Prior to discussing the empirical results for the testing of our three hypotheses, we shall present a summary of the general results for the four countries under investigation.

3.10.1 The four countries

3.10.1.1 Hong Kong

Detailed regression results for the HSI are presented in Table 3-8.1, while Table 3-7.1 produces a summary of these results. In line with other previous studies such as Campbell (1987) and Zhou (1996), we also find evidence that the information content of the U.S. yield spread on the change in stock market volatility only exists in the short- medium maturities up to 24 months. Furthermore, the information content of the U.S. yield spread lasts in most cases up to 3 to 4 months, except for the 24-3 spread where it appears at 8 months. For the 6-3 and 12-3 spread cases, when the U.S. yield spread is one per cent (or 100 basis point) then over the course of three months, the HSI is expected to have accumulated a change in stock volatility of 0.84 per cent and 0.386 per cent respectively. Whereas, for the 24-3 spread, the U.S. yield spread's influence on the cumulative volatility change in Hong Kong stock market is reduced from 0.203 per cent to 0.12 per cent in the course of 8 months. In all cases, the estimated spread coefficient shows a positive relationship between cumulative change in stock market volatility and the U.S. yield spread. This indicates that when there is a falling spread *i.e.* U.S. inflation is expected to fall, cumulative volatility of the HSI decreases. Overall, the generally and statistically insignificant intercept terms indicate that whenever the slope coefficients are positive,

which is true in the HSI case, a direct positive volatility-spread relationship emerges. However, the size of the slope coefficients does not support a *one-for-one* movement between the dependent and independent variables. As to our generally low $\overline{R}^2$s (0.010 to 0.382) for the four stock markets, they are also not far from those of Campbell (1987) -0.018 to 0.118 and Zhou (1996) -0.001 to 0.251. It seems that the weak correlation of determination is a common feature in the empirical testing of this topic.

3.10.1.2 Japan

The Nikkei estimation results (Tables 3-7.1 and 3-8.2) provide us with a very different picture. Contrary to the HSI in which there are statistically significant positive spread coefficients for three maturity spectrums, for the Nikkei we find a negative spread coefficient for all the statistically significant results. That is when we are faced with an inverted yield curve or future short rates are expected to fall, cumulative change in Nikkei volatility rises. In general, the size of these estimated results are rather similar to the HSI case except that they decrease as horizon extends. The U.S. yield spread at the five maturity spectrums seems to contain information on the Japanese stock market volatility up to one year ahead. Over the course of twelve months, these cumulative changes in Nikkei volatility have reduced from the highest of 0.554 to 0.051 per cent for the whole maturity spectrum. From the spread coefficient first becomes significant until the end of the twelve months, it decays according to the following pattern: 6-3 (-74%), 12-3 (-65%), 24-3 (+9%), 60-3 (-68%) and 120-3 (-80%). This figures show that the information content of the U.S. yield spread diminishes rather rapidly over the course of twelve months. For the 12-3 and 120-3 yield spreads, the predictive power of the U.S. spread exists in about two thirds of the cases all through the 12 months horizon. Unlike the HSI case, not all of the intercept coefficients are statistically equal to zero at the 10 per cent critical level. The significant intercept coefficients all carry a positive term, indicating that a negative slope coefficient does not guarantee a decrease in the cumulative change in stock volatility. However, in this case since all the significant intercept coefficients are smaller than the slope coefficients, a negative cumulative change in volatility is expected. Take the case of 12-3 spread, in four month's time, a negative spread-volatility would have occurred only if the slope were less than -0.55 per cent or 55 basis points (-

0.55=0.181/-0.33). Once again, the Nikkei results reject the hypothesis at 10 per cent level of a *one-for-one* relationship between the U.S. yield spread and cumulative volatility change.

3.10.1.3 The U.K.

When we examine the London FTSE regression results in Tables 3-7.2 and 3-8.3, in terms of the number of statistically significant spread coefficients, as relating to the Nikkei case, we notice a somewhat reverse situation. In the Nikkei case, most of the significant coefficients occur after the fourth month and remain significant until the twelfth month of the horizon. The FTSE regression produces statistically significant spread coefficients from the first month[51] and they are mostly distributed in the one to four and six to nine month periods. The most striking feature of the FTSE result is the substantial size of some the spread coefficients, in particular for the first couple months of the testing horizon. The magnitude of these coefficients will be discussed in more details later on in this paper. In terms of the sign of the spread coefficient, the FTSE share predominantly the same positive sign as the HSI while maintaining a negative effect as in the Nikkei. Though it seems like a very peculiar phenomenon, we shall attempt to offer a rational and economic explanation for the situation in later sections. However, before we proceed further, it is important to highlight a special feature of the FTSE volatility series. As mentioned previously in Section 3.5, the FTSE became available in January 1978. Prior to December 1983, only monthly data were posted. Therefore, for the period between January 1978 and December 1983, stock volatility of the FTSE is measured by using equation (3.25) while volatility for the other period within the U.K. and also for the other three countries equation (3.24) is used. These two different volatility measures for the two periods might be an important factor in causing significant divergence in our U.K. regression estimation.

Also different from the Nikkei result is the fact that this information content of the U.S. yield spread tends to cluster around the first three months instead of persisting down to the last couple of months of our horizon. The only two exceptions in this dispersal pattern is the 12-3 and 24-3 cases, in which strong persistence of the U.S. yield spread

[51] Except for the 120-3 case.

effect remains for twelve and eleven months respectively. From Table 3-8.3 we can see that nearly all but one (12-3, 12 months ahead) intercept coefficients are not statistically not different from zero, therefore a direct spread effect can be determined by the scale of the slope coefficient alone. The FTSE case is the only case that in seven occasions the *one-for-one* hypothesis is proved statistically significant. The size of the remaining slope coefficients is for the most part below one. Nevertheless, the FTSE result reflects the importance of the medium term maturity spread – 12-3 and 24-3, in our model.

3.10.1.4 The U.S.

Lastly, looking at the domestic situation for the U.S. as represented by the testing on the S&P 500 index (Tables 3-7.2 and 3-8.4), we identify the pattern of these results as similar to those of the Nikkei but at a greatly reduced scale. Like the Nikkei case, all statistically significant spread coefficients carry a negative term, but they tend to cluster only around the longer horizon of eight to twelve months. All intercept coefficients are positive while slope coefficients are negative, hence a negative slope does not guarantee a decrease in the cumulative change in stock volatility. But once again, since the size of the intercept coefficients is smaller than the size of the spread coefficients, a positive effect on the cumulative change in S&P volatility is expected. As in the other three cases above, the S&P results fail to accept the *one-for-one* spread-volatility relationship. Similar to the HSI case, the short and medium maturity yield spread seems to possess useful information about cumulative change in stock volatility.

3.10.2 The three hypotheses

Summarizing all the results presented above, we arrive at several conclusions which are classified according to Fisher effect, economic reasons or the business leverage effect. We shall present them according to the three hypotheses this paper sets out to test.

3.10.2.1 1) One-for-one movements between yield spread and volatility for the

whole maturity spectrum

For Model 1A – static model:

$$H_0^{S1} : \hat{a}_1^{6-3} = \hat{a}_1^{12-3} = \hat{a}_1^{24-3} = \hat{a}_1^{60-3} = \hat{a}_1^{120-3} = 1 \qquad \text{vs.}$$

$$H_1^{S1} : \hat{a}_1^{6-3} = \hat{a}_1^{12-3} = \hat{a}_1^{24-3} = \hat{a}_1^{60-3} = \hat{a}_1^{120-3} \neq 1.$$

For Model 1B – dynamic model:

$$H_0^{D1} : \hat{b}_2^{6-3} = \hat{b}_2^{12-3} = \hat{b}_2^{24-3} = \hat{b}_2^{60-3} = \hat{b}_2^{120-3} = 1 \qquad \text{vs.}$$

$$H_1^{D1} : \hat{b}_2^{6-3} = \hat{b}_2^{12-3} = \hat{b}_2^{24-3} = \hat{b}_2^{60-3} = \hat{b}_2^{120-3} \neq 1.$$

Firstly, we fail to accept the hypothesis that the U.S. yield spread of all maturity spectrums has a *one-for-one* relationship with cumulative change in stock market volatility. Except for the FTSE, in which a statistically significant $\hat{a}_1$ or $\hat{b}_2$ of value equal to one at 10 per cent critical level has been found in seven occasions (approximately 22 per cent of all significant cases): 6-3, 3 and 4 months ahead, 12-3, 2 and 3 months ahead, 24-3, 1 and 2 months ahead and finally 60-3, 1 month ahead. Nonetheless, the remaining 78 per cent of the significant estimated spread coefficients reject the null hypothesis. Our failure to find supporting evidence for the *one-for-one* relationship leads us to believe that we should look into alternative explanations such as the business leverage effect to account for the event. Alternatively we also question the assumption of a constant real rate of interest in the Fisher hypothesis. The Fisher hypothesis states clearly that under an efficient capital market, the one period nominal interest rate equals to the real rate plus the fully anticipated inflation rate. Figures 3-7.1 to 3-7.6 depict six classes of real interest rates and they evidently show that the assumption of a constant real interest rate cannot be maintained. Given this fact, our empirical result seems to indicate that the efficient market hypothesis is rejected. However, instead of directly rejecting the efficient market

hypothesis, we offer the following discussions to gain further understanding of the situation:

In equation (3.28) we presented the Fisher hypothesis as $nr_{t+1} = rr + E_t(\pi_{t+1} \mid \Theta_t)$. In equation (3.13) we show that the long rate of a *two*-period bond can be written as $R_t^2 = \theta + \frac{1}{2}(r_t^1 + E_t r_{t+1}^1)$, while (3.17) says the yield spread can be measured according to $Spd_t^{(n,1)} = R_t^n - r_t^1$. For simplicity, let us consider a two-period case with a zero risk premium term. Substituting (3.13) into (3.17) we have,

$$\begin{aligned} Spd_t^{(2,1)} &= \frac{1}{2}(r_t^1 + E_t r_{t+1}^1) - r_t^1 \\ &= \frac{1}{2}(E_t r_{t+1}^1 - r_t^1) \end{aligned} \tag{3.31}$$

Substituting the Fisher equation into (3.31), we have,

$$Spd_t^{(2,1)} = \frac{1}{2}(E_t rr_{t+1}^1 + E_t \pi_{t+1} - rr_t - \pi_t) \tag{3.32}$$

Rearranging (3.32) gives us,

$$Spd_t^{(2,1)} = \frac{1}{2}(E_t rr_{t+1}^1 - rr_t) + \frac{1}{2}(E_r \pi_{t+1} - \pi_t) \tag{3.33}$$

The above decomposition of the spread according to the Fisher hypothesis gives rise to three possible scenarios:

1) If the real interest rates in both periods are constant and equal *i.e.* $E_t rr_{t+1}^1 = rr_t^1$, then,

$$Spd_t^{(2,1)} = \frac{1}{2}(E_t \pi_{t+1} - \pi_t)$$

This implies that given the current observed inflation rate, the change in the spread is positively related to expectations form on next period inflation rate $E_t\pi_{t+1}$ (future interest rate). This is precisely the assumption that we impose on our first hypothesis.

2) If the real rates in both periods are equal *i.e.* $E_t rr^1_{t+1} = rr^1_t$, but not constant, then the result of 1) still holds *viz.* the yield spread is related to future inflation rate.

3) If the real interest rates are not equal and are not constant, then changes in either $E_t rr_{t+1}$ or $E_t\pi_{t+1}$ will have an effect on the spread.

Our empirical results clearly show that we fail to observe a *one-for-one* relationship between the U.S. yield spread and cumulative change in stock volatility. This indicates that we are likely facing the third scenario in which the real rate of interest is not constant over time or in other words the capital market is not efficient enough to maintain a constant real interest rate. In this case, either the change in real interest rate or change in inflation expectation, or even both could explain movements in the yield spread. Nonetheless, our first hypothesis of a *one-for-one* is built on sound economic theory and previous empirical results, hence, this exercise of hypothesis testing remains beneficial to the study of the yield spread. Furthermore, it is equally likely that we could be facing the second scenario of an equal but not constant real rate of interest. Unfortunately, since $E_t rr_{t+1}$ is an *ex ante* variable that we cannot observe at time t and also given the limited scope of this paper, we shall end our discussion of this issue at this juncture.

As shown in Tables 3-8.1 to 3-8.4, our finding favours the acceptance of the alternative hypothesis. Though surprising, is nevertheless consistent with previous studies such as Fama and Schwert (1977). When they regress monthly stock returns on the consumer price index, the estimated coefficient is significantly negative, which is contrary to the original null hypothesis. Taking the case of an inverted yield curve that is falling interest rate signifies a forthcoming recession in the U.S. Given the high degree of trade openness among the developed countries, a U.S. recession reduces the demand for foreign

imports thus hurting the revenue of firms that are heavily engaged in exports. This negative effect will be reflected in the price and return of these companies' stocks, hence, extra stock volatility will be cumulated. This is a likely circumstance that will prevail in the business world, therefore a positive U.S. yield spread effect is frequently assumed.[52] However, as our empirical results indicate a negative spread coefficient is also a likely result, we will attempt to offer a probable explanation to this observation.

In line with previous empirical findings, we are not the first to find a negative spread coefficient. In two papers that are very similar to ours in spirit, Fama and Schwert (1977) and Zhou (1996), both find a negative relationship between stock returns and inflation, and stock returns and yield spread respectively. Unfortunately, Zhou (1996) offers no account for the finding. In this paper however, we assert that investor confidence may play an important role in our negative spread-volatility relationship. For example when Japanese investors observe a falling U.S. interest rate with an expected subsequent economic slowdown, this creates uncertainty about the condition of the U.S. economy. At the same time, the Japanese economy looks relatively more stable than the U.S., hence confidence in the domestic stock market increases and Japanese stock volatility decreases. As for the S&P case, we believe that although faced with a possible economic slowdown, a falling interest rate may indicate the willingness of the U.S. government in taking remedial action for the weakening economy, hence investor confidence may be supported thus less stock volatility results. With the existence of a mixture of both positive and negative empirical finding of the relationship between interest rate and stock returns or stock volatility, and we consider that the two different situations that lead to opposite results are both likely phenomena in the real world, it is therefore our original intention not to impose a positive relationship in our first hypothesis. The investor confidence effect scenario could possibly explain our estimation result for both the Nikkei and S&P cases, while the HSI and FTSE results are more aptly accounted by the adverse firm profitability effect.

We believe that in general, stock investors appear to be equally sensitive to economic uncertainty and the real returns effect by actually weighing up the

[52] This more practical explanation is in addition to the conventional Fisher effect analysis.

appreciation/depreciation in the real returns via the Fisher effect. Therefore, we maintain that the change in stock volatility could either be due to investors' reaction to ensuring economic uncertainty or a simple compensation effect working through the Fisher hypothesis.

One additional remark of our empirical result that is not explicitly tested in the first hypothesis is the disparate degree of predictive power amongst the five spread maturities. Based on the analysis of the economic activity effect, the spread-volatility relationship exists because investors are making use of the information about future economic activity contained in the yield spread, thus adjusting their investment portfolio accordingly. Previously equation (3.12) indicates the long rate is just the average of all future expected short rates *vis-à-vis* movements of future short rates, which implies the 6-3 spread should contain information about economic outlook for the next six months, while the 120-3 spread tells us what the economy would prevail for the next ten years. Naturally, making predictions about a shorter horizon should be more accurate or at least hold fewer errors than forecasting for a long horizon. In other words, accuracy of information embedded in the yield spread deteriorates as maturity lengthens. Based on this line of reasoning, we are not surprised to see a stronger spread-volatility effect for the short to medium maturity spectrum than for the long maturity spectrum of five and ten years.

3.10.2.2 Homogeneous reaction to change in U.S. yield spread

For Model 1A – static model:

$$H_0^{S2}: \hat{a}_1^{HSI} = \hat{a}_1^{Nikkei} = \hat{a}_1^{FTSE} = \hat{a}_1^{S\&P} \quad \text{vs.} \quad H_1^{S2}: \hat{a}_1^{HSI} \neq \hat{a}_1^{Nikkei} \neq \hat{a}_1^{FTSE} \neq \hat{a}_1^{S\&P}.$$

For Model 1B – dynamic model:

$$H_0^{D2}: \hat{b}_2^{HSI} = \hat{b}_2^{Nikkei} = \hat{b}_2^{FTSE} = \hat{b}_2^{S\&P} \quad \text{vs.} \quad H_1^{D2}: \hat{b}_2^{HSI} \neq \hat{b}_2^{Nikkei} \neq \hat{b}_2^{FTSE} \neq \hat{b}_2^{S\&P}$$

At the outset, one would expect that the U.S. stock market should react to changes in U.S. interest rates more intensely than the other three international stock markets.

However, this paper finds evidence to support otherwise, and we fail to accept the null hypothesis of equal spread coefficient for all four countries. Tables 3-7.1 and 3-7.2 illustrate clearly that on average the magnitude of $\hat{a}_1^{FTSE}$ / $\hat{b}_2^{FTSE}$ exceeds the other three markets' spread coefficient, in particular for the short to medium maturity spectrum at one to two months ahead by a substantial margin. For the London case, we believe that one of the probable causes for this situation is due to the competition for investment funds between the U.K. and the U.S.. It has been a long tradition that London and New York are the two most important financial centers of the world. Given the idea of capital mobility, with huge amounts of capital ('hot money') shifting between these two places to seek the highest investment returns, it is not difficult to see that when the U.S. is expecting an economic downturn, much of this capital will flow from New York to London, thus creating additional change in stock market volatility in FTSE.

As mentioned above, we fail to find a more intense U.S. stock market reaction to its domestic future interest rate and economic condition. In addition to the investor confidence effect that we have discussed, we offer one more probable reason. With very comprehensive media coverage on both economic and financial news, it is likely that U.S. investors are using much more information and economic statistics such as unemployment rate, tax incentives, domestic and foreign demand etc., to evaluate their investment opportunities. Should it be the case, the immediate response to movements of future interest rates would not be as pronounced as we first expected, and the action of switching out of stock investment would also be limited.

Previously in our discussion of the business leverage effect, we said that an inverted yield curve or a negative yield spread could lead to three equally possible outcomes of stock volatility changes. When we observe a negative spread-volatility relationship such as the cases of the Nikkei and to a lesser degree of the S&P, it could be explained by the low level of *OL* that existed in the majority of firms in that country. The second scenario depicts exactly our above claim. If this is the accurate situation, then a falling yield creates concern over the profitability of firms and eventually causes a rising volatility of the stock return. We do not know precisely *a priori* the composition of firms with either of these two categories, *i.e.* low *OL* and high *OL* of each individual country.

However, we postulate that because of the different degree of effects that each type of firm receives from a change in U.S. yield spread in time, it is more or less impossible to obtain a *one-for-one* relationship for the whole stock market at all times. However, our business leverage effect hypothesis does offer us information about the magnitude of the spread effect. For negative yield spread effect which is the consequence of increased investors' confidence, we do not think it appropriate to use the business leverage effect to add further explanation. However, for positive cases of yield spread effects such as the empirical results of HSI and FTSE, the business leverage effect could offer robust support to the magnitude of our results. According to the business leverage effect hypothesis, the degree of the level of *OL* existing firms in the economy denotes the extent of the spread effect to a country. Our results show that the magnitude of the spread coefficient of the FTSE is generally above those of the HSI, this serves a good indication that there must be more firms with high *OL* in the U.K. than those in Hong Kong. Hong Kong being a relatively much smaller economy than the U.K., the assumption of having more high *OL* possibly export-oriented large firms in the U.K. than in Hong Kong is indeed a reasonable one. Therefore, when the U.S. economic slowdown is expected, stronger adverse effects on the U.K. economy and its stock volatility is a logical result.

In summary, our business leverage effect implies that in general we should expect a positive relationship, *viz.* falling interest rate (recession) and rising stock volatility, between U.S. spread and change in stock market volatility in particular if high *OL* export firms dominate the local country. In other words, if a country exports substantially to the U.S., a U.S. recession certainly means bad news as returns of those exporting companies will be reduced. The profit reduction will lead to a drop in their stock prices, hence, a bigger change in stock volatility. Half of our estimation results support this hypothesis: the U.K. and to a lesser extent Hong Kong.

3.10.2.3 Persistence of effect up to 12 months ahead

$$H_0^{S3}: \hat{a}_1^{1m} = \hat{a}_1^{2m} = \hat{a}_1^{3m} =,\ldots,= \hat{a}_1^{12m} \quad \text{vs.} \quad H_1^{S3}: \hat{a}_2^{1m} \neq \hat{a}_1^{2m} \neq \hat{a}_1^{3m} \neq,\ldots,\neq \hat{a}_1^{12m}$$

$$H_0^{D3}: \hat{b}_2^{1m} = \hat{b}_2^{2m} = \hat{b}_2^{3m} =,\ldots,= \hat{b}_2^{12m} \quad \text{vs.} \quad H_1^{D3}: \hat{b}_2^{1m} \neq \hat{b}_2^{2m} \neq \hat{b}_2^{3m} \neq,\ldots,\neq \hat{b}_2^{12m}$$

The results for the test of the hypothesis of spread-volatility persistence show that we fail to accept the hypothesis. The strongest case for a persistent relationship[53] comes from the FTSE 24-3 spread case, which lasts up to eleven months ahead. The FTSE study also suggests that most of the U.S. spread information appears in the first three or four months. Beyond that, it decays slowly and completely disappears by the twelfth month. Examination of the Nikkei results provides a dissimilar picture. The U.S. spread seems to contain useful information about the change in stock market volatility after a lag of at about two months, then this usefulness appears at a decreasing scale as the horizon extends. Information plays a crucial part in stock market volatility. It is commonly known that stock market participants trade because of the arrival of new information. As the same set of information is being used to forecast activities over a long horizon, forecast errors increase. Therefore, it is not surprising to see how the effect of the U.S. yield spread on stock market volatility diminishes over time. However, except for the FTSE case, it is rather surprising to see a lag of a couple of months before the stock market reacts to information about movements of the U.S. economy. This observation should motivate research that will lead to a more thorough and better understanding of the micro dynamics of the spread-volatility relationship.

3.11 Decomposition of Yield Spread

3.11.1 Model specifications and estimation procedure

Our previous empirical analysis relies heavily on the existence of yield spread and the future economic condition relationship to account for the change in stock market volatility. Under the rational expectations model presented by equation (3.11), we see that the yield spread is determined by investors' expectation of future short rates plus a risk term premium. Since the formulation of the yield spread comprises these two terms, the

[53] This is also the case with the most consistent spread-volatility relationship.

relationship between the yield spread and future economic condition could be derived from either the yield spread's role as a signal of future expected short rates (expectation effect) or as a signal of the change in the risk premium term (risk premium effect). In other words, we are interested to find out whether financial market participants are using and reacting to changes in future short rates as an indicator of future economic activities or if the risk premium term plays a more important role in their investment decisions. To investigate this, we shall decompose the yield spread into two noted components accordingly.

Assuming the risk premium term θ to be time-varying, we can write the long rate as: [54]

$$R_t^n = \theta_t + \frac{1}{n}\sum_{j=0}^{n-1}(E_t r_{t+j}^1) \tag{3.34}$$

Equivalently,
$$\theta_t = R_t^n - \frac{1}{n}\sum_{j=0}^{n-1}(E_t r_{t+j}^1) \tag{3.35}$$

Subtracting r_t^1 on both sides of (3.34) and rearrange, we have

$$\left(R_t^n - r_t^1\right) = \left(\frac{1}{n}\sum_{j=0}^{n-1} E_t r_{t+j}^1 - r_t^1\right) + \theta_t \ . \tag{3.36}$$

Substituting (3.35) into (3.36), we have

$$\left(R_t^n - r_t^1\right) = \left(\frac{1}{n}\sum_{j=0}^{n-1} E_t r_{t+j}^1 - r_t^1\right) + \left(R_t^n - \frac{1}{n}\sum_{j=0}^{n-1} E_t r_{t+j}^1\right), \tag{3.37}$$

where the left hand side is just the yield spread, the first term on the right hand side represents the difference between expected future short rates averaged over n period and current short rate, and the second term contains the time-varying risk premium. This risk

[54] Same as equation (3.11) that we showed earlier except θ is now time varying.

premium term is essentially reflecting in part the risk of alternative investments that are available for investor consideration. From equation (3.37) we can see that if there is a fall in the spread it could be due to either the current short rate being higher than expected future short rates or a fall in the risk premium on long bonds relative to the long rate, or even both terms changing at the same time. Upon the decomposition of the yield spread, we set up the appropriate general regression model according to the following procedures:

$$CCV_t^k = c_0 + c_1\left(\frac{1}{n}\sum_{j=0}^{n-1}E_t r_{t+j}^1 - r_t^1\right) + c_2\left(R_t^n - \frac{1}{n}\sum_{j=0}^{n-1}E_t r_{t+j}^1\right) + \upsilon_t \tag{3.38}$$

Let $\omega_{t+n} = \frac{1}{n}\sum_{j=0}^{n-1} r_{t+j}^1 - \frac{1}{n}\sum_{j=0}^{n-1} E_t r_{t+j}^1$ denote the forecasting error in future short rates, then (3.38) can be written as Model 2A (static model):

$$CCV_t^k = c_0 + c_1\left(\frac{1}{n}\sum_{j=0}^{n-1}r_{t+j}^1 - r_t^1\right) + c_2\left(R_t^n - \frac{1}{n}\sum_{j=0}^{n-1}r_{t+j}^1\right) + e_t \tag{3.39}$$

where $e_t = \upsilon_t + (c_2 - c_1)\omega_{t+n}$.

Since our model includes variables that are not observable at time t but based on expectations, applying the simple OLS will give us the well-known errors-in-variables problem. Under rational expectations, the error term e_t should be uncorrelated with any variables known at time t, thus (3.39) can be estimated by using the instrumental variable (IV) approach with any variables dated t or earlier as instruments. The basic criteria of choosing proxies for unobservable variables are that they should be highly correlated with these unobservable variables but are uncorrelated with the error term. The method of two-stage least squares (TSLS) is a special case of IV regression. TSLS involves two- stage least squares. In the first stage, it finds the endogenous and exogenous variables that can be attributed to the instruments. The second stage is a regression of the original equation, with all of the variables replaced by the fitted values from the first-stage regressions. We apply the IV method to (3.39) with a constant, R_t^n and r_t^1 as instruments.

To continue with our COMFAC approach in model selection, we also develop a second model - Model 2B (dynamic model) which is a first order autoregressive distributed lag (ADL(1)) model with the structure near identical to equation (3.30) of Model 1B as below:

$$CCV_t^k = d_0 + d_1 CCV_{t-1}^k + d_2\left(\frac{1}{n}\sum_{j=0}^{n-1} r_{t+j}^1 - r_t^1\right) + d_3\left(\frac{i}{n}\sum_{j=0}^{n-1} r_{t+j}^1 - r_t^1\right)_{t-1} + d_4\left(R_t^n - \frac{1}{n}\sum_{j=0}^{n-1} r_{t+j}^1\right) + d_5\left(R_t^n - \frac{1}{n}\sum_{j=0}^{n-1} r_{t+j}^1\right)_{t-1} + v_t \quad (3.40)$$

Once again, to utilize this COMFAC approach in our estimation of the spread decomposed models, we pursue the search for the correct estimation model to all of our 480 possible regression models through the following steps:

1. Run TSLS IV regression on equation (3.39). Use the Breusch-Godfrey Serial Correlation LM test to detect the existence of serial correlation.

2. If serial correlation is found, run IV on (3.40).

3. Using the Wald-Test, test restrictions of $d_3 = -d_1 d_2$ and $d_5 = -d_1 d_4$.

4. If restriction is valid, use Model 2A for regression with an AR(1) process to take into account of the presence of first order serial correlation.

5. If restrictions are proved invalid, estimate dynamic model of 2B instead.

Tables 3-9.1 and 3-9.2 list the results of our COMFAC search for the appropriate model between equations (3.39) and (3.40). Evidently, once again the AR(1) Model of 2A fits well with the majority of our regression models, in particular for the Nikkei, FTSE and S&P. HSI is the only market that shows a somewhat stronger validity of using the dynamic model of 2B. Again, the frequent appearance of the dynamic model in the short

to medium spread spectrum such as 6-3, 12-3 and 24-3 reflects the different dynamic structure that exists in these maturity spectrums.

This process of decomposing the yield spread provides us with two important beneficial insights into our study of the U.S. spot yield spread on international stock market volatility. Firstly, when the yield spread is decomposed into the expected change in future short rates and the risk premium term, we can capture the respective statistical significance of each component in our overall analysis. Secondly, through the Wald test of the hypothesis that both slope coefficients are equal, we can identify the difference of individual contribution to cumulative change in stock volatility.

3.11.2 Estimation evidence

3.11.2.1 Hong Kong

$$H_0 : \hat{c}_1^{HSI} / \hat{d}_2^{HSI} = \hat{c}_2^{HSI} / \hat{d}_4^{HSI} \text{ vs. } H_1 : \hat{c}_1^{HSI} / \hat{d}_2^{HSI} \neq \hat{c}_2^{HSI} / \hat{d}_4^{HSI}$$

Table 3-10.1 shows the Wald test results of those significant coefficients for the HSI under the H_0 of equal coefficients, while Tables 3-11.1 and 3-11.2 present detailed IV estimation results of our model. The two slope coefficients show an even mixture of both positive and negative terms together with inconclusive Wald Test results. We reject the null hypothesis of equal slope coefficients at 5 per cent critical level in 4 out of 6 cases (approximately 67 per cent). Nonetheless, for all of the significant coefficients both the future expected change of short rates and risk premium term carry the same sign. Hence, though they may not be equal in magnitude, they do contribute to the cumulative change of HSI volatility in the same manner. When we study the figures in these two tables, we note that the values of $\hat{c}_1 / \hat{d}_2$ are always greater than $\hat{c}_2 / \hat{d}_4$. Therefore, we acknowledge that future expected change of the U.S. short rates has a bigger contribution than that of the risk term premium to the cumulative change of stock volatility in Hong Kong. Based on these results, we believe that the principal reason for the U.S. yield spread containing information about the cumulative change of the Hong Kong stock market volatility is

through investors' expectations of future U.S. inflation via observing the movements in the future expected change of short rates.

3.11.2.2 *Japan*

$$H_0 : \hat{c}_1^{Nikkei} / \hat{d}_2^{Nikkei} = \hat{c}_2^{Nikkei} / \hat{d}_4^{Nikkei} \text{ vs. } H_1 : \hat{c}_1^{Nikkei} / \hat{d}_2^{Nikkei} \neq \hat{c}_2^{Nikkei} / \hat{d}_4^{Nikkei}$$

The Nikkei market provides us with some interesting results (Tables 3-10.2, 3-12.1 and 3-12.2). The Wald test result summary in Table 3-10.2 tells us that the overall negative slope coefficients are in agreement with our previous results of Table 3-7.1. As indicated by the Wald test, the majority of the coefficients are not equal at the 5 per cent significance level. A further inspection of Tables 3-12.1 and 3-12.2 we notice that indeed $\hat{c}_1 / \hat{d}_2$ are always greater than $\hat{c}_2 / \hat{d}_4$. This indicates that movements in future expected change of U.S. short rates plays a more important role than the risk term premium to the spread-volatility relationship. Earlier in the Nikkei case, we showed that this U.S. spread effect persisted all through the twelve months horizon, yet when estimated with this IV approach according to the decomposed spread, this effect seems to disappear beyond the tenth month. Nonetheless, the main purpose of this exercise of decomposing the spread is to identify and quantify the relationship between movements in expected future short rates and the risk term premium and the role they each respectively play in our yield spread model. Although theoretically the spread can be expressed by these two terms, there may be other factors affecting the yield spread model that we used in the first instance which are not accounted for by the individual components of this decomposition. Furthermore, two different estimation methods are used in these two exercises; hence, we shall restrict our comments on the comparison of estimation results between models 1A, 1B, 2A and 2B.

3.11.2.3 *The U.K.*

$$H_0 : \hat{c}_1^{FTSE} / \hat{d}_2^{FTSE} = \hat{c}_2^{FTSE} / \hat{d}_4^{FTSE} \text{ vs. } H_1 : \hat{c}_1^{FTSE} / \hat{d}_2^{FTSE} \neq \hat{c}_2^{FTSE} / \hat{d}_4^{FTSE}$$

Table 3-10.3, Tables 3-13.1 and 3-13.2 report our FTSE Wald test of the hypothesis of equal slope coefficients and IV estimation results. Table 3-10.3 shows a very interesting pattern with positive slope coefficients appearing in the short and medium maturity spectrum of the one month ahead horizon. Beyond this horizon, all significant coefficients are negative and disperse around the short to medium yield spread spectrum and mostly occur in the longer horizons of between seven to twelve months. In general, the majority (91 per cent – 20 out of 22) of slope coefficients fail to accept the hypothesis of equal slopes. These results suggest that in the short run the expected future U.S. short rate and risk premium have a positive effect on the FTSE change in volatility, while in the longer run, this effect is reversed. In any event, figures in Tables 3-13.1 and 3-13.2 indicate that once again $\hat{c}_1 / \hat{d}_2$ is always greater than $\hat{c}_2 / \hat{d}_4$. In other words, investors in the U.K. pay more attention to the movements in U.S. future short rates than the size of risk premium, when making investment decisions in the London stock market.

3.11.2.4 The U.S.

$$H_0 : \hat{c}_1^{S\&P} / \hat{d}_2^{S\&P} = \hat{c}_2^{S\&P} / \hat{d}_4^{S\&P} \quad \text{vs.} \quad H_1 : \hat{c}_1^{S\&P} / \hat{d}_2^{S\&P} \neq \hat{c}_2^{S\&P} / \hat{d}_4^{S\&P}$$

Results for the S&P (Tables 3-10.4, Tables 3-14.1 and 3-14.2) show that the decomposed spread has a negative effect on the domestic stock market: in particular, in the medium and the long maturity spectrum. In fact, the results indicate that the stronger the maturity, the stronger the effect. We note from Tables 3-14.1 and 3-14.2 once again that movements in expected future short rates play a more influential role than the risk premium in explaining the effect of yield spread on cumulative change in stock market volatility.

Synthesizing all the estimation results presented above, first we see that both the expected change of future short rate and the time-vary risk premium term contain information about the cumulative change in stock market volatility. Secondly, we also identify the factor that contributes most to the spread-volatility relationship. In other words, the expectation effect is stronger than the risk premium effect in all the four countries that we study. The estimates presented in Tables 3-11.1 to 3-14.2,

overwhelmingly confirm that the most important reason that the U.S. yield spread affects the cumulative change in stock market volatility both in the U.S. and the other three international stock markets is that a falling spread implies falling future U.S. short rates, thus causing a revision of investors stock investment decisions. This exercise offers us additional beneficial insight into the functional aspect of the association between the U.S. yield spread and the cumulative change in stock market volatility.

3.12 Concluding Remarks

In this paper, we choose to focus our study of the U.S. yield spread on four international stock markets. We expect that the U.S. yield spread contains important information about future economic activities of the U.S. And if this information content exists, it will certainly provide many investors, both individual and institutional, with a good gauge on their portfolio allocation situation. Furthermore, instead of the presumption of a strong U.S. economic influence on the global economy and the usual over-emphasis about this influence that tends to be placed by the media or even the so called "analysts" on economic affairs, empirical findings of this paper should facilitate a more accurate assessment for the four (three foreign plus U.S.) individual countries that we studied. Overall empirical results of this paper indicate that the term 'over-emphasis' is a fairly accurate description of the real situation.

Figures 3-8.1 and 3-8.2 display graphically our major estimation results. These two figures help to provide visual answers to our three hypotheses. Firstly, we fail to see 100 per cent of the spread-volatility relationship, so for the four countries we reject the hypothesis of a *one-for-one* spread-volatility movement. Secondly, the extent of influence of the U.S. yield spread on both domestic and overseas stock markets are not equal. In fact, when we rank these influences, a certain position comes up in which the U.K. leads Japan, followed by the U.S. and then Hong Kong. And lastly, in terms of the persistence of this information content, a very ambiguous picture emerges. The two countries that were shown to have the strongest U.S. yield spread effect also demonstrate different degrees of effect persistence. After a lag of about two to three months, the Japanese case seems to be able to maintain a longer spread effect. However, the U.K. case demonstrates a more

immediate U.S. yield spread effect that decays slowly and mostly disappears beyond the ninth month.

The other issue also tested under the first hypothesis is whether the yield spread contains any information about change in stock volatility through all the maturity spectrums. Comparing each spread coefficient according to maturity, our estimation results certainly suggest that this strength of the spread effect varies from country to country. For the U.K. and Japan, this spread-volatility relationship seems to appear all over the spectrum. For the other two countries, Hong Kong and the U.S., we only find very weak evidence to support this spread effect in most of the maturity spectrums. Nonetheless, adding all these results together, we assert that the effect of the U.S. yield spread has a tendency to cluster around the short to medium maturities of 6, 12 and 24 months.

In harmony with previous studies, this paper fails to find overwhelming evidence to support the expectations hypothesis, that is movements in interest rate contains information about future inflation, economic growth and changes in stock returns, in particular for the local U.S. stock market. What the U.S. result tells us is that perhaps there exist other factors in the economy, which exert stronger influence on the fluctuations of the stock market. Numerous studies have sought to find possible contributing factors to stock market volatility. This paper approaches the subject from a different approach. We handle the problem from a broad, a multi-country, multi-spectrum, and multi-horizon prospective. In addition to our interesting empirical finding of the subject, this paper also aims to function as a symposium of all existing research on stock market volatility and movement of the yield spread.

Many economic studies of the term structure of interest rates or yield spread have focused on its relationship with other macroeconomic variables such as the GDP growth and inflation (Hamilton and Kim (2000), Estrella and Hardouvelis (1991), Kozichk (1997), Bonser-Neal and Morley (1997) and Fama (1975)). Frequently, these studies find evidence to support the hypothesis that the yield spread contains information about future inflation movements. Empirically, this paper finds that the U.S. yield spread has direct

influence over the stock market volatility either domestically or internationally through investors' expectations on future inflation changes. Although the magnitude and direction of this U.S. interest rate impact varies from country to country, nevertheless, we believe that our results provide important implications for government policy formulation.

The most interesting and serviceable finding of this paper is the U.K. case. With the greatest magnitude of a positive spread effect, particularly in the short horizon of one to two months ahead, our estimation results show that the U.K. is the country under the strongest U.S. economic influence. We apply the business leverage effect hypothesis to account for this observation and it suggests that firm structure in the U.K. may play an essential role in the result. In proven correct, this assertion leads to a very important policy implication for the U.K. government or indeed the government of any economy which is concentrated with high *OL* firms.

Take the case of the U.K., when the U.K. authorities are faced with the need to reduce stock market volatility, in conjunction with other domestic factors such as inflation rate, unemployment rate, industrial production and so on that have been proven to have a more direct link to domestic stock volatility. Observing the movements of U.S. spot yield spread can offer additional policy tools. Our business leverage effect hypothesis implies that large automated or large fixed cost industries in the economy and the strong dependence of exports to the U.S. seem to play key roles in the extent of the U.S. spread effect. If our assessment is correct, then we believe that in order to lessen and to absorb these adverse U.S. economic effects the government should endeavour to reduce the degree of dependency on exports to the U.S. This objective can be achieved through the encouragement of domestic economic expansions while at the same time attempts to restructure local firms to meet economic fluctuations. With the benefit of being a member country of the European Union (EU), the U.K. government or any EU members has the opportunity to redirect some of its exports from the U.S. to Europe. Unfortunately, this advantage is not readily available to non-EU member countries, and for them domestic economic expansions and restructuring are two viable options to avoid a substantial U.S. negative effect whenever a U.S. economic slowdown is expected.

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Table 3-1

Meiselman's Test of the Error-Learning Model

Regression Results: Equation (3.10)

n (in years)	Constant term a_n (and its standard error)	Regression Coefficient b_n	R^2
1	0.00 (0.02)	0.703	0.906
2	0.00 (0.03)	0.526	0.752
3	-0.01 (0.04)	0.403	0.590
4	-0.03 (0.04)	0.326	0.465
5	-0.02 (0.04)	0.277	0.412
6	-0.01 (0.03)	0.233	0.391
7	-0.02 (0.03)	0.239	0.398
8	0.01 (0.03)	0.208	0.348

Source: Meiselman (1966) p. 22, Table 1, with correlation coefficient converted to coefficients of determination.

Table 3-2

U. S. Yield Spread (1979:02 – 1998:12)

Descriptive Statistics

	3 Months	6 Months	12 Months	24 Months	60 Months	120 Months
Mean	7.229	7.448	7.701	8.043	8.469	8.782
Maximum	15.999	16.511	16.345	16.145	15.696	15.065
Minimum	2.780	2.878	3.090	3.803	4.352	4.514
Std. Dev.	3.044	3.084	3.018	2.851	2.610	2.398
Kurtosis	3.398	3.255	3.007	2.813	2.577	2.416
Jarque-Bera	35.717	32.111	24.535	21.046	20.244	16.533
Observations	239	239	239	239	239	239

Note. Calculations are based on estimated monthly zero-coupon spot yields from G. R. Duffee (2001)[55]. Data are monthly data expressed in annualised percentage.

[55] Data are spliced data and extended from McCulloch and Kwon and Bliss (1993).

Table 3-3

The Predictive Power of the Spread

Dependent variable: Equation (3.16)

Period	1959-1979	1951-1958	1934-1951	1915-1933	1890-1914
Constant	-0.03	0.08	0.13	-0.11	-0.57
	(0.12)	(0.05)	(0.05)	(0.11)	(0.14)
$(R_t^n - r_t^1)$	0.46	-0.66	-0.50	0.83	1.51
	(0.37)	(0.71)	(0.22)	(0.45)	(0.18)
R^2	0.01	0.00	0.06	0.03	0.40
D.W.	1.78	1.73	1.77	1.88	2.08
s.e.	0.67	0.25	0.14	0.84	1.18

Source: Mankiw and Miron (1986).

Table 3-4.1 HSI - CCV_t^k

Augmented Dickey-Fuller Unit Root Test

k =	ADF Test Statistics
1	-9.212
2	-8.078
3	-8.218
4	-8.096
5	-11.794
6	-7.710
7	-6.881
8	-6.253
9	-6.225
10	-5.441
11	-4.845
12	-4.736

MacKinnon critical values for rejection of hypothesis of a unit root:

-3.4599 (1%); -2.8740 (5%); -2.5734 (10%)

Lagged Difference: 4

Table 3-4.2 Nikkei - CCV_t^k

Augmented Dickey-Fuller Unit Root Test

k =	ADF Test Statistics
1	-10.368
2	-8.308
3	-7.607
4	-7.107
5	-10.604
6	-7.091
7	-6.287
8	-5.458
9	-5.361
10	-5.342
11	-5.244
12	-5.093

MacKinnon critical values for rejection of hypothesis of a unit root:

-3.4599 (1%); -2.8740 (5%); -2.5734 (10%)

Lagged Difference: 4

Table 3-4.3 FTSE - CCV_t^k

Augmented Dickey-Fuller Unit Root Test

k =	ADF Test Statistics
1	-11.222
2	-8.946
3	-10.161
4	-9.209
5	-11.738
6	-5.770
7	-5.949
8	-5.680
9	-5.610
10	-5.567
11	-5.858
12	-5.523

MacKinnon critical values for rejection of hypothesis of a unit root:

-3.4599 (1%); -2.8740 (5%); -2.5734 (10%)

Lagged Difference: 4

Table 3-4.4 S&P - CCV_t^k

Augmented Dickey-Fuller Unit Root Test

k =	ADF Test Statistics
1	-10.733
2	-8.900
3	-7.249
4	-7.900
5	-10.261
6	-6.235
7	-5.858
8	-5.323
9	-4.805
10	-5.230
11	-5.192
12	-5.027

MacKinnon critical values for rejection of hypothesis of a unit root:

-3.4599 (1%); -2.8740 (5%); -2.5734 (10%)

Lagged Difference: 4

Table 3-5 U.S. Spot Yield Spread

Augmented Dickey-Fuller Unit Root Test

Series	ADF Test Statistics
6-3 Spread	-3.819
12-3 Spread	-3.800
24-3 Spread	-7.935
60-3 Spread	-8.227
120-3 Spread	-7.948

MacKinnon critical values for rejection of hypothesis of a unit root:

-3.4599 (1%); -2.8740 (5%); -2.5734 (10%)

Lagged Difference: 4

Table 3-6.1

COMFAC Approach – Model Selection

Static (S) : $CCV_t^k = a_0 + a_1 Spd_t + \varepsilon_t$ **[AR(1)]**

Dynamic (D): $CCV_t^k = b_0 + b_1 CCV_{t-1}^k + b_2 Spd_t + b_3 Spd_{t-1} + u_t$ **[ADL(1)]**

HSI

Spread	1	2	3	4	5	6	7	8	9	10	11	12
120-3	S	S	S	S	S	S	S	S	S	S	S	S
60-3	S	S	S	S	S	S	S	S	S	S	S	S
24-3	S	S	S	S	S	S	S	S	S	S	S	S
12-3	S	S	D	D	S	D	D	D	S	D	S	S
6-3	S	S	D	D	S	D	S	D	D	S	S	S
	Months ahead											

Nikkei

Spread	1	2	3	4	5	6	7	8	9	10	11	12
120-3	S	S	S	S	S	S	S	S	S	S	S	S
60-3	S	S	S	S	S	S	S	S	S	S	S	S
24-3	S	S	S	S	S	S	S	D	D	S	S	S
12-3	S	S	S	S	S	S	S	S	S	S	S	S
6-3	S	S	S	S	S	S	S	S	S	S	S	S
	Months ahead											

Table 3-6.2

COMFAC Approach – Model Selection

Static (S) : $CCV_t^k = a_0 + a_1 Spd_t + \varepsilon_t$ **[AR(1)]**

Dynamic (D): $CCV_t^k = b_0 + b_1 CCV_{t-1}^k + b_2 Spd_t + b_3 Spd_{t-1} + u_t$ **[ADL(1)]**

FTSE

Spread	1	2	3	4	5	6	7	8	9	10	11	12
120-3	S	S	S	S	S	S	S	S	S	S	S	D
60-3	S	S	S	S	S	S	S	S	S	S	S	D
24-3	S	D	S	D	S	S	D	S	S	S	D	D
12-3	D	D	D	D	S	D	D	D	D	D	S*	S
6-3	D	S	D	D	S	S	S	D	D	D	D	D
Months ahead												

S&P

Spread	1	2	3	4	5	6	7	8	9	10	11	12
120-3	S	S	S	S	S	S	S	S	S	S	S	S
60-3	S	S	S	S	S	S	S	S	S	S	S	S
24-3	S	S	S	S	S	S	S	S	S	S	S	S
12-3	S	S	S	S	S	D	D	D	S	S	S	S
6-3	S	S	S	S	S	D	D	S	S	S	S	S
Months ahead												

* Denotes the basic static model that is free of serial correlation thus it is estimated without an AR(1) disturbance term.

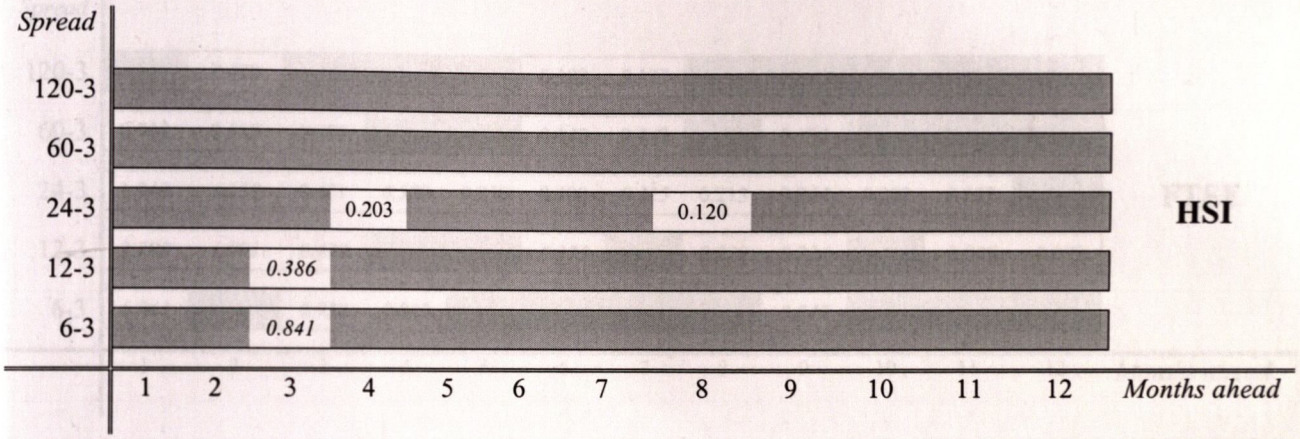
Table 3-7.1

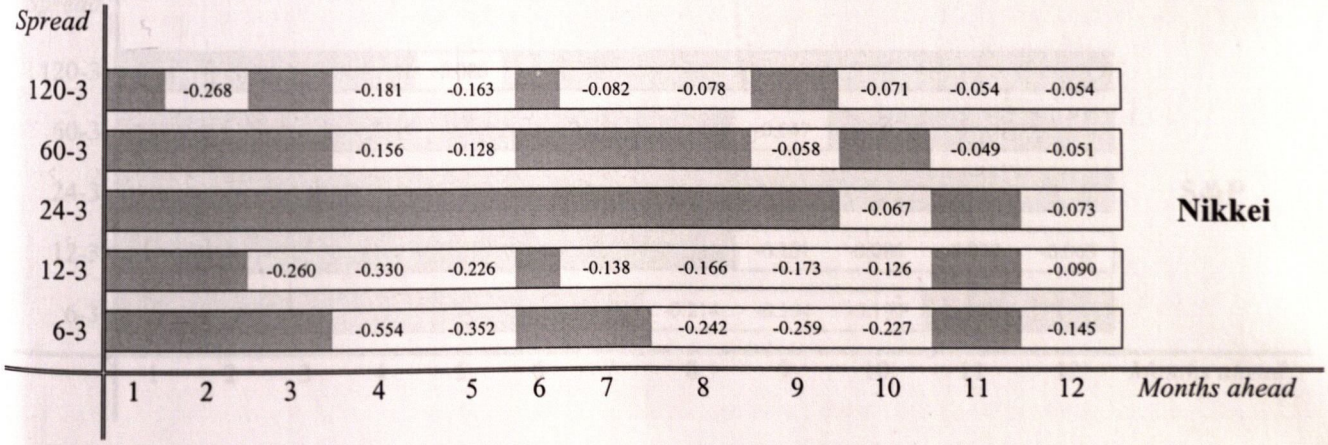
Summary of Regression Results:

Effects of the U.S. Spot Yield Spread on Change of Stock Volatility

Static (S) : $CCV_t^k = a_0 + a_1 Spd_t + \varepsilon_t$ [AR(1)]

Dynamic (D): $CCV_t^k = b_0 + b_1 CCV_{t-1} + b_2 Spd_t + b_3 Spd_{t-1} + u_t$ [ADL(1)]





Note: Sign and size of statistically significant estimation results at 10% level of the spread coefficients $\hat{a}_1$ and $\hat{b}_2$. Spread coefficients for dynamic models are shown in italics.

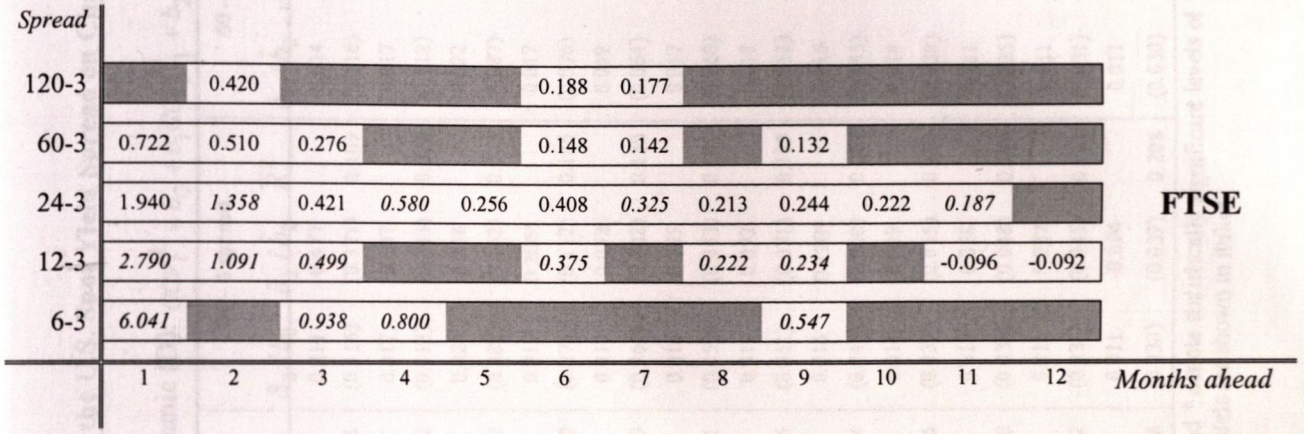
Table 3-7.2

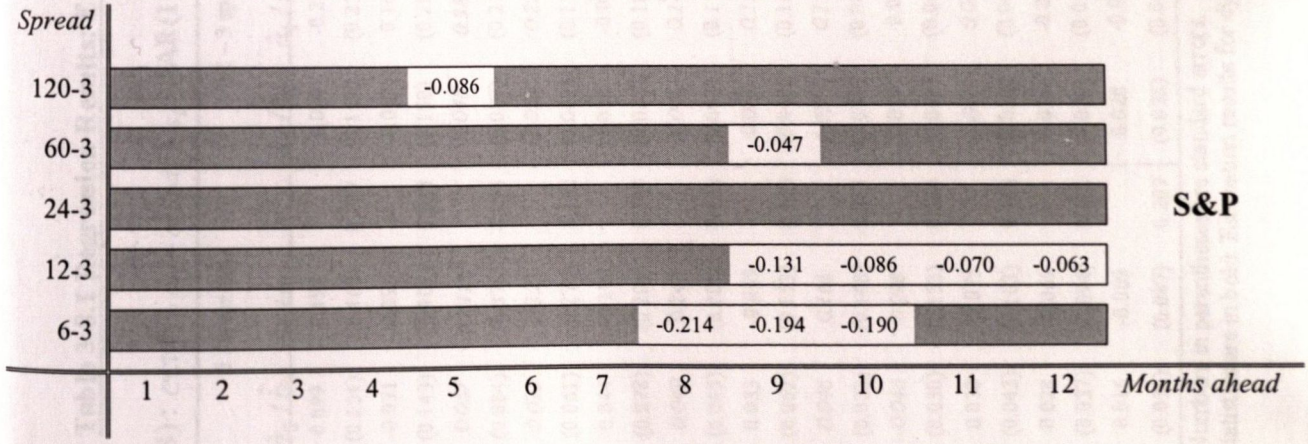
Summary of Regression Results:

Effects of the U.S. Spot Yield Spread on Change of Stock Volatility

Static (S) : $CCV_t^k = a_0 + a_1 Spd_t + \varepsilon_t$ [AR(1)]

Dynamic (D): $CCV_t^k = b_0 + b_1 CCV_{t-1} + b_2 Spd_t + b_3 Spd_{t-1} + u_t$ [ADL(1)]





Note: Sign and size of statistically significant estimation results at 10% level of the spread coefficients $\hat{a}_1$ and $\hat{b}_2$. Spread coefficients for dynamic models are shown in italics.

Table 3-8.1 Regression Results: Effects of the U.S. Spot Yield Spread on Change in HSI Volatility

Static (S): $CCV_t^k = a_0 + a_1 Spd_t + \varepsilon_t$ [AR(1)] Dynamic (D): $CCV_t^k = b_0 + b_1 CCV_{t-1}^k + b_2 Spd_t + b_3 Spd_{t-1} + u_t$ [ADL(1)]

k (months ahead)	6 - 3 spread			12 – 3 spread			24 – 3 spread			60 – 3 spread			120 – 3 spread		
	$\hat{a}_0/\hat{b}_0$	$\hat{a}_1/\hat{b}_2$	$\overline{R}^2$	$\hat{a}_0/\hat{b}_0$	$\hat{a}_1/\hat{b}_2$	$\overline{R}^2$	$\hat{a}_0/\hat{b}_0$	$\hat{a}_1/\hat{b}_2$	$\overline{R}^2$	$\hat{a}_0/\hat{b}_0$	$\hat{a}_1/\hat{b}_2$	$\overline{R}^2$	$\hat{a}_0/\hat{b}_0$	$\hat{a}_1/\hat{b}_2$	$\overline{R}^2$
1	0.099	0.499		-0.084	-0.201		0.014	0.477		0.014	-0.012		0.015	-0.059	
	(0.154)	(0.460)	0.107	(0.159)	(0.230)	0.105	(0.116)	(0.371)	0.109	(0.116)	(0.274)	0.103	(0.116)	(0.256)	0.103
2	-0.071	0.391		-0.062	0.161		0.017	0.307		0.017	0.009		0.018	-0.059	
	(0.143)	(0.406)	0.023	(0.150)	(0.208)	0.022	(0.112)	(0.243)	0.026	(0.112)	(0.169)	0.019	(0.112)	(0.171)	0.020
3	*0.057*	***0.841***		*0.048*	***0.386****		0.021	0.218		0.022	0.027		0.022	0.047	
	(0.084)	(0.378)	0.094	(0.087)	(0.219)	0.082	(0.087)	(0.162)	0.075	(0.087)	(0.111)	0.068	(0.088)	(0.115)	0.068
4	*0.073*	*0.292*		*0.059*	*0.227*		0.017	**0.203***		0.017	0.032		0.017	0.032	
	(0.061)	(0.276)	0.162	(0.063)	(0.159)	0.160	(0.076)	(0.113)	0.166	(0.076)	(0.077)	0.155	(0.077)	(0.081)	0.155
5	0.044	-0.100		0.033	-0.023		0.019	0.052		0.019	-0.022		0.019	-0.053	
	(0.078)	(0.204)	0.129	(0.082)	(0.108)	0.129	(0.064)	(0.102)	0.130	(0.064)	(0.069)	0.129	(0.065)	(0.072)	0.131
6	*0.049*	*0.243*		*0.048*	*0.144*		0.016	0.135		0.017	0.006		0.017	0.028	
	(0.045)	(0.201)	0.193	(0.047)	(0.116)	0.191	(0.059)	(0.083)	0.190	(0.060)	(0.056)	0.180	(0.059)	(0.059)	0.181
7	0.033	-0.055		*0.053*	*0.111*		0.018	0.092		0.018	-0.004		0.018	0.000	
	(0.062)	(0.153)	0.183	(0.040)	(0.100)	0.195	(0.051)	(0.071)	0.189	(0.052)	(0.048)	0.184	(0.052)	(0.051)	0.184
8	*0.046*	*0.161*		***0.057****	*0.139*		0.016	**0.120***		0.016	0.050		0.016	0.029	
	(0.033)	(0.148)	0.211	(0.034)	(0.085)	0.224	(0.045)	(0.060)	0.212	(0.045)	(0.040)	0.203	(0.045)	(0.043)	0.200
9	*0.046*	*0.088*		0.057	-0.085		0.014	0.029		0.014	-0.037		0.014	-0.020	
	(0.030)	(0.133)	0.184	(0.048)	(0.061)	0.176	(0.039)	(0.055)	0.170	(0.039)	(0.037)	0.173	(0.039)	(0.039)	0.170
10	0.030	-0.075		*0.042*	*0.048*		0.010	0.058		0.011	-0.009		0.011	-0.006	
	(0.042)	(0.103)	0.188	(0.027)	(0.067)	0.200	(0.035)	(0.048)	0.194	(0.035)	(0.032)	0.189	(0.035)	(0.034)	0.188
11	0.028	-0.069		0.036	-0.048		0.011	0.037		0.011	0.003		0.011	-0.005	
	(0.037)	(0.094)	0.161	(0.039)	(0.050)	0.162	(0.031)	(0.045)	0.161	(0.031)	(0.030)	0.159	(0.031)	(0.032)	0.159
12	0.016	-0.009		0.026	-0.024		0.011	-0.004		0.011	-0.030		0.011	-0.027	
	(0.036)	(0.087)	0.207	(0.038)	(0.046)	0.208	(0.030)	(0.039)	0.208	(0.030)	(0.026)	0.213	(0.030)	(0.028)	0.212

Numbers in parentheses are standard errors. ***, ** and * denote statistically significant levels of 1%, 5% and 10% respectively. Significant statistics are in bold. Estimation results for dynamic models are shown in italics.

Table 3-8.2 Regression Results: Effects of the U.S. Spot Yield Spread on Change in Nikkei Volatility

Static (S): $CCV_t^k = a_0 + a_1 Spd_t + \varepsilon_t$ [AR(1)] Dynamic (D): $CCV_t^k = b_0 + b_1 CCV_{t-1}^k + b_2 Spd_t + b_3 Spd_{t-1} + u_t$ [ADL(1)]

k (months ahead)	6 - 3 spread			12 – 3 spread			24 – 3 spread			60 – 3 spread			120 –3 spread		
	$\hat{a}_0/\hat{b}_0$	$\hat{a}_1/\hat{b}_2$	$\overline{R}^2$	$\hat{a}_0/\hat{b}_0$	$\hat{a}_1/\hat{b}_2$	$\overline{R}^2$	$\hat{a}_0/\hat{b}_0$	$\hat{a}_1/\hat{b}_2$	$\overline{R}^2$	$\hat{a}_0/\hat{b}_0$	$\hat{a}_1/\hat{b}_2$	$\overline{R}^2$	$\hat{a}_0/\hat{b}_0$	$\hat{a}_1/\hat{b}_2$	$\overline{R}^2$
1	0.105	-0.375		0.126	-0.219		0.015	0.112		0.016	-0.253		0.017	-0.314	
	(0.142)	(0.425)	0.075	(0.147)	(0.213)	0.076	(0.107)	(0.339)	0.074	(0.108)	(0.248)	0.077	(0.107)	(0.233)	0.080
2	0.118	-0.462		0.140	-0.261		0.016	-0.095		0.016	-0.202		0.017	**-0.268***	
	(0.138)	(0.382)	0.054	(0.144)	(0.197)	0.055	(0.111)	(0.218)	0.048	(0.111)	(0.148)	0.055	(0.110)	(0.152)	0.060
3	0.095	-0.332		0.146	**-0.260***		0.018	0.007		0.018	-0.015		0.018	-0.036	
	(0.111)	(0.291)	0.136	(0.116)	(0.153)	0.142	(0.093)	(0.146)	0.131	(0.093)	(0.098)	0.131	(0.092)	(0.103)	0.131
4	0.146	**-0.554***		**0.181***	**-0.330*****		0.023	-0.154		0.024	**-0.156***		0.024	**-0.181***	
	(0.091)	(0.229)	0.204	(0.096)	(0.121)	0.209	(0.078)	(0.109)	0.191	(0.078)	(0.072)	0.200	(0.078)	(0.076)	0.203
5	0.102	**-0.352***		**0.132***	**-0.226***		0.028	-0.140		0.028	**-0.128***		0.028	**-0.163***	
	(0.075)	(0.190)	0.203	(0.079)	(0.101)	0.208	(0.065)	(0.089)	0.201	(0.065)	(0.059)	0.209	(0.065)	(0.063)	0.216
6	0.050	-0.108		0.079	-0.111		0.028	0.006		0.028	-0.028		0.028	-0.028	
	(0.068)	(0.160)	0.261	(0.070)	(0.086)	0.265	(0.059)	(0.069)	0.259	(0.059)	(0.046)	0.260	(0.059)	(0.049)	0.260
7	0.075	-0.205		0.096	**-0.138***		0.024	-0.013		0.024	-0.052		0.024	**-0.082***	
	(0.059)	(0.140)	0.258	(0.061)	(0.075)	0.262	(0.052)	(0.061)	0.257	(0.052)	(0.040)	0.262	(0.052)	(0.043)	0.268
8	0.075	**-0.242***		**0.101***	**-0.166***		*0.011*	*-0.074*		0.023	-0.038		0.023	**-0.078***	
	(0.053)	(0.125)	0.281	(0.056)	(0.067)	0.289	(0.023)	(0.060)	0.282	(0.048)	(0.036)	0.275	(0.048)	(0.038)	0.285
9	**0.081***	**-0.259***		**0.107***	**-0.173*****		*0.025*	*0.102*		0.025	**-0.058***		0.025	-0.036	
	(0.048)	(0.112)	0.296	(0.050)	(0.060)	0.305	(0.024)	(0.062)	0.027	(0.044)	(0.032)	0.291	(0.044)	(0.034)	0.284
10	**0.077***	**-0.227***		**0.087***	**-0.126***		0.029	**-0.067***		0.029	-0.037		0.030	**-0.071***	
	(0.045)	(0.099)	0.350	(0.048)	(0.054)	0.350	(0.042)	(0.041)	0.343	(0.042)	(0.027)	0.341	(0.041)	(0.029)	0.353
11	0.054	-0.120		0.068	-0.085		0.026	-0.023		0.026	**-0.049***		0.026	**-0.054***	
	(0.041)	(0.096)	0.289	(0.043)	(0.051)	0.292	(0.037)	(0.040)	0.285	(0.037)	(0.027)	0.295	(0.037)	(0.029)	0.295
12	0.058	**-0.145***		0.069	**-0.090***		0.023	**-0.073***		0.023	**-0.051***		0.023	**-0.054***	
	(0.041)	(0.084)	0.374	(0.043)	(0.046)	0.377	(0.038)	(0.033)	0.381	(0.038)	(0.022)	0.383	(0.038)	(0.024)	0.382

Numbers in parentheses are standard errors. ***, ** and * denote statistically significant levels of 1% , 5% and 10% respectively. Significant statistics are in bold. Estimation results for dynamic models are shown in italics.

Table 3-8.3 Regression Results: Effects of the U.S. Spot Yield Spread on Change in FTSE Volatility

Static (S): $CCV_t^k = a_0 + a_1 Spd_t + \varepsilon_t$ [AR(1)] Dynamic (D): $CCV_t^k = b_0 + b_1 CCV_{t-1}^k + b_2 Spd_t + b_3 Spd_{t-1} + u_t$ [ADL(1)]

k (months ahead)	6 - 3 spread			12 – 3 spread			24 – 3 spread			60 – 3 spread			120 – 3 spread		
	$\hat{a}_0/\hat{b}_0$	$\hat{a}_1/\hat{b}_2$	$\bar{R}^2$	$\hat{a}_0/\hat{b}_0$	$\hat{a}_1/\hat{b}_2$	$\bar{R}^2$	$\hat{a}_0/\hat{b}_0$	$\hat{a}_1/\hat{b}_2$	$\bar{R}^2$	$\hat{a}_0/\hat{b}_0$	$\hat{a}_1/\hat{b}_2$	$\bar{R}^2$	$\hat{a}_0/\hat{b}_0$	$\hat{a}_1/\hat{b}_2$	$\bar{R}^2$
1	*0.032*	***6.041******		*-0.092*	***2.79*****		-0.005	**1.940*****		-0.006	**0.722***		-0.005	0.511	
	(0.289)	(1.315)	0.318	(0.304)	(0.769)	0.294	(0.146)	(0.496)	0.297	(0.150)	(0.378)	0.262	(0.150)	(0.348)	0.257
2	0.088	-0.394		*0.091*	***1.091****		*-0.000*	***1.358*****		-0.001	**0.510***		-0.002	**0.420***	
	(0.159)	(0.468)	0.002	(0.179)	(0.456)	0.028	(0.125)	(0.329)	0.081	(0.119)	(0.235)	0.019	(0.120)	(0.232)	0.013
3	*0.094*	***0.938****		*0.091*	***0.499****		0.005	**0.421***		0.005	**0.276***		0.005	0.177	
	(0.106)	(0.477)	0.027	(0.110)	(0.276)	0.020	(0.086)	(0.207)	0.016	(0.086)	(0.144)	0.014	(0.087)	(0.145)	0.004
4	*0.117*	***0.800****		*0.089*	*0.373*		*0.012*	***0.580*****		0.010	0.201		0.010	0.173	
	(0.093)	(0.419)	0.037	(0.098)	(0.244)	0.018	(0.069)	(0.179)	0.057	(0.064)	(0.129)	0.012	(0.065)	(0.125)	0.009
5	0.066	-0.252		0.035	-0.052		0.010	**0.256***		0.010	0.104		0.010	0.056	
	(0.075)	(0.214)	0.013	(0.079)	(0.110)	0.008	(0.059)	(0.133)	0.023	(0.059)	(0.093)	0.013	(0.059)	(0.094)	0.009
6	0.031	-0.068		*0.063*	***0.375****		0.015	**0.408*****		0.015	**0.148***		0.015	**0.188***	
	(0.065)	(0.185)	-0.003	(0.064)	(0.158)	0.030	(0.050)	(0.118)	0.046	(0.050)	(0.084)	0.010	(0.049)	(0.083)	0.018
7	0.046	-0.142		*0.067*	*0.180*		*0.013*	***0.325*****		0.013	**0.142***		0.013	**0.177***	
	(0.056)	(0.161)	-0.004	(0.058)	(0.143)	0.009	(0.041)	(0.105)	0.044	(0.043)	(0.075)	0.008	(0.043)	(0.074)	0.017
8	*0.048*	*0.247*		*0.056*	***0.222****		0.008	**0.213***		0.009	0.091		0.009	0.015	
	(0.043)	(0.194)	0.033	(0.045)	(0.111)	0.048	(0.038)	(0.083)	0.042	(0.038)	(0.060)	0.025	(0.038)	(0.059)	0.015
9	*0.067*	***0.547*****		*0.069*	***0.234****		0.008	**0.244*****		0.008	**0.132***		0.008	0.076	
	(0.040)	(0.179)	0.078	(0.042)	(0.105)	0.046	(0.033)	(0.079)	0.036	(0.033)	(0.055)	0.020	(0.034)	(0.056)	0.003
10	***0.078****	*0.099*		***0.071****	*0.110*		0.008	**0.222*****		0.008	0.032		0.008	0.064	
	(0.038)	(0.169)	0.050	(0.039)	(0.097)	0.045	(0.033)	(0.072)	0.051	(0.033)	(0.051)	0.013	(0.034)	(0.052)	0.018
11	***0.083****	*0.158*		0.055	**-0.096***		*0.008*	***0.187*****		0.009	0.060		0.009	0.037	
	(0.036)	(0.158)	0.048	(0.037)	(0.051)	0.011	(0.026)	(0.067)	0.071	(0.028)	(0.050)	-0.002	(0.030)	(0.049)	-0.006
12	***0.066****	*-0.038*		**0.053***	**-0.092***		*0.007*	*0.051*		*0.007*	*0.039*		*0.007*	*0.042*	
	(0.028)	(0.123)	0.051	(0.032)	(0.044)	0.030	(0.020)	(0.052)	0.084	(0.021)	(0.037)	0.063	(0.021)	(0.037)	0.053

Numbers in parentheses are standard errors. ***, ** and * denote statistically significant levels of 1% , 5% and 10% respectively. Significant statistics are in bold. Estimation results for dynamic models are shown in italics.

Table 3-8.4 Regression Results: Effects of the U.S. Spot Yield Spread on Change in S&P Volatility

Static (S): $CCV_t^k = a_0 + a_1 Spd_t + \varepsilon_t$ [AR(1)] Dynamic (D): $CCV_t^k = b_0 + b_1 CCV_{t-1}^k + b_2 Spd_t + b_3 Spd_{t-1} + u_t$ [ADL(1)]

k (months ahead)	6 - 3 spread			12 – 3 spread			24 – 3 spread			60 – 3 spread			120 –3 spread		
	$\hat{a}_0 / \hat{b}_0$	$\hat{a}_1 / \hat{b}_2$	$\overline{R}^2$	$\hat{a}_0 / \hat{b}_0$	$\hat{a}_1 / \hat{b}_2$	$\overline{R}^2$	$\hat{a}_0 / \hat{b}_0$	$\hat{a}_1 / \hat{b}_2$	$\overline{R}^2$	$\hat{a}_0 / \hat{b}_0$	$\hat{a}_1 / \hat{b}_2$	$\overline{R}^2$	$\hat{a}_0 / \hat{b}_0$	$\hat{a}_1 / \hat{b}_2$	$\overline{R}^2$
1	0.024	-0.044		0.021	-0.013		0.015	0.040		0.016	-0.086		0.016	-0.155	
	(0.102)	(0.308)	0.186	(0.106)	(0.154)	0.186	(0.077)	(0.256)	0.186	(0.077)	(0.190)	0.186	(0.077)	(0.175)	0.188
2	0.035	-0.095		0.039	-0.053		0.012	0.083		0.012	-0.004		0.012	-0.082	
	(0.099)	(0.279)	0.019	(0.103)	(0.143)	0.019	(0.077)	(0.168)	0.020	(0.077)	(0.116)	0.019	(0.077)	(0.118)	0.021
3	0.065	-0.229		0.064	-0.104		0.016	-0.083		0.016	-0.053		0.016	-0.034	
	(0.078)	(0.215)	0.057	(0.082)	(0.111)	0.056	(0.062)	(0.121)	0.054	(0.062)	(0.082)	0.054	(0.062)	(0.085)	0.053
4	0.056	-0.164		0.053	-0.070		0.019	0.018		0.019	-0.021		0.019	-0.019	
	(0.063)	(0.172)	0.064	(0.066)	(0.089)	0.063	(0.051)	(0.096)	0.060	(0.051)	(0.065)	0.061	(0.051)	(0.067)	0.061
5	0.060	-0.170		0.064	-0.086		0.024	-0.083		0.025	-0.064		0.025	**-0.086***	
	(0.053)	(0.139)	0.123	(0.055)	(0.073)	0.123	(0.044)	(0.070)	0.123	(0.044)	(0.047)	0.125	(0.044)	(0.049)	0.129
6	*0.047*	*0.134*		*0.055*	*0.099*		0.020	0.048		0.020	0.007		0.020	0.015	
	(0.032)	(0.143)	0.106	(0.033)	(0.082)	0.112	(0.035)	(0.061)	0.097	(0.035)	(0.041)	0.094	(0.035)	(0.043)	0.095
7	***0.058****	*0.007*		***0.064****	*0.027*		0.017	0.030		0.017	-0.007		0.017	-0.025	
	(0.027)	(0.120)	0.150	(0.028)	(0.069)	0.154	(0.032)	(0.051)	0.128	(0.032)	(0.034)	0.127	(0.032)	(0.036)	0.129
8	**0.063***	**-0.214***		***0.067*****	*-0.009*		0.014	0.021		0.014	0.008		0.015	-0.003	
	(0.033)	(0.089)	0.131	(0.026)	(0.063)	0.146	(0.028)	(0.047)	0.108	(0.028)	(0.032)	0.108	(0.028)	(0.033)	0.108
9	**0.058***	**-0.194***		**0.078***	**-0.131*****		0.016	-0.048		0.016	**-0.047***		0.016	-0.034	
	(0.031)	(0.080)	0.172	(0.032)	(0.042)	0.186	(0.027)	(0.040)	0.158	(0.027)	(0.027)	0.164	(0.027)	(0.028)	0.158
10	**0.058***	**-0.190***		**0.057***	**-0.086***		0.013	-0.031		0.013	-0.002		0.013	-0.030	
	(0.030)	(0.074)	0.186	(0.030)	(0.039)	0.179	(0.025)	(0.036)	0.169	(0.025)	(0.024)	0.170	(0.025)	(0.026)	0.171
11	0.035	-0.105		0.045	**-0.070***		0.010	-0.003		0.010	-0.013		0.010	-0.021	
	(0.027)	(0.070)	0.161	(0.028)	(0.037)	0.165	(0.023)	(0.035)	0.151	(0.023)	(0.023)	0.152	(0.023)	(0.024)	0.154
12	0.033	-0.100		0.041	**-0.063***		0.008	-0.028		0.008	-0.024		0.008	-0.022	
	(0.026)	(0.064)	0.210	(0.027)	(0.034)	0.213	(0.022)	(0.030)	0.202	(0.022)	(0.020)	0.204	(0.022)	(0.021)	0.203

Numbers in parentheses are standard errors. ***, ** and * denote statistically significant levels of 1%, 5% and 10% respectively. Significant statistics are in bold. Estimation results for dynamic models are shown in italics.

Table 3-9.1 COMFAC Approach – Decomposition Model Selection

Static (S): [AR(1)]

$$CCV_t^k = c_0 + c_1\left(\frac{1}{n}\sum_{j=0}^{n-1} r_{t+j}^1 - r_t^1\right) + c_2\left(R_t^n - \frac{1}{n}\sum_{j=0}^{n-1} r_{t+j}^1\right) + e_t$$

Dynamic (D): [ADL(1)]

$$CCV_t^k = d_o + d_1 CCV_{t-1}^k + d_2\left(\frac{1}{n}\sum_{j=0}^{n-1} r_{t+j}^1 - r_t^1\right) + d_3\left(\frac{1}{n}\sum_{j=0}^{n-1} r_{t+j}^1 - r_t^1\right)_{t-1} + d_4\left(R_t^n - \frac{1}{n}\sum_{j=0}^{n-1} r_{t+j}^1\right) + d_5\left(R_{t-1}^n - \frac{1}{n}\sum_{j=0}^{n-1} r_{t+j}^1\right)_{t-1} + v_t$$

Two-Stage Least Square using a constant, R_t^n and r_t^1 as instruments[56]

HSI

Spread	1	2	3	4	5	6	7	8	9	10	11	12
120-3	S	S	S	S	S	D	S	S	S	S	S	S
60-3	S	S	S	S	S	S	S	S	S	S	S	S
24-3	S	S	S	S	S	D	S	D	S	S	S	S
12-3	S	S	S	D	S	D	D	D	S	D	S	S
6-3	S	S	D	S	S	D	S	D	S	S	S	S
	1	2	3	4	5	6	7	8	9	10	11	12

Months ahead

Nikkei

Spread	1	2	3	4	5	6	7	8	9	10	11	12
120-3	S	S	S	S	S	S	S	S	S	S	S	S
60-3	S	S	S	S	S	S	S	S	S	S	S	S
24-3	S	S	S	S	S	S	S	S	S	S	S	S
12-3	S	S	S	S	S	S	S	S	D	S	S	S
6-3	S	S	S	S	S	S	S	S	S	S	S	S
	1	2	3	4	5	6	7	8	9	10	11	12

Months ahead

[56] For dynamic ADL(1) models, instruments include a constant, CCV_{t-2}^k, R_t^n, R_{t-1}^n, r_t^1 and r_{t-1}^1.

Table 3-9.2 COMFAC Approach – Decomposition Model Selection

Static (S): [AR(1)]

$$CCV_t^k = c_0 + c_1\left(\frac{1}{n}\sum_{j=0}^{n-1} r_{t+j}^1 - r_t^1\right) + c_2\left(R_t^n - \frac{1}{n}\sum_{j=0}^{n-1} r_{t+j}^1\right) + e_t$$

Dynamic (D): [ADL(1)]

$$CCV_t^k = d_o + d_1 CCV_{t-1}^k + d_2\left(\frac{1}{n}\sum_{j=0}^{n-1} r_{t+j}^1 - r_t^1\right) + d_3\left(\frac{1}{n}\sum_{j=0}^{n-1} r_{t+j}^1 - r_t^1\right)_{t-1} + d_4\left(R_t^n - \frac{1}{n}\sum_{j=0}^{n-1} r_{t+j}^1\right) + d_5\left(R_{t-1}^n - \frac{1}{n}\sum_{j=0}^{n-1} r_{t+j}^1\right)_{t-1} + v_t$$

Two-Stage Least Square using a constant, R_t^n and r_t^1 as instruments[57]

FTSE

Spread	1	2	3	4	5	6	7	8	9	10	11	12	
120-3	S	S	S	S	S	S	S	S	S	S	S	S	
60-3	D	S	S	S	S	S	S	S	S	S	S	S	
24-3	D	S	S	S	S	S	S	S	S	S	S	S	
12-3	D	S	S	S	S	S	S	S	S	S	S	S	
6-3	D	S	S	S	S	S	S	S	S	S	S	S	
													Months ahead

S&P

Spread	1	2	3	4	5	6	7	8	9	10	11	12	
120-3	S	S	S	S	S	S	S	S	S	S	S	S	
60-3	S	S	S	S	S	S	S	S	S	S	S	S	
24-3	S	S	S	S	S	S	S	S	S	S	S	S	
12-3	S	S	S	S	S	S	S	S	S	S	S	S	
6-3	S	S	S	S	S	S	S	S	S	S	S	S	
													Months ahead

[57] For dynamic ADL(1) models, instruments include a constant, CCV_{t-2}^k, R_t^n, R_{t-1}^n, r_t^1 and r_{t-1}^1.

Table 3-10.1 Summary of Regression Results:

Effects of the U.S. Spot Spread on Cumulative Volatility Change -- Decomposition

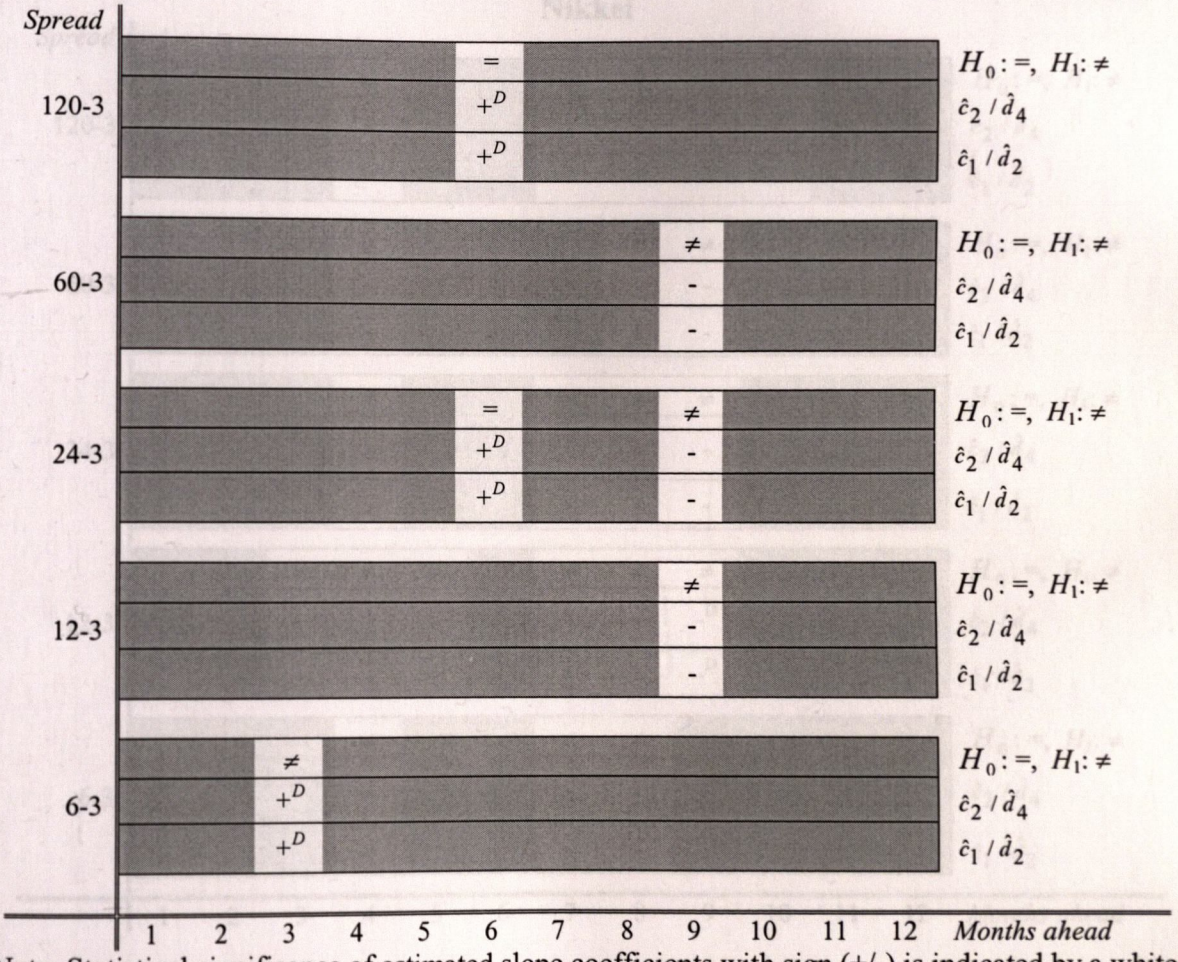
Static (S): $$CCV_t^k = c_0 + c_1\left(\frac{1}{n}\sum_{j=0}^{n-1} r_{t+j}^1 - r_t^1\right) + c_2\left(R_t^n - \frac{1}{n}\sum_{j=0}^{n-1} r_{t+j}^1\right) + e_t \quad \text{[AR(1)]}$$

Dynamic (D): [ADL(1)]

$$CCV_t^k = d_o + d_1 CCV_{t-1}^k + d_2\left(\frac{1}{n}\sum_{j=0}^{n-1} r_{t+j}^1 - r_t^1\right) + d_3\left(\frac{1}{n}\sum_{j=0}^{n-1} r_{t+j}^1 - r_t^1\right)_{t-1} + d_4\left(R_t^n - \frac{1}{n}\sum_{j=0}^{n-1} r_{t+j}^1\right) + d_5\left(R_{t-1}^n - \frac{1}{n}\sum_{j=0}^{n-1} r_{t+j}^1\right)_{t-1} + v_t$$

Two-Stage Least Square using a constant, R_t^n and r_t^1 as instruments[58]

HSI



Note: Statistical significance of estimated slope coefficients with sign (+/-) is indicated by a white box. Statistical significance of hypothesis testing of non-equal coefficient is represented by a white box with ≠, whereas = means equal coefficients. For static models, slope coefficients are denoted by c_1 and c_2, while for dynamic models, slope coefficients are d_2 and d_4. Estimation results for dynamic models are shown with superscript D.

[58] For dynamic ADL(1) models, instruments include a constant, CCV_{t-2}^k, R_t^n, R_{t-1}^n, r_t^1 and r_{t-1}^1.

Table 3-10.2 Summary of Regression Results:

Effects of the U.S. Spot Spread on Cumulative Volatility Change -- Decomposition

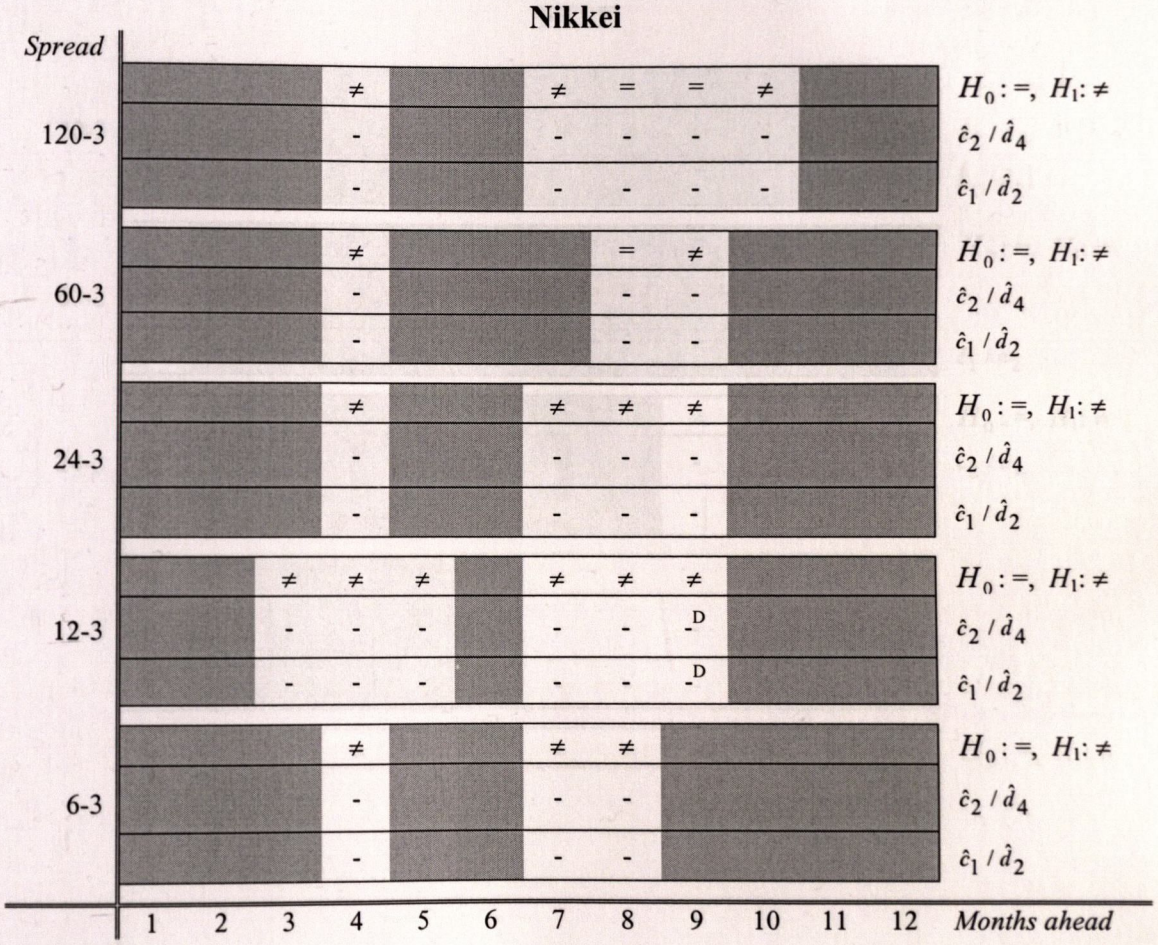
Static (S): $CCV_t^k = c_0 + c_1\left(\frac{1}{n}\sum_{j=0}^{n-1} r_{t+j}^1 - r_t^1\right) + c_2\left(R_t^n - \frac{1}{n}\sum_{j=0}^{n-1} r_{t+j}^1\right) + e_t$ [AR(1)]

Dynamic (D): [ADL(1)]

$$CCV_t^k = d_o + d_1 CCV_{t-1}^k + d_2\left(\frac{1}{n}\sum_{j=0}^{n-1} r_{t+j}^1 - r_t^1\right) + d_3\left(\frac{1}{n}\sum_{j=0}^{n-1} r_{t+j}^1 - r_t^1\right)_{t-1} + d_4\left(R_t^n - \frac{1}{n}\sum_{j=0}^{n-1} r_{t+j}^1\right) + d_5\left(R_{t-1}^n - \frac{1}{n}\sum_{j=0}^{n-1} r_{t+j}^1\right)_{t-1} + v_t$$

Two-Stage Least Square using a constant, R_t^n and r_t^1 as instruments[59]

Nikkei



Note: Statistical significance of estimated slope coefficients with sign (+/-) is indicated by a white box. Statistical significance of hypothesis testing of non-equal coefficient is represented by a white box with ≠, whereas = means equal coefficients. For static models, slope coefficients are denoted by c_1 and c_2, while for dynamic models, slope coefficients are d_2 and d_4. Estimation results for dynamic models are shown with superscript D.

[59] For dynamic ADL(1) models, instruments include a constant, CCV_{t-2}^k, R_t^n, R_{t-1}^n, r_t^1 and r_{t-1}^1.

Table 3-10.3 Summary of Regression Results:

Effects of the U.S. Spot Spread on Cumulative Volatility Change -- Decomposition

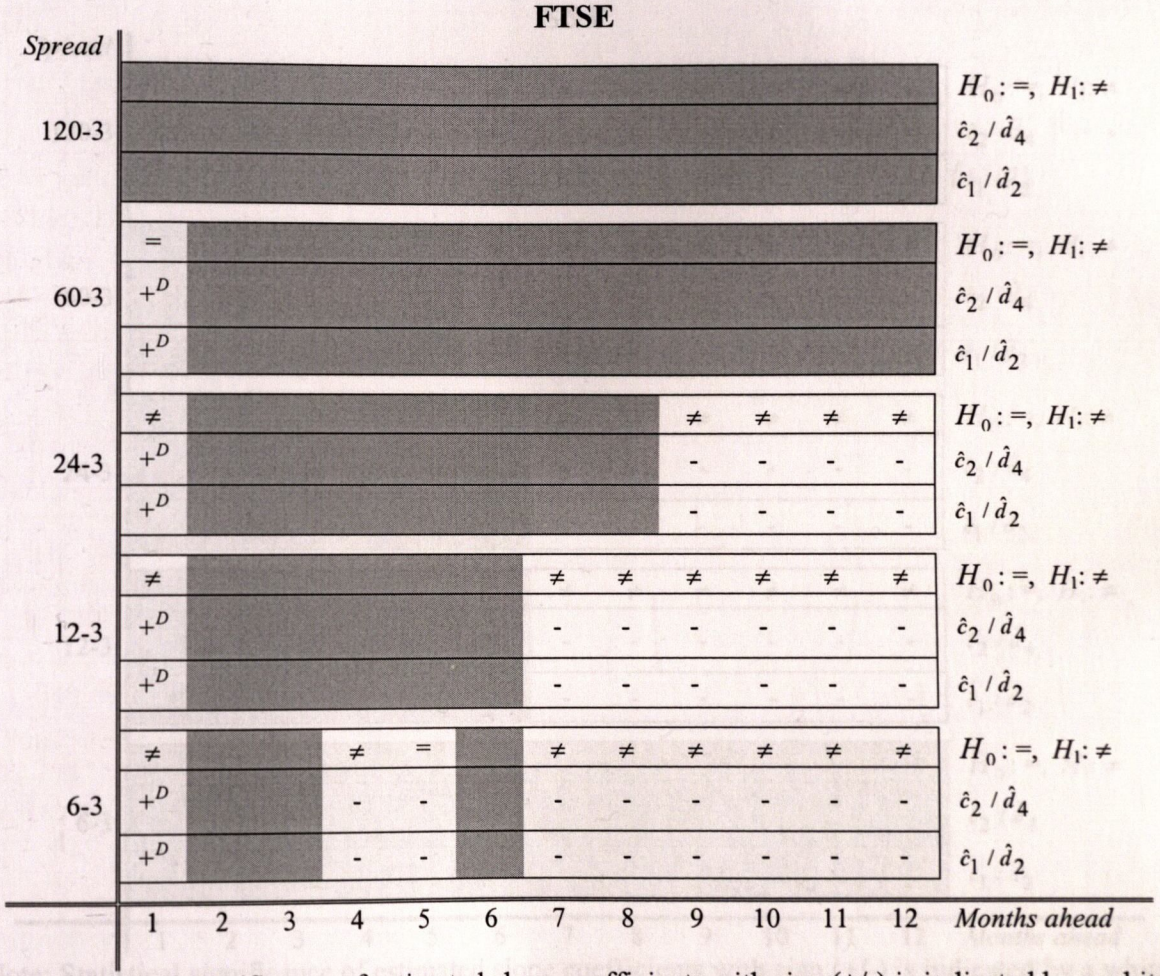
Static (S): $CCV_t^k = c_0 + c_1\left(\frac{1}{n}\sum_{j=0}^{n-1} r_{t+j}^1 - r_t^1\right) + c_2\left(R_t^n - \frac{1}{n}\sum_{j=0}^{n-1} r_{t+j}^1\right) + e_t$ [AR(1)]

Dynamic (D): [ADL(1)]

$$CCV_t^k = d_o + d_1 CCV_{t-1}^k + d_2\left(\frac{1}{n}\sum_{j=0}^{n-1} r_{t+j}^1 - r_t^1\right) + d_3\left(\frac{1}{n}\sum_{j=0}^{n-1} r_{t+j}^1 - r_t^1\right)_{t-1} + d_4\left(R_t^n - \frac{1}{n}\sum_{j=0}^{n-1} r_{t+j}^1\right) + d_5\left(R_{t-1}^n - \frac{1}{n}\sum_{j=0}^{n-1} r_{t+j}^1\right)_{t-1} + v_t$$

Two-Stage Least Square using a constant, R_t^n and r_t^1 as instruments[60]

FTSE



Note: Statistical significance of estimated slope coefficients with sign (+/-) is indicated by a white box. Statistical significance of hypothesis testing of non-equal coefficient is represented by a white box with ≠. For static models, slope coefficients are denoted by c_1 and c_2, while for dynamic models, slope coefficients are d_2 and d_4. Estimation results for dynamic models are shown with superscript D.

[60] For dynamic ADL(1) models, instruments include a constant, CCV_{t-2}^k, R_t^n, R_{t-1}^n, r_t^1 and r_{t-1}^1.

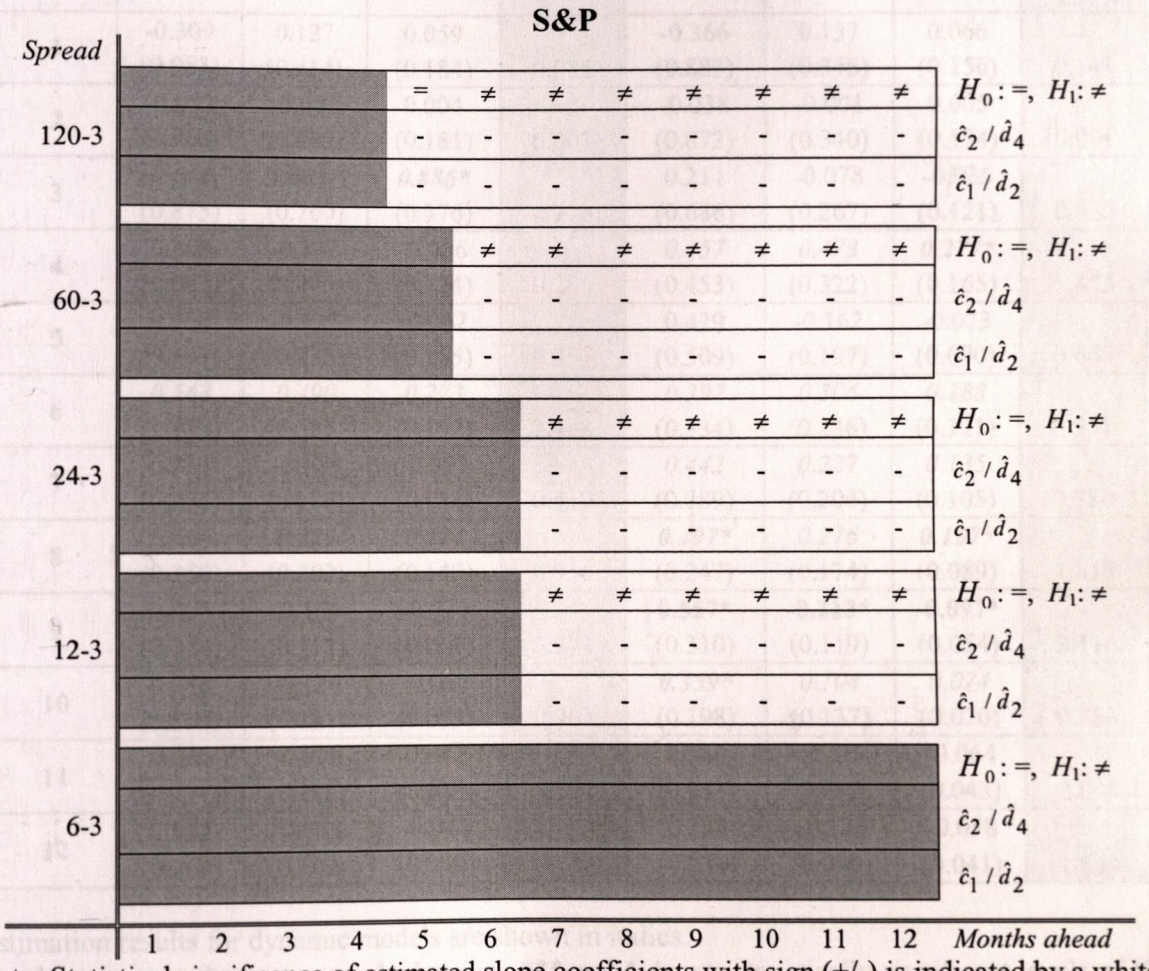
Table 3-10.4 Summary of Regression Results:
Effects of the U.S. Spot Spread on Cumulative Volatility Change -- Decomposition

Static (S): $$CCV_t^k = c_0 + c_1\left(\frac{1}{n}\sum_{j=0}^{n-1} r_{t+j}^1 - r_t^1\right) + c_2\left(R_t^n - \frac{1}{n}\sum_{j=0}^{n-1} r_{t+j}^1\right) + e_t \quad \text{[AR(1)]}$$

Dynamic (D): [ADL(1)]

$$CCV_t^k = d_o + d_1 CCV_{t-1}^k + d_2\left(\frac{1}{n}\sum_{j=0}^{n-1} r_{t+j}^1 - r_t^1\right) + d_3\left(\frac{1}{n}\sum_{j=0}^{n-1} r_{t+j}^1 - r_t^1\right)_{t-1} + d_4\left(R_t^n - \frac{1}{n}\sum_{j=0}^{n-1} r_{t+j}^1\right) + d_5\left(R_{t-1}^n - \frac{1}{n}\sum_{j=0}^{n-1} r_{t+j}^1\right)_{t-1} + v_t$$

Two-Stage Least Square using a constant, R_t^n and r_t^1 as instruments[61]



Note: Statistical significance of estimated slope coefficients with sign (+/-) is indicated by a white box. Statistical significance of hypothesis testing of non-equal coefficient is represented by a white box with ≠, whereas = means equal coefficients. For static models, slope coefficients are denoted by c_1 and c_2, while for dynamic models, slope coefficients are d_2 and d_4. Estimation results for dynamic models are shown with superscript *D*.

[61] For dynamic ADL(1) models, instruments include a constant, CCV_{t-2}^k, R_t^n, R_{t-1}^n, r_t^1 and r_{t-1}^1.

Table 3-11.1 Regression Results: Effects of the U.S. Spot Yield Spread on Change in HSI Volatility -- Decomposition

Two-Stage Least Square using a constant, R_t^n and r_t^1 as instruments[62]

	6 – 3 spread				12 – 3 spread			
k (months ahead)	$\hat{c}_0 / \hat{d}_0$	$\hat{c}_1 / \hat{d}_2$	$\hat{c}_2 / \hat{d}_4$	H_0 : $\hat{c}_1 = \hat{c}_2$ / $\hat{d}_2 = \hat{d}_4$	$\hat{c}_0 / \hat{d}_0$	$\hat{c}_1 / \hat{d}_2$	$\hat{c}_2 / \hat{d}_4$	H_0 : $\hat{c}_1 = \hat{c}_2$ / $\hat{d}_2 = \hat{d}_4$
1	-0.309 (0.983)	0.127 (0.414)	0.059 (0.184)	0.085	-0.366 (0.883)	0.137 (0.345)	0.066 (0.156)	0.141
2	-0.023 (0.966)	-0.002 (0.405)	0.004 (0.181)	0.001	-0.038 (0.872)	-0.001 (0.340)	0.005 (0.154)	0.001
3	*0.619* (0.875)	***1.685**** (0.760)	***0.886**** (0.376)	***4.174***	0.211 (0.686)	-0.078 (0.267)	-0.035 (0.121)	0.087
4	0.368 (0.662)	-0.147 (0.275)	-0.066 (0.124)	0.286	*0.457* (0.453)	*0.473* (0.322)	***0.277**** (0.165)	1.423
5	0.350 (0.561)	-0.137 (0.233)	-0.062 (0.105)	0.337	0.429 (0.509)	-0.162 (0.197)	-0.073 (0.090)	0.665
6	*0.568* (0.412)	*0.490* (0.387)	*0.273* (0.192)	2.448	*0.397* (0.334)	*0.306* (0.236)	*0.188* (0.121)	0.957
7	0.331 (0.451)	-0.124 (0.186)	-0.057 (0.084)	0.419	*0.442* (0.289)	*0.227* (0.204)	*0.135* (0.105)	0.780
8	*0.546* (0.350)	*0.326* (0.302)	*0.174* (0.149)	0.956	***0.497**** (0.247)	*0.276* (0.174)	***0.157**** (0.089)	1.813
9	0.405 (0.344)	-0.166 (0.142)	-0.074 (0.064)	1.374	**0.557*** (0.310)	**-0.213*** (0.119)	**-0.097*** (0.054)	**3.116**
10	0.318 (0.309)	-0.126 (0.127)	-0.057 (0.057)	0.963	***0.359**** (0.198)	*0.104* (0.137)	*0.074* (0.070)	0.183
11	0.242 (0.271)	-0.090 (0.112)	0.042 (0.050)	0.597	0.380 (0.243)	-0.138 (0.093)	-0.064 (0.043)	2.048
12	0.252 (0.264)	-0.098 (0.109)	-0.044 (0.049)	0.782	0.339 (0.236)	-0.125 (0.090)	-0.058 (0.041)	1.844

Estimation results for dynamic models are shown in italics.
Numbers in parentheses are standard errors. *** and * denote statistically significant levels of 1% and 10% respectively, with significant statistics in bold.
Figures in the shaded columns are χ^2 test statistics of the H_0 : Estimated coefficient of the future expected change of the short rate is equal to the risk premium. Statistics significant at 10% level are in bold.

[62] For dynamic ADL(1) models, instruments include a constant, CCV_{t-2}^k, R_t^n, R_{t-1}^n, r_t^1 and r_{t-1}^1.

Table 3-11.2 Regression Results: Effects of the U.S. Spot Yield Spread on Change in HSI Volatility – Decomposition (Continued)

Two-Stage Least Square using a constant, R_t^n and r_t^1 as instruments

k (months ahead)	24 -3 spread				60 - 3 spread				120 -3 spread			
	$\hat{c}_0 / \hat{d}_0$	$\hat{c}_1 / \hat{d}_2$	$\hat{c}_2 / \hat{d}_4$	H_0 : $\hat{c}_1 = \hat{c}_2 / \hat{d}_2 = \hat{d}_4$	$\hat{c}_0 / \hat{d}_0$	$\hat{c}_1 / \hat{d}_2$	$\hat{c}_2 / \hat{d}_4$	H_0 : $\hat{c}_1 = \hat{c}_2 / \hat{d}_2 = \hat{d}_4$	$\hat{c}_0 / \hat{d}_0$	$\hat{c}_1 / \hat{d}_2$	$\hat{c}_2 / \hat{d}_4$	H_0 : $\hat{c}_1 = \hat{c}_2 / \hat{d}_2 = \hat{d}_4$
1	-0.278	0.090	0.046		-0.107	0.030	0.017		-0.049	0.011	0.008	
	(0.807)	(0.278)	(0.130)	0.085	(0.711)	(0.207)	(0.103)	0.015	(0.698)	(0.178)	(0.093)	0.002
2	-0.077	0.013	0.012		-0.118	0.030	0.018		-0.060	0.011	0.009	
	(0.790)	(0.272)	(0.128)	0.000	(0.685)	(0.199)	(0.099)	0.013	(0.675)	(0.171)	(0.090)	0.001
3	0.141	-0.044	-0.020		0.136	-0.030	-0.016		0.105	-0.020	-0.011	
	(0.619)	(0.213)	(0.100)	0.042	(0.531)	(0.154)	(0.076)	0.028	(0.526)	(0.133)	(0.070)	0.015
4	0.288	-0.099	-0.045		0.271	-0.073	-0.037		0.264	-0.061	-0.033	
	(0.535)	(0.183)	(0.086)	0.297	(0.452)	(0.130)	(0.065)	0.276	(0.452)	(0.113)	(0.060)	0.243
5	0.339	-0.110	-0.052		0.337	-0.088	-0.046		0.303	-0.066	-0.038	
	(0.459)	(0.157)	(0.074)	0.469	(0.389)	(0.111)	(0.056)	0.510	(0.388)	(0.097)	(0.051)	0.346
6	*0.276*	***0.328****	***0.214****		0.264	-0.069	-0.036		*0.164*	***0.262****	***0.221****	
	(0.272)	(0.184)	(0.102)	1.564	(0.354)	(0.101)	(0.051)	0.401	(0.218)	(0.149)	(0.103)	0.431
7	0.459	-0.149	-0.071		0.366	-0.093	-0.050		0.346	-0.076	-0.043	
	(0.367)	(0.125)	(0.059)	1.342	(0.307)	(0.087)	(0.044)	0.914	(0.310)	(0.077)	(0.041)	0.703
8	***0.385****	*0.165*	*0.103*		0.377	-0.099	-0.052		0.355	-0.079	-0.045	
	(0.203)	(0.137)	(0.075)	0.842	(0.269)	(0.076)	(0.038)	1.388	(0.273)	(0.067)	(0.036)	1.008
9	**0.486***	**-0.163***	**-0.077***		**0.453***	**-0.122***	**-0.063***		0.344	-0.080	-0.044	
	(0.277)	(0.094)	(0.044)	**2.882**	(0.233)	(0.066)	(0.033)	**2.840**	(0.235)	(0.058)	(0.031)	1.511
10	0.395	-0.130	-0.062		0.306	-0.080	-0.042		0.288	-0.065	-0.037	
	(0.247)	(0.084)	(0.039)	2.297	(0.209)	(0.059)	(0.030)	1.497	(0.213)	(0.052)	(0.028)	1.169
11	**0.363***	-0.114	-0.056		0.288	-0.072	-0.039		0.283	-0.060	-0.035	
	(0.219)	(0.074)	(0.035)	2.136	(0.187)	(0.053)	(0.027)	1.416	(0.190)	(0.046)	(0.025)	1.111
12	0.310	-0.098	-0.048		0.275	-0.068	-0.037		0.249	-0.053	-0.031	
	(0.212)	(0.071)	(0.034)	1.751	(0.180)	(0.050)	(0.025)	1.418	(0.184)	(0.045)	(0.024)	0.984

Estimation results for dynamic models are shown in italics.
Numbers in parentheses are standard errors. *** and * denote statistically significant levels of 1% and 10% respectively, with significant statistics in bold.
Figures in the shaded columns are χ^2 test statistics of the H_0 : Estimated coefficient of the future expected change of the short rate is equal to the risk premium. Statistics significant at 10% level are in bold.

Table 3-12.1 Regression Results: Effects of the U.S. Spot Yield Spread on Change in Nikkei Volatility -- Decomposition

Two-Stage Least Square using a constant, R_t^n and r_t^1 as instruments[63]

k (months ahead)	6 – 3 spread				12 – 3 spread			
	$\hat{c}_0 / \hat{d}_0$	$\hat{c}_1 / \hat{d}_2$	$\hat{c}_2 / \hat{d}_4$	H_0 : $\hat{c}_1 = \hat{c}_2$ / $\hat{d}_2 = \hat{d}_4$	$\hat{c}_0 / \hat{d}_0$	$\hat{c}_1 / \hat{d}_2$	$\hat{c}_2 / \hat{d}_4$	H_0 : $\hat{c}_1 = \hat{c}_2$ / $\hat{d}_2 = \hat{d}_4$
1	1.101	-0.540	-0.221		0.935	-0.438	-0.178	
	(0.905)	(0.381)	(0.170)	2.251	(0.813)	(0.318)	(0.144)	2.164
2	1.193	-0.565	-0.236		1.114	-0.495	-0.208	
	(0.931)	(0.390)	(0.174)	2.280	(0.838)	(0.327)	(0.148)	2.497
3	1.194	-0.532	-0.229		**1.244***	**-0.511***	**-0.225***	
	(0.775)	(0.323)	(0.145)	**2.827**	(0.700)	(0.270)	(0.123)	**3.675**
4	**1.168***	**-0.520***	**-0.224***		**1.163***	**-0.477***	**-0.209***	
	(0.651)	(0.270)	(0.122)	**3.894**	(0.583)	(0.225)	(0.103)	**4.624**
5	0.804	-0.359	-0.154		0.795	**-0.327***	**-0.142***	
	(0.544)	(0.226)	(0.101)	2.697	(0.487)	(0.188)	(0.086)	**3.149**
6	0.615	-0.265	-0.115		0.646	-0.257	-0.113	
	(0.495)	(0.205)	(0.092)	1.749	(0.439)	(0.169)	(0.077)	2.362
7	**0.787***	**-0.350***	**-0.149***		**0.791***	**-0.327***	**-0.141***	
	(0.435)	(0.179)	(0.081)	**4.106**	(0.385)	(0.148)	(0.067)	**5.207**
8	**0.745***	**-0.316***	**-0.139***		**0.800***	**-0.312***	**-0.140***	
	(0.397)	(0.163)	(0.074)	**3.833**	(0.352)	(0.135)	(0.062)	**5.365**
9	0.599	-0.247	-0.110		***0.618****	***-0.400****	***-0.181****	
	(0.365)	(0.150)	(0.068)	**2.734**	(0.294)	(0.151)	(0.077)	***7.423***
10	0.490	-0.208	-0.090		0.470	-0.184	-0.081	
	(0.351)	(0.143)	(0.065)	2.233	(0.310)	(0.118)	(0.054)	2.503
11	0.338	-0.144	-0.061		0.344	-0.134	-0.058	
	(0.314)	(0.129)	(0.058)	1.336	(0.279)	(0.107)	(0.049)	1.652
12	0.259	-0.101	-0.045		0.311	-0.112	-0.051	
	(0.318)	(0.129)	(0.059)	0.630	(0.279)	(0.106)	(0.049)	1.092

Estimation results for dynamic models are shown in italics.
Numbers in parentheses are standard errors. *** and * denote statistically significant levels of 1% and 10% respectively, with significant statistics in bold.

Figures in the shaded columns are χ^2 test statistics of the H_0: Estimated coefficient of the future expected change of the short rate is equal to the risk premium. Statistics significant at 10% level are in bold.

[63] For dynamic ADL(1) models, instruments include a constant, CCV_{t-2}^k, R_t^n, R_{t-1}^n, r_t^1 and r_{t-1}^1.

Table 3-12.2 Regression Results: Effects of the U.S. Spot Yield Spread on Change in Nikkei Volatility – Decomposition (Continued)

Two-Stage Least Square using a constant, R_t^n and r_t^1 as instruments

	24 -3 spread				60 - 3 spread				120 -3 spread			
k (months ahead)	$\hat{c}_0 / \hat{d}_0$	$\hat{c}_1 / \hat{d}_2$	$\hat{c}_2 / \hat{d}_4$	H_0 : $\hat{c}_1 = \hat{c}_2 / \hat{d}_2 = \hat{d}_4$	$\hat{c}_0 / \hat{d}_0$	$\hat{c}_1 / \hat{d}_2$	$\hat{c}_2 / \hat{d}_4$	H_0 : $\hat{c}_1 = \hat{c}_2 / \hat{d}_2 = \hat{d}_4$	$\hat{c}_0 / \hat{d}_0$	$\hat{c}_1 / \hat{d}_2$	$\hat{c}_2 / \hat{d}_4$	H_0 : $\hat{c}_1 = \hat{c}_2 / \hat{d}_2 = \hat{d}_4$
1	0.792	-0.341	-0.140		0.555	-0.216	-0.089		0.653	-0.217	-0.096	
	(0.742)	(0.256)	(0.120)	2.076	(0.654)	(0.190)	(0.094)	1.585	(0.641)	(0.163)	(0.086)	2.091
2	0.855	-0.347	-0.148		0.446	-0.169	-0.071		0.556	-0.178	-0.081	
	(0.758)	(0.261)	(0.122)	1.968	(0.658)	(0.191)	(0.095)	0.934	(0.648)	(0.164)	(0.087)	1.315
3	0.954	-0.349	-0.158		0.614	-0.194	-0.091		0.683	-0.187	-0.094	
	(0.627)	(0.215)	(0.101)	2.679	(0.538)	(0.156)	(0.077)	1.561	(0.534)	(0.135)	(0.071)	1.819
4	0.863	**-0.316***	**-0.142***		0.731	**-0.223***	**-0.107***		**0.789***	**-0.209***	**-0.107***	
	(0.525)	(0.179)	(0.084)	**3.202**	(0448)	(0.129)	(0.064)	2.908	(0.448)	(0.112)	(0.059)	**3.171**
5	0.604	-0.223	-0.099		0.439	-0.137	-0.064		0.542	-0.145	-0.073	
	(0.442)	(0.151)	(0.071)	2.304	(0.378)	(0.108)	(0.054)	1.624	(0.376)	(0.094)	(0.050)	2.243
6	0.539	-0.191	-0.087		0.352	-0.104	-0.050		0.442	-0.112	-0.058	
	(0.394)	(0.134)	(0.063)	2.083	(0.334)	(0.095)	(0.048)	1.156	(0.337)	(0.084)	(0.044)	1.622
7	**0.669***	**-0.247***	**-0.109***		0.434	-0.137	-0.063		**0.537***	**-0.143***	**-0.072***	
	(0.345)	(0.117)	(0.055)	**4.777**	(0.292)	(0.083)	(0.042)	**2.884**	(0.295)	(0.073)	(0.039)	**3.814**
8	**0.668***	**-0.229***	**-0.107***		**0.456***	**-0.129***	**-0.064***		**0.492***	**-0.118***	**-0.064***	
	(0.316)	(0.107)	(0.050)	**4.498**	(0.268)	(0.076)	(0.038)	2.632	(0.274)	(0.067)	(0.036)	2.561
9	**0.594***	**-0.195***	**-0.093***		**0.513***	**-0.138***	**-0.071***		**0.445***	**-0.104***	**-0.057***	
	(0.290)	(0.098)	(0.046)	**3.729**	(0.245)	(0.069)	(0.035)	**3.389**	(0.251)	(0.062)	(0.033)	2.315
10	0.431	-0.147	-0.068		0.339	-0.098	-0.047		**0.455***	**-0.110***	**-0.059***	
	(0.276)	(0.093)	(0.044)	2.555	(0.229)	(0.064)	(0.032)	2.292	(0.237)	(0.057)	(0.031)	**3.246**
11	0.317	-0.109	-0.049		**0.353***	**-0.099***	-0.049		0.344	-0.084	-0.044	
	(0.250)	(0.084)	(0.040)	1.731	(0.208)	(0.059)	(0.029)	2.648	(0.214)	(0.052)	(0.028)	2.331
12	0.309	-0.098	-0.046		0.278	-0.073	-0.037		0.318	-0.072	-0.039	
	(0.247)	(0.083)	(0.039)	1.362	(0.203)	(0.057)	(0.029)	1.483	(0.212)	(0.051)	(0.028)	1.661

Estimation results for dynamic models are shown in italics.
Numbers in parentheses are standard errors. *** and * denote statistically significant levels of 1% and 10% respectively, with significant statistics in bold.

Figures in the shaded columns are χ^2 test statistics of the H_0: Estimated coefficient of the future expected change of the short rate is equal to the risk premium. Statistics significant at 10% level are in bold.

Table 3-13.1 Regression Results: Effects of the U.S. Spot Yield Spread on Change in FTSE Volatility -- Decomposition

Two-Stage Least Square using a constant, R_t^n and r_t^1 as instruments[64]

k (months ahead)	6 – 3 spread				12 – 3 spread			
	$\hat{c}_0 / \hat{d}_0$	$\hat{c}_1 / \hat{d}_2$	$\hat{c}_2 / \hat{d}_4$	H_0 : $\hat{c}_1 = \hat{c}_2 / \hat{d}_2 = \hat{d}_4$	$\hat{c}_0 / \hat{d}_0$	$\hat{c}_1 / \hat{d}_2$	$\hat{c}_2 / \hat{d}_4$	H_0 : $\hat{c}_1 = \hat{c}_2 / \hat{d}_2 = \hat{d}_4$
1	*2.787* (3.782)	***15.293**** (3.377)	***7.475**** (1.663)	***16.776***	*0.693* (2.661)	***7.254**** (1.944)	***3.597**** (0.993)	***13.395***
2	1.225 (1.040)	-0.509 (0.437)	-0.231 (0.195)	1.301	1.023 (0.937)	-0.401 (0.365)	-0.183 (0.165)	1.153
3	1.106 (0.750)	-0.169 (0.315)	-0.209 (0.141)	2.182	0.966 (0.678)	-0.381 (0.264)	-0.173 (0.119)	2.034
4	**0.997*** (0.554)	**-0.414*** (0.232)	**-0.186*** (0.104)	**3.073**	0.794 (0.499)	-0.303 (0.194)	-0.139 (0.088)	2.326
5	0.866* (0.509)	-0.355* (0.213)	-0.161* (0.095)	2.683	0.652 (0.461)	-0.246 (0.179)	-0.114 (0.081)	1.804
6	0.706 (0.429)	-0.293 (0.179)	-0.131 (0.080)	2.633	0.601 (0.388)	-0.233 (0.150)	-0.105 (0.068)	2.354
7	**0.703*** (0.373)	**-0.298*** (0.156)	**-0.132*** (0.070)	**3.649**	**0.629*** (0.338)	**-0.247*** (0.131)	**-0.111*** (0.059)	**3.541**
8	**0.742*** (0.328)	**-0.327*** (0.137)	**-0.142*** (0.061)	**5.879**	**0.640*** (0.297)	**-0.265*** (0.115)	**-0.116*** (0.052)	**5.539**
9	**0.775***** (0.280)	**-0.332***** (0.117)	**-0.147***** (0.052)	**8.126**	**0.674***** (0.254)	**-0.268***** (0.098)	**-0.120***** (0.044)	**7.507**
10	**0.756***** (0.284)	**-0.317***** (0.118)	**-0.142***** (0.053)	**7.107**	**0.688***** (0.256)	**-0.268***** (0.098)	**-0.121***** (0.045)	**7.236**
11	**0.678***** (0.235)	**-0.284***** (0.096)	**-0.127***** (0.044)	**8.337**	**0.627***** (0.211)	**-0.243***** (0.081)	**-0.110***** (0.037)	**8.688**
12	**0.600***** (0.205)	**-0.247***** (0.085)	**-0.111***** (0.038)	**8.178**	**0.503***** (0.186)	**-0.190***** (0.071)	**-0.087***** (0.032)	**6.729**

Estimation results for dynamic models are shown in italics.
Numbers in parentheses are standard errors. *** and * denote statistically significant levels of 1% and 10% respectively, with significant statistics in bold.
Figures in the shaded columns are χ^2 test statistics of the H_0: Estimated coefficient of the future expected change of the short rate is equal to the risk premium. Statistics significant at 10% level are in bold.

[64] For dynamic ADL(1) models, instruments include a constant, CCV_{t-2}^k, R_t^n, R_{t-1}^n, r_t^1 and r_{t-1}^1.

Table 3-13.2 Regression Results: Effects of the U.S. Spot Yield Spread on Change in FTSE Volatility – Decomposition (Continued)

Two-Stage Least Square using a constant, R_t^n and r_t^1 as instruments

	24 -3 spread				60 - 3 spread				120 -3 spread			
k (months ahead)	$\hat{c}_0 / \hat{d}_0$	$\hat{c}_1 / \hat{d}_2$	$\hat{c}_2 / \hat{d}_4$	H_0 : $\hat{c}_1 = \hat{c}_2 / \hat{d}_2 = \hat{d}_4$	$\hat{c}_0 / \hat{d}_0$	$\hat{c}_1 / \hat{d}_2$	$\hat{c}_2 / \hat{d}_4$	H_0 : $\hat{c}_1 = \hat{c}_2 / \hat{d}_2 = \hat{d}_4$	$\hat{c}_0 / \hat{d}_0$	$\hat{c}_1 / \hat{d}_2$	$\hat{c}_2 / \hat{d}_4$	H_0 : $\hat{c}_1 = \hat{c}_2 / \hat{d}_2 = \hat{d}_4$
1	*0.080*	***6.590******	***3.506******		*0.081*	***2.521****	***1.307****		0.165	0.052	0.024	
	(2.136)	(1.551)	(0.846)	***15.924***	(1.848)	(1.154)	(0.695)	***4.390***	(0.908)	(0.231)	(0.121)	0.054
2	0.606	-0.215	-0.100		0.058	-0.012	-0.008		0.075	-0.013	-0.009	
	(0.850)	(0.293)	(0.137)	0.520	(0.741	(0.215)	(0.107)	0.002	(0.729)	(0.185)	(0.097)	0.001
3	0.562	-0.195	-0.092		0.134	-0.037	-0.019		0.145	-0.032	-0.019	
	(0.615)	(0.211)	(0.099)	0.807	(0.537)	(0.155)	(0.077)	0.048	(0.529)	(0.134)	(0.070)	0.041
4	0.513	-0.172	-0.082		0.293	-0.076	-0.040		0.252	-0.054	-0.032	
	(0.457)	(0.156)	(0.073)	1.128	(0.403)	(0.116)	(0.058)	0.336	(0.397)	(0.100)	(0.053)	0.198
5	0.453	-0.149	-0.072		0.225	-0.055	-0.030		0.217	-0.044	-0.027	
	(0.422)	(0.144)	(0.068)	0.983	(0.369)	(0.106)	(0.053)	0.203	(0.365)	(0.091)	(0.048)	0.133
6	0.420	-0.144	-0.067		0.209	-0.056	-0.028		0.206	-0.048	-0.026	
	(0.356)	(0.121)	(0.057)	1.373	(0.314)	(0.090)	(0.045)	0.338	(0.310)	(0.077)	(0.041)	0.327
7	0.479	-0.168	-0.078		0.221	-0.065	-0.031		0.292	-0.074	-0.039	
	(0.311)	(0.106)	(0.050)	2.516	(0.275)	(0.078)	(0.039)	0.668	(0.272)	(0.068)	(0.036)	1.096
8	0.409	**-0.155***	-0.068		0.096	-0.038	-0.015		0.219	-0.062	-0.030	
	(0.273)	(0.093)	(0.044)	**2.942**	(0.243)	(0.069)	(0.035)	0.395	(0.240)	(0.060)	(0.032)	1.121
9	**0.423***	**-0.146***	**-0.067***		0.183	-0.055	-0.026		0.197	-0.050	-0.026	
	(0.235)	(0.080)	(0.038)	**3.360**	(0.211)	(0.060)	(0.030)	0.815	(0.209)	(0.052)	(0.028)	0.835
10	**0.441***	**-0.152***	**-0.071***		0.236	-0.063	-0.033		0.213	-0.050	-0.027	
	(0.237)	(0.080)	(0.038)	**3.465**	(0.212)	(0.060)	(0.030)	0.947	(0.211)	(0.052)	(0.028)	0.725
11	**0.439***	**-0.149***	**-0.070***		0.177	-0.048	-0.024		0.215	-0.050	-0.028	
	(0.198)	(0.067)	(0.032)	**4.778**	(0.179)	(0.050)	(0.025)	0.774	(0.178)	(0.044)	(0.023)	1.032
12	**0.342***	**-0.111***	**-0.054***		0.144	-0.036	-0.019		0.175	-0.037	-0.022	
	(0.174)	(0.059)	(0.028)	**3.257**	(0.158)	(0.044)	(0.022)	0.510	(0.157)	(0.039)	(0.021)	0.652

Estimation results for dynamic models are shown in italics.
Numbers in parentheses are standard errors. *** and * denote statistically significant levels of 1% and 10% respectively, with significant statistics in bold.
Figures in the shaded columns are χ^2 test statistics of the H_0 : Estimated coefficient of the future expected change of the short rate is equal to the risk premium. Statistics significant at 10% level are in bold.

Table 3-14.1 Regression Results: Effects of the U.S. Spot Yield Spread on Change in S&P Volatility -- Decomposition

Two-Stage Least Square using a constant, R_t^n and r_t^1 as instruments[65]

	6 – 3 spread				12 – 3 spread			
k (months ahead)	$\hat{c}_0 / \hat{d}_0$	$\hat{c}_1 / \hat{d}_2$	$\hat{c}_2 / \hat{d}_4$	H_0 : $\hat{c}_1 = \hat{c}_2$ / $\hat{d}_2 = \hat{d}_4$	$\hat{c}_0 / \hat{d}_0$	$\hat{c}_1 / \hat{d}_2$	$\hat{c}_2 / \hat{d}_4$	H_0 : $\hat{c}_1 = \hat{c}_2$ / $\hat{d}_2 = \hat{d}_4$
1	0.012	-0.012	-0.002		0.067	-0.035	-0.012	
	(0.651)	(0.274)	(0.122)	0.005	(0.585)	(0.228)	(0.103)	0.033
2	0.145	-0.063	-0.026		0.297	-0.121	-0.053	
	(0.664)	(0.279)	(0.125)	0.056	(0.601)	(0.234)	(0.106)	0.278
3	0.156	-0.058	-0.026		0.315	-0.117	-0.054	
	(0.536)	(0.224)	(0.100)	0.062	(0.485)	(0.189)	(0.085)	0.367
4	0.162	-0.064	-0.028		0.301	-0.116	-0.051	
	(0.436)	(0.182)	(0.081)	0.128	(0.394)	(0.153)	(0.069)	0.581
5	0.153	-0.061	-0.026		0.310	-0.119	-0.053	
	(0.376)	(0.156)	(0.070)	0.163	(0.341)	(0.132)	(0.060)	0.838
6	0.167	-0.067	-0.029		0.330	-0.129	-0.057	
	(0.305)	(0.127)	(0.057)	0.302	(0.277)	(0.107)	(0.049)	1.505
7	0.340	-0.141	-0.062		**0.515***	**-0.202***	**-0.090***	
	(0.285)	(0.118)	(0.053)	1.468	(0.260)	(0.100)	(0.046)	**4.085**
8	0.336	-0.139	-0.062		**0.547***	**-0.213***	**-0.096***	
	(0.249)	(0.103)	(0.046)	1.827	(0.227)	(0.087)	(0.040)	**5.952**
9	0.315	-0.130	-0.057		**0.501***	**-0.192***	**-0.087***	
	(0.236)	(0.098)	(0.044)	1.796	(0.213)	(0.082)	(0.037)	**5.408**
10	0.185	-0.075	-0.033		**0.354***	**-0.137***	**-0.061***	
	(0.221)	(0.091)	(0.041)	0.692	(0.197)	(0.076)	(0.035)	**3.289**
11	0.144	-0.059	-0.026		**0.306***	**-0.119***	**-0.053***	
	(0.203)	(0.084)	(0.038)	0.519	(0.183)	(0.070)	(0.032)	**2.893**
12	0.182	-0.075	-0.033		**0.307***	**-0.118***	**-0.053***	
	(0.198)	(0.081)	(0.037)	0.870	(0.177)	(0.068)	(0.031)	**3.049**

Estimation results for dynamic models are shown in italics.
Numbers in parentheses are standard errors. *** and * denote statistically significant levels of 1% and 10% respectively, with significant statistics in bold.
Figures in the shaded columns are χ^2 test statistics of the H_0: Estimated coefficient of the future expected change of the short rate is equal to the risk premium. Statistics significant at 10% level are in bold.

[65] For dynamic ADL(1) models, instruments include a constant, CCV_{t-2}^k, R_t^n, R_{t-1}^n, r_t^1 and r_{t-1}^1.

Table 3-14.2 Regression Results: Effects of the U.S. Spot Yield Spread on Change in S&P Volatility – Decomposition (Continued)

Two-Stage Least Square using a constant, R_t^n and r_t^1 as instruments

	24 -3 spread				60 - 3 spread				120 -3 spread			
k (months ahead)	$\hat{c}_0 / \hat{d}_0$	$\hat{c}_1 / \hat{d}_2$	$\hat{c}_2 / \hat{d}_4$	H_0 : $\hat{c}_1 = \hat{c}_2 / \hat{d}_2 = \hat{d}_4$	$\hat{c}_0 / \hat{d}_0$	$\hat{c}_1 / \hat{d}_2$	$\hat{c}_2 / \hat{d}_4$	H_0 : $\hat{c}_1 = \hat{c}_2 / \hat{d}_2 = \hat{d}_4$	$\hat{c}_0 / \hat{d}_0$	$\hat{c}_1 / \hat{d}_2$	$\hat{c}_2 / \hat{d}_4$	H_0 : $\hat{c}_1 = \hat{c}_2 / \hat{d}_2 = \hat{d}_4$
1	0.134	-0.052	-0.022		0.223	-0.068	-0.032		0.288	-0.077	-0.039	
	(0.534)	(0.184)	(0.086)	0.093	(0.471)	(0.137)	(0.068)	0.252	(0.462)	(0.118)	(0.062)	0.394
2	0.236	-0.084	-0.038		0.248	-0.073	-0.035		0.286	-0.072	-0.038	
	(0.543)	(0.187)	(0.088)	0.209	(0.470)	(0.136)	(0.068)	0.271	(0.463)	(0.118)	(0.062)	0.319
3	0.311	-0.100	-0.048		0.400	-0.110	-0.057		0.356	-0.085	-0.047	
	(0.438)	(0.150)	(0.071)	0.397	(0.377)	(0.109)	(0.054)	0.864	(0.372)	(0.094)	(0.050)	0.646
4	0.314	-0.106	-0.049		0.402	-0.114	-0.057		0.418	-0.103	-0.055	
	(0.356)	(0.122)	(0.057)	0.744	(0.306)	(0.088)	(0.044)	1.501	(0.303)	(0.076)	(0.040)	1.550
5	0.359	-0.122	-0.056		0.421	-0.119	-0.059		**0.458***	**-0.112***	**-0.060***	
	(0.307)	(0.105)	(0.049)	1.334	(0.260)	(0.074)	(0.037)	2.337	(0.258)	(0.064)	(0.034)	2.583
6	0.376	-0.129	-0.059		**0.395***	**-0.113***	**-0.056***		**0.415***	**-0.103***	**-0.054***	
	(0.249)	(0.085)	(0.040)	2.322	(0.211)	(0.060)	(0.030)	**3.238**	(0.209)	(0.052)	(0.028)	**3.491**
7	**0.507***	**-0.174***	**-0.081***		**0.465***	**-0.133***	**-0.066***		**0.495*****	**-0.122***	**-0.065***	
	(0.230)	(0.078)	(0.037)	**4.955**	(0.191)	(0.054)	(0.027)	**5.488**	(0.190)	(0.047)	(0.025)	**5.738**
8	**0.530*****	**-0.181*****	**-0.085*****		**0.480*****	**-0.137*****	**-0.069*****		**0.467*****	**-0.115*****	**-0.062*****	
	(0.200)	(0.068)	(0.032)	**6.925**	(0.167)	(0.047)	(0.024)	**7.540**	(0.166)	(0.041)	(0.022)	**6.706**
9	**0.504*****	**-0.169*****	**-0.080*****		**0.513*****	**-0.143*****	**-0.073*****		**0.489*****	**-0.119*****	**-0.064*****	
	(0.188)	(0.064)	(0.030)	**6.750**	(0.157)	(0.045)	(0.022)	**9.054**	(0.157)	(0.039)	(0.021)	**7.835**
10	**0.393***	**-0.133***	**-0.062***		**0.393*****	**-0.111*****	**-0.056*****		**0.438*****	**-0.107*****	**-0.057*****	
	(0.176)	(0.059)	(0.028)	**4.874**	(0.147)	(0.042)	(0.021)	**6.507**	(0.147)	(0.036)	(0.019)	**7.444**
11	**0.327***	**-0.111***	**-0.052***		**0.335***	**-0.095***	**-0.048***		**0.370*****	**-0.090*****	**-0.049*****	
	(0.163)	(0.055)	(0.026)	**4.012**	(0.137)	(0.039)	(0.019)	**5.443**	(0.137)	(0.034)	(0.018)	**6.135**
12	**0.325***	**-0.110***	**-0.052***		**0.324***	**-0.091***	**-0.046***		**0.346*****	**-0.084*****	**-0.045*****	
	(0.158)	(0.053)	(0.025)	**4.138**	(0.131)	(0.037)	(0.019)	**5.427**	(0.132)	(0.032)	(0.017)	**5.772**

Estimation results for dynamic models are shown in italics.
Numbers in parentheses are standard errors. *** and * denote statistically significant levels of 1% and 10% respectively, with significant statistics in bold.
Figures in the shaded columns are χ^2 test statistics of the H_0: Estimated coefficient of the future expected change of the short rate is equal to the risk premium. Statistics significant at 10% level are in bold.

Figure 3-1 U.S. Spot Yield Curve

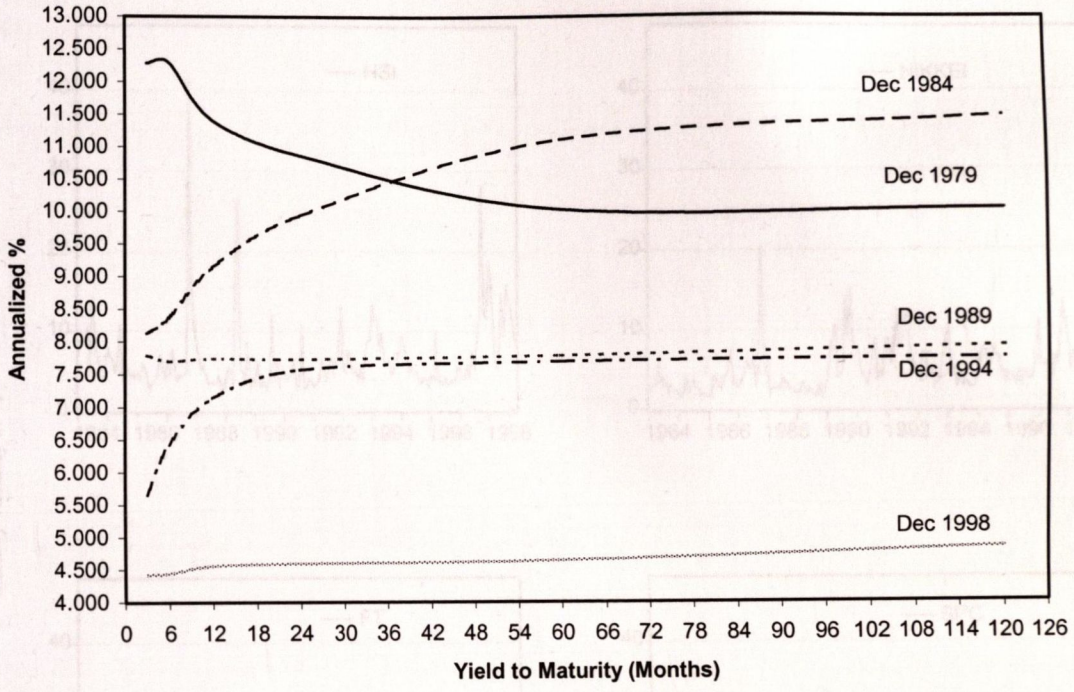


Figure 3-2 Monthly Stock market volatility

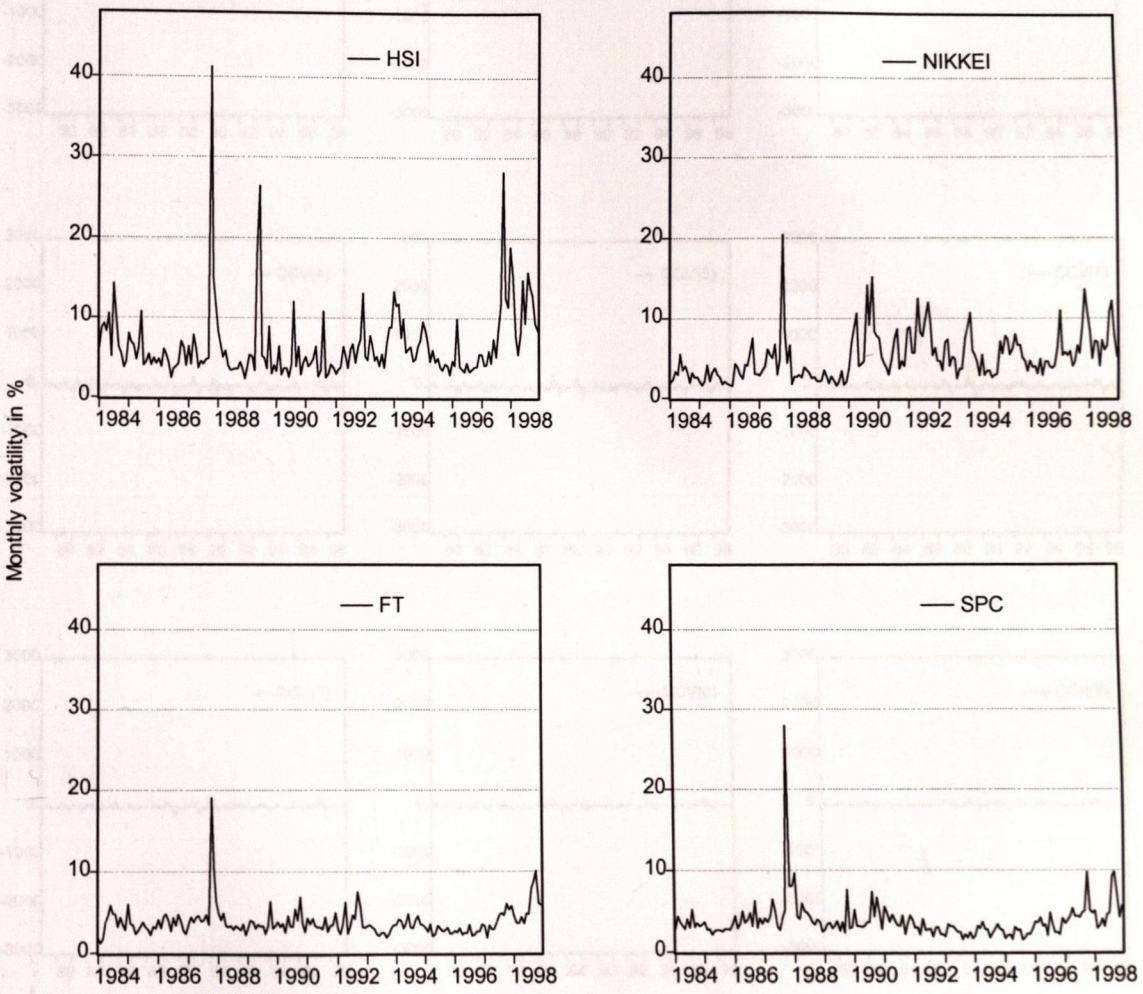


Figure 3-3.1 HSI - Annualised cumulative volatility change in %

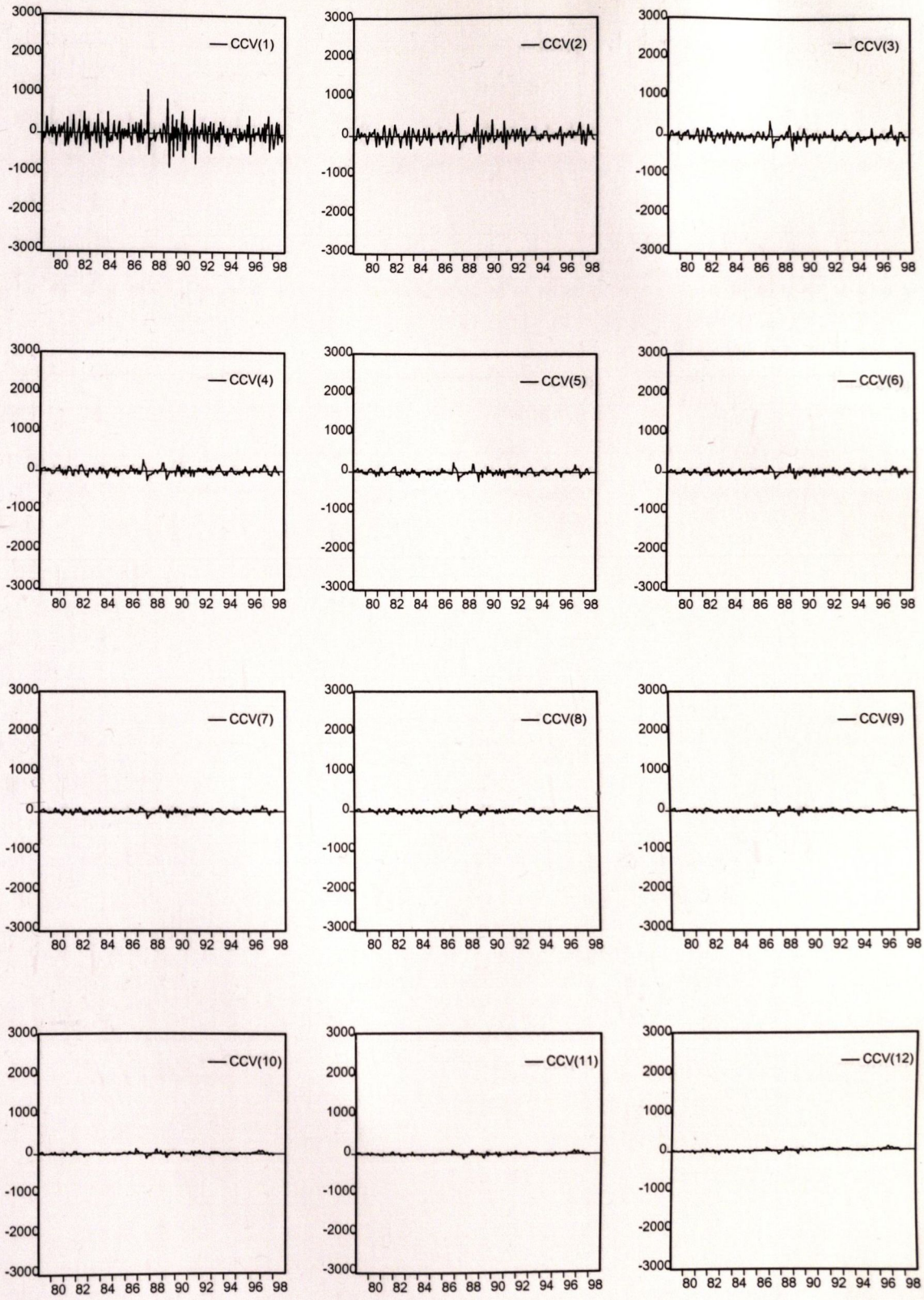


Figure 3-3.2 Nikkei - Annualised cumulative volatility change in %

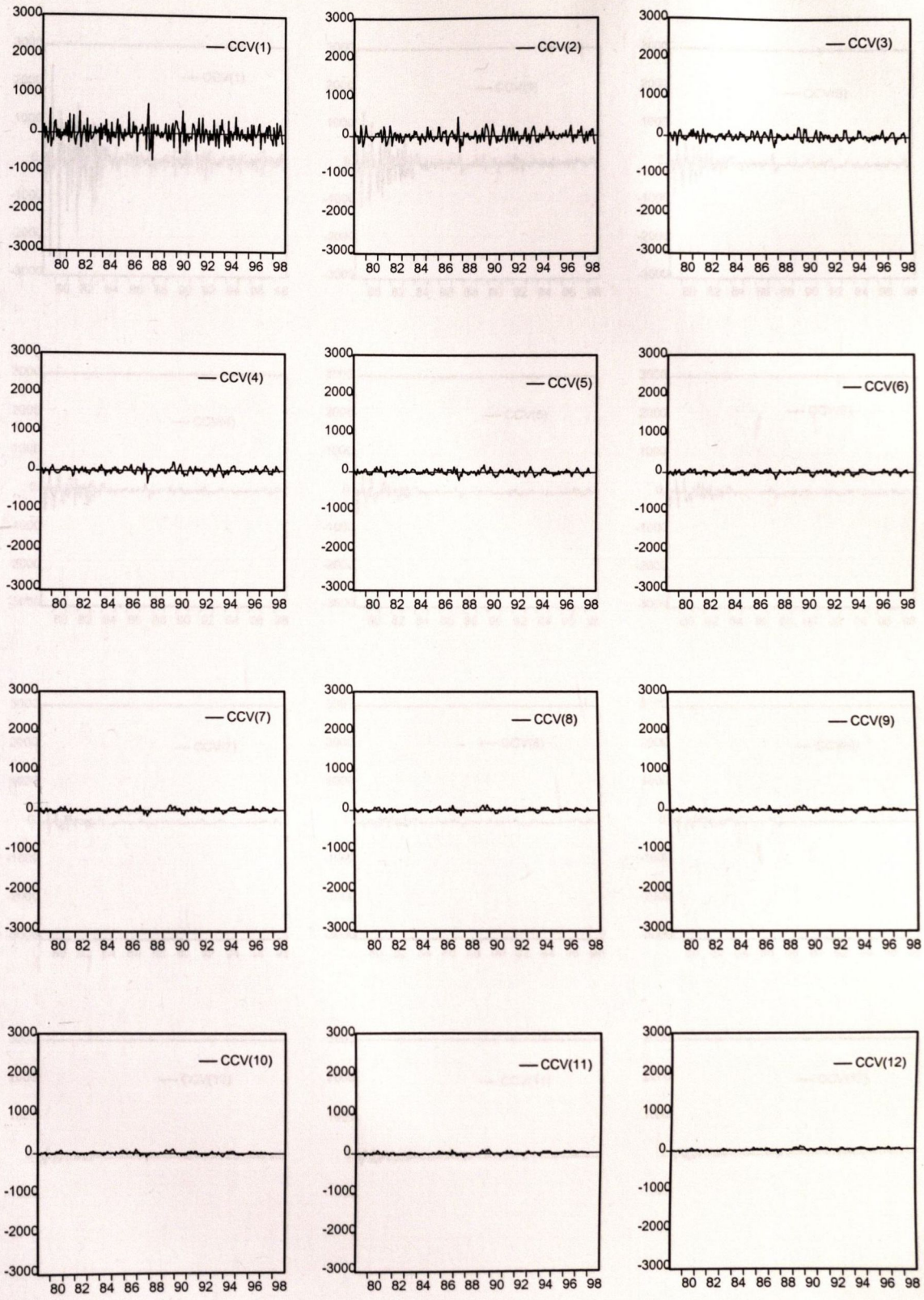


Figure 3-3.3 FTSE - Annualised cumulative volatility change in %

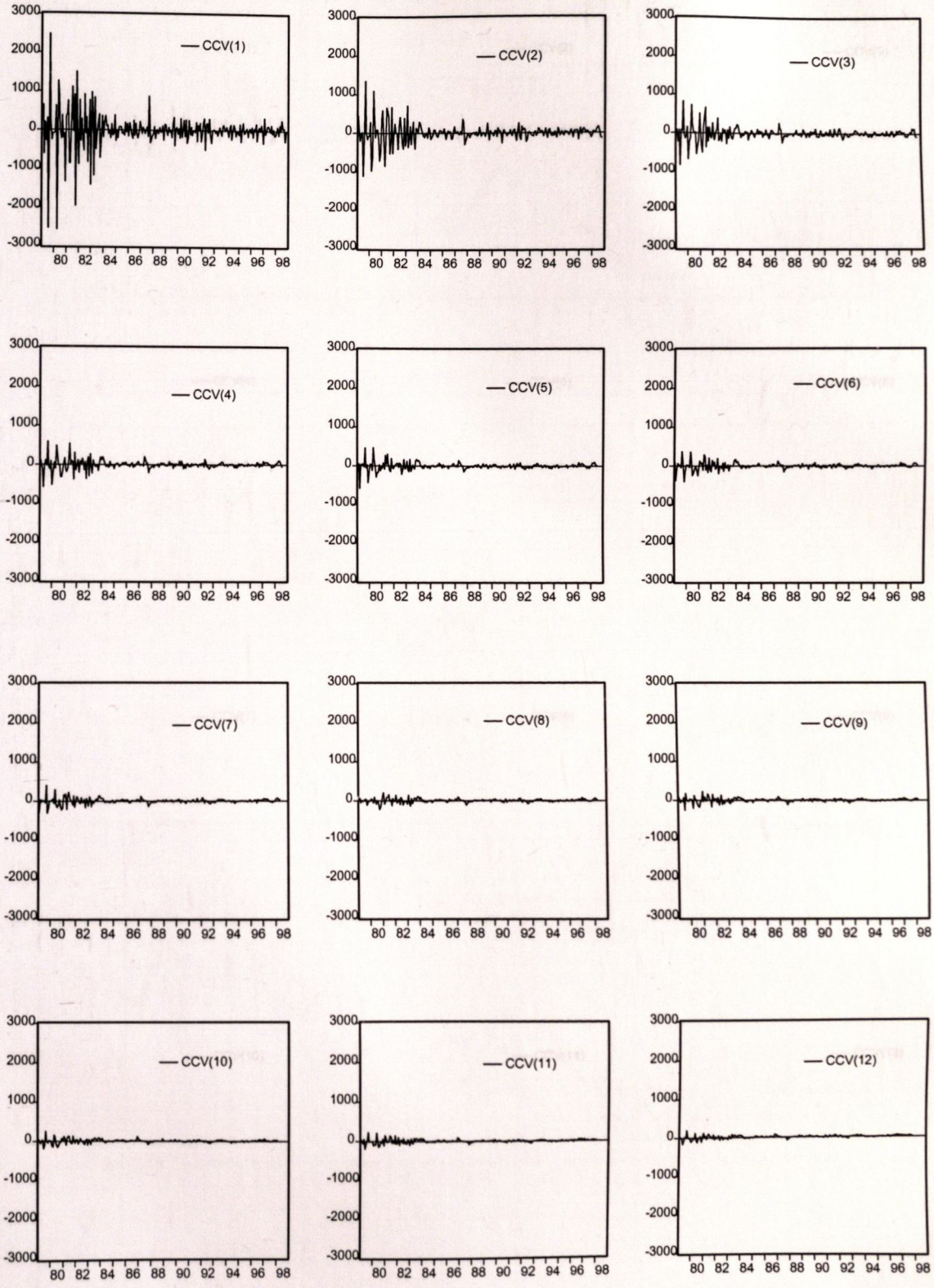


Figure 3-3.4 S&P - Annualised cumulative volatility change in %

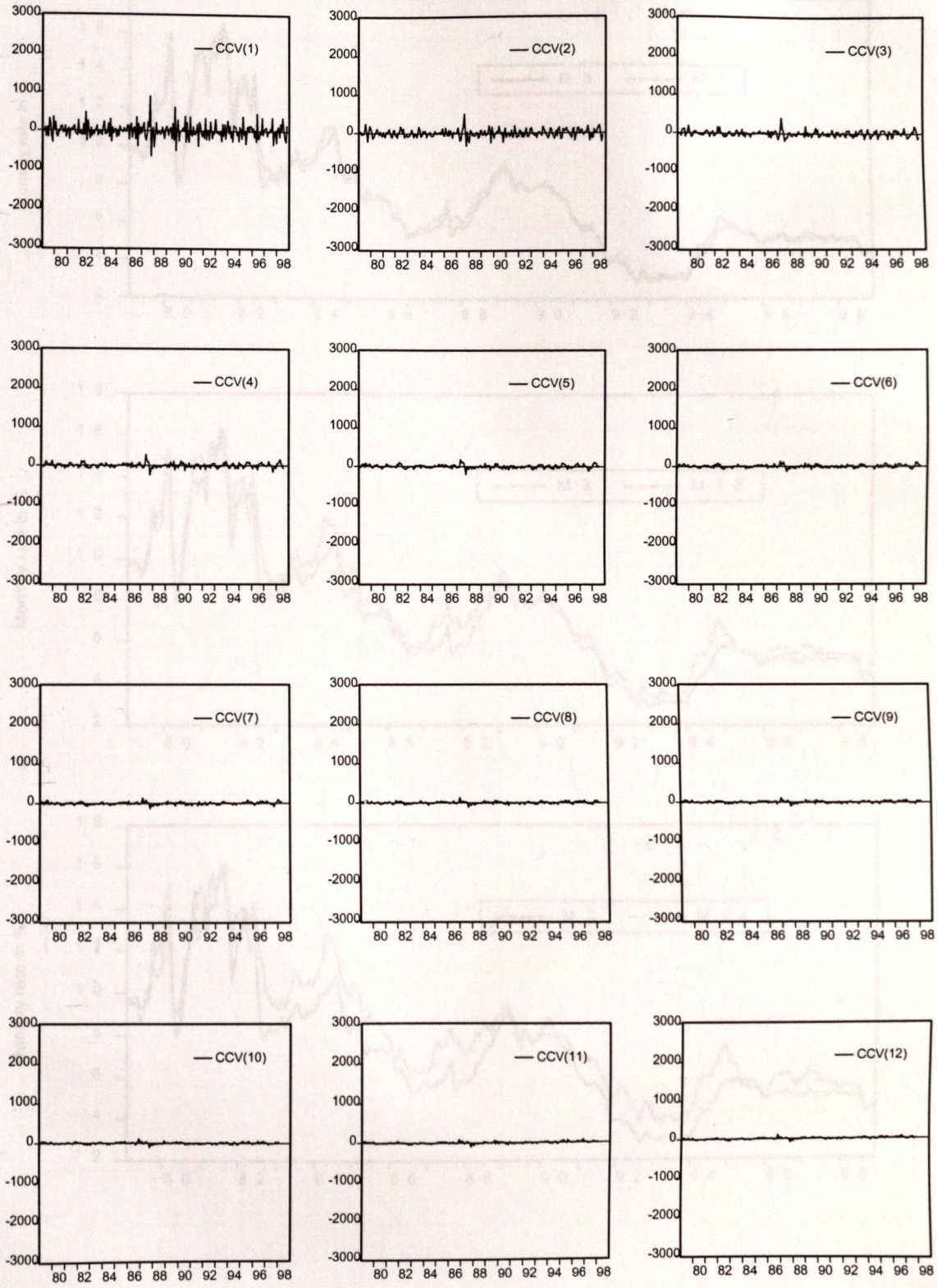


Figure 3-4.1 U. S. Zero Coupon Rates February 1979 to December 1998

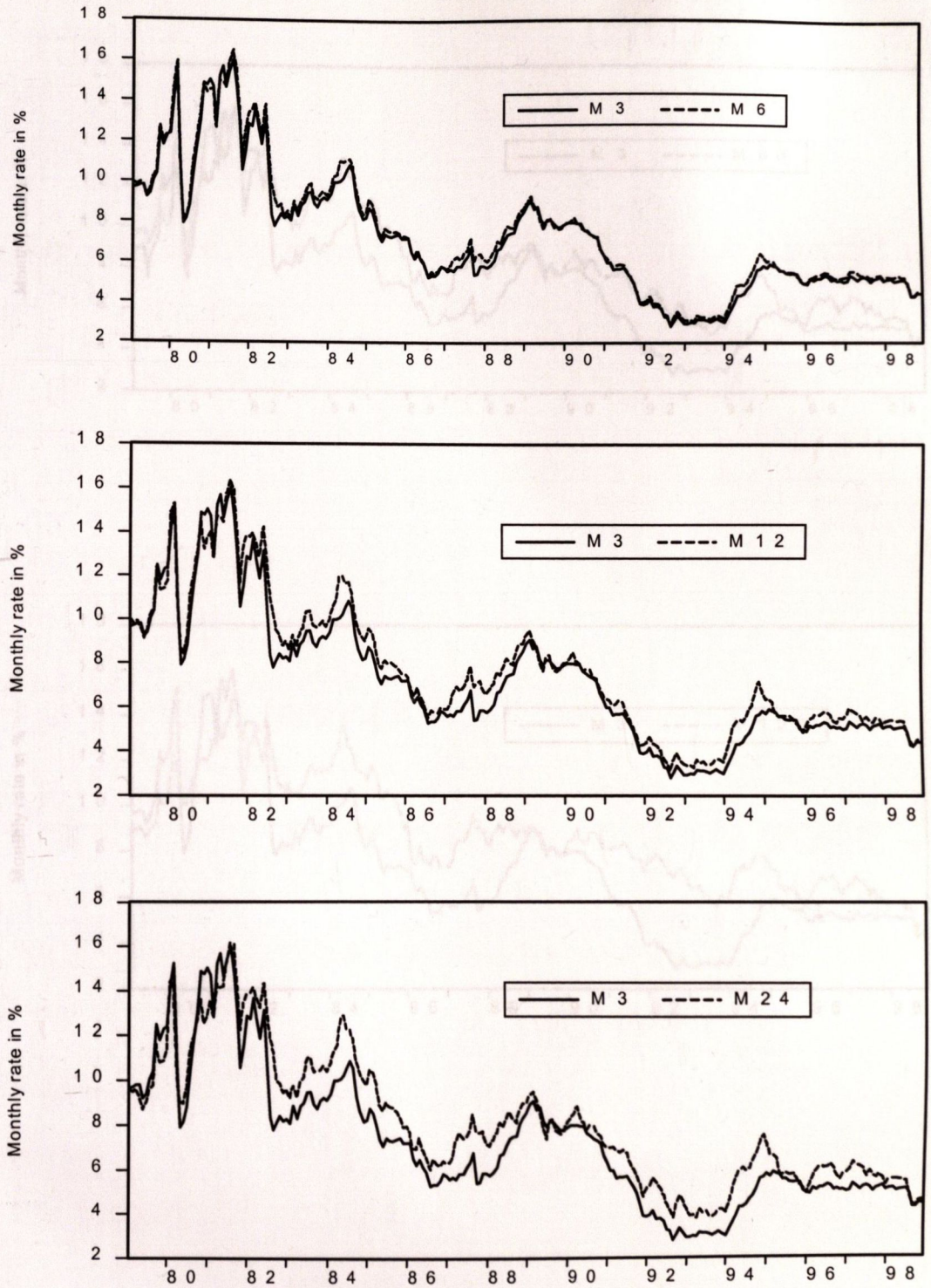


Figure 3-4.2 U. S. Zero Coupon Rates February 1979 to December 1998

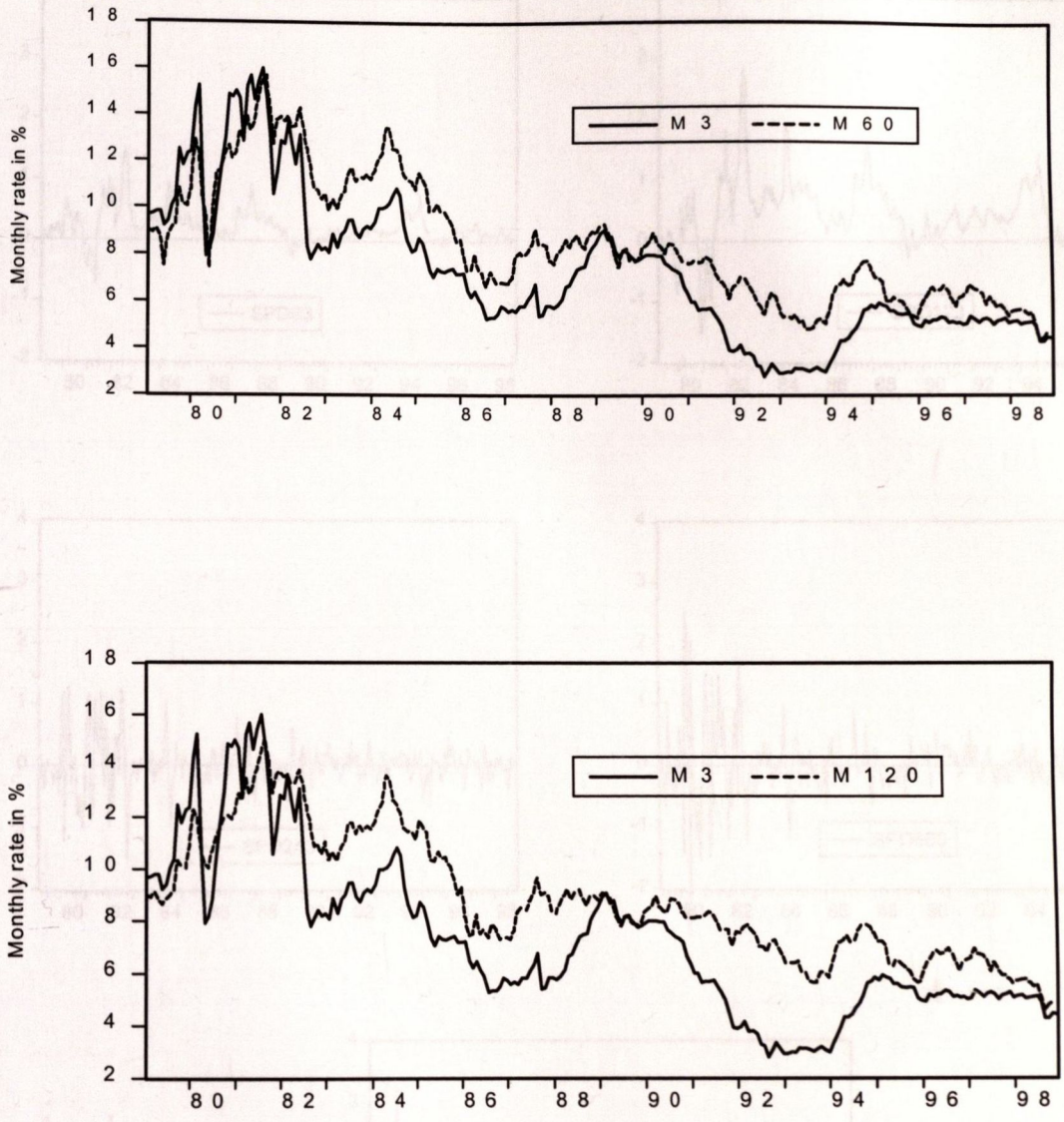


Figure 3-5 U.S. spot yield spread 1979 - 1998

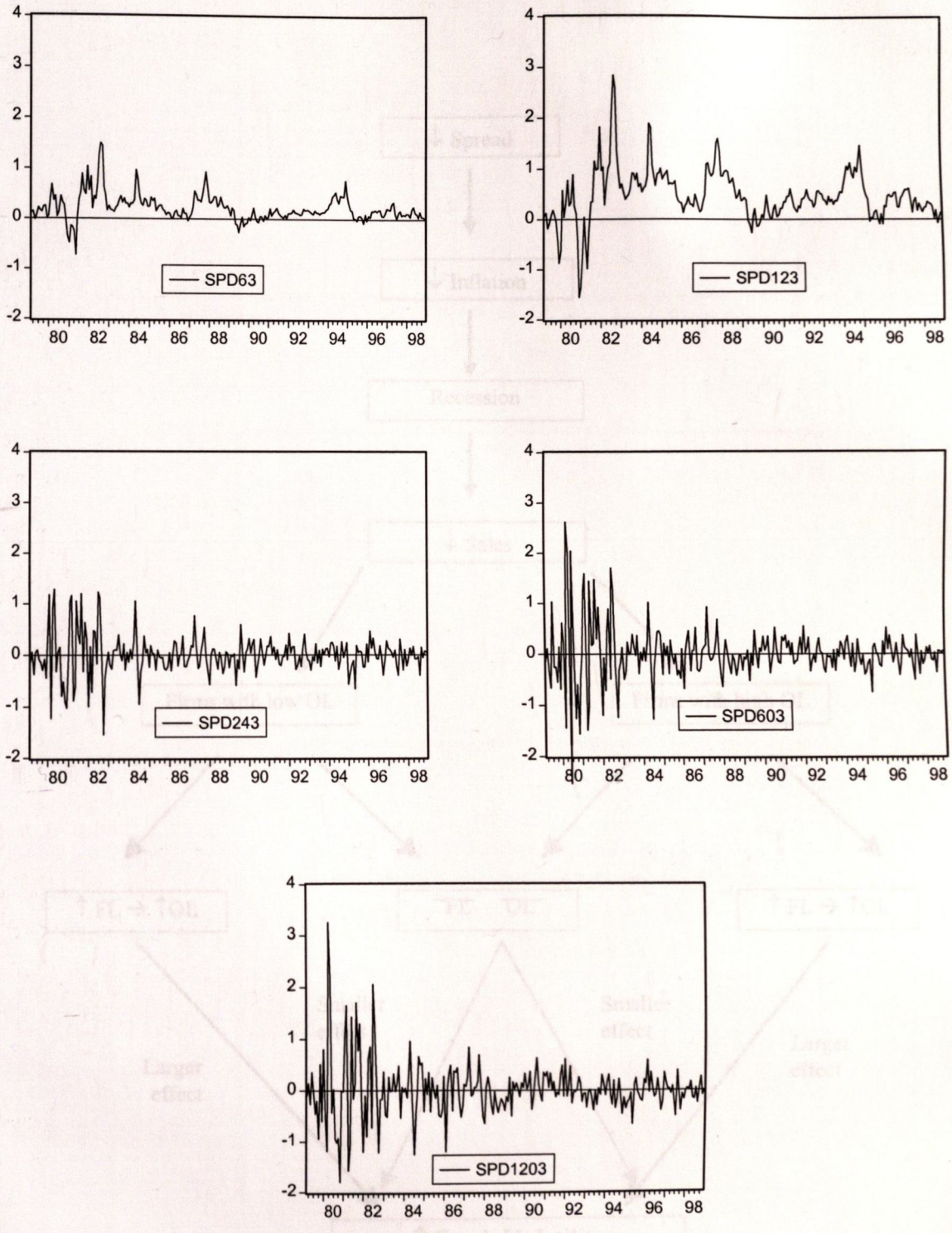


Figure 3-6 Business Leverage Effect

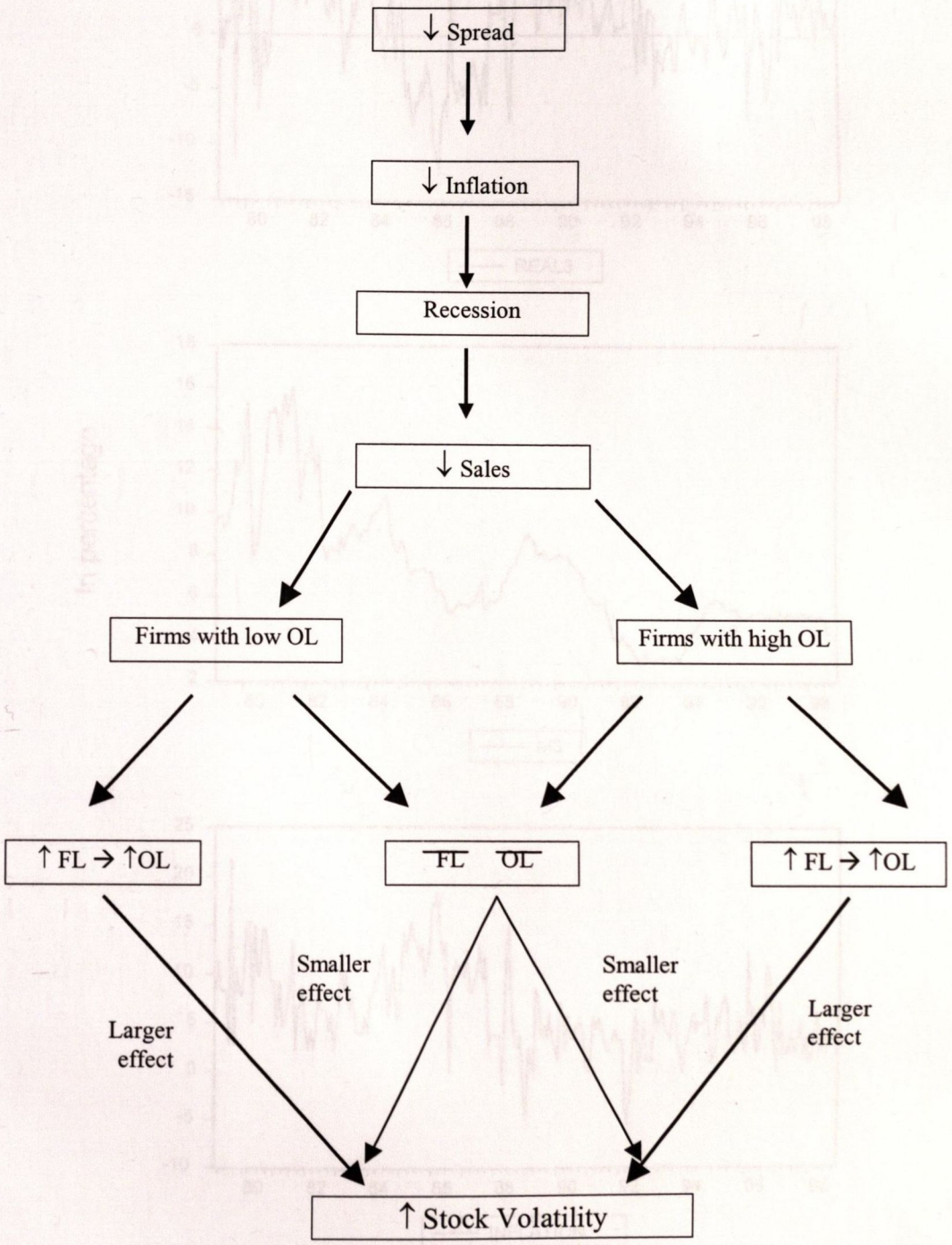


Figure 3-7.1 U.S. 3 month real rate of interest, inflation and nominal interest rate

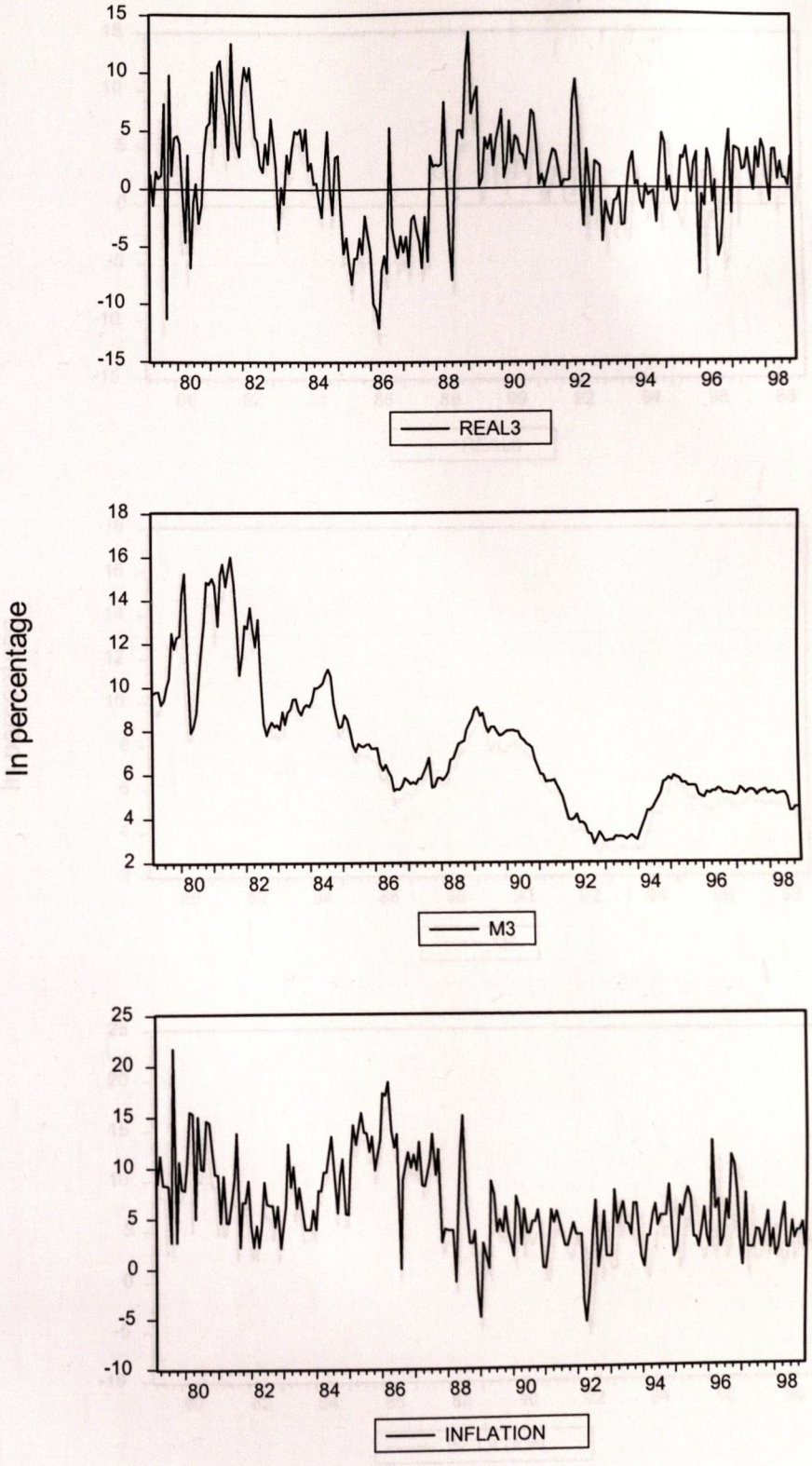


Figure 3-7.2 U.S. 6 month real rate of interest, inflation and nominal interest rate

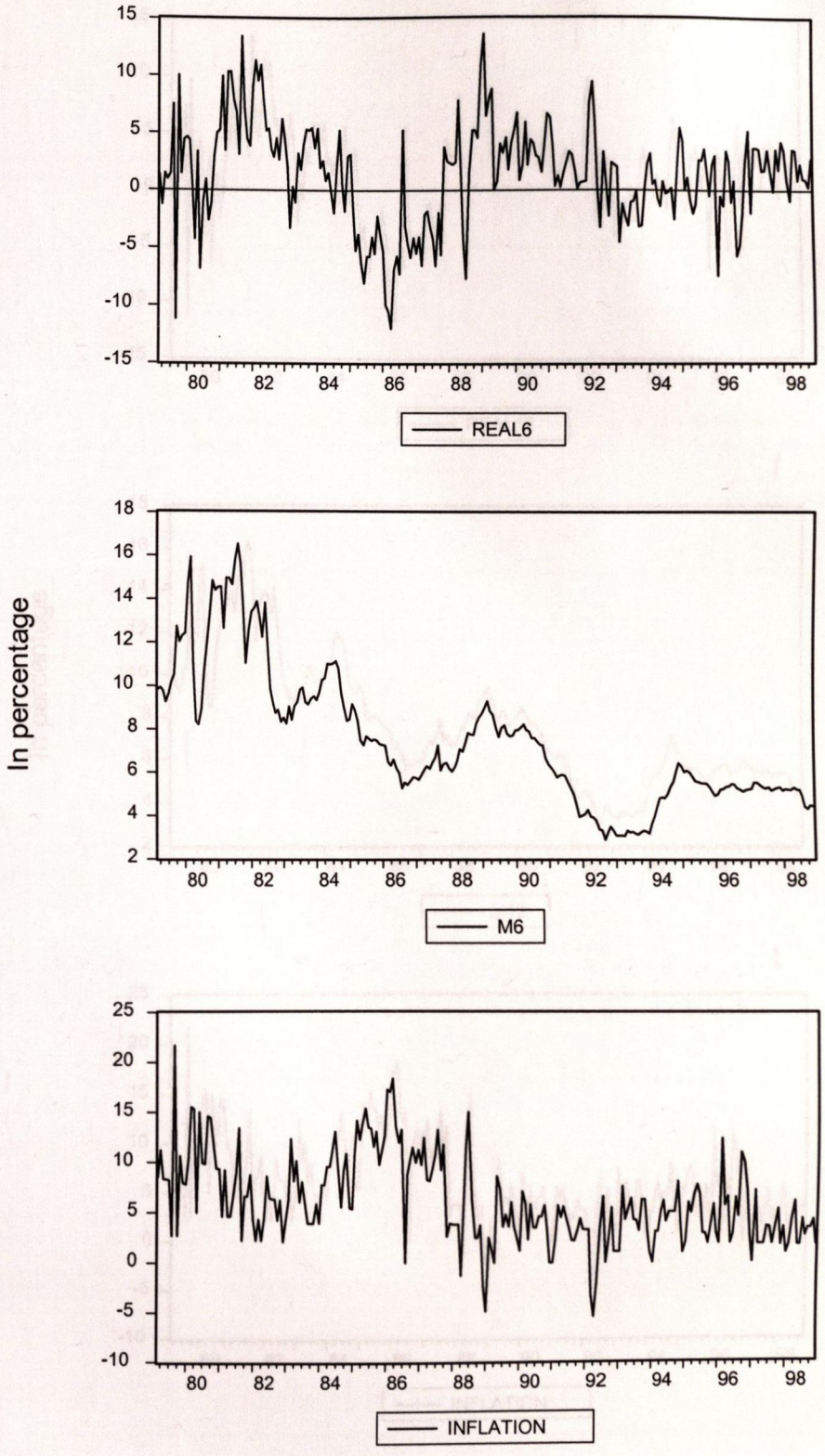


Figure 3-7.3 U.S. 12 month real rate of interest, inflation and nominal interest rate

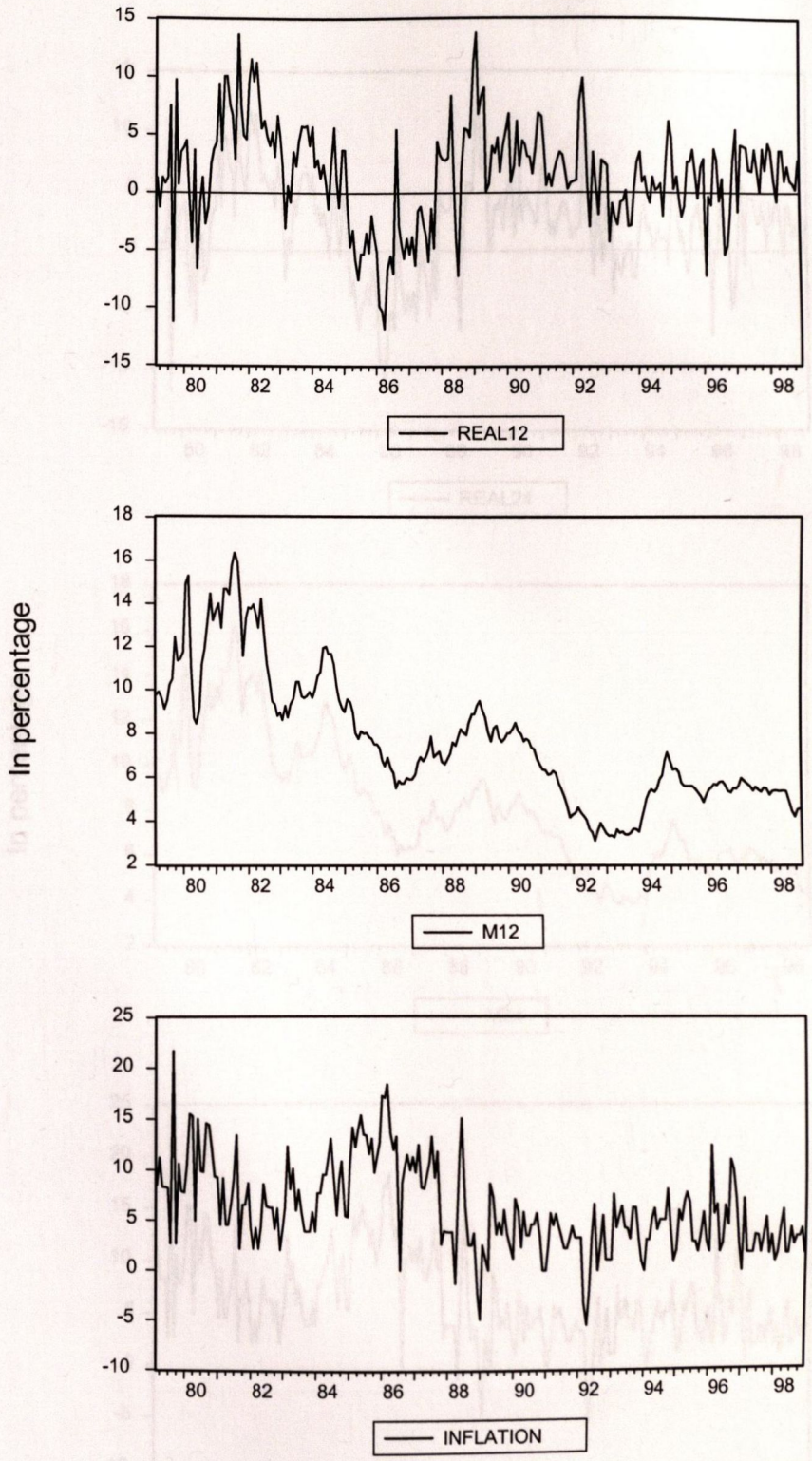


Figure 3-7.4 U.S. 24 month real rate of interest, inflation and nominal interest rate

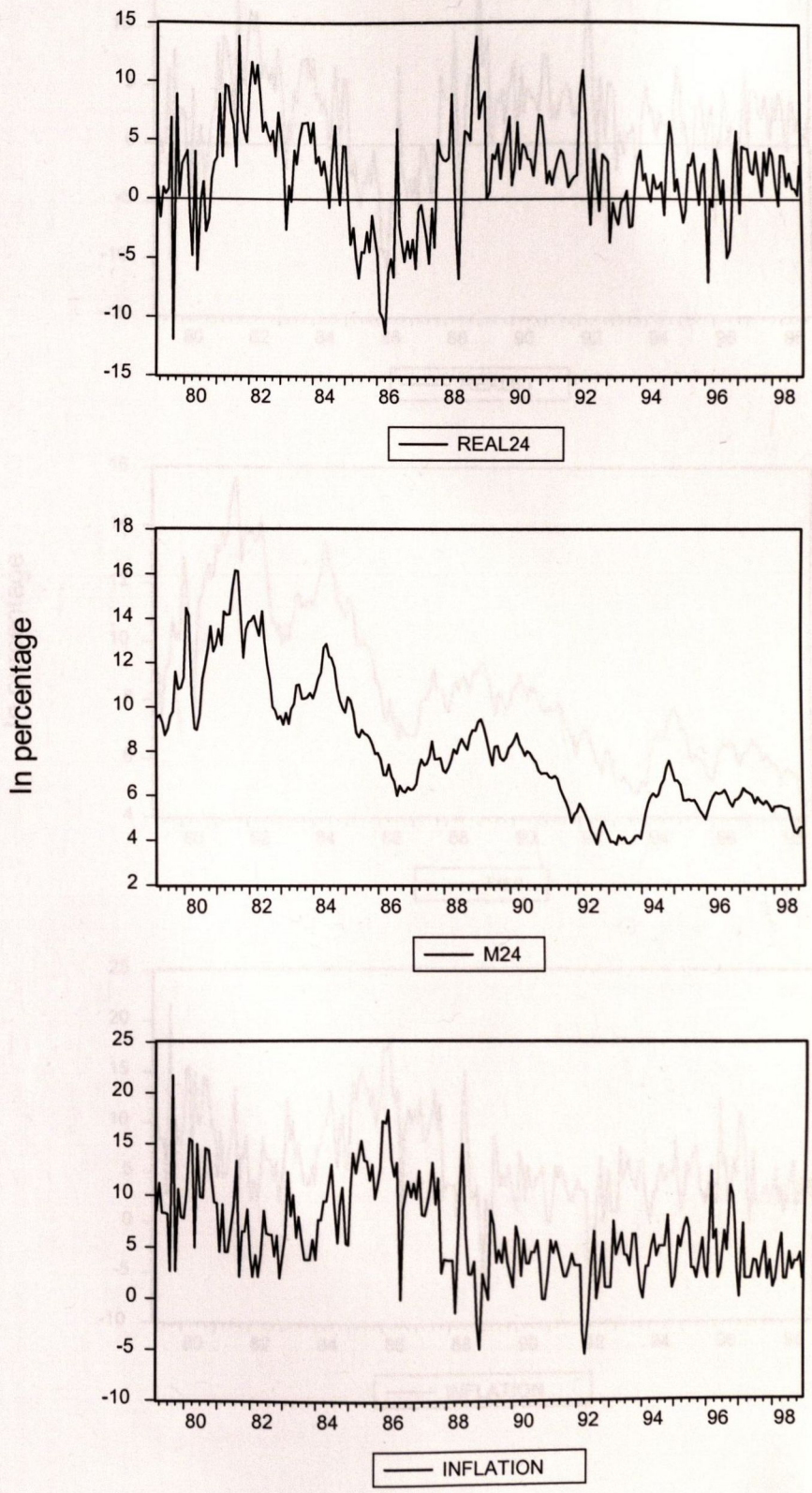


Figure 3-7.5 U.S. 60 month real rate of interest, inflation and nominal interest rate

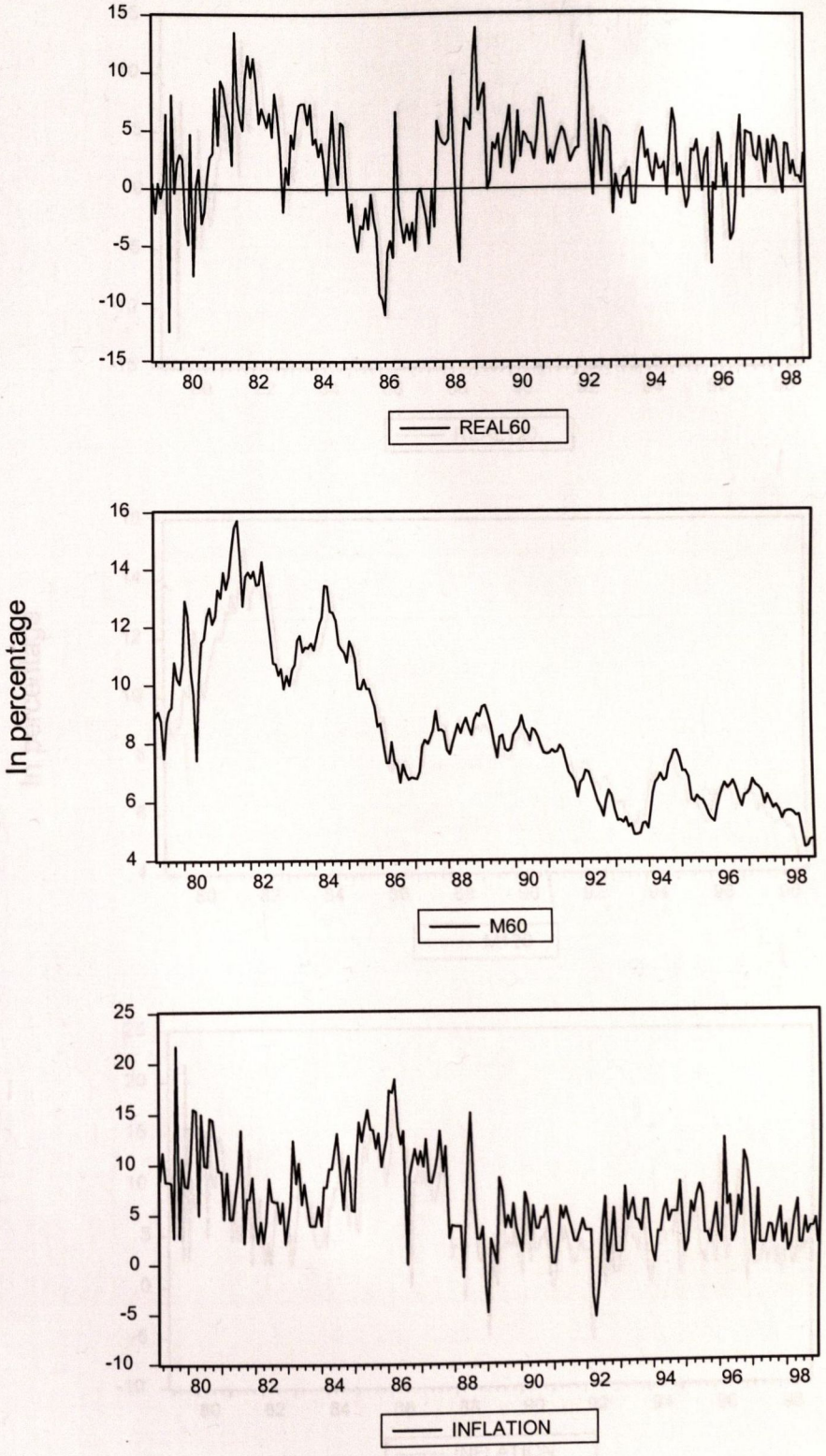


Figure 3-7.6 U.S. 120 month real rate of interest, inflation and nominal interest rate

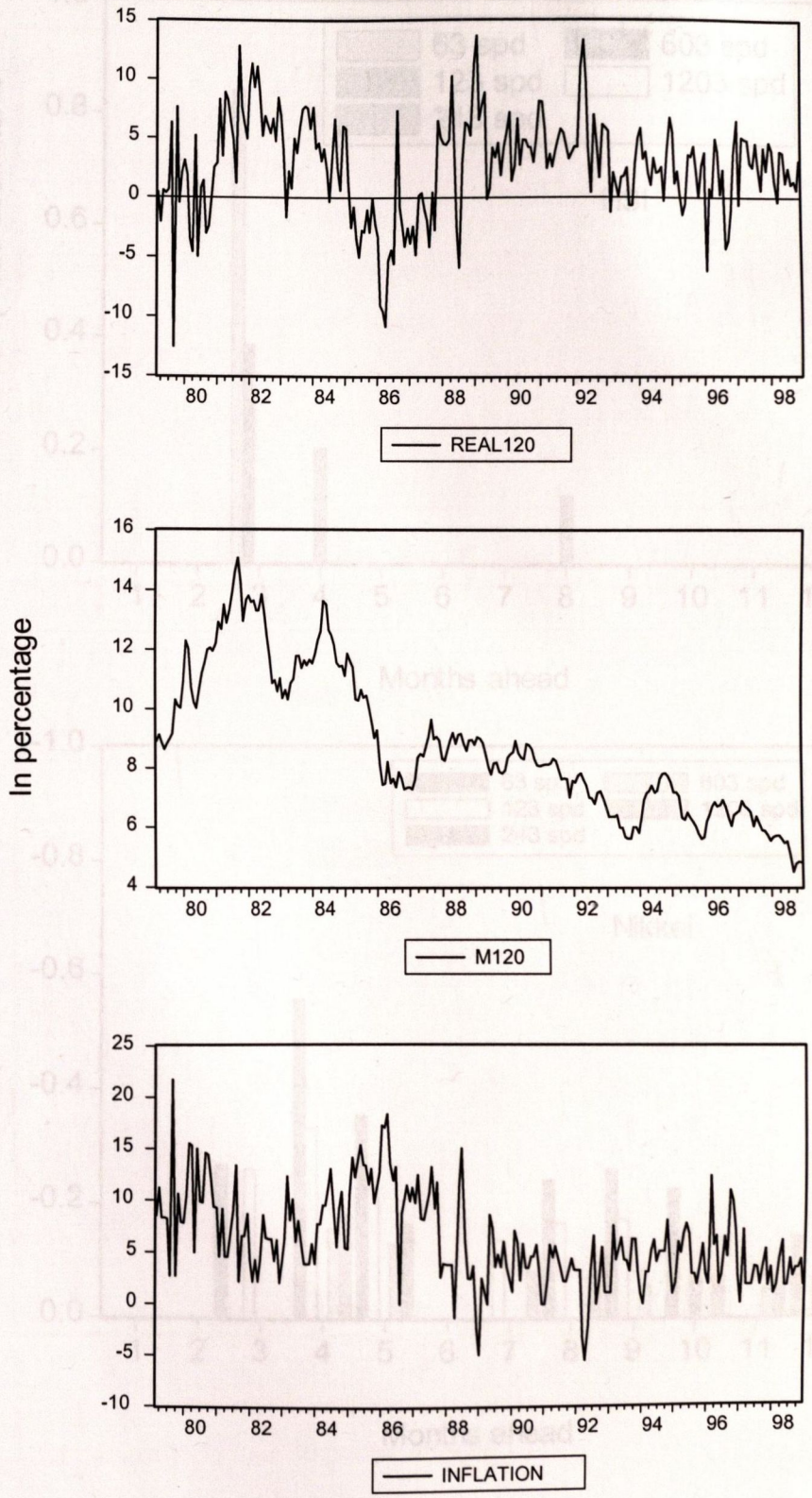
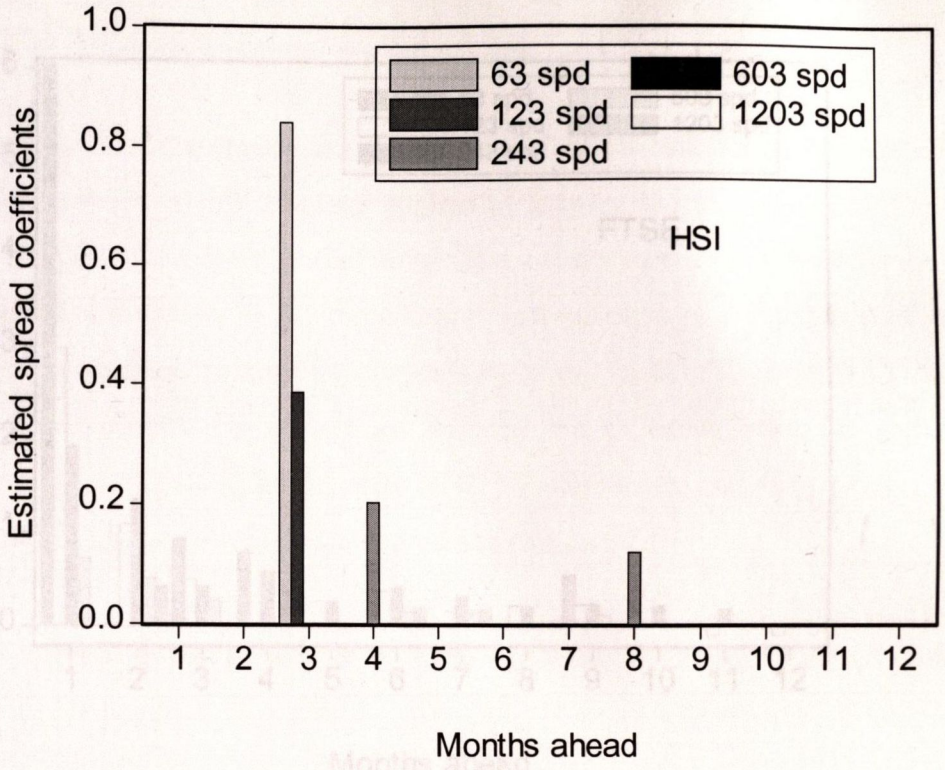


Figure 3-8.1 Effects of the U.S. spot yield spread on change in stock market volatility



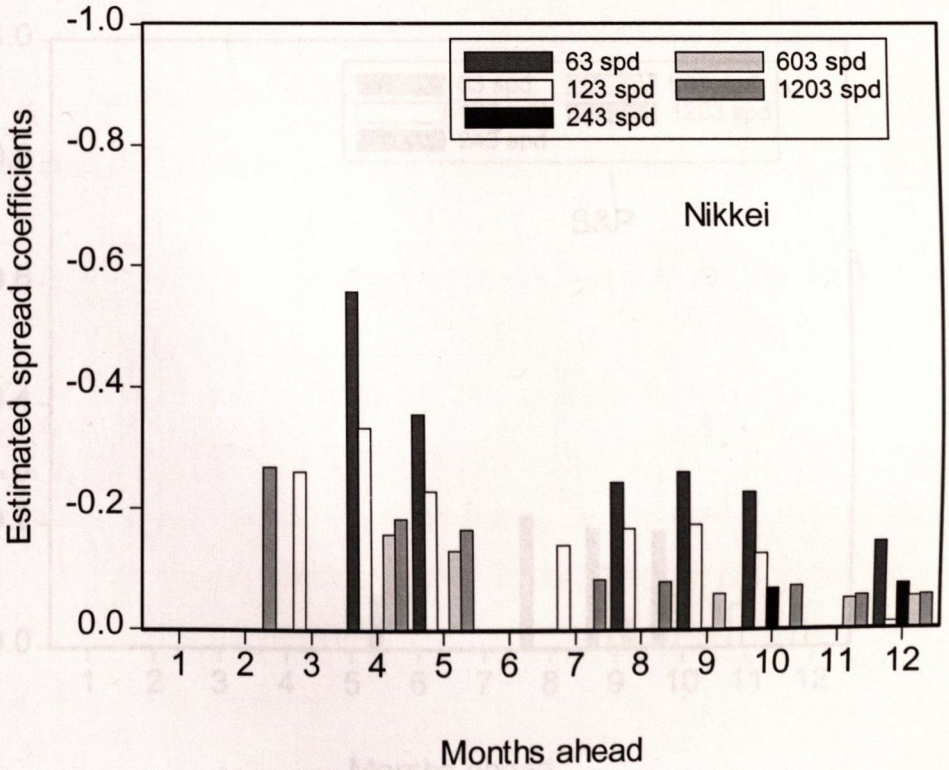
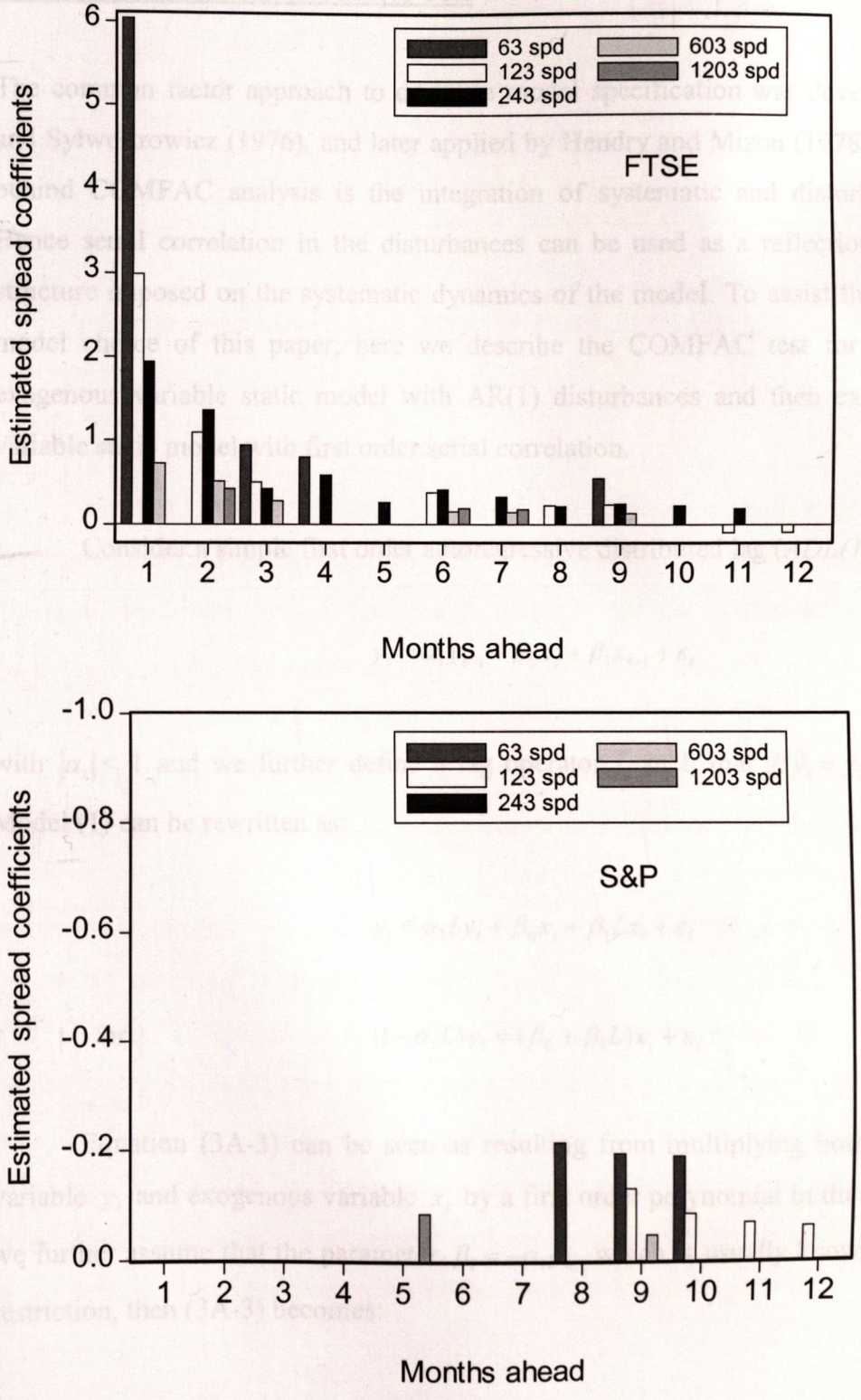


Figure 3-8.2 Effects of the U.S. spot yield spread on change in stock market volatility



Appendix 3A

The COMFAC (Common Factor) Test

The common factor approach to dynamic model specification was developed by Sargan and Sylwestrowicz (1976), and later applied by Hendry and Mizon (1978). The basic idea behind COMFAC analysis is the integration of systematic and disturbance dynamics. Hence serial correlation in the disturbances can be used as a reflection of a particular structure imposed on the systematic dynamics of the model. To assist the clarification of model choice of this paper, here we describe the COMFAC test for a simple single exogenous variable static model with AR(1) disturbances and then extend it to a two variable static model with first order serial correlation.

Consider a simple first order autoregressive distributed lag (*ADL(1)*) model

$$y_t = \alpha_1 y_{t-1} + \beta_0 x_t + \beta_1 x_{t-1} + \varepsilon_t \tag{3A-1}$$

with $|\alpha_1| < 1$ and we further define a lag operator L such that $L^i y_t = y_{t-i}$ and $L^i x_t = x_{t-i}$. Model (1) can be rewritten as:

$$y_t = \alpha_1 L y_t + \beta_0 x_t + \beta_1 L x_t + \varepsilon_t \tag{3A-2}$$

or

$$(1-\alpha_1 L) y_t = (\beta_0 + \beta_1 L) x_t + \varepsilon_t \tag{3A-3}$$

Equation (3A-3) can be seen as resulting from multiplying both the endogenous variable y_t and exogenous variable x_t by a first order polynomial in the lag operator L. If we further assume that the parameter $\beta_1 = -\alpha_1 \beta_0$, which is usually known as a COMFAC restriction, then (3A-3) becomes:

$$(1-\alpha_1 L) y_t = \beta_0 (1-\alpha_1 L) x_t + \varepsilon_t \tag{3A-4}$$

In this case, we say that both y_t and x_t have a common factor of $(1-\alpha_1 L)$. Dividing both sides of (3A-4) by this common factor gives us the following:

$$y_t = \beta_0 x_t + \frac{\varepsilon_t}{(1-\alpha_1 L)} = \beta_0 x_t + \nu_t \tag{3A-5}$$

where

$$\nu_t = \frac{\varepsilon_t}{(1-\alpha_1 L)}$$

or

$$\nu_t = \alpha_1 \nu_{t-1} + \varepsilon_t \tag{3A-6}$$

Equation (3A-6) can easily be seen as a disturbance term generated by a first order autoregressive process. In other words, if (3A-1) with one period lagged variables satisfied the non-linear restriction of $\beta_1 = -\alpha_1 \beta_0$, then it can be written as a static model of $y_t = \beta_0 x_t + \nu_t$ with a first order autoregressive disturbance term ν_t.

According to Henry and Mizon (1978), when this non-linear restriction is valid in the model, the existence of serial correlation is actually a convenience and not a nuisance to be eliminated. If the final model chosen through the COMFAC approach has an autoregressive error and the number of parameters to be estimated is reduced, the indication of serial correlation could serve as a useful signal to the researcher. Furthermore, verification of a valid non-linear restriction implies that the static restricted model has captured all the dynamics specifications and estimates of the restricted model are consistent with those of the unrestricted dynamic model. Alternatively, if the restriction is rejected or there is no common factor exists, then presence of serial correlation in the simple static model reflects 'misspecified dynamics' and variables such as y_{t-1} and x_{t-1} have been wrongly omitted from the static model.

To facilitate the discussion of model specification of this paper, we shall extend the above analysis to a two exogenous variables case. Consider the following model:

$$y_t = \alpha_1 y_{t-1} + \beta_0 x_{1t} + \beta_1 x_{1t-1} + \beta_2 x_{2t} + \beta_3 x_{2t-1} + \varepsilon_t \quad \text{(3A-7)}$$

Once again, utilizing the lag operator L, (3A-7) can be rewritten as:

$$y_t = \alpha_1 L y_t + \beta_0 x_{1t} + \beta_1 L x_{1t} + \beta_2 x_{2t} + \beta_3 L x_{2t} + \varepsilon_t \quad \text{(3A-8)}$$

or
$$(1-\alpha_1 L) y_t = (\beta_0 + \beta_1 L) x_{1t} + (\beta_2 + \beta_3 L) x_{2t} - \varepsilon_t \quad \text{(3A-9)}$$

Equation (3A-9) shows that there exists one common factor in the model and by setting two non-linear restrictions, $\beta_1 = -\alpha_1 \beta_0$ and $\beta_3 = -\alpha_1 \beta_2$, we have:

$$(1-\alpha_1 L) y_t = \beta_0 (1-\alpha_1 L) x_{1t} + \beta_2 (1-\alpha_1 L) x_{2t} + \varepsilon_t \quad \text{(3A-10)}$$

Dividing (3A-10) by the common factor on both sides, it yields:

$$y_t = \beta_0 x_{1t} + \beta_2 x_{2t} + \frac{\varepsilon_t}{(1-\alpha_1 L)} = \beta_0 x_t + \beta_2 x_{2t} + \nu_t \quad \text{(3A-11)}$$

In this case, once again we show that when we fail to reject the validity of the two non-linear restrictions, then rather than estimate equation (3A-7), a simpler procedure would be to estimate the simple static regression model allowing for first order autocorrelated disturbance errors such as (3A-11).

The COMFAC approach may be generalized as follows:

Take a ADL (k, n) model one explanatory variable:

$$y_t = \alpha_1 y_{t-1} + \alpha_2 y_{t-2} + \ldots + \alpha_k y_{t-k} + \beta_0 x_t + \beta_1 x_{t-1} + \beta_2 x_{t-2} + \ldots + \beta_n x_{t-n} + \varepsilon_t$$

Using polynomial lag operation we have:

$$y_t = \alpha_1 L^1 y_t + \alpha_2 L^2 y_t + ... + \alpha_k L^k y_t + \beta_0 x_t + \beta_1 L^1 x_t + \beta_2 L^2 x_t + ... + \beta_n L^n x_t + \varepsilon_t$$

or we put express it as:

$$a(L)y_t = b(L)x_t + \varepsilon_t \qquad \text{(3A-12)}$$

where $a(L)$ and $b(L)$ are distributed lag parts of the model of order k and n such that,

$$a(L) = \sum_{i=0}^{k} a_i L_i, \qquad \text{(3A-13)}$$

$$a_o = 1, \quad a_i = -\alpha_i, \quad i = 1,2,...k.$$

and

$$b(L) = \sum_{i=0}^{n} b_i L_i \qquad \text{(3A-14)}$$

It is possible for $a(L)$ and $b(L)$ to have at most l (l = min (k, n)) common roots, and if $\rho \leq l$, then there exists a polynomial $\rho(L)$ of order ρ common to $a(L)$ and $b(L)$. Therefore, the polynomial can be factorised as:

$$a(L) = \rho(L)a^*(L) \quad \text{and} \quad b(L) = \rho(L)b^*(L)$$

Using (3A-10), we can rewrite (3A-9) as:

$$\rho(L)a^*(L)y_t = \rho(L)b^*(L)x_t + v_t \qquad \text{(3A-15)}$$

so that

$$a^*(L)y_t = b^*(L)x_t + u_t \qquad \text{(3A-16)}$$

where

$$v_t = \rho(L)u_t$$

The end result is that the number of parameters in the original (general) model is reduced, while the disturbance term becomes an AR(ρ) process. This reduction in the number of parameters can greatly enhance estimation efficiency. However, the above analysis assumes that the orders of the lag polynomials are known *a priori*. This approach is frequently referred as the general to specific model selection in the sense that one starts with a general model with several regressors and then reduces down to a specific model containing only the relevant variables.

An important implication of the COMFAC approach is that we must have a tool that allows us to test whether or not the restrictions, which lead to a specific model, are valid. Therefore we want a statistical test of the null hypothesis that the restrictions imposed on the general dynamic model are true. Several tests have been suggested for testing both linear and non-linear restrictions in an econometric model. The most well known are the Likelihood Ratio, Wald and Lagrange Multiplier tests. In this paper we select the Wald test. The Wald test statistic has an asymptotic $\chi^2(q)$ distribution, where q is the number of restrictions under H_0. 'Large' value of the test statistic indicates the rejection of the null hypothesis. All Wald tests in this paper are performed by the econometric package EVIEWS V.4.